

GiNaC

1.8.7

Generated by Doxygen 1.9.6

1 Namespace Index	1
1.1 Namespace List	1
2 Hierarchical Index	3
2.1 Class Hierarchy	3
3 Class Index	7
3.1 Class List	7
4 File Index	15
4.1 File List	15
5 Namespace Documentation	19
5.1 GiNaC Namespace Reference	19
5.1.1 Typedef Documentation	58
5.1.1.1 archive_node_id	58
5.1.1.2 archive_atom	58
5.1.1.3 synthesize_func	58
5.1.1.4 unarchive_map_t	59
5.1.1.5 exvector	59
5.1.1.6 exset	59
5.1.1.7 exmap	59
5.1.1.8 evalffunctype	59
5.1.1.9 FUNCP_1P	59
5.1.1.10 FUNCP_2P	59
5.1.1.11 FUNCP_CUBA	60
5.1.1.12 epvector	60
5.1.1.13 epp	60
5.1.1.14 exprseq	60
5.1.1.15 paramset	60
5.1.1.16 eval_funcp	60
5.1.1.17 evalf_funcp	60
5.1.1.18 conjugate_funcp	61
5.1.1.19 real_part_funcp	61
5.1.1.20 imag_part_funcp	61
5.1.1.21 expand_funcp	61
5.1.1.22 derivative_funcp	61
5.1.1.23 expl_derivative_funcp	61
5.1.1.24 power_funcp	61
5.1.1.25 series_funcp	61
5.1.1.26 print_funcp	62
5.1.1.27 info_funcp	62
5.1.1.28 eval_funcp_1	62
5.1.1.29 evalf_funcp_1	62

5.1.1.30 conjugate_funcp_1	62
5.1.1.31 real_part_funcp_1	62
5.1.1.32 imag_part_funcp_1	62
5.1.1.33 expand_funcp_1	62
5.1.1.34 derivative_funcp_1	63
5.1.1.35 expl_derivative_funcp_1	63
5.1.1.36 power_funcp_1	63
5.1.1.37 series_funcp_1	63
5.1.1.38 print_funcp_1	63
5.1.1.39 info_funcp_1	63
5.1.1.40 eval_funcp_2	63
5.1.1.41 evalf_funcp_2	63
5.1.1.42 conjugate_funcp_2	64
5.1.1.43 real_part_funcp_2	64
5.1.1.44 imag_part_funcp_2	64
5.1.1.45 expand_funcp_2	64
5.1.1.46 derivative_funcp_2	64
5.1.1.47 expl_derivative_funcp_2	64
5.1.1.48 power_funcp_2	64
5.1.1.49 series_funcp_2	64
5.1.1.50 print_funcp_2	65
5.1.1.51 info_funcp_2	65
5.1.1.52 eval_funcp_3	65
5.1.1.53 evalf_funcp_3	65
5.1.1.54 conjugate_funcp_3	65
5.1.1.55 real_part_funcp_3	65
5.1.1.56 imag_part_funcp_3	65
5.1.1.57 expand_funcp_3	65
5.1.1.58 derivative_funcp_3	66
5.1.1.59 expl_derivative_funcp_3	66
5.1.1.60 power_funcp_3	66
5.1.1.61 series_funcp_3	66
5.1.1.62 print_funcp_3	66
5.1.1.63 info_funcp_3	66
5.1.1.64 eval_funcp_4	66
5.1.1.65 evalf_funcp_4	67
5.1.1.66 conjugate_funcp_4	67
5.1.1.67 real_part_funcp_4	67
5.1.1.68 imag_part_funcp_4	67
5.1.1.69 expand_funcp_4	67
5.1.1.70 derivative_funcp_4	67
5.1.1.71 expl_derivative_funcp_4	67

5.1.1.72 power_funcp_4	68
5.1.1.73 series_funcp_4	68
5.1.1.74 print_funcp_4	68
5.1.1.75 info_funcp_4	68
5.1.1.76 eval_funcp_5	68
5.1.1.77 evalf_funcp_5	68
5.1.1.78 conjugate_funcp_5	68
5.1.1.79 real_part_funcp_5	69
5.1.1.80 imag_part_funcp_5	69
5.1.1.81 expand_funcp_5	69
5.1.1.82 derivative_funcp_5	69
5.1.1.83 expl_derivative_funcp_5	69
5.1.1.84 power_funcp_5	69
5.1.1.85 series_funcp_5	69
5.1.1.86 print_funcp_5	70
5.1.1.87 info_funcp_5	70
5.1.1.88 eval_funcp_6	70
5.1.1.89 evalf_funcp_6	70
5.1.1.90 conjugate_funcp_6	70
5.1.1.91 real_part_funcp_6	70
5.1.1.92 imag_part_funcp_6	70
5.1.1.93 expand_funcp_6	71
5.1.1.94 derivative_funcp_6	71
5.1.1.95 expl_derivative_funcp_6	71
5.1.1.96 power_funcp_6	71
5.1.1.97 series_funcp_6	71
5.1.1.98 print_funcp_6	71
5.1.1.99 info_funcp_6	71
5.1.1.100 eval_funcp_7	72
5.1.1.101 evalf_funcp_7	72
5.1.1.102 conjugate_funcp_7	72
5.1.1.103 real_part_funcp_7	72
5.1.1.104 imag_part_funcp_7	72
5.1.1.105 expand_funcp_7	72
5.1.1.106 derivative_funcp_7	72
5.1.1.107 expl_derivative_funcp_7	73
5.1.1.108 power_funcp_7	73
5.1.1.109 series_funcp_7	73
5.1.1.110 print_funcp_7	73
5.1.1.111 info_funcp_7	73
5.1.1.112 eval_funcp_8	73
5.1.1.113 evalf_funcp_8	73

5.1.1.114 conjugate_funcp_8	74
5.1.1.115 real_part_funcp_8	74
5.1.1.116 imag_part_funcp_8	74
5.1.1.117 expand_funcp_8	74
5.1.1.118 derivative_funcp_8	74
5.1.1.119 expl_derivative_funcp_8	74
5.1.1.120 power_funcp_8	74
5.1.1.121 series_funcp_8	75
5.1.1.122 print_funcp_8	75
5.1.1.123 info_funcp_8	75
5.1.1.124 eval_funcp_9	75
5.1.1.125 evalf_funcp_9	75
5.1.1.126 conjugate_funcp_9	75
5.1.1.127 real_part_funcp_9	75
5.1.1.128 imag_part_funcp_9	76
5.1.1.129 expand_funcp_9	76
5.1.1.130 derivative_funcp_9	76
5.1.1.131 expl_derivative_funcp_9	76
5.1.1.132 power_funcp_9	76
5.1.1.133 series_funcp_9	76
5.1.1.134 print_funcp_9	76
5.1.1.135 info_funcp_9	77
5.1.1.136 eval_funcp_10	77
5.1.1.137 evalf_funcp_10	77
5.1.1.138 conjugate_funcp_10	77
5.1.1.139 real_part_funcp_10	77
5.1.1.140 imag_part_funcp_10	77
5.1.1.141 expand_funcp_10	77
5.1.1.142 derivative_funcp_10	78
5.1.1.143 expl_derivative_funcp_10	78
5.1.1.144 power_funcp_10	78
5.1.1.145 series_funcp_10	78
5.1.1.146 print_funcp_10	78
5.1.1.147 info_funcp_10	78
5.1.1.148 eval_funcp_11	78
5.1.1.149 evalf_funcp_11	79
5.1.1.150 conjugate_funcp_11	79
5.1.1.151 real_part_funcp_11	79
5.1.1.152 imag_part_funcp_11	79
5.1.1.153 expand_funcp_11	79
5.1.1.154 derivative_funcp_11	79
5.1.1.155 expl_derivative_funcp_11	79

5.1.1.156 power_funcp_11	80
5.1.1.157 series_funcp_11	80
5.1.1.158 print_funcp_11	80
5.1.1.159 info_funcp_11	80
5.1.1.160 eval_funcp_12	80
5.1.1.161 evalf_funcp_12	80
5.1.1.162 conjugate_funcp_12	80
5.1.1.163 real_part_funcp_12	81
5.1.1.164 imag_part_funcp_12	81
5.1.1.165 expand_funcp_12	81
5.1.1.166 derivative_funcp_12	81
5.1.1.167 expl_derivative_funcp_12	81
5.1.1.168 power_funcp_12	81
5.1.1.169 series_funcp_12	82
5.1.1.170 print_funcp_12	82
5.1.1.171 info_funcp_12	82
5.1.1.172 eval_funcp_13	82
5.1.1.173 evalf_funcp_13	82
5.1.1.174 conjugate_funcp_13	82
5.1.1.175 real_part_funcp_13	83
5.1.1.176 imag_part_funcp_13	83
5.1.1.177 expand_funcp_13	83
5.1.1.178 derivative_funcp_13	83
5.1.1.179 expl_derivative_funcp_13	83
5.1.1.180 power_funcp_13	83
5.1.1.181 series_funcp_13	84
5.1.1.182 print_funcp_13	84
5.1.1.183 info_funcp_13	84
5.1.1.184 eval_funcp_14	84
5.1.1.185 evalf_funcp_14	84
5.1.1.186 conjugate_funcp_14	84
5.1.1.187 real_part_funcp_14	85
5.1.1.188 imag_part_funcp_14	85
5.1.1.189 expand_funcp_14	85
5.1.1.190 derivative_funcp_14	85
5.1.1.191 expl_derivative_funcp_14	85
5.1.1.192 power_funcp_14	85
5.1.1.193 series_funcp_14	86
5.1.1.194 print_funcp_14	86
5.1.1.195 info_funcp_14	86
5.1.1.196 eval_funcp_exvector	86
5.1.1.197 evalf_funcp_exvector	86

5.1.1.198 conjugate_funcp_exvector	86
5.1.1.199 real_part_funcp_exvector	86
5.1.1.200 imag_part_funcp_exvector	87
5.1.1.201 expand_funcp_exvector	87
5.1.1.202 derivative_funcp_exvector	87
5.1.1.203 expl_derivative_funcp_exvector	87
5.1.1.204 power_funcp_exvector	87
5.1.1.205 series_funcp_exvector	87
5.1.1.206 print_funcp_exvector	87
5.1.1.207 info_funcp_exvector	87
5.1.1.208 exhashmap	88
5.1.1.209 spmap	88
5.1.1.210 lookup_map	88
5.1.1.211 lst	88
5.1.1.212 uintvector	88
5.1.1.213 unsignedvector	88
5.1.1.214 exvectorvector	88
5.1.1.215 sym_desc_vec	89
5.1.1.216 digits_changed_callback	89
5.1.1.217 print_context_class_info	89
5.1.1.218 registered_class_info	89
5.1.2 Enumeration Type Documentation	89
5.1.2.1 anonymous enum	89
5.1.3 Function Documentation	89
5.1.3.1 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [1/33]	89
5.1.3.2 GINAC_BIND_UNARCHIVER() [1/49]	90
5.1.3.3 GINAC_DECLARE_UNARCHIVER() [1/51]	90
5.1.3.4 write_unsigned()	90
5.1.3.5 read_unsigned()	90
5.1.3.6 operator<<() [1/16]	90
5.1.3.7 operator<<() [2/16]	91
5.1.3.8 operator>>() [1/3]	91
5.1.3.9 operator>>() [2/3]	91
5.1.3.10 find_factory_fcn()	91
5.1.3.11 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [2/33]	91
5.1.3.12 is_a() [1/3]	92
5.1.3.13 is_exactly_a() [1/2]	92
5.1.3.14 dynallocate() [1/2]	92
5.1.3.15 dynallocate() [2/2]	92
5.1.3.16 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [3/33]	93
5.1.3.17 print_func< print_dflt >() [1/3]	93
5.1.3.18 GINAC_BIND_UNARCHIVER() [2/49]	93

5.1.3.19 GINAC_BIND_UNARCHIVER() [3/49]	93
5.1.3.20 GINAC_BIND_UNARCHIVER() [4/49]	93
5.1.3.21 GINAC_BIND_UNARCHIVER() [5/49]	93
5.1.3.22 GINAC_BIND_UNARCHIVER() [6/49]	94
5.1.3.23 GINAC_BIND_UNARCHIVER() [7/49]	94
5.1.3.24 GINAC_BIND_UNARCHIVER() [8/49]	94
5.1.3.25 is_dirac_slash()	94
5.1.3.26 base_and_index()	94
5.1.3.27 dirac_ONE()	94
5.1.3.28 get_dim_uint()	95
5.1.3.29 clifford_unit()	95
5.1.3.30 dirac_gamma()	95
5.1.3.31 dirac_gamma5()	96
5.1.3.32 dirac_gammaL()	96
5.1.3.33 dirac_gammaR()	97
5.1.3.34 dirac_slash()	97
5.1.3.35 get_representation_label() [1/2]	97
5.1.3.36 trace_string()	97
5.1.3.37 dirac_trace() [1/3]	98
5.1.3.38 dirac_trace() [2/3]	98
5.1.3.39 dirac_trace() [3/3]	98
5.1.3.40 canonicalize_clifford()	99
5.1.3.41 clifford_star_bar()	99
5.1.3.42 clifford_prime()	99
5.1.3.43 remove_dirac_ONE()	99
5.1.3.44 clifford_max_label()	100
5.1.3.45 clifford_norm()	100
5.1.3.46 clifford_inverse()	100
5.1.3.47 lst_to_clifford() [1/2]	100
5.1.3.48 lst_to_clifford() [2/2]	101
5.1.3.49 get_clifford_comp()	101
5.1.3.50 clifford_to_lst()	102
5.1.3.51 clifford_moebius_map() [1/2]	103
5.1.3.52 clifford_moebius_map() [2/2]	103
5.1.3.53 GINAC_DECLARE_UNARCHIVER() [2/51]	104
5.1.3.54 GINAC_DECLARE_UNARCHIVER() [3/51]	104
5.1.3.55 GINAC_DECLARE_UNARCHIVER() [4/51]	104
5.1.3.56 GINAC_DECLARE_UNARCHIVER() [5/51]	104
5.1.3.57 GINAC_DECLARE_UNARCHIVER() [6/51]	105
5.1.3.58 GINAC_DECLARE_UNARCHIVER() [7/51]	105
5.1.3.59 GINAC_DECLARE_UNARCHIVER() [8/51]	105
5.1.3.60 is_clifford_tinfo()	105

5.1.3.61 clifford_bar()	105
5.1.3.62 clifford_star()	106
5.1.3.63 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [4/33]	106
5.1.3.64 print_func< print_dflt >() [2/3]	106
5.1.3.65 GINAC_BIND_UNARCHIVER() [9/49]	106
5.1.3.66 GINAC_BIND_UNARCHIVER() [10/49]	106
5.1.3.67 GINAC_BIND_UNARCHIVER() [11/49]	106
5.1.3.68 GINAC_BIND_UNARCHIVER() [12/49]	107
5.1.3.69 GINAC_BIND_UNARCHIVER() [13/49]	107
5.1.3.70 permute_free_index_to_front()	107
5.1.3.71 color_ONE()	107
5.1.3.72 color_T()	108
5.1.3.73 color_f()	108
5.1.3.74 color_d()	109
5.1.3.75 color_h()	109
5.1.3.76 is_color_tinfo()	110
5.1.3.77 get_representation_label() [2/2]	110
5.1.3.78 color_trace() [1/3]	110
5.1.3.79 color_trace() [2/3]	110
5.1.3.80 color_trace() [3/3]	111
5.1.3.81 GINAC_DECLARE_UNARCHIVER() [9/51]	111
5.1.3.82 GINAC_DECLARE_UNARCHIVER() [10/51]	111
5.1.3.83 GINAC_DECLARE_UNARCHIVER() [11/51]	111
5.1.3.84 GINAC_DECLARE_UNARCHIVER() [12/51]	112
5.1.3.85 GINAC_DECLARE_UNARCHIVER() [13/51]	112
5.1.3.86 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [5/33]	112
5.1.3.87 GINAC_BIND_UNARCHIVER() [14/49]	112
5.1.3.88 GINAC_DECLARE_UNARCHIVER() [14/51]	112
5.1.3.89 crc32()	112
5.1.3.90 are_ex_trivially_equal()	113
5.1.3.91 operator<<() [3/16]	113
5.1.3.92 operator<<() [4/16]	113
5.1.3.93 operator<<() [5/16]	113
5.1.3.94 nops() [1/2]	114
5.1.3.95 expand() [1/2]	114
5.1.3.96 conjugate()	114
5.1.3.97 real_part()	114
5.1.3.98 imag_part()	115
5.1.3.99 has()	115
5.1.3.100 find()	115
5.1.3.101 is_polynomial()	115
5.1.3.102 degree()	116

5.1.3.103 ldegree()	116
5.1.3.104 coeff()	116
5.1.3.105 numer() [1/2]	116
5.1.3.106 denom() [1/2]	117
5.1.3.107 numer_denom()	117
5.1.3.108 normal()	117
5.1.3.109 to_rational()	117
5.1.3.110 to_polynomial()	117
5.1.3.111 collect()	118
5.1.3.112 eval()	118
5.1.3.113 evalf() [1/2]	118
5.1.3.114 evalm()	118
5.1.3.115 eval_integ()	118
5.1.3.116 diff()	119
5.1.3.117 series()	119
5.1.3.118 match()	119
5.1.3.119 simplify_indexed() [1/3]	119
5.1.3.120 simplify_indexed() [2/3]	120
5.1.3.121 symmetrize() [1/4]	120
5.1.3.122 symmetrize() [2/4]	120
5.1.3.123 antisymmetrize() [1/4]	120
5.1.3.124 antisymmetrize() [2/4]	120
5.1.3.125 symmetrize_cyclic() [1/4]	121
5.1.3.126 symmetrize_cyclic() [2/4]	121
5.1.3.127 op()	121
5.1.3.128 lhs()	121
5.1.3.129 rhs()	121
5.1.3.130 is_zero() [1/2]	122
5.1.3.131 swap() [1/2]	122
5.1.3.132 subs() [1/3]	122
5.1.3.133 subs() [2/3]	122
5.1.3.134 subs() [3/3]	123
5.1.3.135 is_a() [2/3]	123
5.1.3.136 is_exactly_a() [2/2]	123
5.1.3.137 ex_to()	123
5.1.3.138 compile_ex() [1/3]	124
5.1.3.139 compile_ex() [2/3]	124
5.1.3.140 compile_ex() [3/3]	125
5.1.3.141 link_ex() [1/3]	125
5.1.3.142 link_ex() [2/3]	125
5.1.3.143 link_ex() [3/3]	126
5.1.3.144 unlink_ex()	126

5.1.3.145 swap() [2/2]	126
5.1.3.146 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [6/33]	127
5.1.3.147 conjugateepvector()	127
5.1.3.148 factor()	127
5.1.3.149 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [7/33]	128
5.1.3.150 GINAC_DECLARE_UNARCHIVER() [15/51]	128
5.1.3.151 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [8/33]	128
5.1.3.152 GINAC_BIND_UNARCHIVER() [15/49]	128
5.1.3.153 GINAC_DECLARE_UNARCHIVER() [16/51]	128
5.1.3.154 GINAC_BIND_UNARCHIVER() [16/49]	129
5.1.3.155 GINAC_DECLARE_UNARCHIVER() [17/51]	129
5.1.3.156 is_the_function()	129
5.1.3.157 make_hash_seed()	129
5.1.3.158 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [9/33]	129
5.1.3.159 print_func< print_context >()	130
5.1.3.160 GINAC_BIND_UNARCHIVER() [17/49]	130
5.1.3.161 GINAC_BIND_UNARCHIVER() [18/49]	130
5.1.3.162 GINAC_BIND_UNARCHIVER() [19/49]	130
5.1.3.163 is_dummy_pair() [1/2]	130
5.1.3.164 is_dummy_pair() [2/2]	131
5.1.3.165 find_free_and_dummy() [1/2]	131
5.1.3.166 minimal_dim()	131
5.1.3.167 GINAC_DECLARE_UNARCHIVER() [18/51]	132
5.1.3.168 GINAC_DECLARE_UNARCHIVER() [19/51]	132
5.1.3.169 GINAC_DECLARE_UNARCHIVER() [20/51]	132
5.1.3.170 find_free_and_dummy() [2/2]	132
5.1.3.171 find_dummy_indices()	132
5.1.3.172 count_dummy_indices()	133
5.1.3.173 count_free_indices()	133
5.1.3.174 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [10/33]	133
5.1.3.175 GINAC_BIND_UNARCHIVER() [20/49]	133
5.1.3.176 indices_consistent()	134
5.1.3.177 number_of_type()	134
5.1.3.178 rename_dummy_indices()	134
5.1.3.179 find_variant_indices()	134
5.1.3.180 reposition_dummy_indices()	135
5.1.3.181 product_to_exvector()	135
5.1.3.182 idx_symmetrization()	135
5.1.3.183 simplify_indexed() [3/3]	135
5.1.3.184 simplify_indexed_product()	136
5.1.3.185 hasindex()	136
5.1.3.186 get_all_dummy_indices_safely()	136

5.1.3.187 <code>get_all_dummy_indices()</code>	136
5.1.3.188 <code>rename_dummy_indices_uniquely()</code> [1/4]	137
5.1.3.189 <code>rename_dummy_indices_uniquely()</code> [2/4]	137
5.1.3.190 <code>rename_dummy_indices_uniquely()</code> [3/4]	137
5.1.3.191 <code>rename_dummy_indices_uniquely()</code> [4/4]	137
5.1.3.192 <code>expand_dummy_sum()</code>	138
5.1.3.193 <code>GINAC_DECLARE_UNARCHIVER()</code> [21/51]	138
5.1.3.194 <code>conjugate_evalf()</code>	138
5.1.3.195 <code>conjugate_eval()</code>	138
5.1.3.196 <code>conjugate_print_latex()</code>	139
5.1.3.197 <code>conjugate_conjugate()</code>	139
5.1.3.198 <code>conjugate_expl_derivative()</code>	139
5.1.3.199 <code>conjugate_real_part()</code>	139
5.1.3.200 <code>conjugate_imag_part()</code>	139
5.1.3.201 <code>func_arg_info()</code>	140
5.1.3.202 <code>conjugate_info()</code>	140
5.1.3.203 <code>REGISTER_FUNCTION()</code> [1/36]	140
5.1.3.204 <code>real_part_evalf()</code>	140
5.1.3.205 <code>real_part_eval()</code>	140
5.1.3.206 <code>real_part_print_latex()</code>	141
5.1.3.207 <code>real_part_conjugate()</code>	141
5.1.3.208 <code>real_part_real_part()</code>	141
5.1.3.209 <code>real_part_imag_part()</code>	141
5.1.3.210 <code>real_part_expl_derivative()</code>	141
5.1.3.211 <code>REGISTER_FUNCTION()</code> [2/36]	141
5.1.3.212 <code>imag_part_evalf()</code>	142
5.1.3.213 <code>imag_part_eval()</code>	142
5.1.3.214 <code>imag_part_print_latex()</code>	142
5.1.3.215 <code>imag_part_conjugate()</code>	142
5.1.3.216 <code>imag_part_real_part()</code>	142
5.1.3.217 <code>imag_part_imag_part()</code>	142
5.1.3.218 <code>imag_part_expl_derivative()</code>	143
5.1.3.219 <code>REGISTER_FUNCTION()</code> [3/36]	143
5.1.3.220 <code>abs_evalf()</code>	143
5.1.3.221 <code>abs_eval()</code>	143
5.1.3.222 <code>abs_expand()</code>	143
5.1.3.223 <code>abs_expl_derivative()</code>	144
5.1.3.224 <code>abs_print_latex()</code>	144
5.1.3.225 <code>abs_print_csrc_float()</code>	144
5.1.3.226 <code>abs_conjugate()</code>	144
5.1.3.227 <code>abs_real_part()</code>	144
5.1.3.228 <code>abs_imag_part()</code>	145

5.1.3.229 <code>abs_power()</code>	145
5.1.3.230 <code>abs_info()</code>	145
5.1.3.231 <code>REGISTER_FUNCTION()</code> [4/36]	145
5.1.3.232 <code>step_evalf()</code>	145
5.1.3.233 <code>step_eval()</code>	146
5.1.3.234 <code>step_series()</code>	146
5.1.3.235 <code>step_conjugate()</code>	146
5.1.3.236 <code>step_real_part()</code>	146
5.1.3.237 <code>step_imag_part()</code>	146
5.1.3.238 <code>REGISTER_FUNCTION()</code> [5/36]	147
5.1.3.239 <code>csgn_evalf()</code>	147
5.1.3.240 <code>csgn_eval()</code>	147
5.1.3.241 <code>csgn_series()</code>	147
5.1.3.242 <code>csgn_conjugate()</code>	147
5.1.3.243 <code>csgn_real_part()</code>	148
5.1.3.244 <code>csgn_imag_part()</code>	148
5.1.3.245 <code>csgn_power()</code>	148
5.1.3.246 <code>REGISTER_FUNCTION()</code> [6/36]	148
5.1.3.247 <code>eta_evalf()</code>	148
5.1.3.248 <code>eta_eval()</code>	149
5.1.3.249 <code>eta_series()</code>	149
5.1.3.250 <code>eta_conjugate()</code>	149
5.1.3.251 <code>eta_real_part()</code>	149
5.1.3.252 <code>eta_imag_part()</code>	149
5.1.3.253 <code>REGISTER_FUNCTION()</code> [7/36]	150
5.1.3.254 <code>Li2_evalf()</code>	150
5.1.3.255 <code>Li2_eval()</code>	150
5.1.3.256 <code>Li2_deriv()</code>	150
5.1.3.257 <code>Li2_series()</code> [1/2]	150
5.1.3.258 <code>Li2_conjugate()</code>	151
5.1.3.259 <code>REGISTER_FUNCTION()</code> [8/36]	151
5.1.3.260 <code>Li3_eval()</code>	151
5.1.3.261 <code>REGISTER_FUNCTION()</code> [9/36]	151
5.1.3.262 <code>zetaderiv_eval()</code>	151
5.1.3.263 <code>zetaderiv_deriv()</code>	152
5.1.3.264 <code>REGISTER_FUNCTION()</code> [10/36]	152
5.1.3.265 <code>factorial_evalf()</code>	152
5.1.3.266 <code>factorial_eval()</code>	152
5.1.3.267 <code>factorial_print_dflit_latex()</code>	152
5.1.3.268 <code>factorial_conjugate()</code>	153
5.1.3.269 <code>factorial_real_part()</code>	153
5.1.3.270 <code>factorial_imag_part()</code>	153

5.1.3.271 REGISTER_FUNCTION() [11/36]	153
5.1.3.272 binomial_evalf()	153
5.1.3.273 binomial_sym()	154
5.1.3.274 binomial_eval()	154
5.1.3.275 binomial_conjugate()	154
5.1.3.276 binomial_real_part()	154
5.1.3.277 binomial_imag_part()	154
5.1.3.278 REGISTER_FUNCTION() [12/36]	155
5.1.3.279 Order_eval()	155
5.1.3.280 Order_series()	155
5.1.3.281 Order_conjugate()	155
5.1.3.282 Order_real_part()	155
5.1.3.283 Order_imag_part()	156
5.1.3.284 Order_power()	156
5.1.3.285 Order_expl_derivative()	156
5.1.3.286 REGISTER_FUNCTION() [13/36]	156
5.1.3.287 lsolve()	156
5.1.3.288 fsolve()	157
5.1.3.289 zeta() [1/3]	157
5.1.3.290 zeta() [2/3]	157
5.1.3.291 is_the_function< zeta_SERIAL >()	158
5.1.3.292 G() [1/2]	158
5.1.3.293 G() [2/2]	158
5.1.3.294 is_the_function< G_SERIAL >()	158
5.1.3.295 psi() [1/4]	158
5.1.3.296 psi() [2/4]	159
5.1.3.297 is_the_function< psi_SERIAL >()	159
5.1.3.298 iterated_integral() [1/2]	159
5.1.3.299 iterated_integral() [2/2]	159
5.1.3.300 is_the_function< iterated_integral_SERIAL >()	159
5.1.3.301 is_order_function()	160
5.1.3.302 convert_H_to_Li()	160
5.1.3.303 EllipticK_evalf()	160
5.1.3.304 EllipticK_eval()	160
5.1.3.305 EllipticK_deriv()	160
5.1.3.306 EllipticK_series()	161
5.1.3.307 EllipticK_print_latex()	161
5.1.3.308 REGISTER_FUNCTION() [14/36]	161
5.1.3.309 EllipticE_evalf()	161
5.1.3.310 EllipticE_eval()	161
5.1.3.311 EllipticE_deriv()	162
5.1.3.312 EllipticE_series()	162

5.1.3.313 EllipticE_print_latex()	162
5.1.3.314 REGISTER_FUNCTION() [15/36]	162
5.1.3.315 iterated_integral_evalf_impl()	162
5.1.3.316 iterated_integral2_evalf()	163
5.1.3.317 iterated_integral3_evalf()	163
5.1.3.318 iterated_integral2_eval()	163
5.1.3.319 iterated_integral3_eval()	163
5.1.3.320 lgamma_evalf()	163
5.1.3.321 lgamma_eval()	163
5.1.3.322 lgamma_deriv()	164
5.1.3.323 lgamma_series()	164
5.1.3.324 lgamma_conjugate()	164
5.1.3.325 REGISTER_FUNCTION() [16/36]	164
5.1.3.326 tgamma_evalf()	165
5.1.3.327 tgamma_eval()	165
5.1.3.328 tgamma_deriv()	165
5.1.3.329 tgamma_series()	165
5.1.3.330 tgamma_conjugate()	166
5.1.3.331 REGISTER_FUNCTION() [17/36]	166
5.1.3.332 beta_evalf()	166
5.1.3.333 beta_eval()	166
5.1.3.334 beta_deriv()	166
5.1.3.335 beta_series()	167
5.1.3.336 REGISTER_FUNCTION() [18/36]	167
5.1.3.337 psi1_evalf()	167
5.1.3.338 psi1_eval()	167
5.1.3.339 psi1_deriv()	168
5.1.3.340 psi1_series()	168
5.1.3.341 psi2_evalf()	168
5.1.3.342 psi2_eval()	168
5.1.3.343 psi2_deriv()	169
5.1.3.344 psi2_series()	169
5.1.3.345 G2_evalf()	169
5.1.3.346 G2_eval()	169
5.1.3.347 G3_evalf()	170
5.1.3.348 G3_eval()	170
5.1.3.349 Li_evalf()	170
5.1.3.350 Li_eval()	170
5.1.3.351 Li_series()	171
5.1.3.352 Li_deriv()	171
5.1.3.353 Li_print_latex()	171
5.1.3.354 REGISTER_FUNCTION() [19/36]	171

5.1.3.355 S_evalf()	171
5.1.3.356 S_eval()	172
5.1.3.357 S_series()	172
5.1.3.358 S_deriv()	172
5.1.3.359 S_print_latex()	172
5.1.3.360 REGISTER_FUNCTION() [20/36]	173
5.1.3.361 H_evalf()	173
5.1.3.362 H_eval()	173
5.1.3.363 H_series()	173
5.1.3.364 H_deriv()	173
5.1.3.365 H_print_latex()	174
5.1.3.366 REGISTER_FUNCTION() [21/36]	174
5.1.3.367 zeta1_evalf()	174
5.1.3.368 zeta1_eval()	174
5.1.3.369 zeta1_deriv()	174
5.1.3.370 zeta1_print_latex()	175
5.1.3.371 zeta2_evalf()	175
5.1.3.372 zeta2_eval()	175
5.1.3.373 zeta2_deriv()	175
5.1.3.374 zeta2_print_latex()	175
5.1.3.375 exp_evalf()	176
5.1.3.376 exp_eval()	176
5.1.3.377 exp_expand()	176
5.1.3.378 exp_deriv()	176
5.1.3.379 exp_real_part()	176
5.1.3.380 exp_imag_part()	177
5.1.3.381 exp_conjugate()	177
5.1.3.382 exp_power()	177
5.1.3.383 exp_info()	177
5.1.3.384 REGISTER_FUNCTION() [22/36]	177
5.1.3.385 log_evalf()	178
5.1.3.386 log_eval()	178
5.1.3.387 log_deriv()	178
5.1.3.388 log_series()	178
5.1.3.389 log_real_part()	178
5.1.3.390 log_imag_part()	179
5.1.3.391 log_expand()	179
5.1.3.392 log_conjugate()	179
5.1.3.393 log_info()	179
5.1.3.394 REGISTER_FUNCTION() [23/36]	179
5.1.3.395 sin_evalf()	180
5.1.3.396 sin_eval()	180

5.1.3.397 sin_deriv()	180
5.1.3.398 sin_real_part()	180
5.1.3.399 sin_imag_part()	180
5.1.3.400 sin_conjugate()	181
5.1.3.401 trig_info()	181
5.1.3.402 REGISTER_FUNCTION() [24/36]	181
5.1.3.403 cos_evalf()	181
5.1.3.404 cos_eval()	181
5.1.3.405 cos_deriv()	182
5.1.3.406 cos_real_part()	182
5.1.3.407 cos_imag_part()	182
5.1.3.408 cos_conjugate()	182
5.1.3.409 REGISTER_FUNCTION() [25/36]	182
5.1.3.410 tan_evalf()	183
5.1.3.411 tan_eval()	183
5.1.3.412 tan_deriv()	183
5.1.3.413 tan_real_part()	183
5.1.3.414 tan_imag_part()	183
5.1.3.415 tan_series()	184
5.1.3.416 tan_conjugate()	184
5.1.3.417 REGISTER_FUNCTION() [26/36]	184
5.1.3.418 asin_evalf()	184
5.1.3.419 asin_eval()	184
5.1.3.420 asin_deriv()	185
5.1.3.421 asin_conjugate()	185
5.1.3.422 asin_info()	185
5.1.3.423 REGISTER_FUNCTION() [27/36]	185
5.1.3.424 acos_evalf()	185
5.1.3.425 acos_eval()	186
5.1.3.426 acos_deriv()	186
5.1.3.427 acos_conjugate()	186
5.1.3.428 REGISTER_FUNCTION() [28/36]	186
5.1.3.429 atan_evalf()	186
5.1.3.430 atan_eval()	187
5.1.3.431 atan_deriv()	187
5.1.3.432 atan_series()	187
5.1.3.433 atan_conjugate()	187
5.1.3.434 atan_info()	187
5.1.3.435 REGISTER_FUNCTION() [29/36]	188
5.1.3.436 atan2_evalf()	188
5.1.3.437 atan2_eval()	188
5.1.3.438 atan2_deriv()	188

5.1.3.439 atan2_info()	188
5.1.3.440 REGISTER_FUNCTION() [30/36]	189
5.1.3.441 sinh_evalf()	189
5.1.3.442 sinh_eval()	189
5.1.3.443 sinh_deriv()	189
5.1.3.444 sinh_real_part()	189
5.1.3.445 sinh_imag_part()	190
5.1.3.446 sinh_conjugate()	190
5.1.3.447 REGISTER_FUNCTION() [31/36]	190
5.1.3.448 cosh_evalf()	190
5.1.3.449 cosh_eval()	190
5.1.3.450 cosh_deriv()	191
5.1.3.451 cosh_real_part()	191
5.1.3.452 cosh_imag_part()	191
5.1.3.453 cosh_conjugate()	191
5.1.3.454 REGISTER_FUNCTION() [32/36]	191
5.1.3.455 tanh_evalf()	192
5.1.3.456 tanh_eval()	192
5.1.3.457 tanh_deriv()	192
5.1.3.458 tanh_series()	192
5.1.3.459 tanh_real_part()	192
5.1.3.460 tanh_imag_part()	193
5.1.3.461 tanh_conjugate()	193
5.1.3.462 REGISTER_FUNCTION() [33/36]	193
5.1.3.463 asinh_evalf()	193
5.1.3.464 asinh_eval()	193
5.1.3.465 asinh_deriv()	194
5.1.3.466 asinh_conjugate()	194
5.1.3.467 REGISTER_FUNCTION() [34/36]	194
5.1.3.468 acosh_evalf()	194
5.1.3.469 acosh_eval()	194
5.1.3.470 acosh_deriv()	195
5.1.3.471 acosh_conjugate()	195
5.1.3.472 REGISTER_FUNCTION() [35/36]	195
5.1.3.473 atanh_evalf()	195
5.1.3.474 atanh_eval()	195
5.1.3.475 atanh_deriv()	196
5.1.3.476 atanh_series()	196
5.1.3.477 atanh_conjugate()	196
5.1.3.478 REGISTER_FUNCTION() [36/36]	196
5.1.3.479 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [11/33]	196
5.1.3.480 subsvalue()	197

5.1.3.481 adaptivesimpson()	197
5.1.3.482 GINAC_BIND_UNARCHIVER() [21/49]	197
5.1.3.483 GINAC_DECLARE_UNARCHIVER() [22/51]	197
5.1.3.484 ifactor()	198
5.1.3.485 is_discriminant_of_quadratic_number_field()	198
5.1.3.486 kronecker_symbol()	198
5.1.3.487 primitive_dirichlet_character()	199
5.1.3.488 dirichlet_character()	199
5.1.3.489 generalised_Bernoulli_number()	199
5.1.3.490 Bernoulli_polynomial()	200
5.1.3.491 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [12/33]	200
5.1.3.492 GINAC_BIND_UNARCHIVER() [22/49]	200
5.1.3.493 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [13/33]	200
5.1.3.494 GINAC_BIND_UNARCHIVER() [23/49]	200
5.1.3.495 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [14/33]	201
5.1.3.496 GINAC_BIND_UNARCHIVER() [24/49]	201
5.1.3.497 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [15/33]	201
5.1.3.498 GINAC_BIND_UNARCHIVER() [25/49]	201
5.1.3.499 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [16/33]	201
5.1.3.500 GINAC_BIND_UNARCHIVER() [26/49]	201
5.1.3.501 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [17/33]	202
5.1.3.502 GINAC_BIND_UNARCHIVER() [27/49]	202
5.1.3.503 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [18/33]	202
5.1.3.504 GINAC_BIND_UNARCHIVER() [28/49]	202
5.1.3.505 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [19/33]	202
5.1.3.506 GINAC_BIND_UNARCHIVER() [29/49]	202
5.1.3.507 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [20/33]	203
5.1.3.508 GINAC_BIND_UNARCHIVER() [30/49]	203
5.1.3.509 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [21/33]	203
5.1.3.510 GINAC_BIND_UNARCHIVER() [31/49]	203
5.1.3.511 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [22/33]	203
5.1.3.512 GINAC_BIND_UNARCHIVER() [32/49]	203
5.1.3.513 GINAC_DECLARE_UNARCHIVER() [23/51]	204
5.1.3.514 GINAC_DECLARE_UNARCHIVER() [24/51]	204
5.1.3.515 GINAC_DECLARE_UNARCHIVER() [25/51]	204
5.1.3.516 GINAC_DECLARE_UNARCHIVER() [26/51]	204
5.1.3.517 GINAC_DECLARE_UNARCHIVER() [27/51]	204
5.1.3.518 GINAC_DECLARE_UNARCHIVER() [28/51]	204
5.1.3.519 GINAC_DECLARE_UNARCHIVER() [29/51]	204
5.1.3.520 GINAC_DECLARE_UNARCHIVER() [30/51]	205
5.1.3.521 GINAC_DECLARE_UNARCHIVER() [31/51]	205
5.1.3.522 GINAC_DECLARE_UNARCHIVER() [32/51]	205

5.1.3.523 GINAC_DECLARE_UNARCHIVER() [33/51]	205
5.1.3.524 GINAC_DECLARE_UNARCHIVER() [34/51]	205
5.1.3.525 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [23/33]	205
5.1.3.526 GINAC_BIND_UNARCHIVER() [33/49]	206
5.1.3.527 lst_to_matrix()	206
5.1.3.528 diag_matrix() [1/2]	206
5.1.3.529 diag_matrix() [2/2]	206
5.1.3.530 unit_matrix() [1/2]	206
5.1.3.531 symbolic_matrix() [1/2]	207
5.1.3.532 reduced_matrix()	207
5.1.3.533 sub_matrix()	207
5.1.3.534 GINAC_DECLARE_UNARCHIVER() [35/51]	207
5.1.3.535 nops() [2/2]	208
5.1.3.536 expand() [2/2]	208
5.1.3.537 evalf() [2/2]	208
5.1.3.538 rows()	208
5.1.3.539 cols()	208
5.1.3.540 transpose()	209
5.1.3.541 determinant()	209
5.1.3.542 trace()	209
5.1.3.543 charpoly()	209
5.1.3.544 inverse() [1/3]	209
5.1.3.545 inverse() [2/3]	210
5.1.3.546 rank() [1/2]	210
5.1.3.547 rank() [2/2]	210
5.1.3.548 unit_matrix() [2/2]	210
5.1.3.549 symbolic_matrix() [2/2]	210
5.1.3.550 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [24/33]	211
5.1.3.551 tryfactsubs()	211
5.1.3.552 algebraic_match_mul_with_mul()	211
5.1.3.553 GINAC_BIND_UNARCHIVER() [34/49]	211
5.1.3.554 GINAC_DECLARE_UNARCHIVER() [36/51]	212
5.1.3.555 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [25/33]	212
5.1.3.556 reeval_ncmul()	212
5.1.3.557 hold_ncmul()	212
5.1.3.558 GINAC_BIND_UNARCHIVER() [35/49]	212
5.1.3.559 GINAC_DECLARE_UNARCHIVER() [37/51]	212
5.1.3.560 get_first_symbol()	212
5.1.3.561 add_symbol()	213
5.1.3.562 collect_symbols()	213
5.1.3.563 get_symbol_stats()	213
5.1.3.564 lcmcoeff()	214

5.1.3.565 lcm_of_coefficients_denominators()	214
5.1.3.566 multiply_lcm()	215
5.1.3.567 quo()	215
5.1.3.568 rem()	216
5.1.3.569 decomp_rational()	216
5.1.3.570 prem()	217
5.1.3.571 sprem()	217
5.1.3.572 divide()	218
5.1.3.573 divide_in_z()	218
5.1.3.574 sr_gcd()	219
5.1.3.575 interpolate()	220
5.1.3.576 heur_gcd_z()	220
5.1.3.577 heur_gcd()	221
5.1.3.578 gcd_pf_pow()	222
5.1.3.579 gcd_pf_mul()	222
5.1.3.580 gcd() $[1/2]$	222
5.1.3.581 gcd_pf_pow_pow()	223
5.1.3.582 lcm() $[1/2]$	223
5.1.3.583 sqrfree_yun()	224
5.1.3.584 sqrfree()	224
5.1.3.585 sqrfree_parfrac()	225
5.1.3.586 replace_with_symbol() $[1/2]$	225
5.1.3.587 replace_with_symbol() $[2/2]$	226
5.1.3.588 frac_cancel()	226
5.1.3.589 find_common_factor()	227
5.1.3.590 collect_common_factors()	227
5.1.3.591 resultant()	228
5.1.3.592 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() $[26/33]$	228
5.1.3.593 make_real_float()	228
5.1.3.594 read_real_float()	229
5.1.3.595 GINAC_BIND_UNARCHIVER() $[36/49]$	229
5.1.3.596 write_real_float()	229
5.1.3.597 print_real_number()	229
5.1.3.598 print_integer_csrc()	230
5.1.3.599 print_real_csrc()	230
5.1.3.600 coerce()	230
5.1.3.601 coerce< int, cln::cl_I >()	231
5.1.3.602 coerce< unsigned int, cln::cl_I >()	231
5.1.3.603 print_real_cl_N()	231
5.1.3.604 exp()	231
5.1.3.605 log()	232
5.1.3.606 sin()	232

5.1.3.607 cos()	233
5.1.3.608 tan()	233
5.1.3.609 asin()	233
5.1.3.610 acos()	234
5.1.3.611 atan() ^[1/2]	234
5.1.3.612 atan() ^[2/2]	234
5.1.3.613 sinh()	235
5.1.3.614 cosh()	235
5.1.3.615 tanh()	236
5.1.3.616 asinh()	236
5.1.3.617 acosh()	236
5.1.3.618 atanh()	237
5.1.3.619 Li2_series() ^[2/2]	237
5.1.3.620 Li2_projection()	237
5.1.3.621 Li2_()	238
5.1.3.622 Li2()	238
5.1.3.623 zeta() ^[3/3]	238
5.1.3.624 guess_precision()	238
5.1.3.625 lgamma() ^[1/2]	239
5.1.3.626 lgamma() ^[2/2]	239
5.1.3.627 tgamma() ^[1/2]	239
5.1.3.628 tgamma() ^[2/2]	239
5.1.3.629 psi() ^[3/4]	240
5.1.3.630 psi() ^[4/4]	240
5.1.3.631 factorial()	240
5.1.3.632 doublefactorial()	240
5.1.3.633 binomial()	241
5.1.3.634 bernoulli()	241
5.1.3.635 fibonacci()	242
5.1.3.636 abs()	242
5.1.3.637 mod()	243
5.1.3.638 smod()	243
5.1.3.639 irem() ^[1/2]	243
5.1.3.640 irem() ^[2/2]	244
5.1.3.641 iquo() ^[1/2]	244
5.1.3.642 iquo() ^[2/2]	245
5.1.3.643 gcd() ^[2/2]	245
5.1.3.644 lcm() ^[2/2]	246
5.1.3.645 sqrt() ^[1/2]	246
5.1.3.646 isqrt()	246
5.1.3.647 PiEvalf()	247
5.1.3.648 EulerEvalf()	247

5.1.3.649 CatalanEvalf()	247
5.1.3.650 operator<<() [6/16]	247
5.1.3.651 GINAC_DECLARE_UNARCHIVER() [38/51]	247
5.1.3.652 pow() [1/3]	248
5.1.3.653 inverse() [3/3]	248
5.1.3.654 step()	248
5.1.3.655 csgn()	248
5.1.3.656 is_zero() [2/2]	249
5.1.3.657 is_positive()	249
5.1.3.658 is_negative()	249
5.1.3.659 is_integer()	249
5.1.3.660 is_pos_integer()	249
5.1.3.661 is_nonneg_integer()	250
5.1.3.662 is_even()	250
5.1.3.663 is_odd()	250
5.1.3.664 is_prime()	250
5.1.3.665 is_rational()	250
5.1.3.666 is_real()	251
5.1.3.667 is_cinteger()	251
5.1.3.668 is_crational()	251
5.1.3.669 to_int()	251
5.1.3.670 to_long()	251
5.1.3.671 to_double()	252
5.1.3.672 real()	252
5.1.3.673 imag()	252
5.1.3.674 numer() [2/2]	252
5.1.3.675 denom() [2/2]	252
5.1.3.676 exadd()	253
5.1.3.677 exmul()	253
5.1.3.678 exminus()	253
5.1.3.679 operator+() [1/4]	253
5.1.3.680 operator-() [1/4]	254
5.1.3.681 operator*() [1/2]	254
5.1.3.682 operator/() [1/2]	254
5.1.3.683 operator+() [2/4]	254
5.1.3.684 operator-() [2/4]	254
5.1.3.685 operator*() [2/2]	255
5.1.3.686 operator/() [2/2]	255
5.1.3.687 operator+=() [1/2]	255
5.1.3.688 operator-=() [1/2]	255
5.1.3.689 operator*=() [1/2]	255
5.1.3.690 operator/=() [1/2]	256

5.1.3.691 operator+=() [2/2]	256
5.1.3.692 operator-=() [2/2]	256
5.1.3.693 operator*=() [2/2]	256
5.1.3.694 operator/=() [2/2]	256
5.1.3.695 operator+() [3/4]	257
5.1.3.696 operator-() [3/4]	257
5.1.3.697 operator+() [4/4]	257
5.1.3.698 operator-() [4/4]	257
5.1.3.699 operator++() [1/4]	257
5.1.3.700 operator--() [1/4]	258
5.1.3.701 operator++() [2/4]	258
5.1.3.702 operator--() [2/4]	258
5.1.3.703 operator++() [3/4]	258
5.1.3.704 operator--() [3/4]	259
5.1.3.705 operator++() [4/4]	259
5.1.3.706 operator--() [4/4]	259
5.1.3.707 operator==()	259
5.1.3.708 operator!=()	260
5.1.3.709 operator<()	260
5.1.3.710 operator<=()	260
5.1.3.711 operator>()	260
5.1.3.712 operator>=()	260
5.1.3.713 my_ios_index()	261
5.1.3.714 my_ios_callback()	261
5.1.3.715 get_print_context()	261
5.1.3.716 set_print_context()	261
5.1.3.717 get_print_options()	261
5.1.3.718 set_print_options()	262
5.1.3.719 operator<<() [7/16]	262
5.1.3.720 operator>>() [3/3]	262
5.1.3.721 dflit()	262
5.1.3.722 latex()	262
5.1.3.723 python()	263
5.1.3.724 python_repr()	263
5.1.3.725 tree()	263
5.1.3.726 csrc()	263
5.1.3.727 csrc_float()	263
5.1.3.728 csrc_double()	264
5.1.3.729 csrc_cl_N()	264
5.1.3.730 index_dimensions()	264
5.1.3.731 no_index_dimensions()	264
5.1.3.732 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [27/33]	264

5.1.3.733 <code>print_sym_pow()</code>	265
5.1.3.734 <code>GINAC_BIND_UNARCHIVER()</code> [37/49]	265
5.1.3.735 <code>GINAC_DECLARE_UNARCHIVER()</code> [39/51]	265
5.1.3.736 <code>pow()</code> [2/3]	265
5.1.3.737 <code>pow()</code> [3/3]	265
5.1.3.738 <code>sqrt()</code> [2/2]	266
5.1.3.739 <code>is_a()</code> [3/3]	266
5.1.3.740 <code>GINAC_IMPLEMENT_REGISTERED_CLASS_OPT()</code> [28/33]	266
5.1.3.741 <code>GINAC_BIND_UNARCHIVER()</code> [38/49]	266
5.1.3.742 <code>GINAC_DECLARE_UNARCHIVER()</code> [40/51]	266
5.1.3.743 <code>series_to_poly()</code>	266
5.1.3.744 <code>is_terminating()</code>	267
5.1.3.745 <code>make_return_type_t()</code>	267
5.1.3.746 <code>set_print_func()</code> [1/2]	267
5.1.3.747 <code>set_print_func()</code> [2/2]	268
5.1.3.748 <code>GINAC_IMPLEMENT_REGISTERED_CLASS_OPT()</code> [29/33]	268
5.1.3.749 <code>GINAC_BIND_UNARCHIVER()</code> [39/49]	268
5.1.3.750 <code>print_operator()</code>	268
5.1.3.751 <code>GINAC_DECLARE_UNARCHIVER()</code> [41/51]	268
5.1.3.752 <code>GINAC_IMPLEMENT_REGISTERED_CLASS_OPT()</code> [30/33]	269
5.1.3.753 <code>get_default_TeX_name()</code>	269
5.1.3.754 <code>GINAC_BIND_UNARCHIVER()</code> [40/49]	269
5.1.3.755 <code>GINAC_BIND_UNARCHIVER()</code> [41/49]	269
5.1.3.756 <code>GINAC_BIND_UNARCHIVER()</code> [42/49]	269
5.1.3.757 <code>GINAC_DECLARE_UNARCHIVER()</code> [42/51]	270
5.1.3.758 <code>GINAC_DECLARE_UNARCHIVER()</code> [43/51]	270
5.1.3.759 <code>GINAC_DECLARE_UNARCHIVER()</code> [44/51]	270
5.1.3.760 <code>GINAC_IMPLEMENT_REGISTERED_CLASS_OPT()</code> [31/33]	270
5.1.3.761 <code>GINAC_BIND_UNARCHIVER()</code> [43/49]	270
5.1.3.762 <code>index0()</code>	270
5.1.3.763 <code>index1()</code>	271
5.1.3.764 <code>index2()</code>	271
5.1.3.765 <code>index3()</code>	271
5.1.3.766 <code>not_symmetric()</code>	271
5.1.3.767 <code>symmetric2()</code>	271
5.1.3.768 <code>symmetric3()</code>	271
5.1.3.769 <code>symmetric4()</code>	272
5.1.3.770 <code>antisymmetric2()</code>	272
5.1.3.771 <code>antisymmetric3()</code>	272
5.1.3.772 <code>antisymmetric4()</code>	272
5.1.3.773 <code>canonicalize()</code>	272
5.1.3.774 <code>symm()</code>	273

5.1.3.775 symmetrize() [3/4]	273
5.1.3.776 antisymmetrize() [3/4]	273
5.1.3.777 symmetrize_cyclic() [3/4]	274
5.1.3.778 GINAC_DECLARE_UNARCHIVER() [45/51]	274
5.1.3.779 sy_none() [1/4]	274
5.1.3.780 sy_none() [2/4]	274
5.1.3.781 sy_none() [3/4]	274
5.1.3.782 sy_none() [4/4]	275
5.1.3.783 sy_symm() [1/4]	275
5.1.3.784 sy_symm() [2/4]	275
5.1.3.785 sy_symm() [3/4]	275
5.1.3.786 sy_symm() [4/4]	275
5.1.3.787 sy_anti() [1/4]	276
5.1.3.788 sy_anti() [2/4]	276
5.1.3.789 sy_anti() [3/4]	276
5.1.3.790 sy_anti() [4/4]	276
5.1.3.791 sy_cycl() [1/4]	276
5.1.3.792 sy_cycl() [2/4]	277
5.1.3.793 sy_cycl() [3/4]	277
5.1.3.794 sy_cycl() [4/4]	277
5.1.3.795 symmetrize() [4/4]	277
5.1.3.796 antisymmetrize() [4/4]	277
5.1.3.797 symmetrize_cyclic() [4/4]	278
5.1.3.798 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [32/33]	278
5.1.3.799 print_func< print_dflt >() [3/3]	278
5.1.3.800 GINAC_BIND_UNARCHIVER() [44/49]	278
5.1.3.801 GINAC_BIND_UNARCHIVER() [45/49]	278
5.1.3.802 GINAC_BIND_UNARCHIVER() [46/49]	278
5.1.3.803 GINAC_BIND_UNARCHIVER() [47/49]	279
5.1.3.804 GINAC_BIND_UNARCHIVER() [48/49]	279
5.1.3.805 delta_tensor()	279
5.1.3.806 metric_tensor()	279
5.1.3.807 lorentz_g()	280
5.1.3.808 spinor_metric()	280
5.1.3.809 epsilon_tensor() [1/2]	281
5.1.3.810 epsilon_tensor() [2/2]	281
5.1.3.811 lorentz_eps()	282
5.1.3.812 GINAC_DECLARE_UNARCHIVER() [46/51]	282
5.1.3.813 GINAC_DECLARE_UNARCHIVER() [47/51]	282
5.1.3.814 GINAC_DECLARE_UNARCHIVER() [48/51]	283
5.1.3.815 GINAC_DECLARE_UNARCHIVER() [49/51]	283
5.1.3.816 GINAC_DECLARE_UNARCHIVER() [50/51]	283

5.1.3.817 log2()	283
5.1.3.818 multinomial_coefficient()	283
5.1.3.819 rotate_left()	284
5.1.3.820 compare_pointers()	284
5.1.3.821 golden_ratio_hash()	284
5.1.3.822 permutation_sign() [1/2]	285
5.1.3.823 permutation_sign() [2/2]	285
5.1.3.824 shaker_sort()	285
5.1.3.825 cyclic_permutation()	285
5.1.3.826 format_index_value() [1/2]	286
5.1.3.827 format_index_value() [2/2]	286
5.1.3.828 operator<<() [8/16]	286
5.1.3.829 operator<<() [9/16]	286
5.1.3.830 operator<<() [10/16]	287
5.1.3.831 operator<<() [11/16]	287
5.1.3.832 operator<<() [12/16]	287
5.1.3.833 operator<<() [13/16]	287
5.1.3.834 operator<<() [14/16]	288
5.1.3.835 operator<<() [15/16]	288
5.1.3.836 operator<<() [16/16]	288
5.1.3.837 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [33/33]	288
5.1.3.838 GINAC_BIND_UNARCHIVER() [49/49]	289
5.1.3.839 haswild()	289
5.1.3.840 GINAC_DECLARE_UNARCHIVER() [51/51]	289
5.1.3.841 wild()	289
5.1.4 Variable Documentation	289
5.1.4.1 unarch_table_instance	289
5.1.4.2 map_evalm	290
5.1.4.3 map_eval_integ	290
5.1.4.4 tensor	290
5.1.4.5 Pi	290
5.1.4.6 Euler	290
5.1.4.7 Catalan	291
5.1.4.8 crctab	291
5.1.4.9 library_initializer	291
5.1.4.10 _num0_bp	291
5.1.4.11 idx	291
5.1.4.12 force_include_tgamma	291
5.1.4.13 force_include_zeta1	292
5.1.4.14 GINAC_BIND_UNARCHIVER	292
5.1.4.15 I	292
5.1.4.16 Digits	292

5.1.4.17 next_print_context_id	293
5.1.4.18 version_major	293
5.1.4.19 version_minor	293
5.1.4.20 version_micro	293
5.1.4.21 _num_120_p	293
5.1.4.22 _ex_120	293
5.1.4.23 _num_60_p	293
5.1.4.24 _ex_60	294
5.1.4.25 _num_48_p	294
5.1.4.26 _ex_48	294
5.1.4.27 _num_30_p	294
5.1.4.28 _ex_30	294
5.1.4.29 _num_25_p	294
5.1.4.30 _ex_25	295
5.1.4.31 _num_24_p	295
5.1.4.32 _ex_24	295
5.1.4.33 _num_20_p	295
5.1.4.34 _ex_20	295
5.1.4.35 _num_18_p	295
5.1.4.36 _ex_18	296
5.1.4.37 _num_15_p	296
5.1.4.38 _ex_15	296
5.1.4.39 _num_12_p	296
5.1.4.40 _ex_12	296
5.1.4.41 _num_11_p	296
5.1.4.42 _ex_11	297
5.1.4.43 _num_10_p	297
5.1.4.44 _ex_10	297
5.1.4.45 _num_9_p	297
5.1.4.46 _ex_9	297
5.1.4.47 _num_8_p	297
5.1.4.48 _ex_8	298
5.1.4.49 _num_7_p	298
5.1.4.50 _ex_7	298
5.1.4.51 _num_6_p	298
5.1.4.52 _ex_6	298
5.1.4.53 _num_5_p	298
5.1.4.54 _ex_5	299
5.1.4.55 _num_4_p	299
5.1.4.56 _ex_4	299
5.1.4.57 _num_3_p	299
5.1.4.58 _ex_3	299

5.1.4.59 _num_2_p	299
5.1.4.60 _ex_2	300
5.1.4.61 _num_1_p	300
5.1.4.62 _ex_1	300
5.1.4.63 _num_1_2_p	300
5.1.4.64 _ex_1_2	300
5.1.4.65 _num_1_3_p	301
5.1.4.66 _ex_1_3	301
5.1.4.67 _num_1_4_p	301
5.1.4.68 _ex_1_4	301
5.1.4.69 _num0_p	301
5.1.4.70 _ex0	302
5.1.4.71 _num1_4_p	302
5.1.4.72 _ex1_4	302
5.1.4.73 _num1_3_p	302
5.1.4.74 _ex1_3	303
5.1.4.75 _num1_2_p	303
5.1.4.76 _ex1_2	303
5.1.4.77 _num1_p	303
5.1.4.78 _ex1	304
5.1.4.79 _num2_p	304
5.1.4.80 _ex2	304
5.1.4.81 _num3_p	305
5.1.4.82 _ex3	305
5.1.4.83 _num4_p	305
5.1.4.84 _ex4	305
5.1.4.85 _num5_p	305
5.1.4.86 _ex5	305
5.1.4.87 _num6_p	306
5.1.4.88 _ex6	306
5.1.4.89 _num7_p	306
5.1.4.90 _ex7	306
5.1.4.91 _num8_p	306
5.1.4.92 _ex8	306
5.1.4.93 _num9_p	307
5.1.4.94 _ex9	307
5.1.4.95 _num10_p	307
5.1.4.96 _ex10	307
5.1.4.97 _num11_p	307
5.1.4.98 _ex11	307
5.1.4.99 _num12_p	308
5.1.4.100 _ex12	308

5.1.4.101 _num15_p	308
5.1.4.102 _ex15	308
5.1.4.103 _num18_p	308
5.1.4.104 _ex18	308
5.1.4.105 _num20_p	309
5.1.4.106 _ex20	309
5.1.4.107 _num24_p	309
5.1.4.108 _ex24	309
5.1.4.109 _num25_p	309
5.1.4.110 _ex25	309
5.1.4.111 _num30_p	310
5.1.4.112 _ex30	310
5.1.4.113 _num48_p	310
5.1.4.114 _ex48	310
5.1.4.115 _num60_p	310
5.1.4.116 _ex60	310
5.1.4.117 _num120_p	311
5.1.4.118 _ex120	311
5.2 GiNaC::internal Namespace Reference	311
5.3 std Namespace Reference	311
5.3.1 Function Documentation	311
5.3.1.1 swap()	311
6 Class Documentation	313
6.1 GiNaC::internal::_iter_rep Struct Reference	313
6.1.1 Constructor & Destructor Documentation	314
6.1.1.1 _iter_rep()	314
6.1.2 Member Function Documentation	314
6.1.2.1 operator==()	314
6.1.2.2 operator!=()	314
6.1.3 Member Data Documentation	314
6.1.3.1 e	315
6.1.3.2 i	315
6.1.3.3 i_end	315
6.2 GiNaC::_numeric_digits Class Reference	315
6.2.1 Detailed Description	316
6.2.2 Constructor & Destructor Documentation	316
6.2.2.1 _numeric_digits()	316
6.2.3 Member Function Documentation	316
6.2.3.1 operator=()	316
6.2.3.2 operator long()	317
6.2.3.3 print()	317

6.2.3.4 add_callback()	317
6.2.4 Member Data Documentation	317
6.2.4.1 digits	317
6.2.4.2 too_late	317
6.2.4.3 callbacklist	318
6.3 GiNaC::add Class Reference	318
6.3.1 Detailed Description	325
6.3.2 Constructor & Destructor Documentation	325
6.3.2.1 add() [1/6]	325
6.3.2.2 add() [2/6]	326
6.3.2.3 add() [3/6]	326
6.3.2.4 add() [4/6]	326
6.3.2.5 add() [5/6]	326
6.3.2.6 add() [6/6]	326
6.3.3 Member Function Documentation	327
6.3.3.1 precedence()	327
6.3.3.2 info()	327
6.3.3.3 is_polynomial()	327
6.3.3.4 degree()	328
6.3.3.5 ldegree()	328
6.3.3.6 coeff()	328
6.3.3.7 eval()	328
6.3.3.8 evalm()	329
6.3.3.9 series()	329
6.3.3.10 normal()	329
6.3.3.11 integer_content()	330
6.3.3.12 smod()	330
6.3.3.13 max_coefficient()	330
6.3.3.14 conjugate()	331
6.3.3.15 real_part()	331
6.3.3.16 imag_part()	331
6.3.3.17 get_free_indices()	331
6.3.3.18 eval_ncmul()	331
6.3.3.19 derivative()	332
6.3.3.20 return_type()	332
6.3.3.21 return_type_tinfo()	332
6.3.3.22 thisexpairseq() [1/2]	332
6.3.3.23 thisexpairseq() [2/2]	333
6.3.3.24 split_ex_to_pair()	333
6.3.3.25 combine_ex_with_coeff_to_pair()	333
6.3.3.26 combine_pair_with_coeff_to_pair()	333
6.3.3.27 recombine_pair_to_ex()	334

6.3.3.28	expand()	334
6.3.3.29	print_add()	334
6.3.3.30	do_print()	335
6.3.3.31	do_print_latex()	335
6.3.3.32	do_print_csrc()	335
6.3.3.33	do_print_python_repr()	335
6.3.4	Friends And Related Function Documentation	335
6.3.4.1	mul	335
6.3.4.2	power	336
6.4	GiNaC::archive Class Reference	336
6.4.1	Detailed Description	337
6.4.2	Member Typedef Documentation	337
6.4.2.1	inv_at_cit	338
6.4.3	Constructor & Destructor Documentation	338
6.4.3.1	archive() [1/3]	338
6.4.3.2	~archive()	338
6.4.3.3	archive() [2/3]	338
6.4.3.4	archive() [3/3]	338
6.4.4	Member Function Documentation	338
6.4.4.1	archive_ex()	338
6.4.4.2	unarchive_ex() [1/3]	339
6.4.4.3	unarchive_ex() [2/3]	339
6.4.4.4	unarchive_ex() [3/3]	340
6.4.4.5	num_expressions()	340
6.4.4.6	get_top_node()	340
6.4.4.7	clear()	340
6.4.4.8	add_node()	341
6.4.4.9	get_node()	341
6.4.4.10	forget()	341
6.4.4.11	printraw()	341
6.4.4.12	atomize()	342
6.4.4.13	unatomize()	342
6.4.5	Friends And Related Function Documentation	342
6.4.5.1	operator<<	342
6.4.5.2	operator>>	342
6.4.6	Member Data Documentation	343
6.4.6.1	nodes	343
6.4.6.2	exprs	343
6.4.6.3	atoms	343
6.4.6.4	inverse_atoms	343
6.4.6.5	exphtable	343
6.5	GiNaC::archive_node Class Reference	344

6.5.1 Detailed Description	346
6.5.2 Member Typedef Documentation	346
6.5.2.1 propinfovector	346
6.5.2.2 archive_node_cit	346
6.5.3 Member Enumeration Documentation	346
6.5.3.1 property_type	346
6.5.4 Constructor & Destructor Documentation	347
6.5.4.1 archive_node() [1/2]	347
6.5.4.2 archive_node() [2/2]	347
6.5.5 Member Function Documentation	347
6.5.5.1 operator=()	347
6.5.5.2 add_bool()	348
6.5.5.3 add_unsigned()	348
6.5.5.4 add_string()	348
6.5.5.5 add_ex()	348
6.5.5.6 find_bool()	349
6.5.5.7 find_unsigned()	349
6.5.5.8 find_string()	349
6.5.5.9 find_first()	350
6.5.5.10 find_last()	350
6.5.5.11 find_property_range()	350
6.5.5.12 find_ex()	350
6.5.5.13 find_ex_by_loc()	351
6.5.5.14 find_ex_node()	351
6.5.5.15 get_properties()	351
6.5.5.16 unarchive()	351
6.5.5.17 has_same_ex_as()	352
6.5.5.18 has_ex()	352
6.5.5.19 get_ex()	352
6.5.5.20 forget()	352
6.5.5.21 printraw()	352
6.5.6 Friends And Related Function Documentation	353
6.5.6.1 operator<<	353
6.5.6.2 operator>>	353
6.5.7 Member Data Documentation	353
6.5.7.1 a	353
6.5.7.2 props	353
6.5.7.3 has_expression	354
6.5.7.4 e	354
6.6 GiNaC::archive_node::archive_node_cit_range Struct Reference	354
6.6.1 Member Data Documentation	355
6.6.1.1 begin	355

6.6.1.2 end	356
6.7 GiNaC::archive::archived_ex Struct Reference	356
6.7.1 Detailed Description	356
6.7.2 Constructor & Destructor Documentation	356
6.7.2.1 archived_ex() [1/2]	356
6.7.2.2 archived_ex() [2/2]	356
6.7.3 Member Data Documentation	357
6.7.3.1 name	357
6.7.3.2 root	357
6.8 GiNaC::basic Class Reference	357
6.8.1 Detailed Description	362
6.8.2 Constructor & Destructor Documentation	362
6.8.2.1 basic() [1/2]	362
6.8.2.2 ~basic()	362
6.8.2.3 basic() [2/2]	362
6.8.3 Member Function Documentation	362
6.8.3.1 operator=()	363
6.8.3.2 duplicate()	363
6.8.3.3 eval()	363
6.8.3.4 evalf()	363
6.8.3.5 evalm()	364
6.8.3.6 eval_integ()	364
6.8.3.7 eval_ncmul()	364
6.8.3.8 eval_indexed()	364
6.8.3.9 print()	364
6.8.3.10 dbgprint()	365
6.8.3.11 dbgprinttree()	365
6.8.3.12 precedence()	365
6.8.3.13 info()	366
6.8.3.14 nops()	366
6.8.3.15 op()	366
6.8.3.16 operator[]() [1/4]	367
6.8.3.17 operator[]() [2/4]	367
6.8.3.18 let_op()	367
6.8.3.19 operator[]() [3/4]	367
6.8.3.20 operator[]() [4/4]	368
6.8.3.21 has()	368
6.8.3.22 match()	368
6.8.3.23 match_same_type()	369
6.8.3.24 subs()	369
6.8.3.25 map()	369
6.8.3.26 accept()	370

6.8.3.27 <code>is_polynomial()</code>	370
6.8.3.28 <code>degree()</code>	370
6.8.3.29 <code>ldegree()</code>	370
6.8.3.30 <code>coeff()</code>	371
6.8.3.31 <code>expand()</code>	371
6.8.3.32 <code>collect()</code>	371
6.8.3.33 <code>derivative()</code>	372
6.8.3.34 <code>series()</code>	372
6.8.3.35 <code>normal()</code>	373
6.8.3.36 <code>to_rational()</code>	373
6.8.3.37 <code>to_polynomial()</code>	373
6.8.3.38 <code>integer_content()</code>	374
6.8.3.39 <code>smod()</code>	374
6.8.3.40 <code>max_coefficient()</code>	374
6.8.3.41 <code>get_free_indices()</code>	375
6.8.3.42 <code>add_indexed()</code>	375
6.8.3.43 <code>scalar_mul_indexed()</code>	375
6.8.3.44 <code>contract_with()</code>	376
6.8.3.45 <code>return_type()</code>	377
6.8.3.46 <code>return_type_tinfo()</code>	377
6.8.3.47 <code>conjugate()</code>	377
6.8.3.48 <code>real_part()</code>	377
6.8.3.49 <code>imag_part()</code>	377
6.8.3.50 <code>compare_same_type()</code>	378
6.8.3.51 <code>is_equal_same_type()</code>	378
6.8.3.52 <code>calchash()</code>	378
6.8.3.53 <code>print_dispatch()</code> [1/2]	379
6.8.3.54 <code>print_dispatch()</code> [2/2]	379
6.8.3.55 <code>archive()</code>	379
6.8.3.56 <code>read_archive()</code>	380
6.8.3.57 <code>subs_one_level()</code>	380
6.8.3.58 <code>diff()</code>	380
6.8.3.59 <code>compare()</code>	381
6.8.3.60 <code>is_equal()</code>	381
6.8.3.61 <code>hold()</code>	382
6.8.3.62 <code>gethash()</code>	382
6.8.3.63 <code>setflag()</code>	383
6.8.3.64 <code>clearflag()</code>	383
6.8.3.65 <code>ensure_if_modifiable()</code>	383
6.8.3.66 <code>do_print()</code>	384
6.8.3.67 <code>do_print_tree()</code>	384
6.8.3.68 <code>do_print_python_repr()</code>	384

6.8.4 Friends And Related Function Documentation	384
6.8.4.1 ex	384
6.8.5 Member Data Documentation	384
6.8.5.1 flags	385
6.8.5.2 hashvalue	385
6.9 GiNaC::basic_log_kernel Class Reference	385
6.9.1 Detailed Description	390
6.9.2 Member Function Documentation	391
6.9.2.1 series_coeff_impl()	391
6.9.2.2 do_print()	391
6.10 GiNaC::basic_multi_iterator< T > Class Template Reference	391
6.10.1 Detailed Description	393
6.10.2 Constructor & Destructor Documentation	393
6.10.2.1 basic_multi_iterator() [1/3]	393
6.10.2.2 basic_multi_iterator() [2/3]	393
6.10.2.3 basic_multi_iterator() [3/3]	394
6.10.2.4 ~basic_multi_iterator()	394
6.10.3 Member Function Documentation	394
6.10.3.1 size()	394
6.10.3.2 overflow()	394
6.10.3.3 get_vector()	395
6.10.3.4 operator[]() [1/2]	395
6.10.3.5 operator[]() [2/2]	395
6.10.3.6 operator()() [1/2]	395
6.10.3.7 operator()() [2/2]	395
6.10.3.8 init()	396
6.10.3.9 operator++()	396
6.10.4 Friends And Related Function Documentation	396
6.10.4.1 operator<<	396
6.10.5 Member Data Documentation	396
6.10.5.1 N	396
6.10.5.2 B	397
6.10.5.3 v	397
6.10.5.4 flag_overflow	397
6.11 GiNaC::basic_partition_generator Class Reference	397
6.11.1 Detailed Description	398
6.11.2 Constructor & Destructor Documentation	398
6.11.2.1 basic_partition_generator()	398
6.11.3 Member Data Documentation	399
6.11.3.1 mpgen	399
6.12 GiNaC::class_info< OPT > Class Template Reference	399
6.12.1 Constructor & Destructor Documentation	400

6.12.1.1 class_info()	400
6.12.2 Member Function Documentation	400
6.12.2.1 get_parent()	401
6.12.2.2 find()	401
6.12.2.3 dump_hierarchy()	401
6.12.2.4 dump_tree()	401
6.12.2.5 identify_parents()	402
6.12.3 Member Data Documentation	402
6.12.3.1 options	402
6.12.3.2 first	402
6.12.3.3 next	402
6.12.3.4 parent	402
6.12.3.5 parents_identified	403
6.13 GiNaC::clifford Class Reference	403
6.13.1 Detailed Description	412
6.13.2 Constructor & Destructor Documentation	412
6.13.2.1 clifford() [1/4]	412
6.13.2.2 clifford() [2/4]	412
6.13.2.3 clifford() [3/4]	413
6.13.2.4 clifford() [4/4]	413
6.13.3 Member Function Documentation	413
6.13.3.1 precedence()	413
6.13.3.2 archive()	413
6.13.3.3 read_archive()	414
6.13.3.4 eval_ncmul()	414
6.13.3.5 match_same_type()	414
6.13.3.6 thiscontainer() [1/2]	415
6.13.3.7 thiscontainer() [2/2]	415
6.13.3.8 return_type()	415
6.13.3.9 return_type_tinfo()	415
6.13.3.10 get_representation_label()	415
6.13.3.11 get_metric() [1/2]	415
6.13.3.12 get_metric() [2/2]	416
6.13.3.13 same_metric()	416
6.13.3.14 get_commutator_sign()	416
6.13.3.15 nops()	416
6.13.3.16 op()	417
6.13.3.17 let_op()	417
6.13.3.18 subs()	417
6.13.3.19 do_print_dflt()	417
6.13.3.20 do_print_latex()	418
6.13.3.21 do_print_tree()	418

6.13.4 Member Data Documentation	418
6.13.4.1 representation_label	418
6.13.4.2 metric	418
6.13.4.3 commutator_sign	419
6.14 GiNaC::cliffordunit Class Reference	419
6.14.1 Detailed Description	423
6.14.2 Member Function Documentation	423
6.14.2.1 contract_with()	424
6.14.2.2 do_print()	424
6.14.2.3 do_print_latex()	424
6.15 GiNaC::color Class Reference	424
6.15.1 Detailed Description	433
6.15.2 Constructor & Destructor Documentation	433
6.15.2.1 color() [1/4]	434
6.15.2.2 color() [2/4]	434
6.15.2.3 color() [3/4]	434
6.15.2.4 color() [4/4]	434
6.15.3 Member Function Documentation	434
6.15.3.1 archive()	435
6.15.3.2 read_archive()	435
6.15.3.3 eval_ncmul()	435
6.15.3.4 match_same_type()	436
6.15.3.5 thiscontainer() [1/2]	436
6.15.3.6 thiscontainer() [2/2]	436
6.15.3.7 return_type()	436
6.15.3.8 return_type_tinfo()	437
6.15.3.9 get_representation_label()	437
6.15.4 Member Data Documentation	437
6.15.4.1 representation_label	437
6.16 GiNaC::compare_all_equal< T > Class Template Reference	437
6.16.1 Detailed Description	438
6.16.2 Constructor & Destructor Documentation	438
6.16.2.1 ~compare_all_equal()	438
6.16.3 Member Function Documentation	438
6.16.3.1 struct_is_equal()	438
6.16.3.2 struct_compare()	438
6.17 GiNaC::compare_bitwise< T > Class Template Reference	439
6.17.1 Detailed Description	439
6.17.2 Constructor & Destructor Documentation	439
6.17.2.1 ~compare_bitwise()	439
6.17.3 Member Function Documentation	439
6.17.3.1 struct_is_equal()	439

6.17.3.2 struct_compare()	440
6.18 GiNaC::compare_std_less< T > Class Template Reference	440
6.18.1 Detailed Description	440
6.18.2 Constructor & Destructor Documentation	440
6.18.2.1 ~compare_std_less()	440
6.18.3 Member Function Documentation	440
6.18.3.1 struct_is_equal()	441
6.18.3.2 struct_compare()	441
6.19 GiNaC::composition_generator Class Reference	441
6.19.1 Detailed Description	442
6.19.2 Constructor & Destructor Documentation	442
6.19.2.1 composition_generator()	442
6.19.3 Member Function Documentation	442
6.19.3.1 get()	442
6.19.3.2 next()	443
6.19.4 Member Data Documentation	443
6.19.4.1 cmgen	443
6.19.4.2 atend	443
6.19.4.3 trivial	443
6.19.4.4 composition	443
6.19.4.5 current_updated	444
6.20 GiNaC::const_iterator Class Reference	444
6.20.1 Member Typedef Documentation	445
6.20.1.1 iterator_category	445
6.20.1.2 value_type	446
6.20.1.3 difference_type	446
6.20.1.4 pointer	446
6.20.1.5 reference	446
6.20.2 Constructor & Destructor Documentation	446
6.20.2.1 const_iterator() [1/2]	446
6.20.2.2 const_iterator() [2/2]	446
6.20.3 Member Function Documentation	446
6.20.3.1 operator*()	447
6.20.3.2 operator->()	447
6.20.3.3 operator[]()	447
6.20.3.4 operator++() [1/2]	447
6.20.3.5 operator++() [2/2]	447
6.20.3.6 operator+=()	447
6.20.3.7 operator+()	448
6.20.3.8 operator--() [1/2]	448
6.20.3.9 operator--() [2/2]	448
6.20.3.10 operator-=()	448

6.20.3.11 operator-()	448
6.20.3.12 operator==(())	448
6.20.3.13 operator!=(())	449
6.20.3.14 operator<()	449
6.20.3.15 operator>()	449
6.20.3.16 operator<=()	449
6.20.3.17 operator>=()	449
6.20.4 Friends And Related Function Documentation	449
6.20.4.1 ex	449
6.20.4.2 const_preorder_iterator	450
6.20.4.3 const_postorder_iterator	450
6.20.4.4 operator+	450
6.20.4.5 operator-	450
6.20.5 Member Data Documentation	450
6.20.5.1 e	450
6.20.5.2 i	450
6.21 GiNaC::const_postorder_iterator Class Reference	451
6.21.1 Member Typedef Documentation	451
6.21.1.1 iterator_category	451
6.21.1.2 value_type	451
6.21.1.3 difference_type	452
6.21.1.4 pointer	452
6.21.1.5 reference	452
6.21.2 Constructor & Destructor Documentation	452
6.21.2.1 const_postorder_iterator() [1/2]	452
6.21.2.2 const_postorder_iterator() [2/2]	452
6.21.3 Member Function Documentation	452
6.21.3.1 operator*()	452
6.21.3.2 operator->()	453
6.21.3.3 operator++() [1/2]	453
6.21.3.4 operator++() [2/2]	453
6.21.3.5 operator==(())	453
6.21.3.6 operator!=(())	453
6.21.3.7 descend()	453
6.21.3.8 increment()	454
6.21.4 Member Data Documentation	454
6.21.4.1 s	454
6.22 GiNaC::const_preorder_iterator Class Reference	454
6.22.1 Member Typedef Documentation	455
6.22.1.1 iterator_category	455
6.22.1.2 value_type	455
6.22.1.3 difference_type	455

6.22.1.4 pointer	455
6.22.1.5 reference	455
6.22.2 Constructor & Destructor Documentation	455
6.22.2.1 const_preorder_iterator() [1/2]	456
6.22.2.2 const_preorder_iterator() [2/2]	456
6.22.3 Member Function Documentation	456
6.22.3.1 operator*()	456
6.22.3.2 operator->()	456
6.22.3.3 operator++() [1/2]	456
6.22.3.4 operator++() [2/2]	456
6.22.3.5 operator==()	457
6.22.3.6 operator!=()	457
6.22.3.7 increment()	457
6.22.4 Member Data Documentation	457
6.22.4.1 s	457
6.23 GiNaC::constant Class Reference	458
6.23.1 Detailed Description	463
6.23.2 Constructor & Destructor Documentation	463
6.23.2.1 constant() [1/2]	463
6.23.2.2 constant() [2/2]	464
6.23.3 Member Function Documentation	464
6.23.3.1 info()	464
6.23.3.2 evalf()	464
6.23.3.3 is_polynomial()	465
6.23.3.4 conjugate()	465
6.23.3.5 real_part()	465
6.23.3.6 imag_part()	465
6.23.3.7 archive()	465
6.23.3.8 read_archive()	466
6.23.3.9 derivative()	466
6.23.3.10 is_equal_same_type()	466
6.23.3.11 calchash()	467
6.23.3.12 do_print()	467
6.23.3.13 do_print_tree()	467
6.23.3.14 do_print_latex()	467
6.23.3.15 do_print_python_repr()	467
6.23.4 Member Data Documentation	468
6.23.4.1 name	468
6.23.4.2 TeX_name	468
6.23.4.3 ef	468
6.23.4.4 number	468
6.23.4.5 serial	468

6.23.4.6 next_serial	469
6.23.4.7 domain	469
6.24 GiNaC::container< C > Class Template Reference	469
6.24.1 Detailed Description	475
6.24.2 Member Typedef Documentation	475
6.24.2.1 STLT	476
6.24.2.2 const_iterator	476
6.24.2.3 const_reverse_iterator	476
6.24.3 Constructor & Destructor Documentation	476
6.24.3.1 container() [1/4]	476
6.24.3.2 container() [2/4]	476
6.24.3.3 container() [3/4]	477
6.24.3.4 container() [4/4]	477
6.24.4 Member Function Documentation	477
6.24.4.1 get_default_flags()	477
6.24.4.2 get_open_delim()	477
6.24.4.3 get_close_delim()	477
6.24.4.4 info()	478
6.24.4.5 precedence()	478
6.24.4.6 nops()	478
6.24.4.7 op()	479
6.24.4.8 let_op()	479
6.24.4.9 subs()	479
6.24.4.10 read_archive()	480
6.24.4.11 archive()	480
6.24.4.12 conjugate()	480
6.24.4.13 real_part()	481
6.24.4.14 imag_part()	481
6.24.4.15 is_equal_same_type()	481
6.24.4.16 thiscontainer() [1/2]	482
6.24.4.17 thiscontainer() [2/2]	482
6.24.4.18 printseq()	482
6.24.4.19 sort_() [1/2]	482
6.24.4.20 sort_() [2/2]	483
6.24.4.21 unique_() [1/2]	483
6.24.4.22 prepend()	483
6.24.4.23 append()	483
6.24.4.24 remove_first()	483
6.24.4.25 remove_last()	484
6.24.4.26 remove_all()	484
6.24.4.27 sort()	484
6.24.4.28 unique()	484

6.24.4.29 begin()	484
6.24.4.30 end()	485
6.24.4.31 rbegin()	485
6.24.4.32 rend()	485
6.24.4.33 do_print()	485
6.24.4.34 do_print_tree()	485
6.24.4.35 do_print_python()	486
6.24.4.36 do_print_python_repr()	486
6.24.4.37 subschildren()	486
6.24.4.38 unique_() [2/2]	486
6.25 GiNaC::container_storage< C > Class Template Reference	487
6.25.1 Detailed Description	488
6.25.2 Member Typedef Documentation	488
6.25.2.1 STLT	488
6.25.3 Constructor & Destructor Documentation	488
6.25.3.1 container_storage() [1/4]	488
6.25.3.2 container_storage() [2/4]	488
6.25.3.3 container_storage() [3/4]	488
6.25.3.4 container_storage() [4/4]	489
6.25.3.5 ~container_storage()	489
6.25.4 Member Function Documentation	489
6.25.4.1 reserve() [1/4]	489
6.25.4.2 reserve() [2/4]	489
6.25.4.3 reserve() [3/4]	489
6.25.4.4 reserve() [4/4]	490
6.25.5 Member Data Documentation	490
6.25.5.1 seq	490
6.26 GiNaC::composition_generator::coolmulti Struct Reference	491
6.26.1 Constructor & Destructor Documentation	491
6.26.1.1 coolmulti()	491
6.26.1.2 ~coolmulti()	492
6.26.2 Member Function Documentation	492
6.26.2.1 next_permutation()	492
6.26.2.2 finished()	492
6.26.3 Member Data Documentation	492
6.26.3.1 head	492
6.26.3.2 i	492
6.26.3.3 after_i	493
6.27 GiNaC::derivative_map_function Struct Reference	493
6.27.1 Detailed Description	494
6.27.2 Constructor & Destructor Documentation	494
6.27.2.1 derivative_map_function()	494

6.27.3 Member Function Documentation	494
6.27.3.1 operator>()	494
6.27.4 Member Data Documentation	495
6.27.4.1 s	495
6.28 GiNaC::determinant_algo Class Reference	495
6.28.1 Detailed Description	495
6.28.2 Member Enumeration Documentation	495
6.28.2.1 anonymous enum	496
6.29 GiNaC::diracgamma Class Reference	496
6.29.1 Detailed Description	502
6.29.2 Member Function Documentation	502
6.29.2.1 contract_with()	502
6.29.2.2 do_print()	502
6.29.2.3 do_print_latex()	502
6.30 GiNaC::diracgamma5 Class Reference	503
6.30.1 Detailed Description	507
6.30.2 Member Function Documentation	507
6.30.2.1 conjugate()	507
6.30.2.2 do_print()	507
6.30.2.3 do_print_latex()	508
6.31 GiNaC::diracgammaL Class Reference	508
6.31.1 Detailed Description	512
6.31.2 Member Function Documentation	512
6.31.2.1 conjugate()	513
6.31.2.2 do_print()	513
6.31.2.3 do_print_latex()	513
6.32 GiNaC::diracgammaR Class Reference	513
6.32.1 Detailed Description	517
6.32.2 Member Function Documentation	517
6.32.2.1 conjugate()	518
6.32.2.2 do_print()	518
6.32.2.3 do_print_latex()	518
6.33 GiNaC::diracone Class Reference	518
6.33.1 Detailed Description	522
6.33.2 Member Function Documentation	522
6.33.2.1 do_print()	522
6.33.2.2 do_print_latex()	523
6.34 GiNaC::do_taylor Class Reference	523
6.34.1 Detailed Description	523
6.35 GiNaC::domain Class Reference	523
6.35.1 Detailed Description	523
6.35.2 Member Enumeration Documentation	523

6.35.2.1 anonymous enum	523
6.36 GiNaC::dunno Class Reference	524
6.36.1 Detailed Description	524
6.37 GiNaC::Ebar_kernel Class Reference	524
6.37.1 Detailed Description	529
6.37.2 Constructor & Destructor Documentation	530
6.37.2.1 Ebar_kernel()	530
6.37.3 Member Function Documentation	530
6.37.3.1 nops()	530
6.37.3.2 op()	530
6.37.3.3 let_op()	530
6.37.3.4 is_numeric()	531
6.37.3.5 get_numerical_value()	531
6.37.3.6 series_coeff_impl()	531
6.37.3.7 do_print()	531
6.37.4 Member Data Documentation	532
6.37.4.1 n	532
6.37.4.2 m	532
6.37.4.3 x	532
6.37.4.4 y	532
6.38 GiNaC::Eisenstein_h_kernel Class Reference	533
6.38.1 Detailed Description	539
6.38.2 Constructor & Destructor Documentation	539
6.38.2.1 Eisenstein_h_kernel()	539
6.38.3 Member Function Documentation	539
6.38.3.1 series()	539
6.38.3.2 nops()	540
6.38.3.3 op()	540
6.38.3.4 let_op()	540
6.38.3.5 is_numeric()	540
6.38.3.6 Laurent_series()	541
6.38.3.7 get_numerical_value()	541
6.38.3.8 uses_Laurent_series()	541
6.38.3.9 coefficient_a0()	541
6.38.3.10 coefficient_an()	542
6.38.3.11 q_expansion_modular_form()	542
6.38.3.12 do_print()	542
6.38.4 Member Data Documentation	542
6.38.4.1 k	542
6.38.4.2 N	543
6.38.4.3 r	543
6.38.4.4 s	543

6.38.4.5 C_norm	543
6.39 GiNaC::Eisenstein_kernel Class Reference	544
6.39.1 Detailed Description	550
6.39.2 Constructor & Destructor Documentation	550
6.39.2.1 Eisenstein_kernel()	550
6.39.3 Member Function Documentation	550
6.39.3.1 series()	551
6.39.3.2 nops()	551
6.39.3.3 op()	551
6.39.3.4 let_op()	551
6.39.3.5 is_numeric()	552
6.39.3.6 Laurent_series()	552
6.39.3.7 get_numerical_value()	552
6.39.3.8 uses_Laurent_series()	552
6.39.3.9 q_expansion_modular_form()	553
6.39.3.10 do_print()	553
6.39.4 Member Data Documentation	553
6.39.4.1 k	553
6.39.4.2 N	553
6.39.4.3 a	553
6.39.4.4 b	554
6.39.4.5 K	554
6.39.4.6 C_norm	554
6.40 GiNaC::composition_generator::coolmulti::element Struct Reference	554
6.40.1 Constructor & Destructor Documentation	555
6.40.1.1 element()	555
6.40.1.2 ~element()	555
6.40.2 Member Data Documentation	555
6.40.2.1 value	555
6.40.2.2 next	555
6.41 GiNaC::ELi_kernel Class Reference	556
6.41.1 Detailed Description	561
6.41.2 Constructor & Destructor Documentation	562
6.41.2.1 ELi_kernel()	562
6.41.3 Member Function Documentation	562
6.41.3.1 nops()	562
6.41.3.2 op()	562
6.41.3.3 let_op()	562
6.41.3.4 is_numeric()	563
6.41.3.5 get_numerical_value()	563
6.41.3.6 series_coeff_impl()	563
6.41.3.7 do_print()	563

6.41.4 Member Data Documentation	564
6.41.4.1 n	564
6.41.4.2 m	564
6.41.4.3 x	564
6.41.4.4 y	564
6.42 std::equal_to< GiNaC::ex > Struct Reference	564
6.42.1 Detailed Description	565
6.42.2 Member Function Documentation	565
6.42.2.1 operator>()	565
6.43 GiNaC::error_and_integral Struct Reference	566
6.43.1 Constructor & Destructor Documentation	566
6.43.1.1 error_and_integral()	567
6.43.2 Member Data Documentation	567
6.43.2.1 error	567
6.43.2.2 integral	567
6.44 GiNaC::error_and_integral_is_less Struct Reference	567
6.44.1 Member Function Documentation	567
6.44.1.1 operator>()	567
6.45 GiNaC::eval_integ_map_function Struct Reference	568
6.45.1 Detailed Description	569
6.45.2 Member Function Documentation	569
6.45.2.1 operator>()	569
6.46 GiNaC::evalf_map_function Struct Reference	569
6.46.1 Detailed Description	570
6.46.2 Member Function Documentation	570
6.46.2.1 operator>()	570
6.47 GiNaC::evalm_map_function Struct Reference	571
6.47.1 Detailed Description	572
6.47.2 Member Function Documentation	572
6.47.2.1 operator>()	572
6.48 GiNaC::ex Class Reference	572
6.48.1 Detailed Description	576
6.48.2 Constructor & Destructor Documentation	576
6.48.2.1 ex() [1/10]	576
6.48.2.2 ex() [2/10]	576
6.48.2.3 ex() [3/10]	577
6.48.2.4 ex() [4/10]	577
6.48.2.5 ex() [5/10]	577
6.48.2.6 ex() [6/10]	577
6.48.2.7 ex() [7/10]	577
6.48.2.8 ex() [8/10]	577
6.48.2.9 ex() [9/10]	578

6.48.2.10 ex() [10/10]	578
6.48.3 Member Function Documentation	578
6.48.3.1 swap()	578
6.48.3.2 begin()	578
6.48.3.3 end()	579
6.48.3.4 preorder_begin()	579
6.48.3.5 preorder_end()	579
6.48.3.6 postorder_begin()	579
6.48.3.7 postorder_end()	579
6.48.3.8 eval()	579
6.48.3.9 evalf()	580
6.48.3.10 evalm()	580
6.48.3.11 eval_ncmul()	580
6.48.3.12 eval_integ()	580
6.48.3.13 print()	581
6.48.3.14 dbgprint()	581
6.48.3.15 dbgprinttree()	581
6.48.3.16 info()	582
6.48.3.17 nops()	582
6.48.3.18 op()	583
6.48.3.19 operator[]() [1/4]	583
6.48.3.20 operator[]() [2/4]	583
6.48.3.21 let_op()	583
6.48.3.22 operator[]() [3/4]	584
6.48.3.23 operator[]() [4/4]	584
6.48.3.24 lhs()	584
6.48.3.25 rhs()	584
6.48.3.26 conjugate()	584
6.48.3.27 real_part()	585
6.48.3.28 imag_part()	585
6.48.3.29 has()	585
6.48.3.30 find()	585
6.48.3.31 match() [1/2]	586
6.48.3.32 match() [2/2]	586
6.48.3.33 subs() [1/3]	586
6.48.3.34 subs() [2/3]	587
6.48.3.35 subs() [3/3]	587
6.48.3.36 map() [1/2]	587
6.48.3.37 map() [2/2]	587
6.48.3.38 accept()	588
6.48.3.39 traverse_preorder()	588
6.48.3.40 traverse_postorder()	588

6.48.3.41	traverse()	588
6.48.3.42	is_polynomial()	589
6.48.3.43	degree()	589
6.48.3.44	ldegree()	589
6.48.3.45	coeff()	589
6.48.3.46	lcoeff()	590
6.48.3.47	tcoeff()	590
6.48.3.48	expand()	590
6.48.3.49	collect()	590
6.48.3.50	diff()	591
6.48.3.51	series()	591
6.48.3.52	normal()	592
6.48.3.53	to_rational()	592
6.48.3.54	to_polynomial()	593
6.48.3.55	numer()	593
6.48.3.56	denom()	594
6.48.3.57	numer_denom()	594
6.48.3.58	unit()	594
6.48.3.59	content()	595
6.48.3.60	integer_content()	596
6.48.3.61	primpart() [1/2]	596
6.48.3.62	primpart() [2/2]	596
6.48.3.63	unitcontprim()	597
6.48.3.64	smod()	597
6.48.3.65	max_coefficient()	598
6.48.3.66	get_free_indices()	598
6.48.3.67	simplify_indexed() [1/2]	598
6.48.3.68	simplify_indexed() [2/2]	599
6.48.3.69	compare()	599
6.48.3.70	is_equal()	600
6.48.3.71	is_zero()	600
6.48.3.72	is_zero_matrix()	601
6.48.3.73	symmetrize() [1/2]	601
6.48.3.74	symmetrize() [2/2]	601
6.48.3.75	antisymmetrize() [1/2]	601
6.48.3.76	antisymmetrize() [2/2]	601
6.48.3.77	symmetrize_cyclic() [1/2]	602
6.48.3.78	symmetrize_cyclic() [2/2]	602
6.48.3.79	return_type()	602
6.48.3.80	return_type_tinfo()	602
6.48.3.81	gethash()	602
6.48.3.82	construct_from_basic()	603

6.48.3.83 construct_from_int()	603
6.48.3.84 construct_from_uint()	603
6.48.3.85 construct_from_long()	603
6.48.3.86 construct_from_ulong()	604
6.48.3.87 construct_from_longlong()	604
6.48.3.88 construct_from_ulonglong()	604
6.48.3.89 construct_from_double()	604
6.48.3.90 construct_from_string_and_lst()	604
6.48.3.91 makewritable()	605
6.48.3.92 share()	605
6.48.4 Friends And Related Function Documentation	605
6.48.4.1 archive_node	605
6.48.4.2 are_ex_trivially_equal	605
6.48.4.3 ex_to	606
6.48.4.4 is_a	607
6.48.4.5 is_exactly_a	607
6.48.5 Member Data Documentation	607
6.48.5.1 bp	607
6.49 GiNaC::ex_base_is_less Struct Reference	608
6.49.1 Member Function Documentation	608
6.49.1.1 operator()	608
6.50 GiNaC::ex_is_equal Struct Reference	608
6.50.1 Member Function Documentation	608
6.50.1.1 operator()	608
6.51 GiNaC::ex_is_less Struct Reference	609
6.51.1 Member Function Documentation	609
6.51.1.1 operator()	609
6.52 GiNaC::ex_swap Struct Reference	609
6.52.1 Member Function Documentation	609
6.52.1.1 operator()	609
6.53 GiNaC::expair Class Reference	610
6.53.1 Detailed Description	611
6.53.2 Constructor & Destructor Documentation	611
6.53.2.1 expair() [1/2]	611
6.53.2.2 expair() [2/2]	611
6.53.3 Member Function Documentation	611
6.53.3.1 is_equal()	611
6.53.3.2 is_less()	612
6.53.3.3 compare()	612
6.53.3.4 print()	612
6.53.3.5 is_canonical_numeric()	612
6.53.3.6 swap()	612

6.53.3.7 conjugate()	613
6.53.4 Member Data Documentation	613
6.53.4.1 rest	613
6.53.4.2 coeff	613
6.54 GiNaC::expair_is_less Struct Reference	613
6.54.1 Detailed Description	614
6.54.2 Member Function Documentation	614
6.54.2.1 operator()	614
6.55 GiNaC::expair_rest_is_less Struct Reference	614
6.55.1 Detailed Description	614
6.55.2 Member Function Documentation	614
6.55.2.1 operator()	615
6.56 GiNaC::expair_swap Struct Reference	615
6.56.1 Member Function Documentation	615
6.56.1.1 operator()	615
6.57 GiNaC::expairseq Class Reference	616
6.57.1 Detailed Description	622
6.57.2 Constructor & Destructor Documentation	622
6.57.2.1 expairseq() [1/4]	622
6.57.2.2 expairseq() [2/4]	622
6.57.2.3 expairseq() [3/4]	623
6.57.2.4 expairseq() [4/4]	623
6.57.3 Member Function Documentation	623
6.57.3.1 precedence()	623
6.57.3.2 info()	623
6.57.3.3 nops()	624
6.57.3.4 op()	624
6.57.3.5 map()	624
6.57.3.6 eval()	625
6.57.3.7 to_rational()	625
6.57.3.8 to_polynomial()	625
6.57.3.9 match()	626
6.57.3.10 subs()	626
6.57.3.11 conjugate()	626
6.57.3.12 archive()	627
6.57.3.13 read_archive()	627
6.57.3.14 is_equal_same_type()	627
6.57.3.15 return_type()	628
6.57.3.16 calchash()	628
6.57.3.17 expand()	628
6.57.3.18 thisexpairseq() [1/2]	629
6.57.3.19 thisexpairseq() [2/2]	629

6.57.3.20 printseq()	629
6.57.3.21 printpair()	629
6.57.3.22 split_ex_to_pair()	630
6.57.3.23 combine_ex_with_coeff_to_pair()	630
6.57.3.24 combine_pair_with_coeff_to_pair()	630
6.57.3.25 recombine_pair_to_ex()	631
6.57.3.26 expair_needs_further_processing()	631
6.57.3.27 default_overall_coeff()	631
6.57.3.28 combine_overall_coeff() [1/2]	631
6.57.3.29 combine_overall_coeff() [2/2]	632
6.57.3.30 can_make_flat()	632
6.57.3.31 do_print()	632
6.57.3.32 do_print_tree()	632
6.57.3.33 construct_from_2_ex()	632
6.57.3.34 construct_from_2_expairseq()	633
6.57.3.35 construct_from_expairseq_ex()	633
6.57.3.36 construct_from_exvector()	633
6.57.3.37 construct_from_epvector() [1/2]	633
6.57.3.38 construct_from_epvector() [2/2]	634
6.57.3.39 make_flat() [1/2]	634
6.57.3.40 make_flat() [2/2]	634
6.57.3.41 canonicalize()	634
6.57.3.42 combine_same_terms_sorted_seq()	635
6.57.3.43 is_canonical()	635
6.57.3.44 expandchildren()	635
6.57.3.45 evalchildren()	636
6.57.3.46 subschildren()	636
6.57.4 Member Data Documentation	636
6.57.4.1 seq	637
6.57.4.2 overall_coeff	637
6.58 GiNaC::expand_map_function Struct Reference	637
6.58.1 Detailed Description	639
6.58.2 Constructor & Destructor Documentation	639
6.58.2.1 expand_map_function()	639
6.58.3 Member Function Documentation	639
6.58.3.1 operator()()	639
6.58.4 Member Data Documentation	639
6.58.4.1 options	639
6.59 GiNaC::expand_options Class Reference	639
6.59.1 Detailed Description	640
6.59.2 Member Enumeration Documentation	640
6.59.2.1 anonymous enum	640

6.60 GiNaC::factor_options Class Reference	640
6.60.1 Detailed Description	640
6.60.2 Member Enumeration Documentation	641
6.60.2.1 anonymous enum	641
6.61 GiNaC::fail Class Reference	641
6.61.1 Member Function Documentation	645
6.61.1.1 return_type()	645
6.61.1.2 do_print()	645
6.62 GiNaC::fderivative Class Reference	646
6.62.1 Detailed Description	655
6.62.2 Constructor & Destructor Documentation	655
6.62.2.1 fderivative() [1/3]	655
6.62.2.2 fderivative() [2/3]	656
6.62.2.3 fderivative() [3/3]	656
6.62.3 Member Function Documentation	656
6.62.3.1 print()	656
6.62.3.2 eval()	657
6.62.3.3 series()	657
6.62.3.4 thiscontainer() [1/2]	657
6.62.3.5 thiscontainer() [2/2]	657
6.62.3.6 archive()	658
6.62.3.7 read_archive()	658
6.62.3.8 derivative()	658
6.62.3.9 is_equal_same_type()	659
6.62.3.10 match_same_type()	659
6.62.3.11 derivatives()	659
6.62.3.12 do_print()	660
6.62.3.13 do_print_latex()	660
6.62.3.14 do_print_csrc()	660
6.62.3.15 do_print_tree()	660
6.62.4 Member Data Documentation	660
6.62.4.1 parameter_set	661
6.63 GiNaC::function Class Reference	661
6.63.1 Detailed Description	669
6.63.2 Constructor & Destructor Documentation	669
6.63.2.1 function() [1/18]	669
6.63.2.2 function() [2/18]	670
6.63.2.3 function() [3/18]	670
6.63.2.4 function() [4/18]	670
6.63.2.5 function() [5/18]	670
6.63.2.6 function() [6/18]	670
6.63.2.7 function() [7/18]	671

6.63.2.8 function() [8/18]	671
6.63.2.9 function() [9/18]	671
6.63.2.10 function() [10/18]	671
6.63.2.11 function() [11/18]	672
6.63.2.12 function() [12/18]	672
6.63.2.13 function() [13/18]	672
6.63.2.14 function() [14/18]	673
6.63.2.15 function() [15/18]	673
6.63.2.16 function() [16/18]	673
6.63.2.17 function() [17/18]	674
6.63.2.18 function() [18/18]	674
6.63.3 Member Function Documentation	674
6.63.3.1 print()	674
6.63.3.2 precedence()	674
6.63.3.3 expand()	675
6.63.3.4 eval()	675
6.63.3.5 evalf()	675
6.63.3.6 eval_ncmul()	676
6.63.3.7 calchash()	676
6.63.3.8 series()	676
6.63.3.9 thiscontainer() [1/2]	677
6.63.3.10 thiscontainer() [2/2]	677
6.63.3.11 conjugate()	677
6.63.3.12 real_part()	677
6.63.3.13 imag_part()	678
6.63.3.14 archive()	678
6.63.3.15 read_archive()	678
6.63.3.16 info()	678
6.63.3.17 derivative()	679
6.63.3.18 is_equal_same_type()	679
6.63.3.19 match_same_type()	679
6.63.3.20 return_type()	680
6.63.3.21 return_type_tinfo()	680
6.63.3.22 pderivative()	680
6.63.3.23 expl_derivative()	680
6.63.3.24 registered_functions()	681
6.63.3.25 lookup_remember_table()	681
6.63.3.26 store_remember_table()	681
6.63.3.27 power()	681
6.63.3.28 register_new()	681
6.63.3.29 find_function()	682
6.63.3.30 get_registered_functions()	682

6.63.3.31	get_serial()	682
6.63.3.32	get_name()	682
6.63.4	Friends And Related Function Documentation	682
6.63.4.1	remember_table_entry	682
6.63.5	Member Data Documentation	683
6.63.5.1	current_serial	683
6.63.5.2	serial	683
6.64	GiNaC::function_options Class Reference	683
6.64.1	Constructor & Destructor Documentation	689
6.64.1.1	function_options() [1/3]	689
6.64.1.2	function_options() [2/3]	689
6.64.1.3	function_options() [3/3]	690
6.64.1.4	~function_options()	690
6.64.2	Member Function Documentation	690
6.64.2.1	initialize()	690
6.64.2.2	dummy()	690
6.64.2.3	set_name()	690
6.64.2.4	latex_name()	691
6.64.2.5	eval_func() [1/15]	691
6.64.2.6	eval_func() [2/15]	691
6.64.2.7	eval_func() [3/15]	691
6.64.2.8	eval_func() [4/15]	691
6.64.2.9	eval_func() [5/15]	691
6.64.2.10	eval_func() [6/15]	692
6.64.2.11	eval_func() [7/15]	692
6.64.2.12	eval_func() [8/15]	692
6.64.2.13	eval_func() [9/15]	692
6.64.2.14	eval_func() [10/15]	692
6.64.2.15	eval_func() [11/15]	692
6.64.2.16	eval_func() [12/15]	693
6.64.2.17	eval_func() [13/15]	693
6.64.2.18	eval_func() [14/15]	693
6.64.2.19	evalf_func() [1/15]	693
6.64.2.20	evalf_func() [2/15]	693
6.64.2.21	evalf_func() [3/15]	693
6.64.2.22	evalf_func() [4/15]	694
6.64.2.23	evalf_func() [5/15]	694
6.64.2.24	evalf_func() [6/15]	694
6.64.2.25	evalf_func() [7/15]	694
6.64.2.26	evalf_func() [8/15]	694
6.64.2.27	evalf_func() [9/15]	694
6.64.2.28	evalf_func() [10/15]	695

6.64.2.29 evalf_func() [11/15]	695
6.64.2.30 evalf_func() [12/15]	695
6.64.2.31 evalf_func() [13/15]	695
6.64.2.32 evalf_func() [14/15]	695
6.64.2.33 conjugate_func() [1/15]	695
6.64.2.34 conjugate_func() [2/15]	696
6.64.2.35 conjugate_func() [3/15]	696
6.64.2.36 conjugate_func() [4/15]	696
6.64.2.37 conjugate_func() [5/15]	696
6.64.2.38 conjugate_func() [6/15]	696
6.64.2.39 conjugate_func() [7/15]	696
6.64.2.40 conjugate_func() [8/15]	697
6.64.2.41 conjugate_func() [9/15]	697
6.64.2.42 conjugate_func() [10/15]	697
6.64.2.43 conjugate_func() [11/15]	697
6.64.2.44 conjugate_func() [12/15]	697
6.64.2.45 conjugate_func() [13/15]	697
6.64.2.46 conjugate_func() [14/15]	698
6.64.2.47 real_part_func() [1/15]	698
6.64.2.48 real_part_func() [2/15]	698
6.64.2.49 real_part_func() [3/15]	698
6.64.2.50 real_part_func() [4/15]	698
6.64.2.51 real_part_func() [5/15]	698
6.64.2.52 real_part_func() [6/15]	699
6.64.2.53 real_part_func() [7/15]	699
6.64.2.54 real_part_func() [8/15]	699
6.64.2.55 real_part_func() [9/15]	699
6.64.2.56 real_part_func() [10/15]	699
6.64.2.57 real_part_func() [11/15]	699
6.64.2.58 real_part_func() [12/15]	700
6.64.2.59 real_part_func() [13/15]	700
6.64.2.60 real_part_func() [14/15]	700
6.64.2.61 imag_part_func() [1/15]	700
6.64.2.62 imag_part_func() [2/15]	700
6.64.2.63 imag_part_func() [3/15]	700
6.64.2.64 imag_part_func() [4/15]	701
6.64.2.65 imag_part_func() [5/15]	701
6.64.2.66 imag_part_func() [6/15]	701
6.64.2.67 imag_part_func() [7/15]	701
6.64.2.68 imag_part_func() [8/15]	701
6.64.2.69 imag_part_func() [9/15]	701
6.64.2.70 imag_part_func() [10/15]	702

6.64.2.71 imag_part_func() [11/15]	702
6.64.2.72 imag_part_func() [12/15]	702
6.64.2.73 imag_part_func() [13/15]	702
6.64.2.74 imag_part_func() [14/15]	702
6.64.2.75 expand_func() [1/15]	702
6.64.2.76 expand_func() [2/15]	703
6.64.2.77 expand_func() [3/15]	703
6.64.2.78 expand_func() [4/15]	703
6.64.2.79 expand_func() [5/15]	703
6.64.2.80 expand_func() [6/15]	703
6.64.2.81 expand_func() [7/15]	703
6.64.2.82 expand_func() [8/15]	704
6.64.2.83 expand_func() [9/15]	704
6.64.2.84 expand_func() [10/15]	704
6.64.2.85 expand_func() [11/15]	704
6.64.2.86 expand_func() [12/15]	704
6.64.2.87 expand_func() [13/15]	704
6.64.2.88 expand_func() [14/15]	705
6.64.2.89 derivative_func() [1/15]	705
6.64.2.90 derivative_func() [2/15]	705
6.64.2.91 derivative_func() [3/15]	705
6.64.2.92 derivative_func() [4/15]	705
6.64.2.93 derivative_func() [5/15]	705
6.64.2.94 derivative_func() [6/15]	706
6.64.2.95 derivative_func() [7/15]	706
6.64.2.96 derivative_func() [8/15]	706
6.64.2.97 derivative_func() [9/15]	706
6.64.2.98 derivative_func() [10/15]	706
6.64.2.99 derivative_func() [11/15]	706
6.64.2.100 derivative_func() [12/15]	707
6.64.2.101 derivative_func() [13/15]	707
6.64.2.102 derivative_func() [14/15]	707
6.64.2.103 expl_derivative_func() [1/15]	707
6.64.2.104 expl_derivative_func() [2/15]	707
6.64.2.105 expl_derivative_func() [3/15]	707
6.64.2.106 expl_derivative_func() [4/15]	708
6.64.2.107 expl_derivative_func() [5/15]	708
6.64.2.108 expl_derivative_func() [6/15]	708
6.64.2.109 expl_derivative_func() [7/15]	708
6.64.2.110 expl_derivative_func() [8/15]	708
6.64.2.111 expl_derivative_func() [9/15]	708
6.64.2.112 expl_derivative_func() [10/15]	709

6.64.2.113 expl_derivative_func() [11/15]	709
6.64.2.114 expl_derivative_func() [12/15]	709
6.64.2.115 expl_derivative_func() [13/15]	709
6.64.2.116 expl_derivative_func() [14/15]	709
6.64.2.117 power_func() [1/15]	709
6.64.2.118 power_func() [2/15]	710
6.64.2.119 power_func() [3/15]	710
6.64.2.120 power_func() [4/15]	710
6.64.2.121 power_func() [5/15]	710
6.64.2.122 power_func() [6/15]	710
6.64.2.123 power_func() [7/15]	710
6.64.2.124 power_func() [8/15]	711
6.64.2.125 power_func() [9/15]	711
6.64.2.126 power_func() [10/15]	711
6.64.2.127 power_func() [11/15]	711
6.64.2.128 power_func() [12/15]	711
6.64.2.129 power_func() [13/15]	711
6.64.2.130 power_func() [14/15]	712
6.64.2.131 series_func() [1/15]	712
6.64.2.132 series_func() [2/15]	712
6.64.2.133 series_func() [3/15]	712
6.64.2.134 series_func() [4/15]	712
6.64.2.135 series_func() [5/15]	712
6.64.2.136 series_func() [6/15]	713
6.64.2.137 series_func() [7/15]	713
6.64.2.138 series_func() [8/15]	713
6.64.2.139 series_func() [9/15]	713
6.64.2.140 series_func() [10/15]	713
6.64.2.141 series_func() [11/15]	713
6.64.2.142 series_func() [12/15]	714
6.64.2.143 series_func() [13/15]	714
6.64.2.144 series_func() [14/15]	714
6.64.2.145 info_func() [1/15]	714
6.64.2.146 info_func() [2/15]	714
6.64.2.147 info_func() [3/15]	714
6.64.2.148 info_func() [4/15]	715
6.64.2.149 info_func() [5/15]	715
6.64.2.150 info_func() [6/15]	715
6.64.2.151 info_func() [7/15]	715
6.64.2.152 info_func() [8/15]	715
6.64.2.153 info_func() [9/15]	715
6.64.2.154 info_func() [10/15]	716

6.64.2.155 info_func() [11/15]	716
6.64.2.156 info_func() [12/15]	716
6.64.2.157 info_func() [13/15]	716
6.64.2.158 info_func() [14/15]	716
6.64.2.159 eval_func() [15/15]	716
6.64.2.160 evalf_func() [15/15]	717
6.64.2.161 conjugate_func() [15/15]	717
6.64.2.162 real_part_func() [15/15]	717
6.64.2.163 imag_part_func() [15/15]	717
6.64.2.164 expand_func() [15/15]	717
6.64.2.165 derivative_func() [15/15]	717
6.64.2.166 expl_derivative_func() [15/15]	718
6.64.2.167 power_func() [15/15]	718
6.64.2.168 series_func() [15/15]	718
6.64.2.169 info_func() [15/15]	718
6.64.2.170 print_func() [1/15]	718
6.64.2.171 print_func() [2/15]	719
6.64.2.172 print_func() [3/15]	719
6.64.2.173 print_func() [4/15]	719
6.64.2.174 print_func() [5/15]	719
6.64.2.175 print_func() [6/15]	719
6.64.2.176 print_func() [7/15]	720
6.64.2.177 print_func() [8/15]	720
6.64.2.178 print_func() [9/15]	720
6.64.2.179 print_func() [10/15]	720
6.64.2.180 print_func() [11/15]	720
6.64.2.181 print_func() [12/15]	721
6.64.2.182 print_func() [13/15]	721
6.64.2.183 print_func() [14/15]	721
6.64.2.184 print_func() [15/15]	721
6.64.2.185 set_return_type()	721
6.64.2.186 do_not_evalf_params()	722
6.64.2.187 remember()	722
6.64.2.188 overloaded()	722
6.64.2.189 set_symmetry()	722
6.64.2.190 get_name()	722
6.64.2.191 get_nparams()	722
6.64.2.192 has_derivative()	723
6.64.2.193 has_power()	723
6.64.2.194 test_and_set_nparams()	723
6.64.2.195 set_print_func()	723
6.64.3 Friends And Related Function Documentation	723

6.64.3.1 function	723
6.64.3.2 fderivative	724
6.64.4 Member Data Documentation	724
6.64.4.1 name	724
6.64.4.2 TeX_name	724
6.64.4.3 nparams	724
6.64.4.4 eval_f	724
6.64.4.5 evalf_f	724
6.64.4.6 conjugate_f	725
6.64.4.7 real_part_f	725
6.64.4.8 imag_part_f	725
6.64.4.9 expand_f	725
6.64.4.10 derivative_f	725
6.64.4.11 expl_derivative_f	725
6.64.4.12 power_f	726
6.64.4.13 series_f	726
6.64.4.14 print_dispatch_table	726
6.64.4.15 info_f	726
6.64.4.16 evalf_params_first	726
6.64.4.17 use_return_type	726
6.64.4.18 return_type	727
6.64.4.19 return_type_tinfo	727
6.64.4.20 use_remember	727
6.64.4.21 remember_size	727
6.64.4.22 remember_assoc_size	727
6.64.4.23 remember_strategy	727
6.64.4.24 eval_use_exvector_args	728
6.64.4.25 evalf_use_exvector_args	728
6.64.4.26 conjugate_use_exvector_args	728
6.64.4.27 real_part_use_exvector_args	728
6.64.4.28 imag_part_use_exvector_args	728
6.64.4.29 expand_use_exvector_args	728
6.64.4.30 derivative_use_exvector_args	729
6.64.4.31 expl_derivative_use_exvector_args	729
6.64.4.32 power_use_exvector_args	729
6.64.4.33 series_use_exvector_args	729
6.64.4.34 print_use_exvector_args	729
6.64.4.35 info_use_exvector_args	729
6.64.4.36 functions_with_same_name	730
6.64.4.37 symtree	730
6.65 GiNaC::G2_SERIAL Class Reference	730
6.65.1 Detailed Description	730

6.65.2 Member Data Documentation	730
6.65.2.1 serial	730
6.66 GiNaC::G3_SERIAL Class Reference	731
6.66.1 Detailed Description	731
6.66.2 Member Data Documentation	731
6.66.2.1 serial	731
6.67 GiNaC::gcd_options Struct Reference	731
6.67.1 Detailed Description	731
6.67.2 Member Enumeration Documentation	731
6.67.2.1 anonymous enum	731
6.68 GiNaC::gcdheu_failed Class Reference	732
6.68.1 Detailed Description	732
6.69 GiNaC::has_distance< T > Class Template Reference	732
6.69.1 Detailed Description	733
6.69.2 Member Typedef Documentation	733
6.69.2.1 yes_type	733
6.69.2.2 no_type	733
6.69.3 Member Enumeration Documentation	733
6.69.3.1 anonymous enum	733
6.69.4 Member Function Documentation	734
6.69.4.1 test() [1/2]	734
6.69.4.2 test() [2/2]	734
6.70 GiNaC::has_options Class Reference	734
6.70.1 Detailed Description	734
6.70.2 Member Enumeration Documentation	734
6.70.2.1 anonymous enum	734
6.71 std::hash< GiNaC::ex > Struct Reference	735
6.71.1 Detailed Description	735
6.71.2 Member Function Documentation	735
6.71.2.1 operator()()	735
6.72 GiNaC::idx Class Reference	736
6.72.1 Detailed Description	741
6.72.2 Constructor & Destructor Documentation	741
6.72.2.1 idx()	741
6.72.3 Member Function Documentation	742
6.72.3.1 info()	742
6.72.3.2 nops()	742
6.72.3.3 op()	742
6.72.3.4 map()	743
6.72.3.5 evalf()	743
6.72.3.6 subs()	743
6.72.3.7 archive()	743

6.72.3.8 read_archive()	744
6.72.3.9 derivative()	744
6.72.3.10 match_same_type()	744
6.72.3.11 calchash()	745
6.72.3.12 is_dummy_pair_same_type()	745
6.72.3.13 get_value()	745
6.72.3.14 is_numeric()	745
6.72.3.15 is_symbolic()	746
6.72.3.16 get_dim()	746
6.72.3.17 is_dim_numeric()	746
6.72.3.18 is_dim_symbolic()	746
6.72.3.19 replace_dim()	747
6.72.3.20 minimal_dim()	747
6.72.3.21 print_index()	747
6.72.3.22 do_print()	747
6.72.3.23 do_print_csrc()	748
6.72.3.24 do_print_latex()	748
6.72.3.25 do_print_tree()	748
6.72.4 Member Data Documentation	748
6.72.4.1 value	748
6.72.4.2 dim	749
6.73 GiNaC::idx_is_equal_ignore_dim Struct Reference	749
6.73.1 Member Function Documentation	749
6.73.1.1 operator()	749
6.74 GiNaC::indexed Class Reference	750
6.74.1 Detailed Description	758
6.74.2 Constructor & Destructor Documentation	758
6.74.2.1 indexed() [1/13]	758
6.74.2.2 indexed() [2/13]	758
6.74.2.3 indexed() [3/13]	759
6.74.2.4 indexed() [4/13]	759
6.74.2.5 indexed() [5/13]	760
6.74.2.6 indexed() [6/13]	760
6.74.2.7 indexed() [7/13]	761
6.74.2.8 indexed() [8/13]	761
6.74.2.9 indexed() [9/13]	762
6.74.2.10 indexed() [10/13]	762
6.74.2.11 indexed() [11/13]	762
6.74.2.12 indexed() [12/13]	763
6.74.2.13 indexed() [13/13]	763
6.74.3 Member Function Documentation	763
6.74.3.1 precedence()	763

6.74.3.2 info()	763
6.74.3.3 eval()	764
6.74.3.4 real_part()	764
6.74.3.5 imag_part()	764
6.74.3.6 get_free_indices()	764
6.74.3.7 archive()	765
6.74.3.8 read_archive()	765
6.74.3.9 derivative()	765
6.74.3.10 thiscontainer() [1/2]	766
6.74.3.11 thiscontainer() [2/2]	766
6.74.3.12 return_type()	766
6.74.3.13 return_type_tinfo()	766
6.74.3.14 expand()	766
6.74.3.15 all_index_values_are()	767
6.74.3.16 get_indices()	767
6.74.3.17 get_dummy_indices() [1/2]	767
6.74.3.18 get_dummy_indices() [2/2]	767
6.74.3.19 has_dummy_index_for()	768
6.74.3.20 get_symmetry()	768
6.74.3.21 printindices()	768
6.74.3.22 print_indexed()	768
6.74.3.23 do_print()	769
6.74.3.24 do_print_latex()	769
6.74.3.25 do_print_tree()	769
6.74.3.26 validate()	769
6.74.4 Friends And Related Function Documentation	769
6.74.4.1 simplify_indexed	770
6.74.4.2 simplify_indexed_product	770
6.74.4.3 reposition_dummy_indices	770
6.74.5 Member Data Documentation	770
6.74.5.1 symtree	771
6.75 GiNaC::info_flags Class Reference	771
6.75.1 Detailed Description	771
6.75.2 Member Enumeration Documentation	771
6.75.2.1 anonymous enum	771
6.76 GiNaC::integral Class Reference	772
6.76.1 Detailed Description	778
6.76.2 Constructor & Destructor Documentation	778
6.76.2.1 integral()	779
6.76.3 Member Function Documentation	779
6.76.3.1 precedence()	779
6.76.3.2 eval()	779

6.76.3.3 evalf()	779
6.76.3.4 degree()	780
6.76.3.5 ldegree()	780
6.76.3.6 eval_ncmul()	780
6.76.3.7 nops()	780
6.76.3.8 op()	781
6.76.3.9 let_op()	781
6.76.3.10 expand()	781
6.76.3.11 get_free_indices()	781
6.76.3.12 return_type()	782
6.76.3.13 return_type_tinfo()	782
6.76.3.14 conjugate()	782
6.76.3.15 eval_integ()	782
6.76.3.16 archive()	782
6.76.3.17 read_archive()	783
6.76.3.18 derivative()	783
6.76.3.19 series()	783
6.76.3.20 do_print()	784
6.76.3.21 do_print_latex()	784
6.76.4 Member Data Documentation	784
6.76.4.1 max_integration_level	784
6.76.4.2 relative_integration_error	784
6.76.4.3 x	784
6.76.4.4 a	785
6.76.4.5 b	785
6.76.4.6 f	785
6.77 GiNaC::integration_kernel Class Reference	785
6.77.1 Detailed Description	790
6.77.2 Member Function Documentation	790
6.77.2.1 series()	791
6.77.2.2 has_trailing_zero()	791
6.77.2.3 is_numeric()	791
6.77.2.4 Laurent_series()	792
6.77.2.5 get_numerical_value()	792
6.77.2.6 uses_Laurent_series()	792
6.77.2.7 series_coeff_impl()	792
6.77.2.8 get_cache_size()	793
6.77.2.9 set_cache_step()	793
6.77.2.10 get_series_coeff()	793
6.77.2.11 series_coeff()	793
6.77.2.12 get_numerical_value_impl()	794
6.77.2.13 do_print()	794

6.77.3 Member Data Documentation	794
6.77.3.1 cache_step_size	794
6.77.3.2 series_vec	794
6.78 GiNaC::is_not_a_clifford Struct Reference	794
6.78.1 Detailed Description	795
6.78.2 Member Function Documentation	795
6.78.2.1 operator()	795
6.79 GiNaC::is_summation_idx Struct Reference	795
6.79.1 Member Function Documentation	795
6.79.1.1 operator()	795
6.80 GiNaC::iterated_integral2_SERIAL Class Reference	796
6.80.1 Detailed Description	796
6.80.2 Member Data Documentation	796
6.80.2.1 serial	796
6.81 GiNaC::iterated_integral3_SERIAL Class Reference	796
6.81.1 Detailed Description	797
6.81.2 Member Data Documentation	797
6.81.2.1 serial	797
6.82 GiNaC::Kronecker_dtau_kernel Class Reference	797
6.82.1 Detailed Description	802
6.82.2 Constructor & Destructor Documentation	803
6.82.2.1 Kronecker_dtau_kernel()	803
6.82.3 Member Function Documentation	803
6.82.3.1 nops()	803
6.82.3.2 op()	803
6.82.3.3 let_op()	803
6.82.3.4 is_numeric()	804
6.82.3.5 get_numerical_value()	804
6.82.3.6 series_coeff_impl()	804
6.82.3.7 do_print()	804
6.82.4 Member Data Documentation	805
6.82.4.1 n	805
6.82.4.2 z	805
6.82.4.3 K	805
6.82.4.4 C_norm	805
6.83 GiNaC::Kronecker_dz_kernel Class Reference	806
6.83.1 Detailed Description	811
6.83.2 Constructor & Destructor Documentation	812
6.83.2.1 Kronecker_dz_kernel()	812
6.83.3 Member Function Documentation	812
6.83.3.1 nops()	812
6.83.3.2 op()	812

6.83.3.3 let_op()	812
6.83.3.4 is_numeric()	813
6.83.3.5 get_numerical_value()	813
6.83.3.6 series_coeff_impl()	813
6.83.3.7 do_print()	813
6.83.4 Member Data Documentation	814
6.83.4.1 n	814
6.83.4.2 z_j	814
6.83.4.3 tau	814
6.83.4.4 K	814
6.83.4.5 C_norm	814
6.84 GiNaC::lanczos_coeffs Class Reference	815
6.84.1 Constructor & Destructor Documentation	815
6.84.1.1 lanczos_coeffs()	815
6.84.2 Member Function Documentation	815
6.84.2.1 sufficiently_accurate()	815
6.84.2.2 get_order()	816
6.84.2.3 calc_lanczos_A()	816
6.84.3 Member Data Documentation	816
6.84.3.1 coeffs	816
6.84.3.2 current_vector	816
6.85 std::less< GiNaC::ptr< T > > Struct Template Reference	816
6.85.1 Detailed Description	817
6.85.2 Member Function Documentation	817
6.85.2.1 operator>()	817
6.86 GiNaC::library_init Class Reference	817
6.86.1 Detailed Description	818
6.86.2 Constructor & Destructor Documentation	818
6.86.2.1 library_init()	818
6.86.2.2 ~library_init()	819
6.86.3 Member Function Documentation	819
6.86.3.1 init_unarchivers()	819
6.86.4 Member Data Documentation	819
6.86.4.1 count	819
6.87 GiNaC::make_flat_inserter Class Reference	819
6.87.1 Detailed Description	820
6.87.2 Constructor & Destructor Documentation	820
6.87.2.1 make_flat_inserter() [1/2]	820
6.87.2.2 make_flat_inserter() [2/2]	820
6.87.3 Member Function Documentation	820
6.87.3.1 handle_factor()	821
6.87.3.2 combine_indices()	821

6.87.4 Member Data Documentation	821
6.87.4.1 do_renaming	821
6.87.4.2 used_indices	821
6.88 GiNaC::map_function Struct Reference	822
6.88.1 Detailed Description	823
6.88.2 Member Typedef Documentation	823
6.88.2.1 argument_type	823
6.88.2.2 result_type	823
6.88.3 Constructor & Destructor Documentation	823
6.88.3.1 ~map_function()	823
6.88.4 Member Function Documentation	823
6.88.4.1 operator()()	824
6.89 GiNaC::matrix Class Reference	824
6.89.1 Detailed Description	830
6.89.2 Constructor & Destructor Documentation	830
6.89.2.1 matrix() [1/5]	831
6.89.2.2 matrix() [2/5]	832
6.89.2.3 matrix() [3/5]	832
6.89.2.4 matrix() [4/5]	832
6.89.2.5 matrix() [5/5]	833
6.89.3 Member Function Documentation	833
6.89.3.1 nops()	833
6.89.3.2 op()	833
6.89.3.3 let_op()	833
6.89.3.4 evalm()	834
6.89.3.5 subs()	834
6.89.3.6 eval_indexed()	834
6.89.3.7 add_indexed()	834
6.89.3.8 scalar_mul_indexed()	835
6.89.3.9 contract_with()	835
6.89.3.10 conjugate()	835
6.89.3.11 real_part()	835
6.89.3.12 imag_part()	836
6.89.3.13 archive()	836
6.89.3.14 read_archive()	836
6.89.3.15 match_same_type()	836
6.89.3.16 return_type()	837
6.89.3.17 rows()	837
6.89.3.18 cols()	837
6.89.3.19 add()	837
6.89.3.20 sub()	838
6.89.3.21 mul() [1/2]	838

6.89.3.22 mul() [2/2]	838
6.89.3.23 mul_scalar()	838
6.89.3.24 pow()	839
6.89.3.25 operator>() [1/2]	839
6.89.3.26 operator>() [2/2]	839
6.89.3.27 set()	840
6.89.3.28 transpose()	840
6.89.3.29 determinant()	840
6.89.3.30 trace()	841
6.89.3.31 charpoly()	841
6.89.3.32 inverse() [1/2]	842
6.89.3.33 inverse() [2/2]	842
6.89.3.34 solve()	843
6.89.3.35 rank() [1/2]	844
6.89.3.36 rank() [2/2]	844
6.89.3.37 is_zero_matrix()	844
6.89.3.38 determinant_minor()	844
6.89.3.39 echelon_form()	845
6.89.3.40 gauss_elimination()	845
6.89.3.41 division_free_elimination()	845
6.89.3.42 fraction_free_elimination()	846
6.89.3.43 markowitz_elimination()	846
6.89.3.44 pivot()	847
6.89.3.45 print_elements()	847
6.89.3.46 do_print()	847
6.89.3.47 do_print_latex()	848
6.89.3.48 do_print_python_repr()	848
6.89.4 Member Data Documentation	848
6.89.4.1 row	848
6.89.4.2 col	848
6.89.4.3 m	849
6.90 GiNaC::minkmetric Class Reference	849
6.90.1 Detailed Description	854
6.90.2 Constructor & Destructor Documentation	854
6.90.2.1 minkmetric()	854
6.90.3 Member Function Documentation	854
6.90.3.1 info()	855
6.90.3.2 eval_indexed()	855
6.90.3.3 archive()	855
6.90.3.4 read_archive()	856
6.90.3.5 return_type()	856
6.90.3.6 do_print()	856

6.90.3.7 do_print_latex()	856
6.90.4 Member Data Documentation	856
6.90.4.1 pos_sig	857
6.91 GiNaC::modular_form_kernel Class Reference	857
6.91.1 Detailed Description	863
6.91.2 Constructor & Destructor Documentation	863
6.91.2.1 modular_form_kernel()	863
6.91.3 Member Function Documentation	863
6.91.3.1 series()	863
6.91.3.2 nops()	863
6.91.3.3 op()	864
6.91.3.4 let_op()	864
6.91.3.5 is_numeric()	864
6.91.3.6 Laurent_series()	864
6.91.3.7 get_numerical_value()	865
6.91.3.8 uses_Laurent_series()	865
6.91.3.9 q_expansion_modular_form()	865
6.91.3.10 do_print()	865
6.91.4 Member Data Documentation	865
6.91.4.1 k	866
6.91.4.2 P	866
6.91.4.3 C_norm	866
6.92 GiNaC::basic_partition_generator::mpartition2 Struct Reference	866
6.92.1 Constructor & Destructor Documentation	866
6.92.1.1 mpartition2()	867
6.92.2 Member Function Documentation	867
6.92.2.1 next_partition()	867
6.92.3 Member Data Documentation	867
6.92.3.1 x	867
6.92.3.2 n	867
6.92.3.3 m	867
6.93 GiNaC::mul Class Reference	868
6.93.1 Detailed Description	876
6.93.2 Constructor & Destructor Documentation	876
6.93.2.1 mul() [1/7]	876
6.93.2.2 mul() [2/7]	876
6.93.2.3 mul() [3/7]	876
6.93.2.4 mul() [4/7]	877
6.93.2.5 mul() [5/7]	877
6.93.2.6 mul() [6/7]	877
6.93.2.7 mul() [7/7]	877
6.93.3 Member Function Documentation	877

6.93.3.1 precedence()	878
6.93.3.2 info()	878
6.93.3.3 is_polynomial()	878
6.93.3.4 degree()	879
6.93.3.5 ldegree()	879
6.93.3.6 coeff()	879
6.93.3.7 has()	879
6.93.3.8 eval()	880
6.93.3.9 evalf()	880
6.93.3.10 real_part()	880
6.93.3.11 imag_part()	881
6.93.3.12 evalm()	881
6.93.3.13 series()	881
6.93.3.14 normal()	882
6.93.3.15 integer_content()	882
6.93.3.16 smod()	882
6.93.3.17 max_coefficient()	883
6.93.3.18 get_free_indices()	883
6.93.3.19 conjugate()	883
6.93.3.20 derivative()	884
6.93.3.21 eval_ncmul()	884
6.93.3.22 return_type()	884
6.93.3.23 return_type_tinfo()	884
6.93.3.24 thisexpairseq() [1/2]	885
6.93.3.25 thisexpairseq() [2/2]	885
6.93.3.26 split_ex_to_pair()	885
6.93.3.27 combine_ex_with_coeff_to_pair()	886
6.93.3.28 combine_pair_with_coeff_to_pair()	886
6.93.3.29 recombine_pair_to_ex()	886
6.93.3.30 expair_needs_further_processing()	886
6.93.3.31 default_overall_coeff()	887
6.93.3.32 combine_overall_coeff() [1/2]	887
6.93.3.33 combine_overall_coeff() [2/2]	887
6.93.3.34 can_make_flat()	887
6.93.3.35 expand()	888
6.93.3.36 algebraic_subs_mul()	888
6.93.3.37 find_real_imag()	888
6.93.3.38 print_overall_coeff()	888
6.93.3.39 do_print()	889
6.93.3.40 do_print_latex()	889
6.93.3.41 do_print_csrc()	889
6.93.3.42 do_print_python_repr()	889

6.93.3.43 can_be_further_expanded()	889
6.93.3.44 expandchildren()	890
6.93.4 Friends And Related Function Documentation	890
6.93.4.1 add	890
6.93.4.2 ncmul	890
6.93.4.3 power	890
6.94 GiNaC::multi_iterator_counter< T > Class Template Reference	891
6.94.1 Detailed Description	892
6.94.2 Constructor & Destructor Documentation	893
6.94.2.1 multi_iterator_counter() [1/3]	893
6.94.2.2 multi_iterator_counter() [2/3]	893
6.94.2.3 multi_iterator_counter() [3/3]	893
6.94.3 Member Function Documentation	893
6.94.3.1 init()	893
6.94.3.2 operator++()	894
6.94.4 Friends And Related Function Documentation	894
6.94.4.1 operator<<	894
6.95 GiNaC::multi_iterator_counter_indv< T > Class Template Reference	894
6.95.1 Detailed Description	896
6.95.2 Constructor & Destructor Documentation	896
6.95.2.1 multi_iterator_counter_indv() [1/3]	896
6.95.2.2 multi_iterator_counter_indv() [2/3]	897
6.95.2.3 multi_iterator_counter_indv() [3/3]	897
6.95.3 Member Function Documentation	897
6.95.3.1 init()	897
6.95.3.2 operator++()	897
6.95.4 Friends And Related Function Documentation	898
6.95.4.1 operator<<	898
6.95.5 Member Data Documentation	898
6.95.5.1 Nv	898
6.96 GiNaC::multi_iterator_ordered< T > Class Template Reference	898
6.96.1 Detailed Description	900
6.96.2 Constructor & Destructor Documentation	900
6.96.2.1 multi_iterator_ordered() [1/3]	900
6.96.2.2 multi_iterator_ordered() [2/3]	901
6.96.2.3 multi_iterator_ordered() [3/3]	901
6.96.3 Member Function Documentation	901
6.96.3.1 init()	901
6.96.3.2 operator++()	901
6.96.4 Friends And Related Function Documentation	902
6.96.4.1 operator<<	902
6.97 GiNaC::multi_iterator_ordered_eq< T > Class Template Reference	902

6.97.1 Detailed Description	904
6.97.2 Constructor & Destructor Documentation	904
6.97.2.1 multi_iterator_ordered_eq() [1/3]	904
6.97.2.2 multi_iterator_ordered_eq() [2/3]	904
6.97.2.3 multi_iterator_ordered_eq() [3/3]	905
6.97.3 Member Function Documentation	905
6.97.3.1 init()	905
6.97.3.2 operator++()	905
6.97.4 Friends And Related Function Documentation	905
6.97.4.1 operator<<	906
6.98 GiNaC::multi_iterator_ordered_eq_indv< T > Class Template Reference	906
6.98.1 Detailed Description	908
6.98.2 Constructor & Destructor Documentation	908
6.98.2.1 multi_iterator_ordered_eq_indv() [1/3]	908
6.98.2.2 multi_iterator_ordered_eq_indv() [2/3]	908
6.98.2.3 multi_iterator_ordered_eq_indv() [3/3]	908
6.98.3 Member Function Documentation	909
6.98.3.1 init()	909
6.98.3.2 operator++()	909
6.98.4 Friends And Related Function Documentation	909
6.98.4.1 operator<<	909
6.98.5 Member Data Documentation	909
6.98.5.1 Nv	910
6.99 GiNaC::multi_iterator_permutation< T > Class Template Reference	910
6.99.1 Detailed Description	912
6.99.2 Constructor & Destructor Documentation	912
6.99.2.1 multi_iterator_permutation() [1/3]	912
6.99.2.2 multi_iterator_permutation() [2/3]	912
6.99.2.3 multi_iterator_permutation() [3/3]	913
6.99.3 Member Function Documentation	913
6.99.3.1 init()	913
6.99.3.2 operator++()	913
6.99.3.3 get_sign()	914
6.99.4 Friends And Related Function Documentation	914
6.99.4.1 operator<<	914
6.100 GiNaC::multi_iterator_shuffle< T > Class Template Reference	914
6.100.1 Detailed Description	917
6.100.2 Constructor & Destructor Documentation	917
6.100.2.1 multi_iterator_shuffle() [1/2]	917
6.100.2.2 multi_iterator_shuffle() [2/2]	917
6.100.3 Member Function Documentation	917
6.100.3.1 init()	917

6.100.3.2 operator++()	918
6.100.4 Friends And Related Function Documentation	918
6.100.4.1 operator<<	918
6.100.5 Member Data Documentation	918
6.100.5.1 N_internal	918
6.100.5.2 v_internal	918
6.100.5.3 v_orig	919
6.101 GiNaC::multi_iterator_shuffle_prime< T > Class Template Reference	919
6.101.1 Detailed Description	921
6.101.2 Constructor & Destructor Documentation	922
6.101.2.1 multi_iterator_shuffle_prime() [1/2]	922
6.101.2.2 multi_iterator_shuffle_prime() [2/2]	922
6.101.3 Member Function Documentation	922
6.101.3.1 init()	922
6.101.4 Friends And Related Function Documentation	922
6.101.4.1 operator<<	922
6.102 GiNaC::multiple_polylog_kernel Class Reference	923
6.102.1 Detailed Description	928
6.102.2 Constructor & Destructor Documentation	929
6.102.2.1 multiple_polylog_kernel()	929
6.102.3 Member Function Documentation	929
6.102.3.1 nops()	929
6.102.3.2 op()	929
6.102.3.3 let_op()	929
6.102.3.4 is_numeric()	930
6.102.3.5 series_coeff_impl()	930
6.102.3.6 do_print()	930
6.102.4 Member Data Documentation	930
6.102.4.1 z	930
6.103 GiNaC::ncmul Class Reference	931
6.103.1 Detailed Description	938
6.103.2 Constructor & Destructor Documentation	938
6.103.2.1 ncmul() [1/7]	938
6.103.2.2 ncmul() [2/7]	938
6.103.2.3 ncmul() [3/7]	938
6.103.2.4 ncmul() [4/7]	938
6.103.2.5 ncmul() [5/7]	939
6.103.2.6 ncmul() [6/7]	939
6.103.2.7 ncmul() [7/7]	939
6.103.3 Member Function Documentation	939
6.103.3.1 precedence()	939
6.103.3.2 info()	939

6.103.3.3 degree()	940
6.103.3.4 ldegree()	940
6.103.3.5 expand()	940
6.103.3.6 coeff()	940
6.103.3.7 eval()	941
6.103.3.8 evalm()	941
6.103.3.9 get_free_indices()	941
6.103.3.10 thiscontainer() [1/2]	942
6.103.3.11 thiscontainer() [2/2]	942
6.103.3.12 conjugate()	942
6.103.3.13 real_part()	942
6.103.3.14 imag_part()	942
6.103.3.15 derivative()	943
6.103.3.16 return_type()	943
6.103.3.17 return_type_tinfo()	943
6.103.3.18 do_print()	943
6.103.3.19 do_print_csrc()	944
6.103.3.20 count_factors()	944
6.103.3.21 append_factors()	944
6.103.3.22 expandchildren()	944
6.103.3.23 get_factors()	944
6.103.4 Friends And Related Function Documentation	945
6.103.4.1 power	945
6.103.4.2 reeval_ncmul	945
6.103.4.3 hold_ncmul	945
6.104 GiNaC::normal_map_function Struct Reference	945
6.104.1 Detailed Description	946
6.104.2 Member Function Documentation	946
6.104.2.1 operator>()	946
6.105 GiNaC::numeric Class Reference	947
6.105.1 Detailed Description	954
6.105.2 Constructor & Destructor Documentation	954
6.105.2.1 numeric() [1/10]	954
6.105.2.2 numeric() [2/10]	954
6.105.2.3 numeric() [3/10]	954
6.105.2.4 numeric() [4/10]	954
6.105.2.5 numeric() [5/10]	955
6.105.2.6 numeric() [6/10]	955
6.105.2.7 numeric() [7/10]	955
6.105.2.8 numeric() [8/10]	955
6.105.2.9 numeric() [9/10]	956
6.105.2.10 numeric() [10/10]	956

6.105.3 Member Function Documentation	956
6.105.3.1 precedence()	956
6.105.3.2 info()	957
6.105.3.3 is_polynomial()	957
6.105.3.4 degree()	957
6.105.3.5 ldegree()	958
6.105.3.6 coeff()	958
6.105.3.7 has()	958
6.105.3.8 eval()	958
6.105.3.9 evalf()	959
6.105.3.10 subs()	959
6.105.3.11 normal()	959
6.105.3.12 to_rational()	960
6.105.3.13 to_polynomial()	960
6.105.3.14 integer_content()	960
6.105.3.15 smod()	960
6.105.3.16 max_coefficient()	961
6.105.3.17 conjugate()	961
6.105.3.18 real_part()	961
6.105.3.19 imag_part()	962
6.105.3.20 archive()	962
6.105.3.21 read_archive()	962
6.105.3.22 derivative()	962
6.105.3.23 is_equal_same_type()	963
6.105.3.24 calchash()	963
6.105.3.25 add()	963
6.105.3.26 sub()	964
6.105.3.27 mul()	964
6.105.3.28 div()	964
6.105.3.29 power()	965
6.105.3.30 add_dyn()	965
6.105.3.31 sub_dyn()	965
6.105.3.32 mul_dyn()	965
6.105.3.33 div_dyn()	965
6.105.3.34 power_dyn()	966
6.105.3.35 operator=() [1/6]	966
6.105.3.36 operator=() [2/6]	966
6.105.3.37 operator=() [3/6]	966
6.105.3.38 operator=() [4/6]	967
6.105.3.39 operator=() [5/6]	967
6.105.3.40 operator=() [6/6]	967
6.105.3.41 inverse()	967

6.105.3.42	step()	967
6.105.3.43	csgn()	968
6.105.3.44	compare()	968
6.105.3.45	is_equal()	968
6.105.3.46	is_zero()	969
6.105.3.47	is_positive()	969
6.105.3.48	is_negative()	969
6.105.3.49	is_integer()	969
6.105.3.50	is_pos_integer()	970
6.105.3.51	is_nonneg_integer()	970
6.105.3.52	is_even()	970
6.105.3.53	is_odd()	970
6.105.3.54	is_prime()	971
6.105.3.55	is_rational()	971
6.105.3.56	is_real()	971
6.105.3.57	is_cinteger()	971
6.105.3.58	is_crational()	972
6.105.3.59	operator==(())	972
6.105.3.60	operator"!=(())	972
6.105.3.61	operator<()	972
6.105.3.62	operator<=()	972
6.105.3.63	operator>()	974
6.105.3.64	operator>=()	974
6.105.3.65	to_int()	974
6.105.3.66	to_long()	975
6.105.3.67	to_double()	975
6.105.3.68	to_cl_N()	975
6.105.3.69	real()	975
6.105.3.70	imag()	976
6.105.3.71	numer()	976
6.105.3.72	denom()	976
6.105.3.73	int_length()	976
6.105.3.74	print_numeric()	977
6.105.3.75	do_print()	977
6.105.3.76	do_print_latex()	977
6.105.3.77	do_print_csrc()	977
6.105.3.78	do_print_csrc_cl_N()	978
6.105.3.79	do_print_tree()	978
6.105.3.80	do_print_python_repr()	978
6.105.4	Member Data Documentation	978
6.105.4.1	value	978
6.106	GiNaC::op0_is_equal Struct Reference	979

6.106.1 Member Function Documentation	979
6.106.1.1 operator()()	979
6.107 GiNaC::partition_generator Class Reference	979
6.107.1 Detailed Description	980
6.107.2 Constructor & Destructor Documentation	981
6.107.2.1 partition_generator()	981
6.107.3 Member Function Documentation	981
6.107.3.1 get()	981
6.107.3.2 next()	981
6.107.4 Member Data Documentation	981
6.107.4.1 partition	981
6.107.4.2 current_updated	982
6.108 GiNaC::partition_with_zero_parts_generator Class Reference	982
6.108.1 Detailed Description	983
6.108.2 Constructor & Destructor Documentation	983
6.108.2.1 partition_with_zero_parts_generator()	983
6.108.3 Member Function Documentation	983
6.108.3.1 get()	984
6.108.3.2 next()	984
6.108.4 Member Data Documentation	984
6.108.4.1 m	984
6.108.4.2 partition	984
6.108.4.3 current_updated	984
6.109 GiNaC::pointer_to_map_function Class Reference	985
6.109.1 Constructor & Destructor Documentation	986
6.109.1.1 pointer_to_map_function()	986
6.109.2 Member Function Documentation	986
6.109.2.1 operator()()	986
6.109.3 Member Data Documentation	987
6.109.3.1 ptr	987
6.110 GiNaC::pointer_to_map_function_1arg< T1 > Class Template Reference	987
6.110.1 Constructor & Destructor Documentation	989
6.110.1.1 pointer_to_map_function_1arg()	989
6.110.2 Member Function Documentation	989
6.110.2.1 operator()()	989
6.110.3 Member Data Documentation	989
6.110.3.1 ptr	989
6.110.3.2 arg1	989
6.111 GiNaC::pointer_to_map_function_2args< T1, T2 > Class Template Reference	990
6.111.1 Constructor & Destructor Documentation	991
6.111.1.1 pointer_to_map_function_2args()	991
6.111.2 Member Function Documentation	991

6.111.2.1 operator()()	991
6.111.3 Member Data Documentation	992
6.111.3.1 ptr	992
6.111.3.2 arg1	992
6.111.3.3 arg2	992
6.112 GiNaC::pointer_to_map_function_3args< T1, T2, T3 > Class Template Reference	992
6.112.1 Constructor & Destructor Documentation	994
6.112.1.1 pointer_to_map_function_3args()	994
6.112.2 Member Function Documentation	994
6.112.2.1 operator()()	994
6.112.3 Member Data Documentation	994
6.112.3.1 ptr	994
6.112.3.2 arg1	995
6.112.3.3 arg2	995
6.112.3.4 arg3	995
6.113 GiNaC::pointer_to_member_to_map_function< C > Class Template Reference	995
6.113.1 Constructor & Destructor Documentation	997
6.113.1.1 pointer_to_member_to_map_function()	997
6.113.2 Member Function Documentation	997
6.113.2.1 operator()()	997
6.113.3 Member Data Documentation	997
6.113.3.1 ptr	997
6.113.3.2 c	997
6.114 GiNaC::pointer_to_member_to_map_function_1arg< C, T1 > Class Template Reference	998
6.114.1 Constructor & Destructor Documentation	999
6.114.1.1 pointer_to_member_to_map_function_1arg()	999
6.114.2 Member Function Documentation	999
6.114.2.1 operator()()	999
6.114.3 Member Data Documentation	1000
6.114.3.1 ptr	1000
6.114.3.2 c	1000
6.114.3.3 arg1	1000
6.115 GiNaC::pointer_to_member_to_map_function_2args< C, T1, T2 > Class Template Reference	1000
6.115.1 Constructor & Destructor Documentation	1002
6.115.1.1 pointer_to_member_to_map_function_2args()	1002
6.115.2 Member Function Documentation	1002
6.115.2.1 operator()()	1002
6.115.3 Member Data Documentation	1002
6.115.3.1 ptr	1002
6.115.3.2 c	1003
6.115.3.3 arg1	1003
6.115.3.4 arg2	1003

6.116 GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2, T3 > Class Template Reference	1003
6.116.1 Constructor & Destructor Documentation	1005
6.116.1.1 pointer_to_member_to_map_function_3args()	1005
6.116.2 Member Function Documentation	1005
6.116.2.1 operator>()	1005
6.116.3 Member Data Documentation	1005
6.116.3.1 ptr	1005
6.116.3.2 c	1006
6.116.3.3 arg1	1006
6.116.3.4 arg2	1006
6.116.3.5 arg3	1006
6.117 GiNaC::pole_error Class Reference	1007
6.117.1 Detailed Description	1007
6.117.2 Constructor & Destructor Documentation	1008
6.117.2.1 pole_error()	1008
6.117.3 Member Function Documentation	1008
6.117.3.1 degree()	1008
6.117.4 Member Data Documentation	1008
6.117.4.1 deg	1008
6.118 GiNaC::possymbol Class Reference	1009
6.118.1 Detailed Description	1015
6.118.2 Constructor & Destructor Documentation	1015
6.118.2.1 possymbol() [1/3]	1015
6.118.2.2 possymbol() [2/3]	1015
6.118.2.3 possymbol() [3/3]	1015
6.118.3 Member Function Documentation	1015
6.118.3.1 get_domain()	1015
6.118.3.2 duplicate()	1016
6.119 GiNaC::power Class Reference	1016
6.119.1 Detailed Description	1022
6.119.2 Constructor & Destructor Documentation	1022
6.119.2.1 power() [1/2]	1022
6.119.2.2 power() [2/2]	1022
6.119.3 Member Function Documentation	1022
6.119.3.1 precedence()	1023
6.119.3.2 info()	1023
6.119.3.3 nops()	1023
6.119.3.4 op()	1023
6.119.3.5 map()	1024
6.119.3.6 is_polynomial()	1024
6.119.3.7 degree()	1024
6.119.3.8 ldegree()	1024

6.119.3.9	coeff()	1025
6.119.3.10	eval()	1025
6.119.3.11	evalf()	1026
6.119.3.12	evalm()	1026
6.119.3.13	series()	1026
6.119.3.14	subs()	1027
6.119.3.15	has()	1027
6.119.3.16	normal()	1027
6.119.3.17	to_rational()	1028
6.119.3.18	to_polynomial()	1028
6.119.3.19	conjugate()	1028
6.119.3.20	real_part()	1028
6.119.3.21	imag_part()	1029
6.119.3.22	archive()	1029
6.119.3.23	read_archive()	1029
6.119.3.24	derivative()	1029
6.119.3.25	eval_ncmul()	1030
6.119.3.26	return_type()	1030
6.119.3.27	return_type_tinfo()	1030
6.119.3.28	expand()	1030
6.119.3.29	print_power()	1031
6.119.3.30	do_print_dflt()	1031
6.119.3.31	do_print_latex()	1031
6.119.3.32	do_print_csrc()	1031
6.119.3.33	do_print_python()	1032
6.119.3.34	do_print_python_repr()	1032
6.119.3.35	do_print_csrc_cl_N()	1032
6.119.3.36	expand_add()	1032
6.119.3.37	expand_add_2()	1033
6.119.3.38	expand_mul()	1033
6.119.4	Friends And Related Function Documentation	1033
6.119.4.1	mul	1033
6.119.5	Member Data Documentation	1034
6.119.5.1	basis	1034
6.119.5.2	exponent	1034
6.120	GiNaC::print_context Class Reference	1034
6.120.1	Detailed Description	1035
6.120.2	Constructor & Destructor Documentation	1035
6.120.2.1	print_context()	1035
6.120.2.2	~print_context()	1035
6.120.3	Member Data Documentation	1035
6.120.3.1	s	1035

6.120.3.2 options	1036
6.121 GiNaC::print_context_options Class Reference	1036
6.121.1 Detailed Description	1036
6.121.2 Constructor & Destructor Documentation	1036
6.121.2.1 print_context_options()	1037
6.121.3 Member Function Documentation	1037
6.121.3.1 get_name()	1037
6.121.3.2 get_parent_name()	1037
6.121.3.3 get_id()	1037
6.121.4 Member Data Documentation	1037
6.121.4.1 name	1037
6.121.4.2 parent_name	1038
6.121.4.3 id	1038
6.122 GiNaC::print_csrc Class Reference	1038
6.122.1 Detailed Description	1039
6.122.2 Constructor & Destructor Documentation	1039
6.122.2.1 print_csrc()	1039
6.123 GiNaC::print_csrc_cl_N Class Reference	1040
6.123.1 Detailed Description	1041
6.123.2 Constructor & Destructor Documentation	1041
6.123.2.1 print_csrc_cl_N()	1041
6.124 GiNaC::print_csrc_double Class Reference	1042
6.124.1 Detailed Description	1043
6.124.2 Constructor & Destructor Documentation	1043
6.124.2.1 print_csrc_double()	1043
6.125 GiNaC::print_csrc_float Class Reference	1044
6.125.1 Detailed Description	1045
6.125.2 Constructor & Destructor Documentation	1045
6.125.2.1 print_csrc_float()	1045
6.126 GiNaC::print_dflt Class Reference	1046
6.126.1 Detailed Description	1047
6.126.2 Constructor & Destructor Documentation	1047
6.126.2.1 print_dflt()	1047
6.127 GiNaC::print_functor Class Reference	1047
6.127.1 Detailed Description	1047
6.127.2 Constructor & Destructor Documentation	1048
6.127.2.1 print_functor() [1/5]	1048
6.127.2.2 print_functor() [2/5]	1048
6.127.2.3 print_functor() [3/5]	1048
6.127.2.4 print_functor() [4/5]	1048
6.127.2.5 print_functor() [5/5]	1048
6.127.3 Member Function Documentation	1048

6.127.3.1 operator=()	1049
6.127.3.2 operator()()	1049
6.127.3.3 is_valid()	1049
6.127.4 Member Data Documentation	1049
6.127.4.1 impl	1049
6.128 GiNaC::print_functor_impl Class Reference	1050
6.128.1 Detailed Description	1050
6.128.2 Constructor & Destructor Documentation	1050
6.128.2.1 ~print_functor_impl()	1050
6.128.3 Member Function Documentation	1050
6.128.3.1 duplicate()	1051
6.128.3.2 operator()()	1051
6.129 GiNaC::print_latex Class Reference	1051
6.129.1 Detailed Description	1052
6.129.2 Constructor & Destructor Documentation	1052
6.129.2.1 print_latex()	1052
6.130 GiNaC::print_memfun_handler< T, C > Class Template Reference	1053
6.130.1 Detailed Description	1054
6.130.2 Member Typedef Documentation	1054
6.130.2.1 F	1054
6.130.3 Constructor & Destructor Documentation	1054
6.130.3.1 print_memfun_handler()	1054
6.130.4 Member Function Documentation	1054
6.130.4.1 duplicate()	1055
6.130.4.2 operator()()	1055
6.130.5 Member Data Documentation	1055
6.130.5.1 f	1055
6.131 GiNaC::print_options Class Reference	1055
6.131.1 Detailed Description	1056
6.131.2 Member Enumeration Documentation	1056
6.131.2.1 anonymous enum	1056
6.132 GiNaC::print_ptrfun_handler< T, C > Class Template Reference	1057
6.132.1 Detailed Description	1058
6.132.2 Member Typedef Documentation	1058
6.132.2.1 F	1058
6.132.3 Constructor & Destructor Documentation	1058
6.132.3.1 print_ptrfun_handler()	1058
6.132.4 Member Function Documentation	1058
6.132.4.1 duplicate()	1059
6.132.4.2 operator()()	1059
6.132.5 Member Data Documentation	1059
6.132.5.1 f	1059

6.133 GiNaC::print_python Class Reference	1060
6.133.1 Detailed Description	1061
6.133.2 Constructor & Destructor Documentation	1061
6.133.2.1 print_python()	1061
6.134 GiNaC::print_python_repr Class Reference	1061
6.134.1 Detailed Description	1062
6.134.2 Constructor & Destructor Documentation	1062
6.134.2.1 print_python_repr()	1062
6.135 GiNaC::print_tree Class Reference	1063
6.135.1 Detailed Description	1064
6.135.2 Constructor & Destructor Documentation	1064
6.135.2.1 print_tree() [1/2]	1064
6.135.2.2 print_tree() [2/2]	1064
6.135.3 Member Data Documentation	1064
6.135.3.1 delta_indent	1064
6.136 GiNaC::archive_node::property Struct Reference	1065
6.136.1 Detailed Description	1065
6.136.2 Constructor & Destructor Documentation	1065
6.136.2.1 property() [1/2]	1065
6.136.2.2 property() [2/2]	1065
6.136.3 Member Data Documentation	1065
6.136.3.1 type	1066
6.136.3.2 name	1066
6.136.3.3 value	1066
6.137 GiNaC::archive_node::property_info Struct Reference	1066
6.137.1 Detailed Description	1067
6.137.2 Constructor & Destructor Documentation	1067
6.137.2.1 property_info() [1/2]	1067
6.137.2.2 property_info() [2/2]	1067
6.137.3 Member Data Documentation	1067
6.137.3.1 type	1067
6.137.3.2 name	1067
6.137.3.3 count	1068
6.138 GiNaC::pseries Class Reference	1068
6.138.1 Detailed Description	1074
6.138.2 Constructor & Destructor Documentation	1074
6.138.2.1 pseries() [1/2]	1074
6.138.2.2 pseries() [2/2]	1075
6.138.3 Member Function Documentation	1075
6.138.3.1 precedence()	1075
6.138.3.2 nops()	1075
6.138.3.3 op()	1075

6.138.3.4 degree()	1076
6.138.3.5 ldegree()	1076
6.138.3.6 coeff()	1076
6.138.3.7 collect()	1077
6.138.3.8 eval()	1077
6.138.3.9 evalf()	1077
6.138.3.10 series()	1077
6.138.3.11 subs()	1078
6.138.3.12 normal()	1078
6.138.3.13 expand()	1078
6.138.3.14 conjugate()	1079
6.138.3.15 real_part()	1079
6.138.3.16 imag_part()	1079
6.138.3.17 eval_integ()	1079
6.138.3.18 evalm()	1079
6.138.3.19 archive()	1080
6.138.3.20 read_archive()	1080
6.138.3.21 derivative()	1080
6.138.3.22 get_var()	1081
6.138.3.23 get_point()	1081
6.138.3.24 convert_to_poly()	1081
6.138.3.25 is_compatible_to()	1081
6.138.3.26 is_zero()	1082
6.138.3.27 is_terminating()	1082
6.138.3.28 coeffop()	1082
6.138.3.29 exponop()	1082
6.138.3.30 add_series()	1082
6.138.3.31 mul_const()	1083
6.138.3.32 mul_series()	1083
6.138.3.33 power_const()	1084
6.138.3.34 shift_exponents()	1084
6.138.3.35 print_series()	1084
6.138.3.36 do_print()	1085
6.138.3.37 do_print_latex()	1085
6.138.3.38 do_print_tree()	1085
6.138.3.39 do_print_python()	1085
6.138.3.40 do_print_python_repr()	1085
6.138.4 Member Data Documentation	1086
6.138.4.1 seq	1086
6.138.4.2 var	1086
6.138.4.3 point	1086
6.139 GiNaC::psi1_SERIAL Class Reference	1086

6.139.1 Detailed Description	1087
6.139.2 Member Data Documentation	1087
6.139.2.1 serial	1087
6.140 GiNaC::psi2_SERIAL Class Reference	1087
6.140.1 Detailed Description	1087
6.140.2 Member Data Documentation	1088
6.140.2.1 serial	1088
6.141 GiNaC::ptr< T > Class Template Reference	1088
6.141.1 Detailed Description	1089
6.141.2 Constructor & Destructor Documentation	1090
6.141.2.1 ptr() [1/3]	1090
6.141.2.2 ptr() [2/3]	1090
6.141.2.3 ptr() [3/3]	1090
6.141.2.4 ~ptr()	1090
6.141.3 Member Function Documentation	1090
6.141.3.1 operator=()	1091
6.141.3.2 operator*()	1091
6.141.3.3 operator->()	1091
6.141.3.4 makewritable()	1091
6.141.3.5 swap()	1091
6.141.3.6 operator==()	1092
6.141.3.7 operator"!=()	1092
6.141.4 Friends And Related Function Documentation	1092
6.141.4.1 std::less< ptr< T > >	1092
6.141.4.2 get_pointer	1092
6.141.4.3 operator== [1/2]	1092
6.141.4.4 operator"!= [1/2]	1093
6.141.4.5 operator== [2/2]	1093
6.141.4.6 operator"!= [2/2]	1093
6.141.4.7 operator<<	1093
6.141.5 Member Data Documentation	1093
6.141.5.1 p	1093
6.142 GiNaC::realsymbol Class Reference	1094
6.142.1 Detailed Description	1099
6.142.2 Constructor & Destructor Documentation	1099
6.142.2.1 realsymbol() [1/3]	1100
6.142.2.2 realsymbol() [2/3]	1100
6.142.2.3 realsymbol() [3/3]	1100
6.142.3 Member Function Documentation	1100
6.142.3.1 get_domain()	1100
6.142.3.2 conjugate()	1100
6.142.3.3 real_part()	1101

6.142.3.4 <code>imag_part()</code>	1101
6.142.3.5 <code>duplicate()</code>	1101
6.143 <code>GiNaC::refcounted</code> Class Reference	1102
6.143.1 Detailed Description	1103
6.143.2 Constructor & Destructor Documentation	1103
6.143.2.1 <code>refcounted()</code>	1103
6.143.3 Member Function Documentation	1103
6.143.3.1 <code>add_reference()</code>	1103
6.143.3.2 <code>remove_reference()</code>	1103
6.143.3.3 <code>get_refcount()</code>	1104
6.143.3.4 <code>set_refcount()</code>	1104
6.143.4 Member Data Documentation	1104
6.143.4.1 <code>refcount</code>	1104
6.144 <code>GiNaC::registered_class_options</code> Class Reference	1104
6.144.1 Detailed Description	1105
6.144.2 Constructor & Destructor Documentation	1105
6.144.2.1 <code>registered_class_options()</code>	1105
6.144.3 Member Function Documentation	1105
6.144.3.1 <code>get_name()</code>	1105
6.144.3.2 <code>get_parent_name()</code>	1105
6.144.3.3 <code>get_id()</code>	1106
6.144.3.4 <code>get_print_dispatch_table()</code>	1106
6.144.3.5 <code>print_func()</code> [1/3]	1106
6.144.3.6 <code>print_func()</code> [2/3]	1106
6.144.3.7 <code>print_func()</code> [3/3]	1106
6.144.3.8 <code>set_print_func()</code>	1107
6.144.4 Member Data Documentation	1107
6.144.4.1 <code>name</code>	1107
6.144.4.2 <code>parent_name</code>	1107
6.144.4.3 <code>tinfo_key</code>	1107
6.144.4.4 <code>print_dispatch_table</code>	1108
6.145 <code>GiNaC::relational</code> Class Reference	1108
6.145.1 Detailed Description	1113
6.145.2 Member Typedef Documentation	1114
6.145.2.1 <code>safe_bool</code>	1114
6.145.3 Member Enumeration Documentation	1114
6.145.3.1 <code>operators</code>	1114
6.145.4 Constructor & Destructor Documentation	1114
6.145.4.1 <code>relational()</code>	1114
6.145.5 Member Function Documentation	1114
6.145.5.1 <code>precedence()</code>	1115
6.145.5.2 <code>info()</code>	1115

6.145.5.3 nops()	1115
6.145.5.4 op()	1115
6.145.5.5 map()	1116
6.145.5.6 subs()	1116
6.145.5.7 archive()	1116
6.145.5.8 read_archive()	1116
6.145.5.9 canonical()	1117
6.145.5.10 eval_ncmul()	1117
6.145.5.11 match_same_type()	1117
6.145.5.12 return_type()	1117
6.145.5.13 return_type_tinfo()	1118
6.145.5.14 calchash()	1118
6.145.5.15 do_print()	1118
6.145.5.16 do_print_python_repr()	1118
6.145.5.17 lhs()	1119
6.145.5.18 rhs()	1119
6.145.5.19 make_safe_bool()	1119
6.145.5.20 operator safe_bool()	1119
6.145.5.21 operator"!()	1119
6.145.6 Member Data Documentation	1120
6.145.6.1 lh	1120
6.145.6.2 rh	1120
6.145.6.3 o	1120
6.146 GiNaC::remember_strategies Class Reference	1120
6.146.1 Detailed Description	1121
6.146.2 Member Enumeration Documentation	1121
6.146.2.1 anonymous enum	1121
6.147 GiNaC::remember_table Class Reference	1122
6.147.1 Detailed Description	1123
6.147.2 Constructor & Destructor Documentation	1123
6.147.2.1 remember_table() [1/2]	1123
6.147.2.2 remember_table() [2/2]	1124
6.147.3 Member Function Documentation	1124
6.147.3.1 lookup_entry()	1124
6.147.3.2 add_entry()	1124
6.147.3.3 clear_all_entries()	1124
6.147.3.4 show_statistics()	1124
6.147.3.5 remember_tables()	1125
6.147.3.6 init_table()	1125
6.147.4 Member Data Documentation	1125
6.147.4.1 table_size	1125
6.147.4.2 max_assoc_size	1125

6.147.4.3 remember_strategy	1125
6.148 GiNaC::remember_table_entry Class Reference	1126
6.148.1 Detailed Description	1127
6.148.2 Constructor & Destructor Documentation	1127
6.148.2.1 remember_table_entry()	1127
6.148.3 Member Function Documentation	1127
6.148.3.1 is_equal()	1127
6.148.3.2 get_result()	1127
6.148.3.3 get_last_access()	1128
6.148.3.4 get_successful_hits()	1128
6.148.4 Member Data Documentation	1128
6.148.4.1 hashvalue	1128
6.148.4.2 seq	1128
6.148.4.3 result	1128
6.148.4.4 last_access	1128
6.148.4.5 successful_hits	1129
6.148.4.6 access_counter	1129
6.149 GiNaC::remember_table_list Class Reference	1129
6.149.1 Detailed Description	1130
6.149.2 Constructor & Destructor Documentation	1130
6.149.2.1 remember_table_list()	1130
6.149.3 Member Function Documentation	1130
6.149.3.1 add_entry()	1130
6.149.3.2 lookup_entry()	1130
6.149.4 Member Data Documentation	1131
6.149.4.1 max_assoc_size	1131
6.149.4.2 remember_strategy	1131
6.150 GiNaC::return_type_t Struct Reference	1131
6.150.1 Detailed Description	1131
6.150.2 Member Function Documentation	1132
6.150.2.1 operator<()	1132
6.150.2.2 operator==(())	1132
6.150.2.3 operator"!=(())	1132
6.150.3 Member Data Documentation	1132
6.150.3.1 tinfo	1132
6.150.3.2 rl	1133
6.151 GiNaC::return_types Class Reference	1133
6.151.1 Member Enumeration Documentation	1133
6.151.1.1 anonymous enum	1133
6.152 GiNaC::relational::safe_bool_helper Struct Reference	1133
6.152.1 Member Function Documentation	1134
6.152.1.1 nonnull()	1134

6.153 GiNaC::scalar_products Class Reference	1134
6.153.1 Detailed Description	1134
6.153.2 Member Function Documentation	1135
6.153.2.1 add() [1/2]	1135
6.153.2.2 add() [2/2]	1135
6.153.2.3 add_vectors()	1135
6.153.2.4 clear()	1135
6.153.2.5 is_defined()	1136
6.153.2.6 evaluate()	1136
6.153.2.7 debugprint()	1136
6.153.3 Member Data Documentation	1136
6.153.3.1 spm	1136
6.154 GiNaC::series_options Class Reference	1137
6.154.1 Detailed Description	1137
6.154.2 Member Enumeration Documentation	1137
6.154.2.1 anonymous enum	1137
6.155 GiNaC::solve_algo Class Reference	1137
6.155.1 Detailed Description	1138
6.155.2 Member Enumeration Documentation	1138
6.155.2.1 anonymous enum	1138
6.156 GiNaC::spinidx Class Reference	1139
6.156.1 Detailed Description	1146
6.156.2 Constructor & Destructor Documentation	1146
6.156.2.1 spinidx()	1146
6.156.3 Member Function Documentation	1146
6.156.3.1 is_dummy_pair_same_type()	1147
6.156.3.2 conjugate()	1147
6.156.3.3 archive()	1147
6.156.3.4 read_archive()	1147
6.156.3.5 match_same_type()	1148
6.156.3.6 is_dotted()	1148
6.156.3.7 is_undotted()	1148
6.156.3.8 toggle_dot()	1148
6.156.3.9 toggle_variance_dot()	1149
6.156.3.10 do_print()	1149
6.156.3.11 do_print_latex()	1149
6.156.3.12 do_print_tree()	1149
6.156.4 Member Data Documentation	1149
6.156.4.1 dotted	1149
6.157 GiNaC::spinmetric Class Reference	1150
6.157.1 Detailed Description	1155
6.157.2 Member Function Documentation	1155

6.157.2.1 info()	1155
6.157.2.2 eval_indexed()	1155
6.157.2.3 contract_with()	1156
6.157.2.4 do_print()	1156
6.157.2.5 do_print_latex()	1156
6.158 GiNaC::spmapkey Class Reference	1156
6.158.1 Constructor & Destructor Documentation	1157
6.158.1.1 spmapkey() [1/2]	1158
6.158.1.2 spmapkey() [2/2]	1158
6.158.2 Member Function Documentation	1158
6.158.2.1 operator==(())	1158
6.158.2.2 operator<()	1158
6.158.2.3 debugprint()	1158
6.158.3 Member Data Documentation	1158
6.158.3.1 v1	1159
6.158.3.2 v2	1159
6.158.3.3 dim	1159
6.159 GiNaC::status_flags Class Reference	1159
6.159.1 Detailed Description	1159
6.159.2 Member Enumeration Documentation	1159
6.159.2.1 anonymous enum	1159
6.160 GiNaC::structure< T, ComparisonPolicy > Class Template Reference	1160
6.160.1 Detailed Description	1166
6.160.2 Constructor & Destructor Documentation	1166
6.160.2.1 structure()	1166
6.160.3 Member Function Documentation	1166
6.160.3.1 get_class_name()	1166
6.160.3.2 eval()	1166
6.160.3.3 evalm()	1167
6.160.3.4 eval_ncmul()	1167
6.160.3.5 eval_indexed()	1167
6.160.3.6 print()	1167
6.160.3.7 precedence()	1168
6.160.3.8 info()	1168
6.160.3.9 nops()	1168
6.160.3.10 op()	1168
6.160.3.11 operator[]() [1/4]	1169
6.160.3.12 operator[]() [2/4]	1169
6.160.3.13 let_op()	1169
6.160.3.14 operator[]() [3/4]	1169
6.160.3.15 operator[]() [4/4]	1169
6.160.3.16 has()	1170

6.160.3.17	match()	1170
6.160.3.18	match_same_type()	1170
6.160.3.19	subs()	1171
6.160.3.20	map()	1171
6.160.3.21	degree()	1171
6.160.3.22	ldegree()	1171
6.160.3.23	coeff()	1172
6.160.3.24	expand()	1172
6.160.3.25	collect()	1172
6.160.3.26	derivative()	1172
6.160.3.27	series()	1173
6.160.3.28	normal()	1173
6.160.3.29	to_rational()	1174
6.160.3.30	to_polynomial()	1174
6.160.3.31	integer_content()	1174
6.160.3.32	smod()	1174
6.160.3.33	max_coefficient()	1175
6.160.3.34	get_free_indices()	1175
6.160.3.35	add_indexed()	1175
6.160.3.36	scalar_mul_indexed()	1176
6.160.3.37	contract_with()	1177
6.160.3.38	return_type()	1177
6.160.3.39	return_type_tinfo()	1177
6.160.3.40	is_equal_same_type()	1178
6.160.3.41	calchash()	1178
6.160.3.42	operator->()	1178
6.160.3.43	get_struct() [1/2]	1178
6.160.3.44	get_struct() [2/2]	1179
6.160.4	Member Data Documentation	1179
6.160.4.1	obj	1179
6.161	GiNaC::su3d Class Reference	1179
6.161.1	Detailed Description	1183
6.161.2	Member Function Documentation	1184
6.161.2.1	eval_indexed()	1184
6.161.2.2	contract_with()	1184
6.161.2.3	return_type()	1184
6.161.2.4	do_print()	1184
6.161.2.5	do_print_latex()	1185
6.162	GiNaC::su3f Class Reference	1185
6.162.1	Detailed Description	1189
6.162.2	Member Function Documentation	1190
6.162.2.1	eval_indexed()	1190

6.162.2.2 contract_with()	1190
6.162.2.3 return_type()	1190
6.162.2.4 do_print()	1190
6.162.2.5 do_print_latex()	1191
6.163 GiNaC::su3one Class Reference	1191
6.163.1 Detailed Description	1195
6.163.2 Member Function Documentation	1195
6.163.2.1 do_print()	1195
6.163.2.2 do_print_latex()	1196
6.164 GiNaC::su3t Class Reference	1196
6.164.1 Detailed Description	1200
6.164.2 Member Function Documentation	1200
6.164.2.1 contract_with()	1201
6.164.2.2 do_print()	1201
6.164.2.3 do_print_latex()	1201
6.165 GiNaC::subs_options Class Reference	1201
6.165.1 Detailed Description	1201
6.165.2 Member Enumeration Documentation	1201
6.165.2.1 anonymous enum	1201
6.166 GiNaC::sy_is_less Class Reference	1202
6.166.1 Constructor & Destructor Documentation	1202
6.166.1.1 sy_is_less()	1202
6.166.2 Member Function Documentation	1202
6.166.2.1 operator>()	1202
6.166.3 Member Data Documentation	1203
6.166.3.1 v	1203
6.167 GiNaC::sy_swap Class Reference	1203
6.167.1 Constructor & Destructor Documentation	1203
6.167.1.1 sy_swap()	1203
6.167.2 Member Function Documentation	1203
6.167.2.1 operator>()	1204
6.167.3 Member Data Documentation	1204
6.167.3.1 v	1204
6.167.3.2 swapped	1204
6.168 GiNaC::sym_desc Struct Reference	1204
6.168.1 Detailed Description	1206
6.168.2 Constructor & Destructor Documentation	1206
6.168.2.1 sym_desc()	1206
6.168.3 Member Function Documentation	1206
6.168.3.1 operator<()	1206
6.168.4 Member Data Documentation	1206
6.168.4.1 sym	1207

6.168.4.2 deg_a	1207
6.168.4.3 deg_b	1207
6.168.4.4 ldeg_a	1207
6.168.4.5 ldeg_b	1207
6.168.4.6 max_deg	1207
6.168.4.7 max_lcnops	1208
6.169 GiNaC::symbol Class Reference	1208
6.169.1 Detailed Description	1213
6.169.2 Constructor & Destructor Documentation	1213
6.169.2.1 symbol() [1/2]	1213
6.169.2.2 symbol() [2/2]	1213
6.169.3 Member Function Documentation	1214
6.169.3.1 info()	1214
6.169.3.2 eval()	1214
6.169.3.3 evalf()	1214
6.169.3.4 series()	1215
6.169.3.5 subs()	1215
6.169.3.6 normal()	1215
6.169.3.7 to_rational()	1216
6.169.3.8 to_polynomial()	1216
6.169.3.9 conjugate()	1216
6.169.3.10 real_part()	1216
6.169.3.11 imag_part()	1216
6.169.3.12 is_polynomial()	1217
6.169.3.13 archive()	1217
6.169.3.14 read_archive()	1217
6.169.3.15 derivative()	1218
6.169.3.16 is_equal_same_type()	1218
6.169.3.17 calchash()	1218
6.169.3.18 get_domain()	1219
6.169.3.19 set_name()	1219
6.169.3.20 set_TeX_name()	1219
6.169.3.21 get_name()	1219
6.169.3.22 get_TeX_name()	1219
6.169.3.23 do_print()	1220
6.169.3.24 do_print_latex()	1220
6.169.3.25 do_print_tree()	1220
6.169.3.26 do_print_python_repr()	1220
6.169.4 Member Data Documentation	1220
6.169.4.1 serial	1220
6.169.4.2 name	1221
6.169.4.3 TeX_name	1221

6.169.4.4 next_serial	1221
6.170 GiNaC::symbolset Class Reference	1221
6.170.1 Constructor & Destructor Documentation	1222
6.170.1.1 symbolset()	1222
6.170.2 Member Function Documentation	1222
6.170.2.1 insert_symbols()	1222
6.170.2.2 has()	1222
6.170.3 Member Data Documentation	1222
6.170.3.1 s	1223
6.171 GiNaC::symmetry Class Reference	1223
6.171.1 Detailed Description	1228
6.171.2 Member Enumeration Documentation	1228
6.171.2.1 symmetry_type	1228
6.171.3 Constructor & Destructor Documentation	1228
6.171.3.1 symmetry() [1/2]	1228
6.171.3.2 symmetry() [2/2]	1228
6.171.4 Member Function Documentation	1229
6.171.4.1 archive()	1229
6.171.4.2 read_archive()	1229
6.171.4.3 calchash()	1229
6.171.4.4 get_type()	1230
6.171.4.5 set_type()	1230
6.171.4.6 add()	1230
6.171.4.7 validate()	1230
6.171.4.8 has_symmetry()	1231
6.171.4.9 has_nonsymmetric()	1231
6.171.4.10 has_cyclic()	1231
6.171.4.11 do_print()	1231
6.171.4.12 do_print_tree()	1231
6.171.5 Friends And Related Function Documentation	1232
6.171.5.1 sy_is_less	1232
6.171.5.2 sy_swap	1232
6.171.5.3 canonicalize	1232
6.171.6 Member Data Documentation	1232
6.171.6.1 type	1232
6.171.6.2 indices	1233
6.171.6.3 children	1233
6.172 GiNaC::symminfo Class Reference	1233
6.172.1 Detailed Description	1235
6.172.2 Constructor & Destructor Documentation	1235
6.172.2.1 symminfo() [1/2]	1235
6.172.2.2 symminfo() [2/2]	1235

6.172.3 Member Data Documentation	1235
6.172.3.1 symmterm	1235
6.172.3.2 coeff	1235
6.172.3.3 orig	1236
6.172.3.4 num	1236
6.173 GiNaC::symminfo_is_less_by_orig Class Reference	1236
6.173.1 Member Function Documentation	1236
6.173.1.1 operator()	1236
6.174 GiNaC::symminfo_is_less_by_symmterm Class Reference	1236
6.174.1 Member Function Documentation	1237
6.174.1.1 operator()	1237
6.175 GiNaC::tensdelta Class Reference	1237
6.175.1 Detailed Description	1242
6.175.2 Member Function Documentation	1242
6.175.2.1 info()	1242
6.175.2.2 eval_indexed()	1242
6.175.2.3 contract_with()	1242
6.175.2.4 return_type()	1243
6.175.2.5 do_print()	1243
6.175.2.6 do_print_latex()	1243
6.176 GiNaC::tensepsilon Class Reference	1243
6.176.1 Detailed Description	1248
6.176.2 Constructor & Destructor Documentation	1248
6.176.2.1 tensepsilon()	1248
6.176.3 Member Function Documentation	1248
6.176.3.1 info()	1248
6.176.3.2 eval_indexed()	1249
6.176.3.3 contract_with()	1249
6.176.3.4 archive()	1249
6.176.3.5 read_archive()	1249
6.176.3.6 return_type()	1250
6.176.3.7 do_print()	1250
6.176.3.8 do_print_latex()	1250
6.176.4 Member Data Documentation	1250
6.176.4.1 minkowski	1250
6.176.4.2 pos_sig	1250
6.177 GiNaC::tensmetric Class Reference	1251
6.177.1 Detailed Description	1256
6.177.2 Member Function Documentation	1256
6.177.2.1 info()	1256
6.177.2.2 eval_indexed()	1256
6.177.2.3 contract_with()	1257

6.177.2.4 return_type()	1257
6.177.2.5 do_print()	1257
6.178 GiNaC::tensor Class Reference	1258
6.178.1 Detailed Description	1262
6.178.2 Member Function Documentation	1262
6.178.2.1 return_type()	1262
6.178.2.2 replace_contr_index()	1262
6.179 GiNaC::terminfo Class Reference	1263
6.179.1 Detailed Description	1263
6.179.2 Constructor & Destructor Documentation	1264
6.179.2.1 terminfo()	1264
6.179.3 Member Data Documentation	1264
6.179.3.1 orig	1264
6.179.3.2 symm	1264
6.180 GiNaC::terminfo_is_less Class Reference	1264
6.180.1 Member Function Documentation	1264
6.180.1.1 operator()	1265
6.181 GiNaC::class_info< OPT >::tree_node Struct Reference	1265
6.181.1 Constructor & Destructor Documentation	1265
6.181.1.1 tree_node()	1266
6.181.2 Member Function Documentation	1266
6.181.2.1 add_child()	1266
6.181.3 Member Data Documentation	1266
6.181.3.1 children	1266
6.181.3.2 info	1266
6.182 GiNaC::unarchive_table_t Class Reference	1266
6.182.1 Constructor & Destructor Documentation	1267
6.182.1.1 unarchive_table_t()	1267
6.182.1.2 ~unarchive_table_t()	1267
6.182.2 Member Function Documentation	1267
6.182.2.1 find()	1267
6.182.2.2 insert()	1268
6.182.3 Member Data Documentation	1268
6.182.3.1 usecount	1268
6.182.3.2 unarch_map	1268
6.183 GiNaC::user_defined_kernel Class Reference	1268
6.183.1 Detailed Description	1275
6.183.2 Constructor & Destructor Documentation	1275
6.183.2.1 user_defined_kernel()	1275
6.183.3 Member Function Documentation	1275
6.183.3.1 nops()	1275
6.183.3.2 op()	1275

6.183.3.3 let_op()	1276
6.183.3.4 is_numeric()	1276
6.183.3.5 Laurent_series()	1276
6.183.3.6 uses_Laurent_series()	1276
6.183.3.7 do_print()	1277
6.183.4 Member Data Documentation	1277
6.183.4.1 f	1277
6.183.4.2 x	1277
6.184 GiNaC::varidx Class Reference	1277
6.184.1 Detailed Description	1284
6.184.2 Constructor & Destructor Documentation	1284
6.184.2.1 varidx()	1284
6.184.3 Member Function Documentation	1285
6.184.3.1 is_dummy_pair_same_type()	1285
6.184.3.2 archive()	1285
6.184.3.3 read_archive()	1285
6.184.3.4 match_same_type()	1286
6.184.3.5 is_covariant()	1286
6.184.3.6 is_contravariant()	1286
6.184.3.7 toggle_variance()	1286
6.184.3.8 do_print()	1287
6.184.3.9 do_print_tree()	1287
6.184.4 Member Data Documentation	1287
6.184.4.1 covariant	1287
6.185 GiNaC::visitor Class Reference	1287
6.185.1 Detailed Description	1288
6.185.2 Constructor & Destructor Documentation	1288
6.185.2.1 ~visitor()	1288
6.186 GiNaC::wildcard Class Reference	1288
6.186.1 Detailed Description	1292
6.186.2 Constructor & Destructor Documentation	1293
6.186.2.1 wildcard()	1293
6.186.3 Member Function Documentation	1293
6.186.3.1 match()	1293
6.186.3.2 archive()	1293
6.186.3.3 read_archive()	1294
6.186.3.4 calchash()	1294
6.186.3.5 get_label()	1294
6.186.3.6 do_print()	1294
6.186.3.7 do_print_tree()	1295
6.186.3.8 do_print_python_repr()	1295
6.186.4 Member Data Documentation	1295

6.186.4.1 label	1295
6.187 GiNaC::zeta1_SERIAL Class Reference	1295
6.187.1 Detailed Description	1296
6.187.2 Member Data Documentation	1296
6.187.2.1 serial	1296
6.188 GiNaC::zeta2_SERIAL Class Reference	1296
6.188.1 Detailed Description	1296
6.188.2 Member Data Documentation	1297
6.188.2.1 serial	1297
7 File Documentation	1299
7.1 add.cpp File Reference	1299
7.1.1 Detailed Description	1299
7.2 add.h File Reference	1300
7.2.1 Detailed Description	1300
7.3 archive.cpp File Reference	1300
7.3.1 Detailed Description	1301
7.4 archive.h File Reference	1301
7.4.1 Detailed Description	1302
7.4.2 Macro Definition Documentation	1302
7.4.2.1 GINAC_DECLARE_UNARCHIVER	1303
7.4.2.2 GINAC_BIND_UNARCHIVER	1303
7.5 assertion.h File Reference	1304
7.5.1 Detailed Description	1304
7.5.2 Macro Definition Documentation	1304
7.5.2.1 GINAC_ASSERT	1304
7.6 basic.cpp File Reference	1304
7.6.1 Detailed Description	1305
7.7 basic.h File Reference	1305
7.7.1 Detailed Description	1306
7.8 class_info.h File Reference	1306
7.8.1 Detailed Description	1307
7.9 clifford.cpp File Reference	1307
7.9.1 Detailed Description	1309
7.10 clifford.h File Reference	1309
7.10.1 Detailed Description	1311
7.11 color.cpp File Reference	1311
7.11.1 Detailed Description	1312
7.11.2 Macro Definition Documentation	1312
7.11.2.1 TEST_PERMUTATION	1313
7.11.2.2 CMPINDICES	1313
7.12 color.h File Reference	1313

7.12.1 Detailed Description	1314
7.13 compiler.h File Reference	1314
7.13.1 Detailed Description	1314
7.13.2 Macro Definition Documentation	1314
7.13.2.1 unlikely	1315
7.13.2.2 likely	1315
7.13.2.3 attribute_deprecated	1315
7.14 constant.cpp File Reference	1315
7.14.1 Detailed Description	1316
7.15 constant.h File Reference	1316
7.15.1 Detailed Description	1316
7.16 container.h File Reference	1317
7.16.1 Detailed Description	1317
7.17 crc32.h File Reference	1317
7.17.1 Detailed Description	1318
7.18 ex.cpp File Reference	1318
7.18.1 Detailed Description	1318
7.19 ex.h File Reference	1318
7.19.1 Detailed Description	1320
7.20 excompiler.cpp File Reference	1321
7.20.1 Detailed Description	1321
7.21 excompiler.h File Reference	1321
7.21.1 Detailed Description	1322
7.22 expair.cpp File Reference	1322
7.22.1 Detailed Description	1323
7.23 expair.h File Reference	1323
7.23.1 Detailed Description	1323
7.24 expairseq.cpp File Reference	1324
7.24.1 Detailed Description	1324
7.25 expairseq.h File Reference	1324
7.25.1 Detailed Description	1325
7.26 exprseq.cpp File Reference	1325
7.26.1 Detailed Description	1325
7.27 exprseq.h File Reference	1326
7.27.1 Detailed Description	1326
7.28 factor.cpp File Reference	1326
7.28.1 Detailed Description	1327
7.28.2 Macro Definition Documentation	1327
7.28.2.1 DCOUT	1327
7.28.2.2 DCOUTVAR	1327
7.28.2.3 DCOUT2	1328
7.28.2.4 USE_SAME_DEGREE_FACTOR	1328

7.28.3 Variable Documentation	1328
7.28.3.1 value	1328
7.28.3.2 r	1328
7.28.3.3 c	1329
7.28.3.4 m	1329
7.28.3.5 lr	1330
7.28.3.6 cache	1330
7.28.3.7 factors	1330
7.28.3.8 one	1330
7.28.3.9 n	1331
7.28.3.10 len	1331
7.28.3.11 last	1331
7.28.3.12 k	1332
7.28.3.13 poly	1332
7.28.3.14 x	1332
7.28.3.15 evalpoint	1333
7.28.3.16 R	1333
7.28.3.17 syms_wox	1333
7.28.3.18 unit	1334
7.28.3.19 cont	1334
7.28.3.20 pp	1334
7.28.3.21 vn	1334
7.28.3.22 vnlst	1334
7.28.3.23 modulus	1334
7.28.3.24 syms	1334
7.28.3.25 options	1335
7.29 factor.h File Reference	1335
7.29.1 Detailed Description	1335
7.30 fail.cpp File Reference	1335
7.30.1 Detailed Description	1336
7.31 fail.h File Reference	1336
7.31.1 Detailed Description	1336
7.32 fderivative.cpp File Reference	1337
7.32.1 Detailed Description	1337
7.33 fderivative.h File Reference	1337
7.33.1 Detailed Description	1338
7.34 flags.h File Reference	1338
7.34.1 Detailed Description	1338
7.35 function.cpp File Reference	1339
7.35.1 Detailed Description	1339
7.36 function.h File Reference	1339
7.36.1 Detailed Description	1346

7.36.2 Macro Definition Documentation	1346
7.36.2.1 DECLARE_FUNCTION_1P	1346
7.36.2.2 DECLARE_FUNCTION_2P	1346
7.36.2.3 DECLARE_FUNCTION_3P	1347
7.36.2.4 DECLARE_FUNCTION_4P	1347
7.36.2.5 DECLARE_FUNCTION_5P	1347
7.36.2.6 DECLARE_FUNCTION_6P	1347
7.36.2.7 DECLARE_FUNCTION_7P	1348
7.36.2.8 DECLARE_FUNCTION_8P	1348
7.36.2.9 DECLARE_FUNCTION_9P	1348
7.36.2.10 DECLARE_FUNCTION_10P	1348
7.36.2.11 DECLARE_FUNCTION_11P	1349
7.36.2.12 DECLARE_FUNCTION_12P	1349
7.36.2.13 DECLARE_FUNCTION_13P	1349
7.36.2.14 DECLARE_FUNCTION_14P	1350
7.36.2.15 REGISTER_FUNCTION	1350
7.36.2.16 is_ex_the_function	1350
7.37 ginc.h File Reference	1350
7.37.1 Detailed Description	1351
7.38 hash_map.h File Reference	1351
7.38.1 Detailed Description	1351
7.39 hash_seed.h File Reference	1352
7.39.1 Detailed Description	1352
7.40 idx.cpp File Reference	1352
7.40.1 Detailed Description	1353
7.41 idx.h File Reference	1353
7.41.1 Detailed Description	1354
7.42 indexed.cpp File Reference	1354
7.42.1 Detailed Description	1356
7.43 indexed.h File Reference	1356
7.43.1 Detailed Description	1357
7.44 inifcns.cpp File Reference	1357
7.44.1 Detailed Description	1360
7.45 inifcns.h File Reference	1360
7.45.1 Detailed Description	1362
7.46 inifcns_elliptic.cpp File Reference	1362
7.46.1 Detailed Description	1363
7.47 inifcns_gamma.cpp File Reference	1363
7.47.1 Detailed Description	1364
7.48 inifcns_nstdsums.cpp File Reference	1364
7.48.1 Detailed Description	1366
7.49 inifcns_trans.cpp File Reference	1366

7.49.1 Detailed Description	1369
7.50 integral.cpp File Reference	1369
7.50.1 Detailed Description	1370
7.51 integral.h File Reference	1370
7.51.1 Detailed Description	1371
7.52 integration_kernel.cpp File Reference	1371
7.52.1 Detailed Description	1372
7.52.2 Variable Documentation	1372
7.52.2.1 qbar	1372
7.52.2.2 order	1373
7.52.2.3 cache_vec	1373
7.52.2.4 x	1373
7.53 integration_kernel.h File Reference	1373
7.53.1 Detailed Description	1375
7.54 lst.cpp File Reference	1375
7.54.1 Detailed Description	1375
7.55 lst.h File Reference	1375
7.55.1 Detailed Description	1376
7.56 matrix.cpp File Reference	1376
7.56.1 Detailed Description	1377
7.57 matrix.h File Reference	1377
7.57.1 Detailed Description	1378
7.58 mul.cpp File Reference	1378
7.58.1 Detailed Description	1379
7.59 mul.h File Reference	1379
7.59.1 Detailed Description	1380
7.60 ncmul.cpp File Reference	1380
7.60.1 Detailed Description	1380
7.61 ncmul.h File Reference	1381
7.61.1 Detailed Description	1381
7.62 normal.cpp File Reference	1381
7.62.1 Detailed Description	1383
7.62.2 Macro Definition Documentation	1383
7.62.2.1 FAST_COMPARE	1384
7.62.2.2 USE_REMEMBER	1384
7.62.2.3 USE_TRIAL_DIVISION	1384
7.62.2.4 STATISTICS	1384
7.63 normal.h File Reference	1384
7.63.1 Detailed Description	1385
7.64 numeric.cpp File Reference	1385
7.64.1 Detailed Description	1388
7.65 numeric.h File Reference	1389

7.65.1 Detailed Description	1391
7.66 operators.cpp File Reference	1391
7.66.1 Detailed Description	1393
7.67 operators.h File Reference	1393
7.67.1 Detailed Description	1395
7.68 power.cpp File Reference	1395
7.68.1 Detailed Description	1395
7.69 power.h File Reference	1396
7.69.1 Detailed Description	1396
7.70 print.cpp File Reference	1396
7.70.1 Detailed Description	1397
7.71 print.h File Reference	1397
7.71.1 Detailed Description	1398
7.71.2 Macro Definition Documentation	1398
7.71.2.1 GINAC_DECLARE_PRINT_CONTEXT_COMMON	1398
7.71.2.2 GINAC_DECLARE_PRINT_CONTEXT_BASE	1399
7.71.2.3 GINAC_DECLARE_PRINT_CONTEXT	1399
7.71.2.4 GINAC_IMPLEMENT_PRINT_CONTEXT	1399
7.72 pseries.cpp File Reference	1400
7.72.1 Detailed Description	1400
7.73 pseries.h File Reference	1400
7.73.1 Detailed Description	1401
7.74 ptr.h File Reference	1401
7.74.1 Detailed Description	1401
7.75 registrar.cpp File Reference	1402
7.75.1 Detailed Description	1402
7.76 registrar.h File Reference	1402
7.76.1 Detailed Description	1403
7.76.2 Macro Definition Documentation	1403
7.76.2.1 GINAC_DECLARE_REGISTERED_CLASS_COMMON	1404
7.76.2.2 GINAC_DECLARE_REGISTERED_CLASS_NO_CTORS	1404
7.76.2.3 GINAC_DECLARE_REGISTERED_CLASS	1404
7.76.2.4 GINAC_IMPLEMENT_REGISTERED_CLASS	1405
7.76.2.5 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT	1405
7.76.2.6 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT_T	1405
7.77 relational.cpp File Reference	1406
7.77.1 Detailed Description	1406
7.78 relational.h File Reference	1406
7.78.1 Detailed Description	1407
7.79 remember.cpp File Reference	1407
7.79.1 Detailed Description	1407
7.80 remember.h File Reference	1407

7.80.1 Detailed Description	1408
7.81 structure.h File Reference	1408
7.81.1 Detailed Description	1408
7.82 symbol.cpp File Reference	1409
7.82.1 Detailed Description	1409
7.83 symbol.h File Reference	1409
7.83.1 Detailed Description	1410
7.84 symmetry.cpp File Reference	1410
7.84.1 Detailed Description	1411
7.85 symmetry.h File Reference	1411
7.85.1 Detailed Description	1412
7.86 tensor.cpp File Reference	1413
7.86.1 Detailed Description	1414
7.87 tensor.h File Reference	1414
7.87.1 Detailed Description	1415
7.88 utils.cpp File Reference	1415
7.88.1 Detailed Description	1417
7.89 utils.h File Reference	1417
7.89.1 Detailed Description	1419
7.89.2 Macro Definition Documentation	1419
7.89.2.1 DEFAULT_CTOR	1419
7.89.2.2 DEFAULT_COMPARE	1419
7.89.2.3 DEFAULT_PRINT	1419
7.89.2.4 DEFAULT_PRINT_LATEX	1419
7.90 utils_multi_iterator.h File Reference	1420
7.90.1 Detailed Description	1421
7.91 version.h File Reference	1421
7.91.1 Detailed Description	1422
7.91.2 Macro Definition Documentation	1422
7.91.2.1 GINACLIB_MAJOR_VERSION	1422
7.91.2.2 GINACLIB_MINOR_VERSION	1422
7.91.2.3 GINACLIB_MICRO_VERSION	1422
7.91.2.4 GINAC_LT_CURRENT	1422
7.91.2.5 GINAC_LT_REVISION	1422
7.91.2.6 GINAC_LT_AGE	1422
7.91.2.7 GINACLIB_ARCHIVE_VERSION	1423
7.91.2.8 GINACLIB_ARCHIVE_AGE	1423
7.91.2.9 GINACLIB_STR_HELPER	1423
7.91.2.10 GINACLIB_STR	1423
7.91.2.11 GINACLIB_VERSION	1423
7.92 wildcard.cpp File Reference	1423
7.92.1 Detailed Description	1424

7.93 wildcard.h File Reference	1424
7.93.1 Detailed Description	1424

Chapter 1

Namespace Index

1.1 Namespace List

Here is a list of all namespaces with brief descriptions:

GiNaC	19
GiNaC::internal	311
std	311

Chapter 2

Hierarchical Index

2.1 Class Hierarchy

This inheritance list is sorted roughly, but not completely, alphabetically:

GiNaC::internal::_iter_rep	313
GiNaC::_numeric_digits	315
GiNaC::archive	336
GiNaC::archive_node	344
GiNaC::archive_node::archive_node_cit_range	354
GiNaC::archive::archived_ex	356
GiNaC::basic_multi_iterator< T >	391
GiNaC::multi_iterator_counter< T >	891
GiNaC::multi_iterator_counter_indv< T >	894
GiNaC::multi_iterator_ordered< T >	898
GiNaC::multi_iterator_ordered_eq< T >	902
GiNaC::multi_iterator_ordered_eq_indv< T >	906
GiNaC::multi_iterator_permutation< T >	910
GiNaC::multi_iterator_shuffle< T >	914
GiNaC::multi_iterator_shuffle_prime< T >	919
GiNaC::basic_partition_generator	397
GiNaC::partition_generator	979
GiNaC::partition_with_zero_parts_generator	982
GiNaC::class_info< OPT >	399
GiNaC::compare_all_equal< T >	437
GiNaC::compare_bitwise< T >	439
GiNaC::compare_std_less< T >	440
ComparisonPolicy	
GiNaC::structure< T, ComparisonPolicy >	1160
GiNaC::composition_generator	441
GiNaC::const_iterator	444
GiNaC::const_postorder_iterator	451
GiNaC::const_preorder_iterator	454
GiNaC::container_storage< C >	487
GiNaC::container< C >	469
GiNaC::function	661
GiNaC::fderivative	646
GiNaC::indexed	750
GiNaC::clifford	403

GiNaC::color	424
GiNaC::ncmul	931
GiNaC::composition_generator::coolmulti	491
GiNaC::determinant_algo	495
GiNaC::do_taylor	523
GiNaC::domain	523
std::domain_error	
GiNaC::pole_error	1007
GiNaC::dunno	524
GiNaC::composition_generator::coolmulti::element	554
std::equal_to< GiNaC::ex >	564
GiNaC::error_and_integral	566
GiNaC::error_and_integral_is_less	567
GiNaC::ex	572
GiNaC::ex_base_is_less	608
GiNaC::ex_is_equal	608
GiNaC::ex_is_less	609
GiNaC::ex_swap	609
GiNaC::expair	610
GiNaC::expair_is_less	613
GiNaC::expair_rest_is_less	614
GiNaC::expair_swap	615
GiNaC::expand_options	639
GiNaC::factor_options	640
GiNaC::function_options	683
GiNaC::G2_SERIAL	730
GiNaC::G3_SERIAL	731
GiNaC::gcd_options	731
GiNaC::gcdheu_failed	732
GiNaC::has_distance< T >	732
GiNaC::has_options	734
std::hash< GiNaC::ex >	735
GiNaC::idx_is_equal_ignore_dim	749
GiNaC::info_flags	771
GiNaC::is_not_a_clifford	794
GiNaC::is_summation_idx	795
GiNaC::iterated_integral2_SERIAL	796
GiNaC::iterated_integral3_SERIAL	796
GiNaC::lanczos_coeffs	815
std::less< GiNaC::ptr< T > >	816
GiNaC::library_init	817
std::list	
GiNaC::remember_table_list	1129
GiNaC::make_flat_inserter	819
GiNaC::map_function	822
GiNaC::derivative_map_function	493
GiNaC::eval_integ_map_function	568
GiNaC::evalf_map_function	569
GiNaC::evalm_map_function	571
GiNaC::expand_map_function	637
GiNaC::normal_map_function	945
GiNaC::pointer_to_map_function	985
GiNaC::pointer_to_map_function_1arg< T1 >	987
GiNaC::pointer_to_map_function_2args< T1, T2 >	990
GiNaC::pointer_to_map_function_3args< T1, T2, T3 >	992
GiNaC::pointer_to_member_to_map_function< C >	995
GiNaC::pointer_to_member_to_map_function_1arg< C, T1 >	998
GiNaC::pointer_to_member_to_map_function_2args< C, T1, T2 >	1000

GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2, T3 >	1003
GiNaC::basic_partition_generator::mpartition2	866
GiNaC::op0_is_equal	979
GiNaC::print_context	1034
GiNaC::print_csrc	1038
GiNaC::print_csrc_cl_N	1040
GiNaC::print_csrc_double	1042
GiNaC::print_csrc_float	1044
GiNaC::print_dflt	1046
GiNaC::print_latex	1051
GiNaC::print_python	1060
GiNaC::print_python_repr	1061
GiNaC::print_tree	1063
GiNaC::print_context_options	1036
GiNaC::print_functor	1047
GiNaC::print_functor_impl	1050
GiNaC::print_memfun_handler< T, C >	1053
GiNaC::print_ptrfun_handler< T, C >	1057
GiNaC::print_options	1055
GiNaC::archive_node::property	1065
GiNaC::archive_node::property_info	1066
GiNaC::psi1_SERIAL	1086
GiNaC::psi2_SERIAL	1087
GiNaC::ptr< T >	1088
GiNaC::ptr< GiNaC::basic >	1088
GiNaC::refcounted	1102
GiNaC::basic	357
GiNaC::constant	458
GiNaC::container< C >	469
GiNaC::expairseq	616
GiNaC::add	318
GiNaC::mul	868
GiNaC::fail	641
GiNaC::idx	736
GiNaC::varidx	1277
GiNaC::spinidx	1139
GiNaC::integral	772
GiNaC::integration_kernel	785
GiNaC::ELi_kernel	556
GiNaC::Ebar_kernel	524
GiNaC::Eisenstein_h_kernel	533
GiNaC::Eisenstein_kernel	544
GiNaC::Kronecker_dtau_kernel	797
GiNaC::Kronecker_dz_kernel	806
GiNaC::basic_log_kernel	385
GiNaC::modular_form_kernel	857
GiNaC::multiple_polylog_kernel	923
GiNaC::user_defined_kernel	1268
GiNaC::matrix	824
GiNaC::numeric	947
GiNaC::power	1016
GiNaC::pseries	1068
GiNaC::relational	1108
GiNaC::structure< T, ComparisonPolicy >	1160
GiNaC::symbol	1208
GiNaC::realsymbol	1094
GiNaC::possymbol	1009

GiNaC::symmetry	1223
GiNaC::tensor	1258
GiNaC::cliffordunit	419
GiNaC::diracgamma	496
GiNaC::diracgamma5	503
GiNaC::diracgammaL	508
GiNaC::diracgammaR	513
GiNaC::diracone	518
GiNaC::su3d	1179
GiNaC::su3f	1185
GiNaC::su3one	1191
GiNaC::su3t	1196
GiNaC::tensdelta	1237
GiNaC::tensepsilon	1243
GiNaC::tensmetric	1251
GiNaC::minkmetric	849
GiNaC::spinmetric	1150
GiNaC::wildcard	1288
GiNaC::registered_class_options	1104
GiNaC::remember_strategies	1120
GiNaC::remember_table_entry	1126
GiNaC::return_type_t	1131
GiNaC::return_types	1133
GiNaC::relational::safe_bool_helper	1133
GiNaC::scalar_products	1134
GiNaC::series_options	1137
GiNaC::solve_algo	1137
GiNaC::spmapkey	1156
GiNaC::status_flags	1159
GiNaC::subs_options	1201
GiNaC::sy_is_less	1202
GiNaC::sy_swap	1203
GiNaC::sym_desc	1204
GiNaC::symbolset	1221
GiNaC::symminfo	1233
GiNaC::symminfo_is_less_by_orig	1236
GiNaC::symminfo_is_less_by_symmterm	1236
GiNaC::terminfo	1263
GiNaC::terminfo_is_less	1264
GiNaC::class_info< OPT >::tree_node	1265
GiNaC::unarchive_table_t	1266
std::vector	
GiNaC::remember_table	1122
GiNaC::visitor	1287
GiNaC::zeta1_SERIAL	1295
GiNaC::zeta2_SERIAL	1296

Chapter 3

Class Index

3.1 Class List

Here are the classes, structs, unions and interfaces with brief descriptions:

GiNaC::internal::_iter_rep	313
GiNaC::_numeric_digits	
This class is used to instantiate a global singleton object Digits which behaves just like Maple's	
Digits	315
GiNaC::add	
Sum of expressions	318
GiNaC::archive	
This class holds archived versions of GiNaC expressions (class ex)	336
GiNaC::archive_node	
This class stores all properties needed to record/retrieve the state of one object of class basic	
(or a derived class)	344
GiNaC::archive_node::archive_node_cit_range	354
GiNaC::archive::archived_ex	
Archived expression descriptor	356
GiNaC::basic	
This class is the ABC (abstract base class) of GiNaC 's class hierarchy	357
GiNaC::basic_log_kernel	
The basic integration kernel with a logarithmic singularity at the origin	385
GiNaC::basic_multi_iterator< T >	
Basic_multi_iterator is a base class	391
GiNaC::basic_partition_generator	
Base class for generating all bounded combinatorial partitions of an integer n with exactly m	
parts in non-decreasing order	397
GiNaC::class_info< OPT >	399
GiNaC::clifford	
This class holds an object representing an element of the Clifford algebra (the Dirac gamma	
matrices)	403
GiNaC::cliffordunit	
This class represents the Clifford algebra generators (units)	419
GiNaC::color	
This class holds a generator T_a or the unity element of the Lie algebra of SU(3), as used for	
calculations in quantum chromodynamics	424
GiNaC::compare_all_equal< T >	
Comparison policy: all structures of one type are equal	437
GiNaC::compare_bitwise< T >	
Comparison policy: use bit-wise comparison to compare structures	439

GiNaC::compare_std_less< T >	
Comparison policy: use <code>std::equal_to</code> / <code>std::less</code> (defaults to operators <code>==</code> and <code><</code>) to compare structures	440
GiNaC::composition_generator	
Generate all compositions of a partition of an integer n , starting with the compositions which has non-decreasing order	441
GiNaC::const_iterator	444
GiNaC::const_postorder_iterator	451
GiNaC::const_preorder_iterator	454
GiNaC::constant	
This class holds constants, symbols with specific numerical value	458
GiNaC::container< C >	
Wrapper template for making GiNaC classes out of STL containers	469
GiNaC::container_storage< C >	
Helper template for encapsulating the <code>reserve()</code> mechanics of STL containers	487
GiNaC::composition_generator::coolmulti	491
GiNaC::derivative_map_function	
Function object to be applied by <code>basic::derivative()</code>	493
GiNaC::determinant_algo	
Switch to control algorithm for determinant computation	495
GiNaC::diracgamma	
This class represents the Dirac gamma Lorentz vector	496
GiNaC::diracgamma5	
This class represents the Dirac gamma5 object which anticommutes with all other gammas	503
GiNaC::diracgammaL	
This class represents the Dirac gammaL object which behaves like $1/2 (1-\text{gamma}5)$	508
GiNaC::diracgammaR	
This class represents the Dirac gammaL object which behaves like $1/2 (1+\text{gamma}5)$	513
GiNaC::diracone	
This class represents the Clifford algebra unity element	518
GiNaC::do_taylor	
Exception class thrown by classes which provide their own series expansion to signal that ordinary Taylor expansion is safe	523
GiNaC::domain	
Domain of an object	523
GiNaC::dunno	
Exception class thrown by functions to signal unimplemented functionality so the expression may just be <code>.hold()</code>	524
GiNaC::Ebar_kernel	
The Ebar-kernel	524
GiNaC::Eisenstein_h_kernel	
The kernel corresponding to the Eisenstein series $h_{k,N,r,s}(\tau)$	533
GiNaC::Eisenstein_kernel	
The kernel corresponding to the Eisenstein series $E_{k,N,a,b,K}(\tau)$	544
GiNaC::composition_generator::coolmulti::element	554
GiNaC::ELi_kernel	
The ELi-kernel	556
std::equal_to< GiNaC::ex >	
Specialization of <code>std::equal_to()</code> for <code>ex</code> objects	564
GiNaC::error_and_integral	566
GiNaC::error_and_integral_is_less	567
GiNaC::eval_integ_map_function	
Function object to be applied by <code>basic::eval_integ()</code>	568
GiNaC::evalf_map_function	
Function object to be applied by <code>basic::evalf()</code>	569
GiNaC::evalm_map_function	
Function object to be applied by <code>basic::evalm()</code>	571

GiNaC::ex	
Lightweight wrapper for GiNaC 's symbolic objects	572
GiNaC::ex_base_is_less	608
GiNaC::ex_is_equal	608
GiNaC::ex_is_less	609
GiNaC::ex_swap	609
GiNaC::expair	
A pair of expressions	610
GiNaC::expair_is_less	
Function object for insertion into third argument of STL's sort() etc	613
GiNaC::expair_rest_is_less	
Function object not caring about the numerical coefficients for insertion into third argument of STL's sort()	614
GiNaC::expair_swap	615
GiNaC::expairseq	
A sequence of class expair	616
GiNaC::expand_map_function	
Function object to be applied by basic::expand()	637
GiNaC::expand_options	
Flags to control the behavior of expand()	639
GiNaC::factor_options	
Flags to control the polynomial factorization	640
GiNaC::fail	641
GiNaC::fderivative	
This class represents the (abstract) derivative of a symbolic function	646
GiNaC::function	
The class function is used to implement builtin functions like sin, cos... and user defined functions	661
GiNaC::function_options	683
GiNaC::G2_SERIAL	
Generalized multiple polylogarithm	730
GiNaC::G3_SERIAL	
Generalized multiple polylogarithm with explicit imaginary parts	731
GiNaC::gcd_options	
Flags to control the behavior of gcd() and friends	731
GiNaC::gcdheu_failed	
Exception thrown by heur_gcd() to signal failure	732
GiNaC::has_distance< T >	
SFINAE test for distance	732
GiNaC::has_options	
Flags to control the behavior of has()	734
std::hash< GiNaC::ex >	
Specialization of std::hash() for ex objects	735
GiNaC::idx	
This class holds one index of an indexed object	736
GiNaC::idx_is_equal_ignore_dim	749
GiNaC::indexed	
This class holds an indexed expression	750
GiNaC::info_flags	
Possible attributes an object can have	771
GiNaC::integral	
Symbolic integral	772
GiNaC::integration_kernel	
The base class for integration kernels for iterated integrals	785
GiNaC::is_not_a_clifford	
Predicate for finding non-clifford objects	794
GiNaC::is_summation_idx	795
GiNaC::iterated_integral2_SERIAL	
Complete elliptic integral of the first kind	796

GiNaC::iterated_integral3_SERIAL	
Iterated integral with explicit truncation	796
GiNaC::Kronecker_dtau_kernel	
The kernel corresponding to integrating the Kronecker coefficient function $g^{(n)}(z_j, K\tau)$ in τ (or equivalently in \bar{q})	797
GiNaC::Kronecker_dz_kernel	
The kernel corresponding to integrating the Kronecker coefficient function $g^{(n-1)}(z - z_j, K\tau)$ in z	806
GiNaC::lanczos_coeffs	815
std::less< GiNaC::ptr< T > >	
Specialization of <code>std::less</code> for <code>ptr<T></code> to enable ordering of <code>ptr<T></code> objects (e.g.	816
GiNaC::library_init	
Helper class to initialize the library	817
GiNaC::make_flat_inserter	
Class to handle the renaming of dummy indices	819
GiNaC::map_function	
Function object for <code>map()</code>	822
GiNaC::matrix	
Symbolic matrices	824
GiNaC::minkmetric	
This class represents a Minkowski metric tensor	849
GiNaC::modular_form_kernel	
A kernel corresponding to a polynomial in Eisenstein series	857
GiNaC::basic_partition_generator::mpartition2	866
GiNaC::mul	
Product of expressions	868
GiNaC::multi_iterator_counter< T >	
The class <code>multi_iterator_counter</code> defines a <code>multi_iterator</code> (i_1, i_2, \dots, i_k) , such that	891
GiNaC::multi_iterator_counter_indv< T >	
The class <code>multi_iterator_counter_indv</code> defines a <code>multi_iterator</code> (i_1, i_2, \dots, i_k) , such that	894
GiNaC::multi_iterator_ordered< T >	
The class <code>multi_iterator_ordered</code> defines a <code>multi_iterator</code> (i_1, i_2, \dots, i_k) , such that	898
GiNaC::multi_iterator_ordered_eq< T >	
The class <code>multi_iterator_ordered_eq</code> defines a <code>multi_iterator</code> (i_1, i_2, \dots, i_k) , such that	902
GiNaC::multi_iterator_ordered_eq_indv< T >	
The class <code>multi_iterator_ordered_eq_indv</code> defines a <code>multi_iterator</code> (i_1, i_2, \dots, i_k) , such that	906
GiNaC::multi_iterator_permutation< T >	
The class <code>multi_iterator_permutation</code> defines a <code>multi_iterator</code> (i_1, i_2, \dots, i_k) , for which	910
GiNaC::multi_iterator_shuffle< T >	
The class <code>multi_iterator_shuffle</code> defines a <code>multi_iterator</code> , which runs over all shuffles of a and b	914
GiNaC::multi_iterator_shuffle_prime< T >	
The class <code>multi_iterator_shuffle_prime</code> defines a <code>multi_iterator</code> , which runs over all shuffles of a and b, excluding the first one (a,b)	919
GiNaC::multiple_polylog_kernel	
The integration kernel for multiple polylogarithms	923
GiNaC::ncmul	
Non-commutative product of expressions	931
GiNaC::normal_map_function	
Function object to be applied by <code>basic::normal()</code>	945
GiNaC::numeric	
This class is a wrapper around CLN-numbers within the <code>GiNaC</code> class hierarchy	947
GiNaC::op0_is_equal	979
GiNaC::partition_generator	
Generate all bounded combinatorial partitions of an integer n with exactly m parts (not including zero parts) in non-decreasing order	979
GiNaC::partition_with_zero_parts_generator	
Generate all bounded combinatorial partitions of an integer n with exactly m parts (including zero parts) in non-decreasing order	982

GiNaC::pointer_to_map_function	985
GiNaC::pointer_to_map_function_1arg< T1 >	987
GiNaC::pointer_to_map_function_2args< T1, T2 >	990
GiNaC::pointer_to_map_function_3args< T1, T2, T3 >	992
GiNaC::pointer_to_member_to_map_function< C >	995
GiNaC::pointer_to_member_to_map_function_1arg< C, T1 >	998
GiNaC::pointer_to_member_to_map_function_2args< C, T1, T2 >	1000
GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2, T3 >	1003
GiNaC::pole_error	
Exception class thrown when a singularity is encountered	1007
GiNaC::possymbol	
Specialization of symbol to real positive domain	1009
GiNaC::power	
This class holds a two-component object, a basis and and exponent representing exponentiation	1016
GiNaC::print_context	
Base class for print_contexts	1034
GiNaC::print_context_options	
This class stores information about a registered print_context class	1036
GiNaC::print_csrc	
Base context for C source output	1038
GiNaC::print_csrc_cl_N	
Context for C source output using CLN numbers	1040
GiNaC::print_csrc_double	
Context for C source output using double precision	1042
GiNaC::print_csrc_float	
Context for C source output using float precision	1044
GiNaC::print_dflt	
Context for default (ginsh-parsable) output	1046
GiNaC::print_functor	
This class represents a print method for a certain algebraic class and print_context type	1047
GiNaC::print_functor_impl	
Base class for print_functor handlers	1050
GiNaC::print_latex	
Context for latex-parsable output	1051
GiNaC::print_memfun_handler< T, C >	
Print_functor handler for member functions of class T, context type C	1053
GiNaC::print_options	
Flags to control the behavior of a print_context	1055
GiNaC::print_ptrfun_handler< T, C >	
Print_functor handler for pointer-to-functions of class T, context type C	1057
GiNaC::print_python	
Context for python pretty-print output	1060
GiNaC::print_python_repr	
Context for python-parsable output	1061
GiNaC::print_tree	
Context for tree-like output for debugging	1063
GiNaC::archive_node::property	
Archived property (data type, name and associated data)	1065
GiNaC::archive_node::property_info	
Information about a stored property	1066
GiNaC::pseries	
This class holds a extended truncated power series (positive and negative integer powers)	1068
GiNaC::psi1_SERIAL	
Polylogarithm and multiple polylogarithm	1086
GiNaC::psi2_SERIAL	
Derivatives of Psi-function (aka polygamma-functions)	1087
GiNaC::ptr< T >	
Class of (intrusively) reference-counted pointers that support copy-on-write semantics	1088

GiNaC::realsymbol	
Specialization of symbol to real domain	1094
GiNaC::refcounted	
Base class for reference-counted objects	1102
GiNaC::registered_class_options	
This class stores information about a registered GiNaC class	1104
GiNaC::relational	
This class holds a relation consisting of two expressions and a logical relation between them	1108
GiNaC::remember_strategies	
Strategies how to clean up the function remember cache	1120
GiNaC::remember_table	
The remember table is organized like an n-fold associative cache in a microprocessor	1122
GiNaC::remember_table_entry	
A single entry in the remember table of a function	1126
GiNaC::remember_table_list	
A list of entries in the remember table having some least significant bits of the hashvalue in common	1129
GiNaC::return_type_t	
To distinguish between different kinds of non-commutative objects	1131
GiNaC::return_types	1133
GiNaC::relational::safe_bool_helper	1133
GiNaC::scalar_products	
Helper class for storing information about known scalar products which are to be automatically replaced by simplify_indexed()	1134
GiNaC::series_options	
Flags to control series expansion	1137
GiNaC::solve_algo	
Switch to control algorithm for linear system solving	1137
GiNaC::spinidx	
This class holds a spinor index that can be dotted or undotted and that also has a variance	1139
GiNaC::spinmetric	
This class represents an antisymmetric spinor metric tensor which can be used to raise/lower indices of 2-component Weyl spinors	1150
GiNaC::spmapkey	1156
GiNaC::status_flags	
Flags to store information about the state of an object	1159
GiNaC::structure< T, ComparisonPolicy >	
Wrapper template for making GiNaC classes out of C++ structures	1160
GiNaC::su3d	
This class represents the tensor of symmetric su(3) structure constants	1179
GiNaC::su3f	
This class represents the tensor of antisymmetric su(3) structure constants	1185
GiNaC::su3one	
This class represents the su(3) unity element	1191
GiNaC::su3t	
This class represents an su(3) generator	1196
GiNaC::subs_options	
Flags to control the behavior of subs()	1201
GiNaC::sy_is_less	1202
GiNaC::sy_swap	1203
GiNaC::sym_desc	
This structure holds information about the highest and lowest degrees in which a symbol appears in two multivariate polynomials "a" and "b"	1204
GiNaC::symbol	
Basic CAS symbol	1208
GiNaC::symbolset	1221
GiNaC::symmetry	
This class describes the symmetry of a group of indices	1223

GiNaC::symminfo	
This structure stores the individual symmetrized terms obtained during the simplification of sums	1233
GiNaC::symminfo_is_less_by_orig	1236
GiNaC::symminfo_is_less_by_symmterm	1236
GiNaC::tensdelta	
This class represents the delta tensor	1237
GiNaC::tensepsilon	
This class represents the totally antisymmetric epsilon tensor	1243
GiNaC::tensmetric	
This class represents a general metric tensor which can be used to raise/lower indices	1251
GiNaC::tensor	
This class holds one of GiNaC 's predefined special tensors such as the delta and the metric tensors	1258
GiNaC::terminfo	
This structure stores the original and symmetrized versions of terms obtained during the simplification of sums	1263
GiNaC::terminfo_is_less	1264
GiNaC::class_info< OPT >::tree_node	1265
GiNaC::unarchive_table_t	1266
GiNaC::user_defined_kernel	
A user-defined integration kernel	1268
GiNaC::varidx	
This class holds an index with a variance (co- or contravariant)	1277
GiNaC::visitor	
Degenerate base class for visitors	1287
GiNaC::wildcard	
This class acts as a wildcard for subs() , match() , has() and find()	1288
GiNaC::zeta1_SERIAL	
Complex conjugate	1295
GiNaC::zeta2_SERIAL	
Alternating Euler sum or colored MZV	1296

Chapter 4

File Index

4.1 File List

Here is a list of all files with brief descriptions:

add.cpp	Implementation of GiNaC 's sums of expressions	1299
add.h	Interface to GiNaC 's sums of expressions	1300
archive.cpp	Archiving of GiNaC expressions	1300
archive.h	Archiving of GiNaC expressions	1301
assertion.h	Assertion macro definition	1304
basic.cpp	Implementation of GiNaC 's ABC	1304
basic.h	Interface to GiNaC 's ABC	1305
class_info.h	Helper templates to provide per-class information for class hierarchies	1306
clifford.cpp	Implementation of GiNaC 's clifford algebra (Dirac gamma) objects	1307
clifford.h	Interface to GiNaC 's clifford algebra (Dirac gamma) objects	1309
color.cpp	Implementation of GiNaC 's color (SU(3) Lie algebra) objects	1311
color.h	Interface to GiNaC 's color (SU(3) Lie algebra) objects	1313
compiler.h	Definition of optimizing macros	1314
constant.cpp	Implementation of GiNaC 's constant types and some special constants	1315
constant.h	Interface to GiNaC 's constant types and some special constants	1316
container.h	Wrapper template for making GiNaC classes out of STL containers	1317
crc32.h	CRC32 hash function	1317
ex.cpp	Implementation of GiNaC 's light-weight expression handles	1318

ex.h	Interface to GiNaC 's light-weight expression handles	1318
excompiler.cpp	Functions to facilitate the conversion of a ex to a function pointer suited for fast numerical integration	1321
excompiler.h	Functions to facilitate the conversion of a ex to a function pointer suited for fast numerical integration	1321
expair.cpp	Implementation of expression pairs (building blocks of expairseq)	1322
expair.h	Definition of expression pairs (building blocks of expairseq)	1323
expairseq.cpp	Implementation of sequences of expression pairs	1324
expairseq.h	Interface to sequences of expression pairs	1324
exprseq.cpp	Implementation of GiNaC 's exprseq	1325
exprseq.h	Definition of GiNaC 's exprseq	1326
factor.cpp	Polynomial factorization (implementation)	1326
factor.h	Polynomial factorization	1335
fail.cpp	Implementation of class signaling failure of operation	1335
fail.h	Interface to class signaling failure of operation	1336
fderivative.cpp	Implementation of abstract derivatives of functions	1337
fderivative.h	Interface to abstract derivatives of functions	1337
flags.h	Collection of all flags used through the GiNaC framework	1338
function.cpp	Implementation of class of symbolic functions	1339
function.h	Interface to class of symbolic functions	1339
ginac.h	This include file includes all other public GiNaC headers	1350
hash_map.h	Replacement for <code>map<></code> using hash tables	1351
hash_seed.h	Type-specific hash seed	1352
idx.cpp	Implementation of GiNaC 's indices	1352
idx.h	Interface to GiNaC 's indices	1353
indexed.cpp	Implementation of GiNaC 's indexed expressions	1354
indexed.h	Interface to GiNaC 's indexed expressions	1356
inifcns.cpp	Implementation of GiNaC 's initially known functions	1357
inifcns.h	Interface to GiNaC 's initially known functions	1360
inifcns_elliptic.cpp	Implementation of some special functions related to elliptic curves	1362

inifcns_gamma.cpp	Implementation of Gamma-function, Beta-function, Polygamma-functions, and some related stuff	1363
inifcns_nstdsums.cpp	Implementation of some special functions that have a representation as nested sums	1364
inifcns_trans.cpp	Implementation of transcendental (and trigonometric and hyperbolic) functions	1366
integral.cpp	Implementation of GiNaC 's symbolic integral	1369
integral.h	Interface to GiNaC 's symbolic integral	1370
integration_kernel.cpp	Implementation of GiNaC 's integration kernels for iterated integrals	1371
integration_kernel.h	Interface to GiNaC 's integration kernels for iterated integrals	1373
lst.cpp	Implementation of GiNaC 's lst	1375
lst.h	Definition of GiNaC 's lst	1375
matrix.cpp	Implementation of symbolic matrices	1376
matrix.h	Interface to symbolic matrices	1377
mul.cpp	Implementation of GiNaC 's products of expressions	1378
mul.h	Interface to GiNaC 's products of expressions	1379
ncmul.cpp	Implementation of GiNaC 's non-commutative products of expressions	1380
ncmul.h	Interface to GiNaC 's non-commutative products of expressions	1381
normal.cpp	This file implements several functions that work on univariate and multivariate polynomials and rational functions	1381
normal.h	This file defines several functions that work on univariate and multivariate polynomials and rational functions	1384
numeric.cpp	This file contains the interface to the underlying bignum package	1385
numeric.h	Makes the interface to the underlying bignum package available	1389
operators.cpp	Implementation of GiNaC 's overloaded operators	1391
operators.h	Interface to GiNaC 's overloaded operators	1393
power.cpp	Implementation of GiNaC 's symbolic exponentiation (basis ^{exponent})	1395
power.h	Interface to GiNaC 's symbolic exponentiation (basis ^{exponent})	1396
print.cpp	Implementation of helper classes for expression output	1396
print.h	Definition of helper classes for expression output	1397
pseries.cpp	Implementation of class for extended truncated power series and methods for series expansion	1400
pseries.h	Interface to class for extended truncated power series	1400
ptr.h	Reference-counted pointer template	1401

registrar.cpp	
GiNaC's class registrar (for class basic and all classes derived from it)	1402
registrar.h	
GiNaC's class registrar (for class basic and all classes derived from it)	1402
relational.cpp	
Implementation of relations between expressions	1406
relational.h	
Interface to relations between expressions	1406
remember.cpp	
Implementation of helper classes for using the remember option in GiNaC functions	1407
remember.h	
Interface to helper classes for using the remember option in GiNaC functions	1407
structure.h	
Wrapper template for making GiNaC classes out of C++ structures	1408
symbol.cpp	
Implementation of GiNaC's symbolic objects	1409
symbol.h	
Interface to GiNaC's symbolic objects	1409
symmetry.cpp	
Implementation of GiNaC's symmetry definitions	1410
symmetry.h	
Interface to GiNaC's symmetry definitions	1411
tensor.cpp	
Implementation of GiNaC's special tensors	1413
tensor.h	
Interface to GiNaC's special tensors	1414
utils.cpp	
Implementation of several small and furry utilities needed within GiNaC but not of any interest to the user of the library	1415
utils.h	
Interface to several small and furry utilities needed within GiNaC but not of any interest to the user of the library	1417
utils_multi_iterator.h	
Utilities for summing over multiple indices	1420
version.h	
GiNaC library version information	1421
wildcard.cpp	
Implementation of GiNaC's wildcard objects	1423
wildcard.h	
Interface to GiNaC's wildcard objects	1424

Chapter 5

Namespace Documentation

5.1 GiNaC Namespace Reference

Namespaces

- namespace [internal](#)

Classes

- class [_numeric_digits](#)
This class is used to instantiate a global singleton object Digits which behaves just like Maple's Digits.
- class [add](#)
Sum of expressions.
- class [archive](#)
This class holds archived versions of [GiNaC](#) expressions (class [ex](#)).
- class [archive_node](#)
This class stores all properties needed to record/retrieve the state of one object of class [basic](#) (or a derived class).
- class [basic](#)
This class is the ABC (abstract base class) of [GiNaC](#)'s class hierarchy.
- class [basic_log_kernel](#)
The basic integration kernel with a logarithmic singularity at the origin.
- class [basic_multi_iterator](#)
[basic_multi_iterator](#) is a base class.
- class [basic_partition_generator](#)
Base class for generating all bounded combinatorial partitions of an integer n with exactly m parts in non-decreasing order.
- class [class_info](#)
- class [clifford](#)
This class holds an object representing an element of the Clifford algebra (the Dirac gamma matrices).
- class [cliffordunit](#)
This class represents the Clifford algebra generators (units).
- class [color](#)
This class holds a generator T_a or the unity element of the Lie algebra of $SU(3)$, as used for calculations in quantum chromodynamics.
- class [compare_all_equal](#)

- Comparison policy: all structures of one type are equal.*

 - class [compare_bitwise](#)

Comparison policy: use bit-wise comparison to compare structures.
 - class [compare_std_less](#)

Comparison policy: use `std::equal_to`/`std::less` (defaults to operators `==` and `<`) to compare structures.
 - class [composition_generator](#)

Generate all compositions of a partition of an integer n , starting with the compositions which has non-decreasing order.
 - class [const_iterator](#)
 - class [const_postorder_iterator](#)
 - class [const_preorder_iterator](#)
 - class [constant](#)

This class holds constants, symbols with specific numerical value.
 - class [container](#)

Wrapper template for making [GiNaC](#) classes out of STL containers.
 - class [container_storage](#)

Helper template for encapsulating the [reserve\(\)](#) mechanics of STL containers.
 - struct [derivative_map_function](#)

Function object to be applied by [basic::derivative\(\)](#).
 - class [determinant_algo](#)

Switch to control algorithm for determinant computation.
 - class [diracgamma](#)

This class represents the Dirac gamma Lorentz vector.
 - class [diracgamma5](#)

This class represents the Dirac gamma5 object which anticommutes with all other gammas.
 - class [diracgammaL](#)

This class represents the Dirac gammaL object which behaves like $1/2 (1-\text{gamma}5)$.
 - class [diracgammaR](#)

This class represents the Dirac gammaL object which behaves like $1/2 (1+\text{gamma}5)$.
 - class [diracone](#)

This class represents the Clifford algebra unity element.
 - class [do_taylor](#)

Exception class thrown by classes which provide their own series expansion to signal that ordinary Taylor expansion is safe.
 - class [domain](#)

Domain of an object.
 - class [dunno](#)

Exception class thrown by functions to signal unimplemented functionality so the expression may just be `.hold()`
 - class [Ebar_kernel](#)

The Ebar-kernel.
 - class [Eisenstein_h_kernel](#)

The kernel corresponding to the Eisenstein series $h_{k,N,r,s}(\tau)$.
 - class [Eisenstein_kernel](#)

The kernel corresponding to the Eisenstein series $E_{k,N,a,b,K}(\tau)$.
 - class [ELi_kernel](#)

The ELi-kernel.
 - struct [error_and_integral](#)
 - struct [error_and_integral_is_less](#)
 - struct [eval_integ_map_function](#)

Function object to be applied by [basic::eval_integ\(\)](#).
 - struct [evalf_map_function](#)

- Function object to be applied by `basic::evalf()`.
- struct `evalm_map_function`
 - Function object to be applied by `basic::evalm()`.
- class `ex`
 - Lightweight wrapper for GiNaC's symbolic objects.
- struct `ex_base_is_less`
- struct `ex_is_equal`
- struct `ex_is_less`
- struct `ex_swap`
- class `expair`
 - A pair of expressions.
- struct `expair_is_less`
 - Function object for insertion into third argument of STL's `sort()` etc.
- struct `expair_rest_is_less`
 - Function object not caring about the numerical coefficients for insertion into third argument of STL's `sort()`.
- struct `expair_swap`
- class `expairseq`
 - A sequence of class `expair`.
- struct `expand_map_function`
 - Function object to be applied by `basic::expand()`.
- class `expand_options`
 - Flags to control the behavior of `expand()`.
- class `factor_options`
 - Flags to control the polynomial factorization.
- class `fail`
- class `fderivative`
 - This class represents the (abstract) derivative of a symbolic function.
- class `function`
 - The class `function` is used to implement builtin functions like `sin`, `cos`... and user defined functions.
- class `function_options`
- class `G2_SERIAL`
 - Generalized multiple polylogarithm.
- class `G3_SERIAL`
 - Generalized multiple polylogarithm with explicit imaginary parts.
- struct `gcd_options`
 - Flags to control the behavior of `gcd()` and friends.
- class `gcdheu_failed`
 - Exception thrown by `heur_gcd()` to signal failure.
- class `has_distance`
 - SFINAE test for distance.
- class `has_options`
 - Flags to control the behavior of `has()`.
- class `idx`
 - This class holds one index of an indexed object.
- struct `idx_is_equal_ignore_dim`
- class `indexed`
 - This class holds an indexed expression.
- class `info_flags`
 - Possible attributes an object can have.
- class `integral`
 - Symbolic integral.

- class [integration_kernel](#)
The base class for integration kernels for iterated integrals.
- struct [is_not_a_clifford](#)
Predicate for finding non-clifford objects.
- struct [is_summation_idx](#)
- class [iterated_integral2_SERIAL](#)
Complete elliptic integral of the first kind.
- class [iterated_integral3_SERIAL](#)
Iterated integral with explicit truncation.
- class [Kronecker_dtau_kernel](#)
The kernel corresponding to integrating the Kronecker coefficient function $g^{(n)}(z_j, K\tau)$ in τ (or equivalently in \bar{q}).
- class [Kronecker_dz_kernel](#)
The kernel corresponding to integrating the Kronecker coefficient function $g^{(n-1)}(z - z_j, K\tau)$ in z .
- class [lanczos_coeffs](#)
- class [library_init](#)
Helper class to initialize the library.
- class [make_flat_inserter](#)
Class to handle the renaming of dummy indices.
- struct [map_function](#)
Function object for `map()`.
- class [matrix](#)
Symbolic matrices.
- class [minkmetric](#)
This class represents a Minkowski metric tensor.
- class [modular_form_kernel](#)
A kernel corresponding to a polynomial in Eisenstein series.
- class [mul](#)
Product of expressions.
- class [multi_iterator_counter](#)
The class [multi_iterator_counter](#) defines a `multi_iterator` (i_1, i_2, \dots, i_k) , such that.
- class [multi_iterator_counter_indv](#)
The class [multi_iterator_counter_indv](#) defines a `multi_iterator` (i_1, i_2, \dots, i_k) , such that.
- class [multi_iterator_ordered](#)
The class [multi_iterator_ordered](#) defines a `multi_iterator` (i_1, i_2, \dots, i_k) , such that.
- class [multi_iterator_ordered_eq](#)
The class [multi_iterator_ordered_eq](#) defines a `multi_iterator` (i_1, i_2, \dots, i_k) , such that.
- class [multi_iterator_ordered_eq_indv](#)
The class [multi_iterator_ordered_eq_indv](#) defines a `multi_iterator` (i_1, i_2, \dots, i_k) , such that.
- class [multi_iterator_permutation](#)
The class [multi_iterator_permutation](#) defines a `multi_iterator` (i_1, i_2, \dots, i_k) , for which.
- class [multi_iterator_shuffle](#)
The class [multi_iterator_shuffle](#) defines a `multi_iterator`, which runs over all shuffles of a and b .
- class [multi_iterator_shuffle_prime](#)
The class [multi_iterator_shuffle_prime](#) defines a `multi_iterator`, which runs over all shuffles of a and b , excluding the first one (a,b) .
- class [multiple_polylog_kernel](#)
The integration kernel for multiple polylogarithms.
- class [ncmul](#)
Non-commutative product of expressions.
- struct [normal_map_function](#)
Function object to be applied by `basic::normal()`.

- class [numeric](#)
This class is a wrapper around CLN-numbers within the [GiNaC](#) class hierarchy.
- struct [op0_is_equal](#)
- class [partition_generator](#)
Generate all bounded combinatorial partitions of an integer n with exactly m parts (not including zero parts) in non-decreasing order.
- class [partition_with_zero_parts_generator](#)
Generate all bounded combinatorial partitions of an integer n with exactly m parts (including zero parts) in non-decreasing order.
- class [pointer_to_map_function](#)
- class [pointer_to_map_function_1arg](#)
- class [pointer_to_map_function_2args](#)
- class [pointer_to_map_function_3args](#)
- class [pointer_to_member_to_map_function](#)
- class [pointer_to_member_to_map_function_1arg](#)
- class [pointer_to_member_to_map_function_2args](#)
- class [pointer_to_member_to_map_function_3args](#)
- class [pole_error](#)
Exception class thrown when a singularity is encountered.
- class [possymbol](#)
Specialization of symbol to real positive domain.
- class [power](#)
This class holds a two-component object, a basis and an exponent representing exponentiation.
- class [print_context](#)
Base class for print_contexts.
- class [print_context_options](#)
This class stores information about a registered [print_context](#) class.
- class [print_csrc](#)
Base context for C source output.
- class [print_csrc_cl_N](#)
Context for C source output using CLN numbers.
- class [print_csrc_double](#)
Context for C source output using double precision.
- class [print_csrc_float](#)
Context for C source output using float precision.
- class [print_dflt](#)
Context for default (ginsh-parsable) output.
- class [print_functor](#)
This class represents a print method for a certain algebraic class and [print_context](#) type.
- class [print_functor_impl](#)
Base class for [print_functor](#) handlers.
- class [print_latex](#)
Context for latex-parsable output.
- class [print_memfun_handler](#)
[print_functor](#) handler for member functions of class T , context type C
- class [print_options](#)
Flags to control the behavior of a [print_context](#).
- class [print_ptrfun_handler](#)
[print_functor](#) handler for pointer-to-functions of class T , context type C
- class [print_python](#)
Context for python pretty-print output.
- class [print_python_repr](#)

- Context for python-parsable output.*

 - class [print_tree](#)
- Context for tree-like output for debugging.*

 - class [pseries](#)
- This class holds a extended truncated power series (positive and negative integer powers).*

 - class [psi1_SERIAL](#)
- Polylogarithm and multiple polylogarithm.*

 - class [psi2_SERIAL](#)
- Derivatives of Psi-function (aka polygamma-functions).*

 - class [ptr](#)
- Class of (intrusively) reference-counted pointers that support copy-on-write semantics.*

 - class [realsymbol](#)
- Specialization of symbol to real domain.*

 - class [refcounted](#)
- Base class for reference-counted objects.*

 - class [registered_class_options](#)
- This class stores information about a registered [GiNaC](#) class.*

 - class [relational](#)
- This class holds a relation consisting of two expressions and a logical relation between them.*

 - class [remember_strategies](#)
- Strategies how to clean up the function remember cache.*

 - class [remember_table](#)
- The remember table is organized like an n-fold associative cache in a microprocessor.*

 - class [remember_table_entry](#)
- A single entry in the remember table of a function.*

 - class [remember_table_list](#)
- A list of entries in the remember table having some least significant bits of the hashvalue in common.*

 - struct [return_type_t](#)
- To distinguish between different kinds of non-commutative objects.*

 - class [return_types](#)
- Helper class for storing information about known scalar products which are to be automatically replaced by [simplify_indexed\(\)](#).*

 - class [scalar_products](#)
- Helper class for storing information about known scalar products which are to be automatically replaced by [simplify_indexed\(\)](#).*

 - class [series_options](#)
- Flags to control series expansion.*

 - class [solve_algo](#)
- Switch to control algorithm for linear system solving.*

 - class [spinidx](#)
- This class holds a spinor index that can be dotted or undotted and that also has a variance.*

 - class [spinmetric](#)
- This class represents an antisymmetric spinor metric tensor which can be used to raise/lower indices of 2-component Weyl spinors.*

 - class [spmapkey](#)
- Flags to store information about the state of an object.*

 - class [status_flags](#)
- Wrapper template for making [GiNaC](#) classes out of C++ structures.*

 - class [structure](#)
- This class represents the tensor of symmetric su(3) structure constants.*

 - class [su3d](#)
- This class represents the tensor of antisymmetric su(3) structure constants.*

 - class [su3f](#)

- class [su3one](#)
This class represents the $su(3)$ unity element.
- class [su3t](#)
This class represents an $su(3)$ generator.
- class [subs_options](#)
Flags to control the behavior of [subs\(\)](#).
- class [sy_is_less](#)
- class [sy_swap](#)
- struct [sym_desc](#)
This structure holds information about the highest and lowest degrees in which a symbol appears in two multivariate polynomials "a" and "b".
- class [symbol](#)
Basic CAS symbol.
- class [symbolset](#)
- class [symmetry](#)
This class describes the symmetry of a group of indices.
- class [symminfo](#)
This structure stores the individual symmetrized terms obtained during the simplification of sums.
- class [symminfo_is_less_by_orig](#)
- class [symminfo_is_less_by_symmterm](#)
- class [tensdelta](#)
This class represents the delta tensor.
- class [tensepsilon](#)
This class represents the totally antisymmetric epsilon tensor.
- class [tensmetric](#)
This class represents a general metric tensor which can be used to raise/lower indices.
- class [tensor](#)
This class holds one of [GiNaC](#)'s predefined special tensors such as the delta and the metric tensors.
- class [terminfo](#)
This structure stores the original and symmetrized versions of terms obtained during the simplification of sums.
- class [terminfo_is_less](#)
- class [unarchive_table_t](#)
- class [user_defined_kernel](#)
A user-defined integration kernel.
- class [varidx](#)
This class holds an index with a variance (co- or contravariant).
- class [visitor](#)
Degenerate base class for visitors.
- class [wildcard](#)
This class acts as a wildcard for [subs\(\)](#), [match\(\)](#), [has\(\)](#) and [find\(\)](#).
- class [zeta1_SERIAL](#)
Complex conjugate.
- class [zeta2_SERIAL](#)
Alternating Euler sum or colored MZV.

Typedefs

- typedef unsigned [archive_node_id](#)
Numerical ID value to refer to an [archive_node](#).
- typedef unsigned [archive_atom](#)
Numerical ID value to refer to a string.
- typedef [basic](#) [*\(* synthesize_func\)](#) ()
- typedef std::map< std::string, [synthesize_func](#) > [unarchive_map_t](#)
- typedef std::vector< [ex](#) > [exvector](#)
- typedef std::set< [ex](#), [ex_is_less](#) > [exset](#)
- typedef std::map< [ex](#), [ex](#), [ex_is_less](#) > [exmap](#)
- typedef [ex](#) [* evalfunctype](#) ()
- typedef double [* FUNCP_1P](#) (double)
Function pointer with one function parameter.
- typedef double [* FUNCP_2P](#) (double, double)
Function pointer with two function parameters.
- typedef void [* FUNCP_CUBA](#) (const int *, const double[], const int *, double[])
Function pointer for use with the CUBA library (<http://www.feynarts.de/cuba>).
- typedef std::vector< [expair](#) > [epvector](#)
expair-vector
- typedef [epvector::iterator](#) [epp](#)
expair-vector pointer
- typedef [container](#) < std::vector > [exprseq](#)
- typedef std::multiset< unsigned > [paramset](#)
- typedef [ex](#) [* eval_funcp](#) ()
- typedef [ex](#) [* evalf_funcp](#) ()
- typedef [ex](#) [* conjugate_funcp](#) ()
- typedef [ex](#) [* real_part_funcp](#) ()
- typedef [ex](#) [* imag_part_funcp](#) ()
- typedef [ex](#) [* expand_funcp](#) ()
- typedef [ex](#) [* derivative_funcp](#) ()
- typedef [ex](#) [* expl_derivative_funcp](#) ()
- typedef [ex](#) [* power_funcp](#) ()
- typedef [ex](#) [* series_funcp](#) ()
- typedef void [* print_funcp](#) ()
- typedef bool [* info_funcp](#) ()
- typedef [ex](#) [* eval_funcp_1](#) (const [ex](#) &)
- typedef [ex](#) [* evalf_funcp_1](#) (const [ex](#) &)
- typedef [ex](#) [* conjugate_funcp_1](#) (const [ex](#) &)
- typedef [ex](#) [* real_part_funcp_1](#) (const [ex](#) &)
- typedef [ex](#) [* imag_part_funcp_1](#) (const [ex](#) &)
- typedef [ex](#) [* expand_funcp_1](#) (const [ex](#) &, unsigned)
- typedef [ex](#) [* derivative_funcp_1](#) (const [ex](#) &, unsigned)
- typedef [ex](#) [* expl_derivative_funcp_1](#) (const [ex](#) &, const [symbol](#) &)
- typedef [ex](#) [* power_funcp_1](#) (const [ex](#) &, const [ex](#) &)
- typedef [ex](#) [* series_funcp_1](#) (const [ex](#) &, const [relational](#) &, int, unsigned)
- typedef void [* print_funcp_1](#) (const [ex](#) &, const [print_context](#) &)
- typedef bool [* info_funcp_1](#) (const [ex](#) &, unsigned)
- typedef [ex](#) [* eval_funcp_2](#) (const [ex](#) &, const [ex](#) &)
- typedef [ex](#) [* evalf_funcp_2](#) (const [ex](#) &, const [ex](#) &)
- typedef [ex](#) [* conjugate_funcp_2](#) (const [ex](#) &, const [ex](#) &)
- typedef [ex](#) [* real_part_funcp_2](#) (const [ex](#) &, const [ex](#) &)
- typedef [ex](#) [* imag_part_funcp_2](#) (const [ex](#) &, const [ex](#) &)
- typedef [ex](#) [* expand_funcp_2](#) (const [ex](#) &, const [ex](#) &, unsigned)

- [illegible]

- [illegible]

- typedef [ex](#)(* [power_funcp_13](#)) (const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &)
- typedef [ex](#)(* [series_funcp_13](#)) (const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [relational](#) &, int, unsigned)
- typedef void(* [print_funcp_13](#)) (const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [print_context](#) &)
- typedef bool(* [info_funcp_13](#)) (const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, unsigned)
- typedef [ex](#)(* [eval_funcp_14](#)) (const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &)
- typedef [ex](#)(* [evalf_funcp_14](#)) (const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &)
- typedef [ex](#)(* [conjugate_funcp_14](#)) (const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &)
- typedef [ex](#)(* [real_part_funcp_14](#)) (const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &)
- typedef [ex](#)(* [imag_part_funcp_14](#)) (const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &)
- typedef [ex](#)(* [expand_funcp_14](#)) (const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, unsigned)
- typedef [ex](#)(* [derivative_funcp_14](#)) (const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, unsigned)
- typedef [ex](#)(* [expl_derivative_funcp_14](#)) (const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [symbol](#) &)
- typedef [ex](#)(* [power_funcp_14](#)) (const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &)
- typedef [ex](#)(* [series_funcp_14](#)) (const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [relational](#) &, int, unsigned)
- typedef void(* [print_funcp_14](#)) (const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [print_context](#) &)
- typedef bool(* [info_funcp_14](#)) (const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, const [ex](#) &, unsigned)
- typedef [ex](#)(* [eval_funcp_exvector](#)) (const [exvector](#) &)
- typedef [ex](#)(* [evalf_funcp_exvector](#)) (const [exvector](#) &)
- typedef [ex](#)(* [conjugate_funcp_exvector](#)) (const [exvector](#) &)
- typedef [ex](#)(* [real_part_funcp_exvector](#)) (const [exvector](#) &)
- typedef [ex](#)(* [imag_part_funcp_exvector](#)) (const [exvector](#) &)
- typedef [ex](#)(* [expand_funcp_exvector](#)) (const [exvector](#) &, unsigned)
- typedef [ex](#)(* [derivative_funcp_exvector](#)) (const [exvector](#) &, unsigned)
- typedef [ex](#)(* [expl_derivative_funcp_exvector](#)) (const [exvector](#) &, const [symbol](#) &)
- typedef [ex](#)(* [power_funcp_exvector](#)) (const [exvector](#) &, const [ex](#) &)
- typedef [ex](#)(* [series_funcp_exvector](#)) (const [exvector](#) &, const [relational](#) &, int, unsigned)
- typedef void(* [print_funcp_exvector](#)) (const [exvector](#) &, const [print_context](#) &)
- typedef bool(* [info_funcp_exvector](#)) (const [exvector](#) &, unsigned)
- template<typename T, class Hash = std::hash<[ex](#)>, class KeyEqual = std::equal_to<[ex](#)>, class Allocator = std::allocator<std::pair<const [ex](#), T>>>
 using [exhashmap](#) = std::unordered_map< [ex](#), T, Hash, KeyEqual, Allocator >
- typedef std::map< [spmapkey](#), [ex](#) > [spmap](#)
- typedef map< [error_and_integral](#), [ex](#), [error_and_integral_is_less](#) > [lookup_map](#)
- typedef [container](#)< std::list > [lst](#)
- typedef std::vector< std::size_t > [uintvector](#)
- typedef std::vector< unsigned > [unsignedvector](#)
- typedef std::vector< [exvector](#) > [exvectorvector](#)

- typedef std::vector< [sym_desc](#) > [sym_desc_vec](#)
- typedef void(* [digits_changed_callback](#)) (long)
Function pointer to implement callbacks in the case 'Digits' gets changed.
- typedef [class_info](#)< [print_context_options](#) > [print_context_class_info](#)
- typedef [class_info](#)< [registered_class_options](#) > [registered_class_info](#)

Enumerations

- enum { [callback_registered](#) = 1 }

Functions

- [GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) ([add](#), [expairseq](#), [print_func](#)< [print_context](#) >(&[add::do_print](#)), [print_func](#)< [print_latex](#) >(&[add::do_print_latex](#)), [print_func](#)< [print_csrc](#) >(&[add::do_print_csrc](#)), [print_func](#)< [print_tree](#) >(&[add::do_print_tree](#)), [print_func](#)< [print_python_repr](#) >(&[add::do_print_python_repr](#)))
[add](#)
- [GINAC_BIND_UNARCHIVER](#) ([add](#))
- [GINAC_DECLARE_UNARCHIVER](#) ([add](#))
- static void [write_unsigned](#) (std::ostream &os, unsigned val)
Write unsigned integer quantity to stream.
- static unsigned [read_unsigned](#) (std::istream &is)
Read unsigned integer quantity from stream.
- std::ostream & [operator<<](#) (std::ostream &os, const [archive_node](#) &n)
Write [archive_node](#) to binary data stream.
- std::ostream & [operator<<](#) (std::ostream &os, const [archive](#) &ar)
Write archive to binary data stream.
- std::istream & [operator>>](#) (std::istream &is, [archive_node](#) &n)
Read [archive_node](#) from binary data stream.
- std::istream & [operator>>](#) (std::istream &is, [archive](#) &ar)
Read archive from binary data stream.
- static [synthesize_func](#) [find_factory_fcn](#) (const std::string &name)
- [GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) ([basic](#), void, [print_func](#)< [print_context](#) >(&[basic::do_print](#)), [print_func](#)< [print_tree](#) >(&[basic::do_print_tree](#)), [print_func](#)< [print_python_repr](#) >(&[basic::do_print_python_repr](#)))
[basic](#)
basic copy constructor: implicitly assumes that the other class is of the exact same type (as it's used by duplicate()), so it can copy the tinfo_key and the hash value.
- template<class T >
bool [is_a](#) (const [basic](#) &obj)
Check if obj is a T, including base classes.
- template<class T >
bool [is_exactly_a](#) (const [basic](#) &obj)
Check if obj is a T, not including base classes.
- template<class B , typename... Args>
B & [dynallocate](#) (Args &&... args)
Constructs a new (class basic or derived) B object on the heap.
- template<class B >
B & [dynallocate](#) (std::initializer_list< [ex](#) > il)
Constructs a new (class basic or derived) B object on the heap.
- [GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) ([clifford](#), [indexed](#), [print_func](#)< [print_dflt](#) >(&[clifford::do_print_dflt](#)), [print_func](#)< [print_latex](#) >(&[clifford::do_print_latex](#)), [print_func](#)< [print_tree](#) >(&[clifford::do_print_tree](#)))
[GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#)([diracone](#)
- [print_func](#)< [print_dflt](#) > (&[diracone::do_print](#)), [print_func](#)< [print_latex](#) >(&[diracone](#)

- [GINAC_BIND_UNARCHIVER](#) ([clifford](#))
- [GINAC_BIND_UNARCHIVER](#) ([cliffordunit](#))
- [GINAC_BIND_UNARCHIVER](#) ([diracone](#))
- [GINAC_BIND_UNARCHIVER](#) ([diracgamma](#))
- [GINAC_BIND_UNARCHIVER](#) ([diracgamma5](#))
- [GINAC_BIND_UNARCHIVER](#) ([diracgammaL](#))
- [GINAC_BIND_UNARCHIVER](#) ([diracgammaR](#))
- static bool [is_dirac_slash](#) (const [ex](#) &seq0)
- static void [base_and_index](#) (const [ex](#) &c, [ex](#) &b, [ex](#) &i)
This function decomposes $\gamma \sim \mu \rightarrow (1, \mu)$ and $a \rightarrow (a.ix, ix)$
- [ex](#) [dirac_ONE](#) (unsigned char rl=0)
Create a Clifford unity object.
- static unsigned [get_dim_uint](#) (const [ex](#) &e)
- [ex](#) [clifford_unit](#) (const [ex](#) &mu, const [ex](#) &metr, unsigned char rl=0)
Create a Clifford unit object.
- [ex](#) [dirac_gamma](#) (const [ex](#) &mu, unsigned char rl=0)
Create a Dirac gamma object.
- [ex](#) [dirac_gamma5](#) (unsigned char rl=0)
Create a Dirac gamma5 object.
- [ex](#) [dirac_gammaL](#) (unsigned char rl=0)
Create a Dirac gammaL object.
- [ex](#) [dirac_gammaR](#) (unsigned char rl=0)
Create a Dirac gammaR object.
- [ex](#) [dirac_slash](#) (const [ex](#) &e, const [ex](#) &dim, unsigned char rl=0)
*Create a term of the form $e_\mu * \gamma \sim \mu$ with a unique index μ .*
- static unsigned char [get_representation_label](#) (const [return_type_t](#) &ti)
Extract representation label from tinfo key (as returned by [return_type_tinfo\(\)](#)).
- static [ex](#) [trace_string](#) (exvector::const_iterator ix, size_t num)
Take trace of a string of an even number of Dirac gammas given a vector of indices.
- [ex](#) [dirac_trace](#) (const [ex](#) &e, const std::set< unsigned char > &rls, const [ex](#) &trONE=4)
Calculate dirac traces over the specified set of representation labels.
- [ex](#) [dirac_trace](#) (const [ex](#) &e, const [lst](#) &rl, const [ex](#) &trONE=4)
Calculate dirac traces over the specified list of representation labels.
- [ex](#) [dirac_trace](#) (const [ex](#) &e, unsigned char rl=0, const [ex](#) &trONE=4)
Calculate the trace of an expression containing gamma objects with a specified representation label.
- [ex](#) [canonicalize_clifford](#) (const [ex](#) &e)
Bring all products of clifford objects in an expression into a canonical order.
- [ex](#) [clifford_star_bar](#) (const [ex](#) &e, bool do_bar, unsigned [options](#))
An auxillary function performing [clifford_star\(\)](#) and [clifford_bar\(\)](#).
- [ex](#) [clifford_prime](#) (const [ex](#) &e)
Automorphism of the Clifford algebra, simply changes signs of all clifford units.
- [ex](#) [remove_dirac_ONE](#) (const [ex](#) &e, unsigned char rl=0, unsigned [options](#)=0)
Replaces [dirac_ONE](#)'s (with a [representation_label](#) no less than rl) in e with 1.
- int [clifford_max_label](#) (const [ex](#) &e, bool ignore_ONE=false)
Returns the maximal representation label of a clifford object if e contains at least one, otherwise returns -1.
- [ex](#) [clifford_norm](#) (const [ex](#) &e)
Calculation of the norm in the Clifford algebra.
- [ex](#) [clifford_inverse](#) (const [ex](#) &e)
Calculation of the inverse in the Clifford algebra.
- [ex](#) [lst_to_clifford](#) (const [ex](#) &v, const [ex](#) &mu, const [ex](#) &metr, unsigned char rl=0)
List or vector conversion into the Clifford vector.

- `ex lst_to_clifford` (const `ex` &v, const `ex` &e)
List or vector conversion into the Clifford vector.
- static `ex get_clifford_comp` (const `ex` &e, const `ex` &c, bool root=true)
Auxiliary structure to define a function for stripping one Clifford unit from vectors.
- `lst clifford_to_lst` (const `ex` &e, const `ex` &c, bool algebraic=true)
An inverse function to `lst_to_clifford()`.
- `ex clifford_moebius_map` (const `ex` &a, const `ex` &b, const `ex` &c, const `ex` &d, const `ex` &v, const `ex` &G, unsigned char rl=0)
Calculations of Moebius transformations (conformal map) defined by a 2x2 Clifford matrix (a b|c d) in linear spaces with arbitrary signature.
- `ex clifford_moebius_map` (const `ex` &M, const `ex` &v, const `ex` &G, unsigned char rl=0)
The second form of Moebius transformations defined by a 2x2 Clifford matrix M This function takes the transformation matrix M as a single entity.
- `GINAC_DECLARE_UNARCHIVER` (clifford)
- `GINAC_DECLARE_UNARCHIVER` (diracone)
- `GINAC_DECLARE_UNARCHIVER` (cliffordunit)
- `GINAC_DECLARE_UNARCHIVER` (diracgamma)
- `GINAC_DECLARE_UNARCHIVER` (diracgamma5)
- `GINAC_DECLARE_UNARCHIVER` (diracgammaL)
- `GINAC_DECLARE_UNARCHIVER` (diracgammaR)
- bool `is_clifford_tinfo` (const `return_type_t` &ti)
Check whether a given `return_type_t` object (as returned by `return_type_tinfo()`) is that of a clifford object (with an arbitrary representation label).
- `ex clifford_bar` (const `ex` &e)
Main anti-automorphism of the Clifford algebra: makes reversion and changes signs of all clifford units.
- `ex clifford_star` (const `ex` &e)
Reversion of the Clifford algebra, reverse the order of all clifford units in ncmul.
- `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT` (su3one, tensor, print_func< `print_dflt` >(&su3one::do_print). print_func< `print_latex` >(&su3one::do_print_latex)) `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT`(su3t
`print_func< print_dflt > (&su3t::do_print). print_func< print_latex >(&su3t`
- `GINAC_BIND_UNARCHIVER` (color)
- `GINAC_BIND_UNARCHIVER` (su3one)
- `GINAC_BIND_UNARCHIVER` (su3t)
- `GINAC_BIND_UNARCHIVER` (su3f)
- `GINAC_BIND_UNARCHIVER` (su3d)
- static `ex permute_free_index_to_front` (const `exvector` &iv3, const `exvector` &iv2, int &sig)
Given a vector iv3 of three indices and a vector iv2 of two indices that is a subset of iv3, return the (free) index that is in iv3 but not in iv2 and the sign introduced by permuting that index to the front.
- `ex color_ONE` (unsigned char rl=0)
Create the su(3) unity element.
- `ex color_T` (const `ex` &a, unsigned char rl=0)
Create an su(3) generator.
- `ex color_f` (const `ex` &a, const `ex` &b, const `ex` &c)
Create an su(3) antisymmetric structure constant.
- `ex color_d` (const `ex` &a, const `ex` &b, const `ex` &c)
Create an su(3) symmetric structure constant.
- `ex color_h` (const `ex` &a, const `ex` &b, const `ex` &c)
*This returns the linear combination d.a.b.c+l*f.a.b.c.*
- static bool `is_color_tinfo` (const `return_type_t` &ti)
Check whether a given tinfo key (as returned by `return_type_tinfo()`) is that of a color object (with an arbitrary representation label).
- static unsigned char `get_representation_label` (const `return_type_t` &ti)

- Extract representation label from tinfo key (as returned by return_type_tinfo()).*
- `ex color_trace` (const `ex` &`e`, const `std::set< unsigned char >` &`rls`)
- Calculate color traces over the specified set of representation labels.*
- `ex color_trace` (const `ex` &`e`, const `lst` &`rl`)
- Calculate color traces over the specified list of representation labels.*
- `ex color_trace` (const `ex` &`e`, unsigned char `rl=0`)
- Calculate the trace of an expression containing color objects with a specified representation label.*
- `GINAC_DECLARE_UNARCHIVER` (`color`)
- `GINAC_DECLARE_UNARCHIVER` (`su3one`)
- `GINAC_DECLARE_UNARCHIVER` (`su3t`)
- `GINAC_DECLARE_UNARCHIVER` (`su3f`)
- `GINAC_DECLARE_UNARCHIVER` (`su3d`)
- `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT` (`constant`, `basic`, `print_func< print_context >` (&`constant::do_print`), `print_func< print_latex >` (&`constant::do_print_latex`), `print_func< print_tree >` (&`constant::do_print_tree`), `print_func< print_python_repr >` (&`constant::do_print_python_repr`)) const ant
- `GINAC_BIND_UNARCHIVER` (`constant`)
- `GINAC_DECLARE_UNARCHIVER` (`constant`)
- static unsigned `crc32` (const char *`c`, const unsigned `len`, const unsigned `crcinit`)
- bool `are_ex_trivially_equal` (const `ex` &`e1`, const `ex` &`e2`)
- Compare two objects of class quickly without doing a deep tree traversal.*
- `std::ostream & operator<<` (`std::ostream` &`os`, const `exvector` &`e`)
- `std::ostream & operator<<` (`std::ostream` &`os`, const `exset` &`e`)
- `std::ostream & operator<<` (`std::ostream` &`os`, const `exmap` &`e`)
- `size_t nops` (const `ex` &`thisex`)
- `ex expand` (const `ex` &`thisex`, unsigned `options=0`)
- `ex conjugate` (const `ex` &`thisex`)
- `ex real_part` (const `ex` &`thisex`)
- `ex imag_part` (const `ex` &`thisex`)
- bool `has` (const `ex` &`thisex`, const `ex` &`pattern`, unsigned `options=0`)
- bool `find` (const `ex` &`thisex`, const `ex` &`pattern`, `exset` &`found`)
- bool `is_polynomial` (const `ex` &`thisex`, const `ex` &`vars`)
- int `degree` (const `ex` &`thisex`, const `ex` &`s`)
- int `ldegree` (const `ex` &`thisex`, const `ex` &`s`)
- `ex coeff` (const `ex` &`thisex`, const `ex` &`s`, int `n=1`)
- `ex numer` (const `ex` &`thisex`)
- `ex denom` (const `ex` &`thisex`)
- `ex numer_denom` (const `ex` &`thisex`)
- `ex normal` (const `ex` &`thisex`)
- `ex to_rational` (const `ex` &`thisex`, `exmap` &`repl`)
- `ex to_polynomial` (const `ex` &`thisex`, `exmap` &`repl`)
- `ex collect` (const `ex` &`thisex`, const `ex` &`s`, bool `distributed=false`)
- `ex eval` (const `ex` &`thisex`)
- `ex evalf` (const `ex` &`thisex`)
- `ex evalm` (const `ex` &`thisex`)
- `ex eval_integ` (const `ex` &`thisex`)
- `ex diff` (const `ex` &`thisex`, const `symbol` &`s`, unsigned `nth=1`)
- `ex series` (const `ex` &`thisex`, const `ex` &`r`, int `order`, unsigned `options=0`)
- bool `match` (const `ex` &`thisex`, const `ex` &`pattern`, `exmap` &`repl_lst`)
- `ex simplify_indexed` (const `ex` &`thisex`, unsigned `options=0`)
- `ex simplify_indexed` (const `ex` &`thisex`, const `scalar_products` &`sp`, unsigned `options=0`)
- `ex symmetrize` (const `ex` &`thisex`)
- `ex symmetrize` (const `ex` &`thisex`, const `lst` &`l`)
- `ex antisymmetrize` (const `ex` &`thisex`)
- `ex antisymmetrize` (const `ex` &`thisex`, const `lst` &`l`)

- [ex symmetrize_cyclic](#) (const [ex](#) &thisex)
- [ex symmetrize_cyclic](#) (const [ex](#) &thisex, const [lst](#) &l)
- [ex op](#) (const [ex](#) &thisex, size_t i)
- [ex lhs](#) (const [ex](#) &thisex)
- [ex rhs](#) (const [ex](#) &thisex)
- [bool is_zero](#) (const [ex](#) &thisex)
- [void swap](#) ([ex](#) &e1, [ex](#) &e2)
- [ex subs](#) (const [ex](#) &thisex, const [exmap](#) &m, unsigned [options](#)=0)
- [ex subs](#) (const [ex](#) &thisex, const [lst](#) &ls, const [lst](#) &lr, unsigned [options](#)=0)
- [ex subs](#) (const [ex](#) &thisex, const [ex](#) &e, unsigned [options](#)=0)
- `template<class T >`
`bool is_a (const ex &obj)`
Check if ex is a handle to a T, including base classes.
- `template<class T >`
`bool is_exactly_a (const ex &obj)`
Check if ex is a handle to a T, not including base classes.
- `template<class T >`
`const T & ex_to (const ex &e)`
Return a reference to the basic-derived class T object embedded in an expression.
- `void compile_ex (const ex &expr, const symbol &sym, FUNCP_1P &fp, const std::string filename="")`
Takes an expression and produces a function pointer to the compiled and linked C code equivalent in double precision.
- `void compile_ex (const ex &expr, const symbol &sym1, const symbol &sym2, FUNCP_2P &fp, const std::string filename="")`
Takes an expression and produces a function pointer to the compiled and linked C code equivalent in double precision.
- `void compile_ex (const lst &exprs, const lst &syms, FUNCP_CUBA &fp, const std::string filename="")`
Takes an expression and produces a function pointer to the compiled and linked C code equivalent in double precision.
- `void link_ex (const std::string filename, FUNCP_1P &fp)`
Opens an existing so-file and returns a function pointer of type FUNCP_1P to the contained function.
- `void link_ex (const std::string filename, FUNCP_2P &fp)`
Opens an existing so-file and returns a function pointer of type FUNCP_2P to the contained function.
- `void link_ex (const std::string filename, FUNCP_CUBA &fp)`
Opens an existing so-file and returns a function pointer of type FUNCP_CUBA to the contained function.
- `void unlink_ex (const std::string filename)`
Closes all linked .so files that have the supplied filename.
- `void swap (expair &e1, expair &e2)`
- `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (expairseq, basic, print_func< print_context >(&expairseq::do_print). print_func< print_tree >(&expairseq::do_print_tree)) class exp_is_less`
- `epvector * conjugateepvector (const epvector &)`
Complex conjugate every element of an epvector.
- `ex factor (const ex &poly, unsigned options)`
Interface function to the outside world.
- `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (fail, basic, print_func< print_context >(&fail::do_print). print_func< print_tree >(&fail::do_print_tree)) GINAC_BIND_UNARCHIVER(fail)`
- `GINAC_DECLARE_UNARCHIVER (fail)`
- `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (fderivative, function, print_func< print_context >(&fderivative::do_print). print_func< print_latex >(&fderivative::do_print_latex). print_func< print_csrc >(&fderivative::do_print_csrc). print_func< print_tree >(&fderivative::do_print_tree)) fderivative`
- `GINAC_BIND_UNARCHIVER (fderivative)`
- `GINAC_DECLARE_UNARCHIVER (fderivative)`
- `GINAC_BIND_UNARCHIVER (function)`
- `GINAC_DECLARE_UNARCHIVER (function)`
- `template<typename T >`
`bool is_the_function (const ex &x)`

- static unsigned `make_hash_seed` (const std::type_info &info)

We need a hash function which gives different values for objects of different types.
- `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT` (idx, basic, print_func< print_context >(&idx::do_print), print_func< print_latex >(&idx::do_print_latex), print_func< print_csrc >(&idx::do_print_csrc), print_func< print_tree >(&idx::do_print_tree)) `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT`(varidx

`print_func< print_context > (&varidx::do_print)`. `print_func< print_latex >(&varidx`
- `GINAC_BIND_UNARCHIVER` (idx)
- `GINAC_BIND_UNARCHIVER` (varidx)
- `GINAC_BIND_UNARCHIVER` (spinidx)
- bool `is_dummy_pair` (const idx &i1, const idx &i2)

Check whether two indices form a dummy pair.
- bool `is_dummy_pair` (const ex &e1, const ex &e2)

Check whether two expressions form a dummy index pair.
- void `find_free_and_dummy` (exvector::const_iterator it, exvector::const_iterator itend, exvector &out_free, exvector &out_dummy)

Given a vector of indices, split them into two vectors, one containing the free indices, the other containing the dummy indices (numeric indices are neither free nor dummy ones).
- `ex minimal_dim` (const ex &dim1, const ex &dim2)

Return the minimum of two index dimensions.
- `GINAC_DECLARE_UNARCHIVER` (idx)
- `GINAC_DECLARE_UNARCHIVER` (varidx)
- `GINAC_DECLARE_UNARCHIVER` (spinidx)
- void `find_free_and_dummy` (const exvector &v, exvector &out_free, exvector &out_dummy)

Given a vector of indices, split them into two vectors, one containing the free indices, the other containing the dummy indices (numeric indices are neither free nor dummy ones).
- void `find_dummy_indices` (const exvector &v, exvector &out_dummy)

Given a vector of indices, find the dummy indices.
- size_t `count_dummy_indices` (const exvector &v)

Count the number of dummy index pairs in an index vector.
- size_t `count_free_indices` (const exvector &v)

Count the number of dummy index pairs in an index vector.
- `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT` (indexed, exprseq, print_func< print_context >(&indexed::do_print), print_func< print_latex >(&indexed::do_print_latex), print_func< print_tree >(&indexed::do_print_tree))

`indexed`
- `GINAC_BIND_UNARCHIVER` (indexed)
- static bool `indices_consistent` (const exvector &v1, const exvector &v2)

Check whether two sorted index vectors are consistent (i.e.
- template<class T >

size_t `number_of_type` (const exvector &v)
- template<class T >

static ex `rename_dummy_indices` (const ex &e, exvector &global_dummy_indices, exvector &local_dummy_↵
_indices)

Rename dummy indices in an expression.
- static void `find_variant_indices` (const exvector &v, exvector &variant_indices)

Given a set of indices, extract those of class varidx.
- bool `reposition_dummy_indices` (ex &e, exvector &variant_dummy_indices, exvector &moved_indices)

Raise/lower dummy indices in a single indexed objects to canonicalize their variance.
- static void `product_to_exvector` (const ex &e, exvector &v, bool &non_commutative)
- template<class T >

`ex idx_symmetrization` (const ex &r, const exvector &local_dummy_indices)
- `ex simplify_indexed` (const ex &e, exvector &free_indices, exvector &dummy_indices, const scalar_products &sp)

Simplify indexed expression, return list of free indices.

- `ex simplify_indexed_product` (const `ex` &*e*, `exvector` &*free_indices*, `exvector` &*dummy_indices*, const `scalar_products` &*sp*)
Simplify product of indexed expressions (commutative, noncommutative and simple squares), return list of free indices.
- `bool hasindex` (const `ex` &*x*, const `ex` &*sym*)
- `exvector get_all_dummy_indices_safely` (const `ex` &*e*)
More reliable version of the form.
- `exvector get_all_dummy_indices` (const `ex` &*e*)
Returns all dummy indices from the exvector.
- `lst rename_dummy_indices_uniquely` (const `exvector` &*va*, const `exvector` &*vb*)
Similar to above, where va and vb are the same and the return value is a list of two lists for substitution in b.
- `ex rename_dummy_indices_uniquely` (const `exvector` &*va*, const `exvector` &*vb*, const `ex` &*b*)
Same as above, where va and vb contain the indices of a and b and are sorted.
- `ex rename_dummy_indices_uniquely` (const `ex` &*a*, const `ex` &*b*)
Returns b with all dummy indices, which are common with a, renamed.
- `ex rename_dummy_indices_uniquely` (`exvector` &*va*, const `ex` &*b*, bool *modify_va*=false)
Returns b with all dummy indices, which are listed in va, renamed if modify_va is set to TRUE all dummy indices of b will be appended to va.
- `ex expand_dummy_sum` (const `ex` &*e*, bool *subs_idx*=false)
This function returns the given expression with expanded sums for all dummy index summations, where the dimensionality of the dummy index is a nonnegative integer.
- `GINAC_DECLARE_UNARCHIVER` (`indexed`)
- static `ex conjugate_evalf` (const `ex` &*arg*)
- static `ex conjugate_eval` (const `ex` &*arg*)
- static void `conjugate_print_latex` (const `ex` &*arg*, const `print_context` &*c*)
- static `ex conjugate_conjugate` (const `ex` &*arg*)
- static `ex conjugate_expl_derivative` (const `ex` &*arg*, const `symbol` &*s*)
- static `ex conjugate_real_part` (const `ex` &*arg*)
- static `ex conjugate_imag_part` (const `ex` &*arg*)
- static bool `func_arg_info` (const `ex` &*arg*, unsigned *inf*)
- static bool `conjugate_info` (const `ex` &*arg*, unsigned *inf*)
- `REGISTER_FUNCTION` (`conjugate_function`, `eval_func`(`conjugate_eval`). `evalf_func`(`conjugate_evalf`). `expl_derivative_func`(`conjugate_expl_derivative`). `info_func`(`conjugate_info`). `print_func`< `print_latex` >(`conjugate_print_latex`). `conjugate_func`(`conjugate_conjugate`). `real_part_func`(`conjugate_real_part`). `imag_part_func`(`conjugate_imag_part`). `set_name`("conjugate","conjugate"))
- static `ex real_part_evalf` (const `ex` &*arg*)
- static `ex real_part_eval` (const `ex` &*arg*)
- static void `real_part_print_latex` (const `ex` &*arg*, const `print_context` &*c*)
- static `ex real_part_conjugate` (const `ex` &*arg*)
- static `ex real_part_real_part` (const `ex` &*arg*)
- static `ex real_part_imag_part` (const `ex` &*arg*)
- static `ex real_part_expl_derivative` (const `ex` &*arg*, const `symbol` &*s*)
- `REGISTER_FUNCTION` (`real_part_function`, `eval_func`(`real_part_eval`). `evalf_func`(`real_part_evalf`). `expl_derivative_func`(`real_part_expl_derivative`). `print_func`< `print_latex` >(`real_part_print_latex`). `conjugate_func`(`real_part_conjugate`). `real_part_func`(`real_part_real_part`). `imag_part_func`(`real_part_imag_part`). `set_name`("real_part","real_part"))
- static `ex imag_part_evalf` (const `ex` &*arg*)
- static `ex imag_part_eval` (const `ex` &*arg*)
- static void `imag_part_print_latex` (const `ex` &*arg*, const `print_context` &*c*)
- static `ex imag_part_conjugate` (const `ex` &*arg*)
- static `ex imag_part_real_part` (const `ex` &*arg*)
- static `ex imag_part_imag_part` (const `ex` &*arg*)
- static `ex imag_part_expl_derivative` (const `ex` &*arg*, const `symbol` &*s*)

- [REGISTER_FUNCTION](#) ([imag_part_function](#), [eval_func\(imag_part_eval\)](#). [evalf_func\(imag_part_evalf\)](#). [expl_derivative_func\(imag_part_expl_derivative\)](#). [print_func< print_latex >\(imag_part_print_latex\)](#). [conjugate_func\(imag_part_conjugate\)](#). [real_part_func\(imag_part_real_part\)](#). [imag_part_func\(imag_part_imag_part\)](#). [set_name\("imag_part","imag_part"\)](#))
- static [ex abs_evalf](#) (const [ex](#) &arg)
- static [ex abs_eval](#) (const [ex](#) &arg)
- static [ex abs_expand](#) (const [ex](#) &arg, unsigned [options](#))
- static [ex abs_expl_derivative](#) (const [ex](#) &arg, const [symbol](#) &s)
- static void [abs_print_latex](#) (const [ex](#) &arg, const [print_context](#) &c)
- static void [abs_print_csrc_float](#) (const [ex](#) &arg, const [print_context](#) &c)
- static [ex abs_conjugate](#) (const [ex](#) &arg)
- static [ex abs_real_part](#) (const [ex](#) &arg)
- static [ex abs_imag_part](#) (const [ex](#) &arg)
- static [ex abs_power](#) (const [ex](#) &arg, const [ex](#) &exp)
- bool [abs_info](#) (const [ex](#) &arg, unsigned inf)
- [REGISTER_FUNCTION](#) ([abs](#), [eval_func\(abs_eval\)](#). [evalf_func\(abs_evalf\)](#). [expand_func\(abs_expand\)](#). [expl_derivative_func\(abs_expl_derivative\)](#). [info_func\(abs_info\)](#). [print_func< print_latex >\(abs_print_latex\)](#). [print_func< print_csrc_float >\(abs_print_csrc_float\)](#). [print_func< print_csrc_double >\(abs_print_csrc_double\)](#). [conjugate_func\(abs_conjugate\)](#). [real_part_func\(abs_real_part\)](#). [imag_part_func\(abs_imag_part\)](#). [power_func\(abs_power\)](#))
- static [ex step_evalf](#) (const [ex](#) &arg)
- static [ex step_eval](#) (const [ex](#) &arg)
- static [ex step_series](#) (const [ex](#) &arg, const [relational](#) &rel, int [order](#), unsigned [options](#))
- static [ex step_conjugate](#) (const [ex](#) &arg)
- static [ex step_real_part](#) (const [ex](#) &arg)
- static [ex step_imag_part](#) (const [ex](#) &arg)
- [REGISTER_FUNCTION](#) ([step](#), [eval_func\(step_eval\)](#). [evalf_func\(step_evalf\)](#). [series_func\(step_series\)](#). [conjugate_func\(step_conjugate\)](#). [real_part_func\(step_real_part\)](#). [imag_part_func\(step_imag_part\)](#))
- static [ex csgn_evalf](#) (const [ex](#) &arg)
- static [ex csgn_eval](#) (const [ex](#) &arg)
- static [ex csgn_series](#) (const [ex](#) &arg, const [relational](#) &rel, int [order](#), unsigned [options](#))
- static [ex csgn_conjugate](#) (const [ex](#) &arg)
- static [ex csgn_real_part](#) (const [ex](#) &arg)
- static [ex csgn_imag_part](#) (const [ex](#) &arg)
- static [ex csgn_power](#) (const [ex](#) &arg, const [ex](#) &exp)
- [REGISTER_FUNCTION](#) ([csgn](#), [eval_func\(csgn_eval\)](#). [evalf_func\(csgn_evalf\)](#). [series_func\(csgn_series\)](#). [conjugate_func\(csgn_conjugate\)](#). [real_part_func\(csgn_real_part\)](#). [imag_part_func\(csgn_imag_part\)](#). [power_func\(csgn_power\)](#))
- static [ex eta_evalf](#) (const [ex](#) &x, const [ex](#) &y)
- static [ex eta_eval](#) (const [ex](#) &x, const [ex](#) &y)
- static [ex eta_series](#) (const [ex](#) &x, const [ex](#) &y, const [relational](#) &rel, int [order](#), unsigned [options](#))
- static [ex eta_conjugate](#) (const [ex](#) &x, const [ex](#) &y)
- static [ex eta_real_part](#) (const [ex](#) &x, const [ex](#) &y)
- static [ex eta_imag_part](#) (const [ex](#) &x, const [ex](#) &y)
- [REGISTER_FUNCTION](#) ([eta](#), [eval_func\(eta_eval\)](#). [evalf_func\(eta_evalf\)](#). [series_func\(eta_series\)](#). [latex_name\("\\eta"\)](#). [set_symmetry\(sym\(0, 1\)\)](#). [conjugate_func\(eta_conjugate\)](#). [real_part_func\(eta_real_part\)](#). [imag_part_func\(eta_imag_part\)](#))
- static [ex Li2_evalf](#) (const [ex](#) &x)
- static [ex Li2_eval](#) (const [ex](#) &x)
- static [ex Li2_deriv](#) (const [ex](#) &x, unsigned [deriv_param](#))
- static [ex Li2_series](#) (const [ex](#) &x, const [relational](#) &rel, int [order](#), unsigned [options](#))
- static [ex Li2_conjugate](#) (const [ex](#) &x)
- [REGISTER_FUNCTION](#) ([Li2](#), [eval_func\(Li2_eval\)](#). [evalf_func\(Li2_evalf\)](#). [derivative_func\(Li2_deriv\)](#). [series_func\(Li2_series\)](#). [conjugate_func\(Li2_conjugate\)](#). [latex_name\("\\mathrm{Li}_2"\)](#))
- static [ex Li3_eval](#) (const [ex](#) &x)

- `REGISTER_FUNCTION` (`Li3`, `eval_func(Li3_eval)`). `latex_name("\\mathrm{Li}_3")`)
- static `ex zetaderiv_eval` (`const ex &n`, `const ex &x`)
- static `ex zetaderiv_deriv` (`const ex &n`, `const ex &x`, `unsigned deriv_param`)
- `REGISTER_FUNCTION` (`zetaderiv`, `eval_func(zetaderiv_eval)`. `derivative_func(zetaderiv_deriv)`. `latex_name("\\zeta^\\prime")`)
- static `ex factorial_evalf` (`const ex &x`)
- static `ex factorial_eval` (`const ex &x`)
- static void `factorial_print_dflt_latex` (`const ex &x`, `const print_context &c`)
- static `ex factorial_conjugate` (`const ex &x`)
- static `ex factorial_real_part` (`const ex &x`)
- static `ex factorial_imag_part` (`const ex &x`)
- `REGISTER_FUNCTION` (`factorial`, `eval_func(factorial_eval)`. `evalf_func(factorial_evalf)`. `print_func<print_dflt>(factorial_print_dflt_latex)`. `print_func<print_latex>(factorial_print_dflt_latex)`. `conjugate_func(factorial_conjugate)`. `real_part_func(factorial_real_part)`. `imag_part_func(factorial_imag_part)`)
- static `ex binomial_evalf` (`const ex &x`, `const ex &y`)
- static `ex binomial_sym` (`const ex &x`, `const numeric &y`)
- static `ex binomial_eval` (`const ex &x`, `const ex &y`)
- static `ex binomial_conjugate` (`const ex &x`, `const ex &y`)
- static `ex binomial_real_part` (`const ex &x`, `const ex &y`)
- static `ex binomial_imag_part` (`const ex &x`, `const ex &y`)
- `REGISTER_FUNCTION` (`binomial`, `eval_func(binomial_eval)`. `evalf_func(binomial_evalf)`. `conjugate_func(binomial_conjugate)`. `real_part_func(binomial_real_part)`. `imag_part_func(binomial_imag_part)`)
- static `ex Order_eval` (`const ex &x`)
- static `ex Order_series` (`const ex &x`, `const relational &r`, `int order`, `unsigned options`)
- static `ex Order_conjugate` (`const ex &x`)
- static `ex Order_real_part` (`const ex &x`)
- static `ex Order_imag_part` (`const ex &x`)
- static `ex Order_power` (`const ex &x`, `const ex &e`)
- static `ex Order_expl_derivative` (`const ex &arg`, `const symbol &s`)
- `REGISTER_FUNCTION` (`Order`, `eval_func(Order_eval)`. `series_func(Order_series)`. `latex_name("\\mathcal{O}")`. `expl_derivative_func(Order_expl_derivative)`. `conjugate_func(Order_conjugate)`. `real_part_func(Order_real_part)`. `imag_part_func(Order_imag_part)`. `power_func(Order_power)`)
- `ex Isolve` (`const ex &eqns`, `const ex &symbols`, `unsigned options=solve_algo::automatic`)

Factorial function.

- `const numeric fsolve` (`const ex &f`, `const symbol &x`, `const numeric &x1`, `const numeric &x2`)

Find a real root of real-valued function f(x) numerically within a given interval.

- `template<typename T1 >`
`function zeta` (`const T1 &p1`)
- `template<typename T1 , typename T2 >`
`function zeta` (`const T1 &p1`, `const T2 &p2`)
- `template<> bool is_the_function< zeta_SERIAL >` (`const ex &x`)
- `template<typename T1 , typename T2 >`
`function G` (`const T1 &x`, `const T2 &y`)
- `template<typename T1 , typename T2 , typename T3 >`
`function G` (`const T1 &x`, `const T2 &s`, `const T3 &y`)
- `template<> bool is_the_function< G_SERIAL >` (`const ex &x`)
- `template<typename T1 >`
`function psi` (`const T1 &p1`)
- `template<typename T1 , typename T2 >`
`function psi` (`const T1 &p1`, `const T2 &p2`)
- `template<> bool is_the_function< psi_SERIAL >` (`const ex &x`)
- `template<typename T1 , typename T2 >`
`function iterated_integral` (`const T1 &kernel_lst`, `const T2 &lambda`)
- `template<typename T1 , typename T2 , typename T3 >`
`function iterated_integral` (`const T1 &kernel_lst`, `const T2 &lambda`, `const T3 &N_trunc`)

- `template<> bool is_the_function< iterated_integral_SERIAL > (const ex &x)`
- `bool is_order_function (const ex &e)`
Check whether a function is the Order ($O(n)$) function.
- `ex convert_H_to_Li (const ex ¶meterlst, const ex &arg)`
Converts a given list containing parameters for H in Remiddi/Vermaseren notation into the corresponding GiNaC functions.
- `static ex EllipticK_evalf (const ex &k)`
- `static ex EllipticK_eval (const ex &k)`
- `static ex EllipticK_deriv (const ex &k, unsigned deriv_param)`
- `static ex EllipticK_series (const ex &k, const relational &rel, int order, unsigned options)`
- `static void EllipticK_print_latex (const ex &k, const print_context &c)`
- `REGISTER_FUNCTION (EllipticK, evalf_func(EllipticK_evalf). eval_func(EllipticK_eval). derivative_↵
func(EllipticK_deriv). series_func(EllipticK_series). print_func< print_latex >(EllipticK_print_latex). do_↵
not_evalf_params())`
- `static ex EllipticE_evalf (const ex &k)`
- `static ex EllipticE_eval (const ex &k)`
- `static ex EllipticE_deriv (const ex &k, unsigned deriv_param)`
- `static ex EllipticE_series (const ex &k, const relational &rel, int order, unsigned options)`
- `static void EllipticE_print_latex (const ex &k, const print_context &c)`
- `REGISTER_FUNCTION (EllipticE, evalf_func(EllipticE_evalf). eval_func(EllipticE_eval). derivative_↵
func(EllipticE_deriv). series_func(EllipticE_series). print_func< print_latex >(EllipticE_print_latex). do_↵
not_evalf_params())`
- `static ex iterated_integral_evalf_impl (const ex &kernel_lst, const ex &lambda, const ex &N_trunc)`
- `static ex iterated_integral2_evalf (const ex &kernel_lst, const ex &lambda)`
- `static ex iterated_integral3_evalf (const ex &kernel_lst, const ex &lambda, const ex &N_trunc)`
- `static ex iterated_integral2_eval (const ex &kernel_lst, const ex &lambda)`
- `static ex iterated_integral3_eval (const ex &kernel_lst, const ex &lambda, const ex &N_trunc)`
- `static ex lgamma_evalf (const ex &x)`
- `static ex lgamma_eval (const ex &x)`
Evaluation of $\lgamma(x)$, the natural logarithm of the Gamma function.
- `static ex lgamma_deriv (const ex &x, unsigned deriv_param)`
- `static ex lgamma_series (const ex &arg, const relational &rel, int order, unsigned options)`
- `static ex lgamma_conjugate (const ex &x)`
- `REGISTER_FUNCTION (lgamma, eval_func(lgamma_eval). evalf_func(lgamma_evalf). derivative_↵
func(lgamma_deriv). series_func(lgamma_series). conjugate_func(lgamma_conjugate). latex_name("\\log
\\Gamma"))`
- `static ex tgamma_evalf (const ex &x)`
- `static ex tgamma_eval (const ex &x)`
Evaluation of $tgamma(x)$, the true Gamma function.
- `static ex tgamma_deriv (const ex &x, unsigned deriv_param)`
- `static ex tgamma_series (const ex &arg, const relational &rel, int order, unsigned options)`
- `static ex tgamma_conjugate (const ex &x)`
- `REGISTER_FUNCTION (tgamma, eval_func(tgamma_eval). evalf_func(tgamma_evalf). derivative_↵
func(tgamma_deriv). series_func(tgamma_series). conjugate_func(tgamma_conjugate). latex_↵
name("\\Gamma"))`
- `static ex beta_evalf (const ex &x, const ex &y)`
- `static ex beta_eval (const ex &x, const ex &y)`
- `static ex beta_deriv (const ex &x, const ex &y, unsigned deriv_param)`
- `static ex beta_series (const ex &arg1, const ex &arg2, const relational &rel, int order, unsigned options)`
- `REGISTER_FUNCTION (beta, eval_func(beta_eval). evalf_func(beta_evalf). derivative_func(beta_deriv).
series_func(beta_series). latex_name("\\mathrm{B}"). set_symmetry(sy_symm(0, 1)))`
- `static ex psi1_evalf (const ex &x)`
- `static ex psi1_eval (const ex &x)`
Evaluation of digamma-function $\psi(x)$.

- static `ex psi1_deriv` (const `ex` &`x`, unsigned `deriv_param`)
- static `ex psi1_series` (const `ex` &`arg`, const `relational` &`rel`, int `order`, unsigned `options`)
- static `ex psi2_evalf` (const `ex` &`n`, const `ex` &`x`)
- static `ex psi2_eval` (const `ex` &`n`, const `ex` &`x`)

Evaluation of polygamma-function $\psi(n,x)$.

- static `ex psi2_deriv` (const `ex` &`n`, const `ex` &`x`, unsigned `deriv_param`)
- static `ex psi2_series` (const `ex` &`n`, const `ex` &`arg`, const `relational` &`rel`, int `order`, unsigned `options`)
- static `ex G2_evalf` (const `ex` &`x_`, const `ex` &`y`)
- static `ex G2_eval` (const `ex` &`x_`, const `ex` &`y`)
- static `ex G3_evalf` (const `ex` &`x_`, const `ex` &`s_`, const `ex` &`y`)
- static `ex G3_eval` (const `ex` &`x_`, const `ex` &`s_`, const `ex` &`y`)
- static `ex Li_evalf` (const `ex` &`m_`, const `ex` &`x_`)
- static `ex Li_eval` (const `ex` &`m_`, const `ex` &`x_`)
- static `ex Li_series` (const `ex` &`m`, const `ex` &`x`, const `relational` &`rel`, int `order`, unsigned `options`)
- static `ex Li_deriv` (const `ex` &`m_`, const `ex` &`x_`, unsigned `deriv_param`)
- static void `Li_print_latex` (const `ex` &`m_`, const `ex` &`x_`, const `print_context` &`c`)
- `REGISTER_FUNCTION` (`Li`, `evalf_func(Li_evalf)`. `eval_func(Li_eval)`. `series_func(Li_series)`. `derivative_↔func(Li_deriv)`. `print_func< print_latex >(Li_print_latex)`. `do_not_evalf_params()`)
- static `ex S_evalf` (const `ex` &`n`, const `ex` &`p`, const `ex` &`x`)
- static `ex S_eval` (const `ex` &`n`, const `ex` &`p`, const `ex` &`x`)
- static `ex S_series` (const `ex` &`n`, const `ex` &`p`, const `ex` &`x`, const `relational` &`rel`, int `order`, unsigned `options`)
- static `ex S_deriv` (const `ex` &`n`, const `ex` &`p`, const `ex` &`x`, unsigned `deriv_param`)
- static void `S_print_latex` (const `ex` &`n`, const `ex` &`p`, const `ex` &`x`, const `print_context` &`c`)
- `REGISTER_FUNCTION` (`S`, `evalf_func(S_evalf)`. `eval_func(S_eval)`. `series_func(S_series)`. `derivative_↔func(S_deriv)`. `print_func< print_latex >(S_print_latex)`. `do_not_evalf_params()`)
- static `ex H_evalf` (const `ex` &`x1`, const `ex` &`x2`)
- static `ex H_eval` (const `ex` &`m_`, const `ex` &`x`)
- static `ex H_series` (const `ex` &`m`, const `ex` &`x`, const `relational` &`rel`, int `order`, unsigned `options`)
- static `ex H_deriv` (const `ex` &`m_`, const `ex` &`x`, unsigned `deriv_param`)
- static void `H_print_latex` (const `ex` &`m_`, const `ex` &`x`, const `print_context` &`c`)
- `REGISTER_FUNCTION` (`H`, `evalf_func(H_evalf)`. `eval_func(H_eval)`. `series_func(H_series)`. `derivative_↔func(H_deriv)`. `print_func< print_latex >(H_print_latex)`. `do_not_evalf_params()`)
- static `ex zeta1_evalf` (const `ex` &`x`)
- static `ex zeta1_eval` (const `ex` &`m`)
- static `ex zeta1_deriv` (const `ex` &`m`, unsigned `deriv_param`)
- static void `zeta1_print_latex` (const `ex` &`m_`, const `print_context` &`c`)
- static `ex zeta2_evalf` (const `ex` &`x`, const `ex` &`s`)
- static `ex zeta2_eval` (const `ex` &`m`, const `ex` &`s_`)
- static `ex zeta2_deriv` (const `ex` &`m`, const `ex` &`s`, unsigned `deriv_param`)
- static void `zeta2_print_latex` (const `ex` &`m_`, const `ex` &`s_`, const `print_context` &`c`)
- static `ex exp_evalf` (const `ex` &`x`)
- static `ex exp_eval` (const `ex` &`x`)
- static `ex exp_expand` (const `ex` &`arg`, unsigned `options`)
- static `ex exp_deriv` (const `ex` &`x`, unsigned `deriv_param`)
- static `ex exp_real_part` (const `ex` &`x`)
- static `ex exp_imag_part` (const `ex` &`x`)
- static `ex exp_conjugate` (const `ex` &`x`)
- static `ex exp_power` (const `ex` &`x`, const `ex` &`a`)
- static bool `exp_info` (const `ex` &`x`, unsigned `inf`)
- `REGISTER_FUNCTION` (`exp`, `eval_func(exp_eval)`. `evalf_func(exp_evalf)`. `info_func(exp_info)`. `expand_↔func(exp_expand)`. `derivative_func(exp_deriv)`. `real_part_func(exp_real_part)`. `imag_part_func(exp_imag_part)`. `conjugate_func(exp_conjugate)`. `power_func(exp_power)`. `latex_name("\\exp")`)
- static `ex log_evalf` (const `ex` &`x`)
- static `ex log_eval` (const `ex` &`x`)
- static `ex log_deriv` (const `ex` &`x`, unsigned `deriv_param`)

- static `ex log_series` (const `ex` &arg, const `relational` &rel, int `order`, unsigned `options`)
- static `ex log_real_part` (const `ex` &x)
- static `ex log_imag_part` (const `ex` &x)
- static `ex log_expand` (const `ex` &arg, unsigned `options`)
- static `ex log_conjugate` (const `ex` &x)
- static bool `log_info` (const `ex` &x, unsigned inf)
- `REGISTER_FUNCTION` (`log`, `eval_func(log_eval)`, `evalf_func(log_evalf)`, `info_func(log_info)`, `expand_func(log_expand)`, `derivative_func(log_deriv)`, `series_func(log_series)`, `real_part_func(log_real_part)`, `imag_part_func(log_imag_part)`, `conjugate_func(log_conjugate)`, `latex_name("\\ln")`)
- static `ex sin_evalf` (const `ex` &x)
- static `ex sin_eval` (const `ex` &x)
- static `ex sin_deriv` (const `ex` &x, unsigned `deriv_param`)
- static `ex sin_real_part` (const `ex` &x)
- static `ex sin_imag_part` (const `ex` &x)
- static `ex sin_conjugate` (const `ex` &x)
- static bool `trig_info` (const `ex` &x, unsigned inf)
- `REGISTER_FUNCTION` (`sin`, `eval_func(sin_eval)`, `evalf_func(sin_evalf)`, `info_func(trig_info)`, `derivative_func(sin_deriv)`, `real_part_func(sin_real_part)`, `imag_part_func(sin_imag_part)`, `conjugate_func(sin_conjugate)`, `latex_name("\\sin")`)
- static `ex cos_evalf` (const `ex` &x)
- static `ex cos_eval` (const `ex` &x)
- static `ex cos_deriv` (const `ex` &x, unsigned `deriv_param`)
- static `ex cos_real_part` (const `ex` &x)
- static `ex cos_imag_part` (const `ex` &x)
- static `ex cos_conjugate` (const `ex` &x)
- `REGISTER_FUNCTION` (`cos`, `eval_func(cos_eval)`, `info_func(trig_info)`, `evalf_func(cos_evalf)`, `derivative_func(cos_deriv)`, `real_part_func(cos_real_part)`, `imag_part_func(cos_imag_part)`, `conjugate_func(cos_conjugate)`, `latex_name("\\cos")`)
- static `ex tan_evalf` (const `ex` &x)
- static `ex tan_eval` (const `ex` &x)
- static `ex tan_deriv` (const `ex` &x, unsigned `deriv_param`)
- static `ex tan_real_part` (const `ex` &x)
- static `ex tan_imag_part` (const `ex` &x)
- static `ex tan_series` (const `ex` &x, const `relational` &rel, int `order`, unsigned `options`)
- static `ex tan_conjugate` (const `ex` &x)
- `REGISTER_FUNCTION` (`tan`, `eval_func(tan_eval)`, `evalf_func(tan_evalf)`, `info_func(trig_info)`, `derivative_func(tan_deriv)`, `series_func(tan_series)`, `real_part_func(tan_real_part)`, `imag_part_func(tan_imag_part)`, `conjugate_func(tan_conjugate)`, `latex_name("\\tan")`)
- static `ex asin_evalf` (const `ex` &x)
- static `ex asin_eval` (const `ex` &x)
- static `ex asin_deriv` (const `ex` &x, unsigned `deriv_param`)
- static `ex asin_conjugate` (const `ex` &x)
- static bool `asin_info` (const `ex` &x, unsigned inf)
- `REGISTER_FUNCTION` (`asin`, `eval_func(asin_eval)`, `evalf_func(asin_evalf)`, `info_func(asin_info)`, `derivative_func(asin_deriv)`, `conjugate_func(asin_conjugate)`, `latex_name("\\arcsin")`)
- static `ex acos_evalf` (const `ex` &x)
- static `ex acos_eval` (const `ex` &x)
- static `ex acos_deriv` (const `ex` &x, unsigned `deriv_param`)
- static `ex acos_conjugate` (const `ex` &x)
- `REGISTER_FUNCTION` (`acos`, `eval_func(acos_eval)`, `evalf_func(acos_evalf)`, `info_func(asin_info)`, `derivative_func(acos_deriv)`, `conjugate_func(acos_conjugate)`, `latex_name("\\arccos")`)
- static `ex atan_evalf` (const `ex` &x)
- static `ex atan_eval` (const `ex` &x)
- static `ex atan_deriv` (const `ex` &x, unsigned `deriv_param`)
- static `ex atan_series` (const `ex` &arg, const `relational` &rel, int `order`, unsigned `options`)

- static `ex atan_conjugate` (const `ex` &`x`)
- static bool `atan_info` (const `ex` &`x`, unsigned inf)
- `REGISTER_FUNCTION` (`atan`, `eval_func(atan_eval)`. `evalf_func(atan_evalf)`. `info_func(atan_info)`. `derivative_func(atan_deriv)`. `series_func(atan_series)`. `conjugate_func(atan_conjugate)`. `latex_name("\\arctan")`)
- static `ex atan2_evalf` (const `ex` &`y`, const `ex` &`x`)
- static `ex atan2_eval` (const `ex` &`y`, const `ex` &`x`)
- static `ex atan2_deriv` (const `ex` &`y`, const `ex` &`x`, unsigned deriv_param)
- static bool `atan2_info` (const `ex` &`y`, const `ex` &`x`, unsigned inf)
- `REGISTER_FUNCTION` (`atan2`, `eval_func(atan2_eval)`. `evalf_func(atan2_evalf)`. `info_func(atan2_info)`. `evalf_func(atan2_evalf)`. `derivative_func(atan2_deriv)`)
- static `ex sinh_evalf` (const `ex` &`x`)
- static `ex sinh_eval` (const `ex` &`x`)
- static `ex sinh_deriv` (const `ex` &`x`, unsigned deriv_param)
- static `ex sinh_real_part` (const `ex` &`x`)
- static `ex sinh_imag_part` (const `ex` &`x`)
- static `ex sinh_conjugate` (const `ex` &`x`)
- `REGISTER_FUNCTION` (`sinh`, `eval_func(sinh_eval)`. `evalf_func(sinh_evalf)`. `info_func(atan_info)`. `derivative_func(sinh_deriv)`. `real_part_func(sinh_real_part)`. `imag_part_func(sinh_imag_part)`. `conjugate_func(sinh_conjugate)`. `latex_name("\\sinh")`)
- static `ex cosh_evalf` (const `ex` &`x`)
- static `ex cosh_eval` (const `ex` &`x`)
- static `ex cosh_deriv` (const `ex` &`x`, unsigned deriv_param)
- static `ex cosh_real_part` (const `ex` &`x`)
- static `ex cosh_imag_part` (const `ex` &`x`)
- static `ex cosh_conjugate` (const `ex` &`x`)
- `REGISTER_FUNCTION` (`cosh`, `eval_func(cosh_eval)`. `evalf_func(cosh_evalf)`. `info_func(exp_info)`. `derivative_func(cosh_deriv)`. `real_part_func(cosh_real_part)`. `imag_part_func(cosh_imag_part)`. `conjugate_func(cosh_conjugate)`. `latex_name("\\cosh")`)
- static `ex tanh_evalf` (const `ex` &`x`)
- static `ex tanh_eval` (const `ex` &`x`)
- static `ex tanh_deriv` (const `ex` &`x`, unsigned deriv_param)
- static `ex tanh_series` (const `ex` &`x`, const `relational` &`rel`, int `order`, unsigned `options`)
- static `ex tanh_real_part` (const `ex` &`x`)
- static `ex tanh_imag_part` (const `ex` &`x`)
- static `ex tanh_conjugate` (const `ex` &`x`)
- `REGISTER_FUNCTION` (`tanh`, `eval_func(tanh_eval)`. `evalf_func(tanh_evalf)`. `info_func(atan_info)`. `derivative_func(tanh_deriv)`. `series_func(tanh_series)`. `real_part_func(tanh_real_part)`. `imag_part_func(tanh_imag_part)`. `conjugate_func(tanh_conjugate)`. `latex_name("\\tanh")`)
- static `ex asinh_evalf` (const `ex` &`x`)
- static `ex asinh_eval` (const `ex` &`x`)
- static `ex asinh_deriv` (const `ex` &`x`, unsigned deriv_param)
- static `ex asinh_conjugate` (const `ex` &`x`)
- `REGISTER_FUNCTION` (`asinh`, `eval_func(asinh_eval)`. `evalf_func(asinh_evalf)`. `info_func(atan_info)`. `derivative_func(asinh_deriv)`. `conjugate_func(asinh_conjugate)`)
- static `ex acosh_evalf` (const `ex` &`x`)
- static `ex acosh_eval` (const `ex` &`x`)
- static `ex acosh_deriv` (const `ex` &`x`, unsigned deriv_param)
- static `ex acosh_conjugate` (const `ex` &`x`)
- `REGISTER_FUNCTION` (`acosh`, `eval_func(acosh_eval)`. `evalf_func(acosh_evalf)`. `info_func(asin_info)`. `derivative_func(acosh_deriv)`. `conjugate_func(acosh_conjugate)`)
- static `ex atanh_evalf` (const `ex` &`x`)
- static `ex atanh_eval` (const `ex` &`x`)
- static `ex atanh_deriv` (const `ex` &`x`, unsigned deriv_param)
- static `ex atanh_series` (const `ex` &`arg`, const `relational` &`rel`, int `order`, unsigned `options`)

- static `ex atanh_conjugate` (const `ex` &`x`)
- `REGISTER_FUNCTION` (`atanh`, `eval_func(atanh_eval)`, `evalf_func(atanh_evalf)`, `info_func(asin_info)`, `derivative_func(atanh_deriv)`, `series_func(atanh_series)`, `conjugate_func(atanh_conjugate)`)
- `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT` (`integral`, `basic`, `print_func< print_dflt >(&integral::do_print)`, `print_func< print_python >(&integral::do_print)`, `print_func< print_latex >(&integral::do_print_latex)`) `integral`
- `ex subsvalue` (const `ex` &`var`, const `ex` &`value`, const `ex` &`fun`)
- `ex adaptivesimpson` (const `ex` &`x`, const `ex` &`a_in`, const `ex` &`b_in`, const `ex` &`f`, const `ex` &`error`)
Numeric integration routine based upon the "Adaptive Quadrature" one in "Numerical Analysis" by Burden and Faires.
- `GINAC_BIND_UNARCHIVER` (`integral`)
- `GINAC_DECLARE_UNARCHIVER` (`integral`)
- `ex ifactor` (const `numeric` &`n`)
Returns the decomposition of the positive integer n into prime numbers in the form $lst(lst(p_1, \dots, pr), lst(a_1, \dots, ar))$ such that $n = p_1^{a_1} \dots p_r^{a_r}$.
- `bool is_discriminant_of_quadratic_number_field` (const `numeric` &`n`)
Returns true if the integer n is either one or the discriminant of a quadratic number field.
- `numeric kronecker_symbol` (const `numeric` &`a`, const `numeric` &`n`)
Returns the Kronecker symbol a : integer n : integer.
- `numeric primitive_dirichlet_character` (const `numeric` &`n`, const `numeric` &`a`)
Defines a primitive Dirichlet character through the Kronecker symbol.
- `numeric dirichlet_character` (const `numeric` &`n`, const `numeric` &`a`, const `numeric` &`N`)
Defines a Dirichlet character through the Kronecker symbol.
- `numeric generalised_Bernoulli_number` (const `numeric` &`k`, const `numeric` &`b`)
The generalised Bernoulli number.
- `ex Bernoulli_polynomial` (const `numeric` &`k`, const `ex` &`x`)
The Bernoulli polynomials.
- `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT` (`integration_kernel`, `basic`, `print_func< print_context >(&integration_kernel::do_print)`) `integration_kernel`
- `GINAC_BIND_UNARCHIVER` (`integration_kernel`)
- `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT` (`basic_log_kernel`, `integration_kernel`, `print_func< print_context >(&basic_log_kernel::do_print)`) `basic_log_kernel`
- `GINAC_BIND_UNARCHIVER` (`basic_log_kernel`)
- `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT` (`multiple_polylog_kernel`, `integration_kernel`, `print_func< print_context >(&multiple_polylog_kernel::do_print)`) `multiple_polylog_kernel`
- `GINAC_BIND_UNARCHIVER` (`multiple_polylog_kernel`)
- `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT` (`ELi_kernel`, `integration_kernel`, `print_func< print_context >(&ELi_kernel::do_print)`) `ELi_kernel`
- `GINAC_BIND_UNARCHIVER` (`ELi_kernel`)
- `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT` (`Ebar_kernel`, `integration_kernel`, `print_func< print_context >(&Ebar_kernel::do_print)`) `Ebar_kernel`
- `GINAC_BIND_UNARCHIVER` (`Ebar_kernel`)
- `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT` (`Kronecker_dtau_kernel`, `integration_kernel`, `print_func< print_context >(&Kronecker_dtau_kernel::do_print)`) `Kronecker_dtau_kernel`
- `GINAC_BIND_UNARCHIVER` (`Kronecker_dtau_kernel`)
- `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT` (`Kronecker_dz_kernel`, `integration_kernel`, `print_func< print_context >(&Kronecker_dz_kernel::do_print)`) `Kronecker_dz_kernel`
- `GINAC_BIND_UNARCHIVER` (`Kronecker_dz_kernel`)
- `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT` (`Eisenstein_kernel`, `integration_kernel`, `print_func< print_context >(&Eisenstein_kernel::do_print)`) `Eisenstein_kernel`
- `GINAC_BIND_UNARCHIVER` (`Eisenstein_kernel`)
- `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT` (`Eisenstein_h_kernel`, `integration_kernel`, `print_func< print_context >(&Eisenstein_h_kernel::do_print)`) `Eisenstein_h_kernel`
- `GINAC_BIND_UNARCHIVER` (`Eisenstein_h_kernel`)
- `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT` (`modular_form_kernel`, `integration_kernel`, `print_func< print_context >(&modular_form_kernel::do_print)`) `modular_form_kernel`

- [GINAC_BIND_UNARCHIVER](#) ([modular_form_kernel](#))
- [GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) ([user_defined_kernel](#), [integration_kernel](#), [print_func](#)<[print_context](#) >(&[user_defined_kernel](#)::do_print)) [user_defined_kernel](#)
- [GINAC_BIND_UNARCHIVER](#) ([user_defined_kernel](#))
- [GINAC_DECLARE_UNARCHIVER](#) ([integration_kernel](#))
- [GINAC_DECLARE_UNARCHIVER](#) ([basic_log_kernel](#))
- [GINAC_DECLARE_UNARCHIVER](#) ([multiple_polylog_kernel](#))
- [GINAC_DECLARE_UNARCHIVER](#) ([ELi_kernel](#))
- [GINAC_DECLARE_UNARCHIVER](#) ([Ebar_kernel](#))
- [GINAC_DECLARE_UNARCHIVER](#) ([Kronecker_dtau_kernel](#))
- [GINAC_DECLARE_UNARCHIVER](#) ([Kronecker_dz_kernel](#))
- [GINAC_DECLARE_UNARCHIVER](#) ([Eisenstein_kernel](#))
- [GINAC_DECLARE_UNARCHIVER](#) ([Eisenstein_h_kernel](#))
- [GINAC_DECLARE_UNARCHIVER](#) ([modular_form_kernel](#))
- [GINAC_DECLARE_UNARCHIVER](#) ([user_defined_kernel](#))
- [GINAC_DECLARE_UNARCHIVER](#) ([lst](#))
- [GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) ([matrix](#), [basic](#), [print_func](#)<[print_context](#) >(&[matrix](#)::do_print). [print_func](#)<[print_latex](#) >(&[matrix](#)::do_print_latex). [print_func](#)<[print_tree](#) >(&[matrix](#)::do_print_tree). [print_func](#)<[print_python_repr](#) >(&[matrix](#)::do_print_python_repr)) [matrix](#)

Default ctor.

- [GINAC_BIND_UNARCHIVER](#) ([matrix](#))
- [ex lst_to_matrix](#) (const [lst](#) &l)

Convert list of lists to matrix.

- [ex diag_matrix](#) (const [lst](#) &l)

Convert list of diagonal elements to matrix.

- [ex diag_matrix](#) (std::initializer_list< [ex](#) > l)
- [ex unit_matrix](#) (unsigned [r](#), unsigned [c](#))

Create an r times c unit matrix.

- [ex symbolic_matrix](#) (unsigned [r](#), unsigned [c](#), const std::string &base_name, const std::string &tex_base_name)

Create an r times c matrix of newly generated symbols consisting of the given base name plus the numeric row/column position of each element.

- [ex reduced_matrix](#) (const [matrix](#) &m, unsigned [r](#), unsigned [c](#))

Return the reduced matrix that is formed by deleting the rth row and cth column of matrix m.

- [ex sub_matrix](#) (const [matrix](#) &m, unsigned [r](#), unsigned [nr](#), unsigned [c](#), unsigned [nc](#))

Return the nr times nc submatrix starting at position r, c of matrix m.

- [GINAC_DECLARE_UNARCHIVER](#) ([matrix](#))
- [size_t nops](#) (const [matrix](#) &m)
- [ex expand](#) (const [matrix](#) &m, unsigned [options](#)=0)
- [ex evalf](#) (const [matrix](#) &m)
- unsigned [rows](#) (const [matrix](#) &m)
- unsigned [cols](#) (const [matrix](#) &m)
- [matrix transpose](#) (const [matrix](#) &m)
- [ex determinant](#) (const [matrix](#) &m, unsigned [options](#)=[determinant_algo::automatic](#))
- [ex trace](#) (const [matrix](#) &m)
- [ex charpoly](#) (const [matrix](#) &m, const [ex](#) &lambda)
- [matrix inverse](#) (const [matrix](#) &m)
- [matrix inverse](#) (const [matrix](#) &m, unsigned [algo](#))
- unsigned [rank](#) (const [matrix](#) &m)
- unsigned [rank](#) (const [matrix](#) &m, unsigned [solve_algo](#))
- [ex unit_matrix](#) (unsigned [x](#))

Create a x times x unit matrix.

- [ex symbolic_matrix](#) (unsigned [r](#), unsigned [c](#), const std::string &base_name)

Create an r times c matrix of newly generated symbols consisting of the given base name plus the numeric row/column position of each element.

- `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT` (`mul`, `expairseq`, `print_func`< `print_context` >(&`mul::do_print`). `print_func`< `print_latex` >(&`mul::do_print_latex`). `print_func`< `print_csrc` >(&`mul::do_print_csrc`). `print_func`< `print_tree` >(&`mul::do_print_tree`). `print_func`< `print_python_repr` >(&`mul::do_print_python_repr`) `mul`
- `bool tryfactsubs` (const `ex` &`origfactor`, const `ex` &`patternfactor`, int &`nummatches`, `exmap` &`repls`)
- `bool algebraic_match_mul_with_mul` (const `mul` &`e`, const `ex` &`pat`, `exmap` &`repls`, int `factor`, int &`nummatches`, const `std::vector`< `bool` > &`subsed`, `std::vector`< `bool` > &`matched`)

Checks whether e matches to the pattern pat and the (possibly to be updated) list of replacements $repls$.

- `GINAC_BIND_UNARCHIVER` (`mul`)
- `GINAC_DECLARE_UNARCHIVER` (`mul`)
- `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT` (`ncmul`, `exprseq`, `print_func`< `print_context` >(&`ncmul::do_print`). `print_func`< `print_tree` >(&`ncmul::do_print_tree`). `print_func`< `print_csrc` >(&`ncmul::do_print_csrc`). `print_func`< `print_python_repr` >(&`ncmul::do_print_csrc`)) `ncmul`
- `ex reeval_ncmul` (const `exvector` &`v`)
- `ex hold_ncmul` (const `exvector` &`v`)
- `GINAC_BIND_UNARCHIVER` (`ncmul`)
- `GINAC_DECLARE_UNARCHIVER` (`ncmul`)
- `static bool get_first_symbol` (const `ex` &`e`, `ex` &`x`)

Return pointer to first symbol found in expression.

- `static void add_symbol` (const `ex` &`s`, `sym_desc_vec` &`v`)
- `static void collect_symbols` (const `ex` &`e`, `sym_desc_vec` &`v`)
- `static void get_symbol_stats` (const `ex` &`a`, const `ex` &`b`, `sym_desc_vec` &`v`)

Collect statistical information about symbols in polynomials.

- `static numeric lcmcoeff` (const `ex` &`e`, const `numeric` &`l`)
- `static numeric lcm_of_coefficients_denominators` (const `ex` &`e`)

Compute LCM of denominators of coefficients of a polynomial.

- `static ex multiply_lcm` (const `ex` &`e`, const `numeric` &`lcm`)

Bring polynomial from $Q[X]$ to $Z[X]$ by multiplying in the previously determined LCM of the coefficient's denominators.

- `ex quo` (const `ex` &`a`, const `ex` &`b`, const `ex` &`x`, bool `check_args`)

Quotient $q(x)$ of polynomials $a(x)$ and $b(x)$ in $Q[x]$.

- `ex rem` (const `ex` &`a`, const `ex` &`b`, const `ex` &`x`, bool `check_args`)

Remainder $r(x)$ of polynomials $a(x)$ and $b(x)$ in $Q[x]$.

- `ex decomp_rational` (const `ex` &`a`, const `ex` &`x`)

Decompose rational function $a(x)=N(x)/D(x)$ into $P(x)+n(x)/D(x)$ with $\text{degree}(n, x) < \text{degree}(D, x)$.

- `ex prem` (const `ex` &`a`, const `ex` &`b`, const `ex` &`x`, bool `check_args`)

Pseudo-remainder of polynomials $a(x)$ and $b(x)$ in $Q[x]$.

- `ex sprem` (const `ex` &`a`, const `ex` &`b`, const `ex` &`x`, bool `check_args`)

Sparse pseudo-remainder of polynomials $a(x)$ and $b(x)$ in $Q[x]$.

- `bool divide` (const `ex` &`a`, const `ex` &`b`, `ex` &`q`, bool `check_args`)

Exact polynomial division of $a(X)$ by $b(X)$ in $Q[X]$.

- `static bool divide_in_z` (const `ex` &`a`, const `ex` &`b`, `ex` &`q`, `sym_desc_vec::const_iterator` `var`)

Exact polynomial division of $a(X)$ by $b(X)$ in $Z[X]$.

- `static ex sr_gcd` (const `ex` &`a`, const `ex` &`b`, `sym_desc_vec::const_iterator` `var`)

Compute GCD of multivariate polynomials using the subresultant PRS algorithm.

- `static ex interpolate` (const `ex` &`gamma`, const `numeric` &`xi`, const `ex` &`x`, int `degree_hint`=1)

ξ -adic polynomial interpolation

- `static bool heur_gcd_z` (`ex` &`res`, const `ex` &`a`, const `ex` &`b`, `ex` *`ca`, `ex` *`cb`, `sym_desc_vec::const_iterator` `var`)

Compute GCD of multivariate polynomials using the heuristic GCD algorithm.

- `static bool heur_gcd` (`ex` &`res`, const `ex` &`a`, const `ex` &`b`, `ex` *`ca`, `ex` *`cb`, `sym_desc_vec::const_iterator` `var`)

Compute GCD of multivariate polynomials using the heuristic GCD algorithm.

- `static ex gcd_pf_pow` (const `ex` &`a`, const `ex` &`b`, `ex` *`ca`, `ex` *`cb`)

- static `ex gcd_pf_mul` (const `ex` &a, const `ex` &b, `ex` *ca, `ex` *cb)
- `ex gcd` (const `ex` &a, const `ex` &b, `ex` *ca, `ex` *cb, bool check_args, unsigned options)
Compute GCD (Greatest Common Divisor) of multivariate polynomials $a(X)$ and $b(X)$ in $\mathbb{Z}[X]$.
- static `ex gcd_pf_pow_pow` (const `ex` &a, const `ex` &b, `ex` *ca, `ex` *cb)
- `ex lcm` (const `ex` &a, const `ex` &b, bool check_args)
Compute LCM (Least Common Multiple) of multivariate polynomials in $\mathbb{Z}[X]$.
- static `epvector sqrfree_yun` (const `ex` &a, const `symbol` &x)
Compute square-free factorization of multivariate polynomial $a(x)$ using Yun's algorithm.
- `ex sqrfree` (const `ex` &a, const `lst` &l)
Compute a square-free factorization of a multivariate polynomial in $\mathbb{Q}[X]$.
- `ex sqrfree_parfrac` (const `ex` &a, const `symbol` &x)
Compute square-free partial fraction decomposition of rational function $a(x)$.
- static `ex replace_with_symbol` (const `ex` &e, `exmap` &repl, `exmap` &rev_lookup, `lst` &modifier)
Create a symbol for replacing the expression "e" (or return a previously assigned symbol).
- static `ex replace_with_symbol` (const `ex` &e, `exmap` &repl)
Create a symbol for replacing the expression "e" (or return a previously assigned symbol).
- static `ex frac_cancel` (const `ex` &n, const `ex` &d)
Fraction cancellation.
- static `ex find_common_factor` (const `ex` &e, `ex` &factor, `exmap` &repl)
Remove the common factor in the terms of a sum 'e' by calculating the GCD, and multiply it into the expression 'factor' (which needs to be initialized to 1, unless you're accumulating factors).
- `ex collect_common_factors` (const `ex` &e)
Collect common factors in sums.
- `ex resultant` (const `ex` &e1, const `ex` &e2, const `ex` &s)
Resultant of two expressions $e1, e2$ with respect to symbol s .
- `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT` (`numeric`, `basic`, print_func< `print_context` >(&numeric::do_print), print_func< `print_latex` >(&numeric::do_print_latex), print_func< `print_csrc` >(&numeric::do_print_csrc), print_func< `print_csrc_cl_N` >(&numeric::do_print_csrc_cl_N), print_func< `print_tree` >(&numeric::do_print_tree), print_func< `print_python_repr` >(&numeric::do_print_python_repr)) `numeric`
default ctor.
- static const `cln::cl_F make_real_float` (const `cln::cl_idcoded_float` &dec)
Construct a floating point number from sign, mantissa, and exponent.
- static const `cln::cl_F read_real_float` (std::istream &s)
Read serialized floating point number.
- `GINAC_BIND_UNARCHIVER` (`numeric`)
- static void `write_real_float` (std::ostream &s, const `cln::cl_R` &n)
- static void `print_real_number` (const `print_context` &c, const `cln::cl_R` &x)
Helper function to print a real number in a nicer way than is CLN's default.
- static void `print_integer_csrc` (const `print_context` &c, const `cln::cl_I` &x)
Helper function to print integer number in C++ source format.
- static void `print_real_csrc` (const `print_context` &c, const `cln::cl_R` &x)
Helper function to print real number in C++ source format.
- template<typename T1, typename T2>
static bool `coerce` (T1 &dst, const T2 &arg)
- template<> bool `coerce`< `int`, `cln::cl_I` > (`int` &dst, const `cln::cl_I` &arg)
Check if CLN integer can be converted into int.
- template<> bool `coerce`< `unsigned int`, `cln::cl_I` > (`unsigned int` &dst, const `cln::cl_I` &arg)
- static void `print_real_cl_N` (const `print_context` &c, const `cln::cl_R` &x)
Helper function to print real number in C++ source format using cl_N types.
- const `numeric exp` (const `numeric` &x)
Exponential function.
- const `numeric log` (const `numeric` &x)

- *Natural logarithm.*
- const [numeric sin](#) (const [numeric &x](#))
- *Numeric sine (trigonometric function).*
- const [numeric cos](#) (const [numeric &x](#))
- *Numeric cosine (trigonometric function).*
- const [numeric tan](#) (const [numeric &x](#))
- *Numeric tangent (trigonometric function).*
- const [numeric asin](#) (const [numeric &x](#))
- *Numeric inverse sine (trigonometric function).*
- const [numeric acos](#) (const [numeric &x](#))
- *Numeric inverse cosine (trigonometric function).*
- const [numeric atan](#) (const [numeric &x](#))
- *Numeric arcustangent.*
- const [numeric atan](#) (const [numeric &y](#), const [numeric &x](#))
- *Numeric arcustangent of two arguments, analytically continued in a suitable way.*
- const [numeric sinh](#) (const [numeric &x](#))
- *Numeric hyperbolic sine (trigonometric function).*
- const [numeric cosh](#) (const [numeric &x](#))
- *Numeric hyperbolic cosine (trigonometric function).*
- const [numeric tanh](#) (const [numeric &x](#))
- *Numeric hyperbolic tangent (trigonometric function).*
- const [numeric asinh](#) (const [numeric &x](#))
- *Numeric inverse hyperbolic sine (trigonometric function).*
- const [numeric acosh](#) (const [numeric &x](#))
- *Numeric inverse hyperbolic cosine (trigonometric function).*
- const [numeric atanh](#) (const [numeric &x](#))
- *Numeric inverse hyperbolic tangent (trigonometric function).*
- static [cln::cl_N Li2_series](#) (const [cln::cl_N &x](#), const [cln::float_format_t &prec](#))
- *Numeric evaluation of Dilogarithm within circle of convergence (unit circle) using a power series.*
- static [cln::cl_N Li2_projection](#) (const [cln::cl_N &x](#), const [cln::float_format_t &prec](#))
- *Folds Li2's argument inside a small rectangle to enhance convergence.*
- const [cln::cl_N Li2_](#) (const [cln::cl_N &value](#))
- *Numeric evaluation of Dilogarithm.*
- const [numeric Li2](#) (const [numeric &x](#))
- const [numeric zeta](#) (const [numeric &x](#))
- *Numeric evaluation of Riemann's Zeta function.*
- static [cln::float_format_t guess_precision](#) (const [cln::cl_N &x](#))
- const [cln::cl_N lgamma](#) (const [cln::cl_N &x](#))
- *The Gamma function.*
- const [numeric lgamma](#) (const [numeric &x](#))
- const [cln::cl_N tgamma](#) (const [cln::cl_N &x](#))
- const [numeric tgamma](#) (const [numeric &x](#))
- const [numeric psi](#) (const [numeric &x](#))
- *The psi function (aka polygamma function).*
- const [numeric psi](#) (const [numeric &n](#), const [numeric &x](#))
- *The psi functions (aka polygamma functions).*
- const [numeric factorial](#) (const [numeric &n](#))
- *Factorial combinatorial function.*
- const [numeric doublefactorial](#) (const [numeric &n](#))
- *The double factorial combinatorial function.*
- const [numeric binomial](#) (const [numeric &n](#), const [numeric &k](#))

The Binomial coefficients.

- const [numeric bernoulli](#) (const [numeric](#) &nn)

Bernoulli number.

- const [numeric fibonacci](#) (const [numeric](#) &n)

Fibonacci number.

- const [numeric abs](#) (const [numeric](#) &x)

Absolute value.

- const [numeric mod](#) (const [numeric](#) &a, const [numeric](#) &b)

Modulus (in positive representation).

- const [numeric smod](#) (const [numeric](#) &a_, const [numeric](#) &b_)

Modulus (in symmetric representation).

- const [numeric irem](#) (const [numeric](#) &a, const [numeric](#) &b)

Numeric integer remainder.

- const [numeric irem](#) (const [numeric](#) &a, const [numeric](#) &b, [numeric](#) &q)

Numeric integer remainder.

- const [numeric iquo](#) (const [numeric](#) &a, const [numeric](#) &b)

Numeric integer quotient.

- const [numeric iquo](#) (const [numeric](#) &a, const [numeric](#) &b, [numeric](#) &r)

Numeric integer quotient.

- const [numeric gcd](#) (const [numeric](#) &a, const [numeric](#) &b)

Greatest Common Divisor.

- const [numeric lcm](#) (const [numeric](#) &a, const [numeric](#) &b)

Least Common Multiple.

- const [numeric sqrt](#) (const [numeric](#) &x)

Numeric square root.

- const [numeric isqrt](#) (const [numeric](#) &x)

Integer numeric square root.

- [ex PiEvalf](#) ()

Floating point evaluation of Archimedes' constant Pi.

- [ex EulerEvalf](#) ()

Floating point evaluation of Euler's constant gamma.

- [ex CatalanEvalf](#) ()

Floating point evaluation of Catalan's constant.

- std::ostream & [operator<<](#) (std::ostream &os, const [_numeric_digits](#) &e)

- [GINAC_DECLARE_UNARCHIVER](#) ([numeric](#))

- const [numeric pow](#) (const [numeric](#) &x, const [numeric](#) &y)

- const [numeric inverse](#) (const [numeric](#) &x)

- [numeric step](#) (const [numeric](#) &x)

- int [csgn](#) (const [numeric](#) &x)

- bool [is_zero](#) (const [numeric](#) &x)

- bool [is_positive](#) (const [numeric](#) &x)

- bool [is_negative](#) (const [numeric](#) &x)

- bool [is_integer](#) (const [numeric](#) &x)

- bool [is_pos_integer](#) (const [numeric](#) &x)

- bool [is_nonneg_integer](#) (const [numeric](#) &x)

- bool [is_even](#) (const [numeric](#) &x)

- bool [is_odd](#) (const [numeric](#) &x)

- bool [is_prime](#) (const [numeric](#) &x)

- bool [is_rational](#) (const [numeric](#) &x)

- bool [is_real](#) (const [numeric](#) &x)

- bool [is_cinteger](#) (const [numeric](#) &x)

- bool [is_crational](#) (const [numeric](#) &x)

- `int to_int (const numeric &x)`
- `long to_long (const numeric &x)`
- `double to_double (const numeric &x)`
- `const numeric real (const numeric &x)`
- `const numeric imag (const numeric &x)`
- `const numeric numer (const numeric &x)`
- `const numeric denom (const numeric &x)`
- `static const ex exadd (const ex &lh, const ex &rh)`
Used internally by `operator+()` to add two ex objects.
- `static const ex exmul (const ex &lh, const ex &rh)`
Used internally by `operator()` to multiply two ex objects.*
- `static const ex exminus (const ex &lh)`
Used internally by `operator-()` and friends to change the sign of an argument.
- `const ex operator+ (const ex &lh, const ex &rh)`
- `const ex operator- (const ex &lh, const ex &rh)`
- `const ex operator* (const ex &lh, const ex &rh)`
- `const ex operator/ (const ex &lh, const ex &rh)`
- `const numeric operator+ (const numeric &lh, const numeric &rh)`
- `const numeric operator- (const numeric &lh, const numeric &rh)`
- `const numeric operator* (const numeric &lh, const numeric &rh)`
- `const numeric operator/ (const numeric &lh, const numeric &rh)`
- `ex & operator+= (ex &lh, const ex &rh)`
- `ex & operator-= (ex &lh, const ex &rh)`
- `ex & operator*= (ex &lh, const ex &rh)`
- `ex & operator/= (ex &lh, const ex &rh)`
- `numeric & operator+= (numeric &lh, const numeric &rh)`
- `numeric & operator-= (numeric &lh, const numeric &rh)`
- `numeric & operator*= (numeric &lh, const numeric &rh)`
- `numeric & operator/= (numeric &lh, const numeric &rh)`
- `const ex operator+ (const ex &lh)`
- `const ex operator- (const ex &lh)`
- `const numeric operator+ (const numeric &lh)`
- `const numeric operator- (const numeric &lh)`
- `ex & operator++ (ex &rh)`
Expression prefix increment.
- `ex & operator-- (ex &rh)`
Expression prefix decrement.
- `const ex operator++ (ex &lh, int)`
Expression postfix increment.
- `const ex operator-- (ex &lh, int)`
Expression postfix decrement.
- `numeric & operator++ (numeric &rh)`
Numeric prefix increment.
- `numeric & operator-- (numeric &rh)`
Numeric prefix decrement.
- `const numeric operator++ (numeric &lh, int)`
Numeric postfix increment.
- `const numeric operator-- (numeric &lh, int)`
Numeric postfix decrement.
- `const relational operator== (const ex &lh, const ex &rh)`
- `const relational operator!= (const ex &lh, const ex &rh)`
- `const relational operator< (const ex &lh, const ex &rh)`
- `const relational operator<= (const ex &lh, const ex &rh)`

- const [relational operator](#)> (const [ex](#) &lh, const [ex](#) &rh)
- const [relational operator](#)>= (const [ex](#) &lh, const [ex](#) &rh)
- static int [my_ios_index](#) ()
- static void [my_ios_callback](#) (std::ios_base::event ev, std::ios_base &s, int i)
- static [print_context](#) * [get_print_context](#) (std::ios_base &s)
- static void [set_print_context](#) (std::ios_base &s, const [print_context](#) &c)
- static unsigned [get_print_options](#) (std::ios_base &s)
- static void [set_print_options](#) (std::ostream &s, unsigned [options](#))
- std::ostream & [operator<<](#) (std::ostream &os, const [ex](#) &e)
- std::istream & [operator>>](#) (std::istream &is, [ex](#) &e)
- std::ostream & [dflt](#) (std::ostream &os)
- std::ostream & [latex](#) (std::ostream &os)
- std::ostream & [python](#) (std::ostream &os)
- std::ostream & [python_repr](#) (std::ostream &os)
- std::ostream & [tree](#) (std::ostream &os)
- std::ostream & [csrc](#) (std::ostream &os)
- std::ostream & [csrc_float](#) (std::ostream &os)
- std::ostream & [csrc_double](#) (std::ostream &os)
- std::ostream & [csrc_cl_N](#) (std::ostream &os)
- std::ostream & [index_dimensions](#) (std::ostream &os)
- std::ostream & [no_index_dimensions](#) (std::ostream &os)
- [GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) ([power](#), [basic](#), print_func< [print_dflt](#) >(&[power::do_print_dflt](#)). print_func< [print_latex](#) >(&[power::do_print_latex](#)). print_func< [print_csrc](#) >(&[power::do_print_csrc](#)). print←_func< [print_python](#) >(&[power::do_print_python](#)). print_func< [print_python_repr](#) >(&[power::do_print_python_repr](#)). print_func< [print_csrc_cl_N](#) >(&[power::do_print_csrc_cl_N](#))) [power](#)
- static void [print_sym_pow](#) (const [print_context](#) &c, const [symbol](#) &x, int [exp](#))
- [GINAC_BIND_UNARCHIVER](#) ([power](#))
- [GINAC_DECLARE_UNARCHIVER](#) ([power](#))
- [ex pow](#) (const [ex](#) &b, const [ex](#) &e)
Symbolic exponentiation.
- template<typename T1 , typename T2 >
[ex pow](#) (const T1 &b, const T2 &e)
- [ex sqrt](#) (const [ex](#) &a)
Square root expression.
- template<class T >
bool [is_a](#) (const [print_context](#) &obj)
Check if obj is a T, including base classes.
- [GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) ([pseries](#), [basic](#), print_func< [print_context](#) >(&[pseries::do_print](#)). print_func< [print_latex](#) >(&[pseries::do_print_latex](#)). print_func< [print_tree](#) >(&[pseries::do_print_tree](#)). print_func< [print_python](#) >(&[pseries::do_print_python](#)). print_func< [print_python_repr](#) >(&[pseries::do_print_python_repr](#))) [pseries](#)
- [GINAC_BIND_UNARCHIVER](#) ([pseries](#))
- [GINAC_DECLARE_UNARCHIVER](#) ([pseries](#))
- [ex series_to_poly](#) (const [ex](#) &e)
Convert the pseries object embedded in an expression to an ordinary polynomial in the expansion variable.
- bool [is_terminating](#) (const [pseries](#) &s)
- template<typename T >
[return_type_t](#) [make_return_type_t](#) (const unsigned rl=0)
- template<class Alg , class Ctx , class T , class C >
void [set_print_func](#) (void f(const T &, const C &c, unsigned))
Add or replace a print method.
- template<class Alg , class Ctx , class T , class C >
void [set_print_func](#) (void(T::*f)(const C &, unsigned))
Add or replace a print method.

- `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT` (`relational`, `basic`, `print_func`< `print_context` >(&`relational::do_print`). `print_func`< `print_tree` >(&`relational::do_print_tree`). `print_func`< `print_python_repr` >(&`relational::do_print_python_repr`) `relational`
- `GINAC_BIND_UNARCHIVER` (`relational`)
- static void `print_operator` (const `print_context` &c, `relational::operators` o)
- `GINAC_DECLARE_UNARCHIVER` (`relational`)
- `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT` (`symbol`, `basic`, `print_func`< `print_context` >(&`symbol::do_print`). `print_func`< `print_latex` >(&`symbol::do_print_latex`). `print_func`< `print_tree` >(&`symbol::do_print_tree`). `print_func`< `print_python_repr` >(&`symbol::do_print_python_repr`) `symbol`
- static const std::string & `get_default_TeX_name` (const std::string &name)
Return default TeX name for symbol.
- `GINAC_BIND_UNARCHIVER` (`symbol`)
- `GINAC_BIND_UNARCHIVER` (`realsymbol`)
- `GINAC_BIND_UNARCHIVER` (`possymbol`)
- `GINAC_DECLARE_UNARCHIVER` (`symbol`)
- `GINAC_DECLARE_UNARCHIVER` (`realsymbol`)
- `GINAC_DECLARE_UNARCHIVER` (`possymbol`)
- `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT` (`symmetry`, `basic`, `print_func`< `print_context` >(&`symmetry::do_print`). `print_func`< `print_tree` >(&`symmetry::do_print_tree`) `symmetry`
- `GINAC_BIND_UNARCHIVER` (`symmetry`)
- static const `symmetry` & `index0` ()
- static const `symmetry` & `index1` ()
- static const `symmetry` & `index2` ()
- static const `symmetry` & `index3` ()
- const `symmetry` & `not_symmetric` ()
- const `symmetry` & `symmetric2` ()
- const `symmetry` & `symmetric3` ()
- const `symmetry` & `symmetric4` ()
- const `symmetry` & `antisymmetric2` ()
- const `symmetry` & `antisymmetric3` ()
- const `symmetry` & `antisymmetric4` ()
- int `canonicalize` (exvector::iterator v, const `symmetry` &symm)
Canonicalize the order of elements of an expression vector, according to the symmetry properties defined in a symmetry tree.
- static `ex symm` (const `ex` &e, exvector::const_iterator first, exvector::const_iterator `last`, bool asymmetric)
- `ex symmetrize` (const `ex` &e, exvector::const_iterator first, exvector::const_iterator `last`)
Symmetrize expression over a set of objects (symbols, indices).
- `ex antisymmetrize` (const `ex` &e, exvector::const_iterator first, exvector::const_iterator `last`)
Antisymmetrize expression over a set of objects (symbols, indices).
- `ex symmetrize_cyclic` (const `ex` &e, exvector::const_iterator first, exvector::const_iterator `last`)
Symmetrize expression by cyclic permutation over a set of objects (symbols, indices).
- `GINAC_DECLARE_UNARCHIVER` (`symmetry`)
- `symmetry sy_none` ()
- `symmetry sy_none` (const `symmetry` &c1, const `symmetry` &c2)
- `symmetry sy_none` (const `symmetry` &c1, const `symmetry` &c2, const `symmetry` &c3)
- `symmetry sy_none` (const `symmetry` &c1, const `symmetry` &c2, const `symmetry` &c3, const `symmetry` &c4)
- `symmetry sy_symm` ()
- `symmetry sy_symm` (const `symmetry` &c1, const `symmetry` &c2)
- `symmetry sy_symm` (const `symmetry` &c1, const `symmetry` &c2, const `symmetry` &c3)
- `symmetry sy_symm` (const `symmetry` &c1, const `symmetry` &c2, const `symmetry` &c3, const `symmetry` &c4)
- `symmetry sy_anti` ()
- `symmetry sy_anti` (const `symmetry` &c1, const `symmetry` &c2)
- `symmetry sy_anti` (const `symmetry` &c1, const `symmetry` &c2, const `symmetry` &c3)
- `symmetry sy_anti` (const `symmetry` &c1, const `symmetry` &c2, const `symmetry` &c3, const `symmetry` &c4)

- [symmetry sy_cycl](#) ()
- [symmetry sy_cycl](#) (const [symmetry](#) &c1, const [symmetry](#) &c2)
- [symmetry sy_cycl](#) (const [symmetry](#) &c1, const [symmetry](#) &c2, const [symmetry](#) &c3)
- [symmetry sy_cycl](#) (const [symmetry](#) &c1, const [symmetry](#) &c2, const [symmetry](#) &c3, const [symmetry](#) &c4)
- [ex symmetrize](#) (const [ex](#) &e, const [exvector](#) &v)
Symmetrize expression over a set of objects (symbols, indices).
- [ex antisymmetrize](#) (const [ex](#) &e, const [exvector](#) &v)
Antisymmetrize expression over a set of objects (symbols, indices).
- [ex symmetrize_cyclic](#) (const [ex](#) &e, const [exvector](#) &v)
Symmetrize expression by cyclic permutation over a set of objects (symbols, indices).
- [GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) ([tensdelta](#), [tensor](#), print_func< [print_dflt](#) >(&[tensdelta::do_print](#)), print_func< [print_latex](#) >(&[tensdelta::do_print_latex](#))) [GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#)([tensmetric](#)
- [print_func< print_dflt >](#) (&[tensmetric::do_print](#)). [print_func< print_latex >](#)(&[tensmetric](#)
- [GINAC_BIND_UNARCHIVER](#) ([minkmetric](#))
- [GINAC_BIND_UNARCHIVER](#) ([tensepsilon](#))
- [GINAC_BIND_UNARCHIVER](#) ([tensdelta](#))
- [GINAC_BIND_UNARCHIVER](#) ([tensmetric](#))
- [GINAC_BIND_UNARCHIVER](#) ([spinmetric](#))
- [ex delta_tensor](#) (const [ex](#) &i1, const [ex](#) &i2)
Create a delta tensor with specified indices.
- [ex metric_tensor](#) (const [ex](#) &i1, const [ex](#) &i2)
Create a symmetric metric tensor with specified indices.
- [ex lorentz_g](#) (const [ex](#) &i1, const [ex](#) &i2, bool pos_sig=false)
Create a Minkowski metric tensor with specified indices.
- [ex spinor_metric](#) (const [ex](#) &i1, const [ex](#) &i2)
Create a spinor metric tensor with specified indices.
- [ex epsilon_tensor](#) (const [ex](#) &i1, const [ex](#) &i2)
Create an epsilon tensor in a Euclidean space with two indices.
- [ex epsilon_tensor](#) (const [ex](#) &i1, const [ex](#) &i2, const [ex](#) &i3)
Create an epsilon tensor in a Euclidean space with three indices.
- [ex lorentz_eps](#) (const [ex](#) &i1, const [ex](#) &i2, const [ex](#) &i3, const [ex](#) &i4, bool pos_sig=false)
Create an epsilon tensor in a Minkowski space with four indices.
- [GINAC_DECLARE_UNARCHIVER](#) ([tensdelta](#))
- [GINAC_DECLARE_UNARCHIVER](#) ([tensmetric](#))
- [GINAC_DECLARE_UNARCHIVER](#) ([minkmetric](#))
- [GINAC_DECLARE_UNARCHIVER](#) ([spinmetric](#))
- [GINAC_DECLARE_UNARCHIVER](#) ([tensepsilon](#))
- unsigned [log2](#) (unsigned n)
Integer binary logarithm.
- const [numeric multinomial_coefficient](#) (const std::vector< unsigned > &p)
*Compute the multinomial coefficient $n!/(p1!*p2!*...*pk!)$ where $n = p1+p2+...+pk$, i.e.*
- unsigned [rotate_left](#) (unsigned n)
Rotate bits of unsigned value by one bit to the left.
- template<class T >
int [compare_pointers](#) (const T *a, const T *b)
Compare two pointers (just to establish some sort of canonical order).
- unsigned [golden_ratio_hash](#) (uintptr_t n)
Truncated multiplication with golden ratio, for computing hash values.
- template<class It >
int [permutation_sign](#) (It first, It last)
- template<class It, class Cmp, class Swap >
int [permutation_sign](#) (It first, It last, Cmp comp, Swap swapit)

- `template<class It , class Cmp , class Swap >`
`void shaker_sort (It first, It last, Cmp comp, Swap swapit)`
- `template<class It , class Swap >`
`void cyclic_permutation (It first, It last, It new_first, Swap swapit)`
- `template<typename T >`
`std::enable_if< has_distance< T >::value, typename std::iterator_traits< T >::difference_type >::type`
`format_index_value (const T &a, const T &b)`
For printing a multi-index: If the templates are used, where T is an iterator, printing the address where the iterator points to is not meaningful.
- `template<typename T >`
`std::enable_if<!has_distance< T >::value, T >::type format_index_value (const T &a, const T &b)`
For all other cases we simply print the value.
- `template<class T >`
`std::ostream & operator<< (std::ostream &os, const basic_multi_iterator< T > &v)`
Output operator.
- `template<class T >`
`std::ostream & operator<< (std::ostream &os, const multi_iterator_ordered< T > &v)`
Output operator.
- `template<class T >`
`std::ostream & operator<< (std::ostream &os, const multi_iterator_ordered_eq< T > &v)`
Output operator.
- `template<class T >`
`std::ostream & operator<< (std::ostream &os, const multi_iterator_ordered_eq_indv< T > &v)`
Output operator.
- `template<class T >`
`std::ostream & operator<< (std::ostream &os, const multi_iterator_counter< T > &v)`
Output operator.
- `template<class T >`
`std::ostream & operator<< (std::ostream &os, const multi_iterator_counter_indv< T > &v)`
Output operator.
- `template<class T >`
`std::ostream & operator<< (std::ostream &os, const multi_iterator_permutation< T > &v)`
Output operator.
- `template<class T >`
`std::ostream & operator<< (std::ostream &os, const multi_iterator_shuffle< T > &v)`
Output operator.
- `template<class T >`
`std::ostream & operator<< (std::ostream &os, const multi_iterator_shuffle_prime< T > &v)`
Output operator.
- `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (wildcard, basic, print_func< print_context >(&wildcard::do_print).`
`print_func< print_tree >(&wildcard::do_print_tree). print_func< print_python_repr >(&wildcard::do_print_python_repr))`
`wildcard`
- `GINAC_BIND_UNARCHIVER (wildcard)`
- `bool haswild (const ex &x)`
Check whether x has a wildcard anywhere as a subexpression.
- `GINAC_DECLARE_UNARCHIVER (wildcard)`
- `ex wild (unsigned label=0)`
Create a wildcard object with the specified label.

Variables

- static `unarchive_table_t` `unarch_table_instance`
- `GiNaC::evalm_map_function` `map_evalm`
- `GiNaC::eval_integ_map_function` `map_eval_integ`
- `tensor`
- const `constant` `Pi` ("Pi", `PiEvalf`, "\\pi", `domain::positive`)
Pi.
- const `constant` `Euler` ("Euler", `EulerEvalf`, "\\gamma_E", `domain::positive`)
Euler's constant.
- const `constant` `Catalan` ("Catalan", `CatalanEvalf`, "G", `domain::positive`)
Catalan's constant.
- static unsigned const `crctab` [256]
- static `library_init` `library_initializer`
For construction of flyweights, etc.
- const `basic` * `_num0_bp`
- `idx`
- unsigned `force_include_tgamma` = `tgamma_SERIAL::serial`
- unsigned `force_include_zeta1` = `zeta1_SERIAL::serial`
- template<> `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT_T`(`lst`, `basic`, `print_func`< `print_context`>(&`lst::do_print`). `print_func`< `print_tree`>(&`lst::do_print_tree`)) template<> bool `lst` `GINAC_BIND_UNARCHIVER`(`lst`)
Specialization of `container::info()` for `lst`.
- const `numeric` `l` = `numeric`(`cln::complex`(`cln::cl_l`(0),`cln::cl_l`(1)))
Imaginary unit.
- `_numeric_digits` `Digits`
Accuracy in decimal digits.
- unsigned `next_print_context_id` = 0
Next free ID for `print_context` types.
- const int `version_major` = `GINACLIB_MAJOR_VERSION`
- const int `version_minor` = `GINACLIB_MINOR_VERSION`
- const int `version_micro` = `GINACLIB_MICRO_VERSION`
- const `numeric` * `_num_120_p`
- const `ex_ex_120` = `ex`(* `_num_120_p`)
- const `numeric` * `_num_60_p`
- const `ex_ex_60` = `ex`(* `_num_60_p`)
- const `numeric` * `_num_48_p`
- const `ex_ex_48` = `ex`(* `_num_48_p`)
- const `numeric` * `_num_30_p`
- const `ex_ex_30` = `ex`(* `_num_30_p`)
- const `numeric` * `_num_25_p`
- const `ex_ex_25` = `ex`(* `_num_25_p`)
- const `numeric` * `_num_24_p`
- const `ex_ex_24` = `ex`(* `_num_24_p`)
- const `numeric` * `_num_20_p`
- const `ex_ex_20` = `ex`(* `_num_20_p`)
- const `numeric` * `_num_18_p`
- const `ex_ex_18` = `ex`(* `_num_18_p`)
- const `numeric` * `_num_15_p`
- const `ex_ex_15` = `ex`(* `_num_15_p`)
- const `numeric` * `_num_12_p`
- const `ex_ex_12` = `ex`(* `_num_12_p`)
- const `numeric` * `_num_11_p`
- const `ex_ex_11` = `ex`(* `_num_11_p`)

- const [numeric](#) * [_num_10_p](#)
- const [ex](#) [_ex_10](#) = [ex](#)(*[_num_10_p](#))
- const [numeric](#) * [_num_9_p](#)
- const [ex](#) [_ex_9](#) = [ex](#)(*[_num_9_p](#))
- const [numeric](#) * [_num_8_p](#)
- const [ex](#) [_ex_8](#) = [ex](#)(*[_num_8_p](#))
- const [numeric](#) * [_num_7_p](#)
- const [ex](#) [_ex_7](#) = [ex](#)(*[_num_7_p](#))
- const [numeric](#) * [_num_6_p](#)
- const [ex](#) [_ex_6](#) = [ex](#)(*[_num_6_p](#))
- const [numeric](#) * [_num_5_p](#)
- const [ex](#) [_ex_5](#) = [ex](#)(*[_num_5_p](#))
- const [numeric](#) * [_num_4_p](#)
- const [ex](#) [_ex_4](#) = [ex](#)(*[_num_4_p](#))
- const [numeric](#) * [_num_3_p](#)
- const [ex](#) [_ex_3](#) = [ex](#)(*[_num_3_p](#))
- const [numeric](#) * [_num_2_p](#)
- const [ex](#) [_ex_2](#) = [ex](#)(*[_num_2_p](#))
- const [numeric](#) * [_num_1_p](#)
- const [ex](#) [_ex_1](#) = [ex](#)(*[_num_1_p](#))
- const [numeric](#) * [_num_1_2_p](#)
- const [ex](#) [_ex_1_2](#) = [ex](#)(*[_num_1_2_p](#))
- const [numeric](#) * [_num_1_3_p](#)
- const [ex](#) [_ex_1_3](#) = [ex](#)(*[_num_1_3_p](#))
- const [numeric](#) * [_num_1_4_p](#)
- const [ex](#) [_ex_1_4](#) = [ex](#)(*[_num_1_4_p](#))
- const [numeric](#) * [_num0_p](#)
- const [ex](#) [_ex0](#) = [ex](#)(*[_num0_p](#))
- const [numeric](#) * [_num1_4_p](#)
- const [ex](#) [_ex1_4](#) = [ex](#)(*[_num1_4_p](#))
- const [numeric](#) * [_num1_3_p](#)
- const [ex](#) [_ex1_3](#) = [ex](#)(*[_num1_3_p](#))
- const [numeric](#) * [_num1_2_p](#)
- const [ex](#) [_ex1_2](#) = [ex](#)(*[_num1_2_p](#))
- const [numeric](#) * [_num1_p](#)
- const [ex](#) [_ex1](#) = [ex](#)(*[_num1_p](#))
- const [numeric](#) * [_num2_p](#)
- const [ex](#) [_ex2](#) = [ex](#)(*[_num2_p](#))
- const [numeric](#) * [_num3_p](#)
- const [ex](#) [_ex3](#) = [ex](#)(*[_num3_p](#))
- const [numeric](#) * [_num4_p](#)
- const [ex](#) [_ex4](#) = [ex](#)(*[_num4_p](#))
- const [numeric](#) * [_num5_p](#)
- const [ex](#) [_ex5](#) = [ex](#)(*[_num5_p](#))
- const [numeric](#) * [_num6_p](#)
- const [ex](#) [_ex6](#) = [ex](#)(*[_num6_p](#))
- const [numeric](#) * [_num7_p](#)
- const [ex](#) [_ex7](#) = [ex](#)(*[_num7_p](#))
- const [numeric](#) * [_num8_p](#)
- const [ex](#) [_ex8](#) = [ex](#)(*[_num8_p](#))
- const [numeric](#) * [_num9_p](#)
- const [ex](#) [_ex9](#) = [ex](#)(*[_num9_p](#))
- const [numeric](#) * [_num10_p](#)
- const [ex](#) [_ex10](#) = [ex](#)(*[_num10_p](#))
- const [numeric](#) * [_num11_p](#)

- const `ex_ex11` = `ex(*_num11_p)`
- const `numeric *_num12_p`
- const `ex_ex12` = `ex(*_num12_p)`
- const `numeric *_num15_p`
- const `ex_ex15` = `ex(*_num15_p)`
- const `numeric *_num18_p`
- const `ex_ex18` = `ex(*_num18_p)`
- const `numeric *_num20_p`
- const `ex_ex20` = `ex(*_num20_p)`
- const `numeric *_num24_p`
- const `ex_ex24` = `ex(*_num24_p)`
- const `numeric *_num25_p`
- const `ex_ex25` = `ex(*_num25_p)`
- const `numeric *_num30_p`
- const `ex_ex30` = `ex(*_num30_p)`
- const `numeric *_num48_p`
- const `ex_ex48` = `ex(*_num48_p)`
- const `numeric *_num60_p`
- const `ex_ex60` = `ex(*_num60_p)`
- const `numeric *_num120_p`
- const `ex_ex120` = `ex(*_num120_p)`

5.1.1 Typedef Documentation

5.1.1.1 `archive_node_id`

```
typedef unsigned GiNaC::archive_node_id
```

Numerical ID value to refer to an [archive_node](#).

5.1.1.2 `archive_atom`

```
typedef unsigned GiNaC::archive_atom
```

Numerical ID value to refer to a string.

5.1.1.3 `synthesize_func`

```
typedef basic *(* GiNaC::synthesize_func) ()
```

5.1.1.4 unarchive_map_t

```
typedef std::map<std::string, synthesize_func> GiNaC::unarchive_map_t
```

5.1.1.5 exvector

```
typedef std::vector<ex> GiNaC::exvector
```

5.1.1.6 exset

```
typedef std::set<ex, ex_is_less> GiNaC::exset
```

5.1.1.7 exmap

```
typedef std::map<ex, ex, ex_is_less> GiNaC::exmap
```

5.1.1.8 evalffunctype

```
typedef ex(* GiNaC::evalffunctype) ()
```

5.1.1.9 FUNCP_1P

```
typedef double(* GiNaC::FUNCP_1P) (double)
```

Function pointer with one function parameter.

5.1.1.10 FUNCP_2P

```
typedef double(* GiNaC::FUNCP_2P) (double, double)
```

Function pointer with two function parameters.

5.1.1.11 FUNCP_CUBA

```
typedef void(* GiNaC::FUNCP_CUBA) (const int *, const double[], const int *, double[])
```

Function pointer for use with the CUBA library (<http://www.feynarts.de/cuba>).

5.1.1.12 epvector

```
typedef std::vector<expair> GiNaC::epvector
```

expair-vector

5.1.1.13 epp

```
typedef epvector::iterator GiNaC::epp
```

expair-vector pointer

5.1.1.14 exprseq

```
typedef container<std::vector> GiNaC::exprseq
```

5.1.1.15 paramset

```
typedef std::multiset<unsigned> GiNaC::paramset
```

5.1.1.16 eval_funcp

```
typedef ex(* GiNaC::eval_funcp) ()
```

5.1.1.17 evalf_funcp

```
typedef ex(* GiNaC::evalf_funcp) ()
```

5.1.1.18 conjugate_funcp

```
typedef ex(* GiNaC::conjugate_funcp) ()
```

5.1.1.19 real_part_funcp

```
typedef ex(* GiNaC::real_part_funcp) ()
```

5.1.1.20 imag_part_funcp

```
typedef ex(* GiNaC::imag_part_funcp) ()
```

5.1.1.21 expand_funcp

```
typedef ex(* GiNaC::expand_funcp) ()
```

5.1.1.22 derivative_funcp

```
typedef ex(* GiNaC::derivative_funcp) ()
```

5.1.1.23 expl_derivative_funcp

```
typedef ex(* GiNaC::expl_derivative_funcp) ()
```

5.1.1.24 power_funcp

```
typedef ex(* GiNaC::power_funcp) ()
```

5.1.1.25 series_funcp

```
typedef ex(* GiNaC::series_funcp) ()
```

5.1.1.26 print_funcp

```
typedef void(* GiNaC::print_funcp) ()
```

5.1.1.27 info_funcp

```
typedef bool(* GiNaC::info_funcp) ()
```

5.1.1.28 eval_funcp_1

```
typedef ex(* GiNaC::eval_funcp_1) (const ex &)
```

5.1.1.29 evalf_funcp_1

```
typedef ex(* GiNaC::evalf_funcp_1) (const ex &)
```

5.1.1.30 conjugate_funcp_1

```
typedef ex(* GiNaC::conjugate_funcp_1) (const ex &)
```

5.1.1.31 real_part_funcp_1

```
typedef ex(* GiNaC::real_part_funcp_1) (const ex &)
```

5.1.1.32 imag_part_funcp_1

```
typedef ex(* GiNaC::imag_part_funcp_1) (const ex &)
```

5.1.1.33 expand_funcp_1

```
typedef ex(* GiNaC::expand_funcp_1) (const ex &, unsigned)
```


5.1.1.34 derivative_funcp_1

```
typedef ex(* GiNaC::derivative_funcp_1) (const ex &, unsigned)
```

5.1.1.35 expl_derivative_funcp_1

```
typedef ex(* GiNaC::expl_derivative_funcp_1) (const ex &, const symbol &)
```

5.1.1.36 power_funcp_1

```
typedef ex(* GiNaC::power_funcp_1) (const ex &, const ex &)
```

5.1.1.37 series_funcp_1

```
typedef ex(* GiNaC::series_funcp_1) (const ex &, const relational &, int, unsigned)
```

5.1.1.38 print_funcp_1

```
typedef void(* GiNaC::print_funcp_1) (const ex &, const print_context &)
```

5.1.1.39 info_funcp_1

```
typedef bool(* GiNaC::info_funcp_1) (const ex &, unsigned)
```

5.1.1.40 eval_funcp_2

```
typedef ex(* GiNaC::eval_funcp_2) (const ex &, const ex &)
```

5.1.1.41 evalf_funcp_2

```
typedef ex(* GiNaC::evalf_funcp_2) (const ex &, const ex &)
```

5.1.1.42 conjugate_funcp_2

```
typedef ex(* GiNaC::conjugate_funcp_2) (const ex &, const ex &)
```

5.1.1.43 real_part_funcp_2

```
typedef ex(* GiNaC::real_part_funcp_2) (const ex &, const ex &)
```

5.1.1.44 imag_part_funcp_2

```
typedef ex(* GiNaC::imag_part_funcp_2) (const ex &, const ex &)
```

5.1.1.45 expand_funcp_2

```
typedef ex(* GiNaC::expand_funcp_2) (const ex &, const ex &, unsigned)
```

5.1.1.46 derivative_funcp_2

```
typedef ex(* GiNaC::derivative_funcp_2) (const ex &, const ex &, unsigned)
```

5.1.1.47 expl_derivative_funcp_2

```
typedef ex(* GiNaC::expl_derivative_funcp_2) (const ex &, const ex &, const symbol &)
```

5.1.1.48 power_funcp_2

```
typedef ex(* GiNaC::power_funcp_2) (const ex &, const ex &, const ex &)
```

5.1.1.49 series_funcp_2

```
typedef ex(* GiNaC::series_funcp_2) (const ex &, const ex &, const relational &, int, unsigned)
```

5.1.1.50 print_funcp_2

```
typedef void(* GiNaC::print_funcp_2) (const ex &, const ex &, const print_context &)
```

5.1.1.51 info_funcp_2

```
typedef bool(* GiNaC::info_funcp_2) (const ex &, const ex &, unsigned)
```

5.1.1.52 eval_funcp_3

```
typedef ex(* GiNaC::eval_funcp_3) (const ex &, const ex &, const ex &)
```

5.1.1.53 evalf_funcp_3

```
typedef ex(* GiNaC::evalf_funcp_3) (const ex &, const ex &, const ex &)
```

5.1.1.54 conjugate_funcp_3

```
typedef ex(* GiNaC::conjugate_funcp_3) (const ex &, const ex &, const ex &)
```

5.1.1.55 real_part_funcp_3

```
typedef ex(* GiNaC::real_part_funcp_3) (const ex &, const ex &, const ex &)
```

5.1.1.56 imag_part_funcp_3

```
typedef ex(* GiNaC::imag_part_funcp_3) (const ex &, const ex &, const ex &)
```

5.1.1.57 expand_funcp_3

```
typedef ex(* GiNaC::expand_funcp_3) (const ex &, const ex &, const ex &, unsigned)
```

5.1.1.58 derivative_funcp_3

```
typedef ex(* GiNaC::derivative_funcp_3) (const ex &, const ex &, const ex &, unsigned)
```

5.1.1.59 expl_derivative_funcp_3

```
typedef ex(* GiNaC::expl_derivative_funcp_3) (const ex &, const ex &, const ex &, const symbol  
&)
```

5.1.1.60 power_funcp_3

```
typedef ex(* GiNaC::power_funcp_3) (const ex &, const ex &, const ex &, const ex &)
```

5.1.1.61 series_funcp_3

```
typedef ex(* GiNaC::series_funcp_3) (const ex &, const ex &, const ex &, const relational &,  
int, unsigned)
```

5.1.1.62 print_funcp_3

```
typedef void(* GiNaC::print_funcp_3) (const ex &, const ex &, const ex &, const print_context  
&)
```

5.1.1.63 info_funcp_3

```
typedef bool(* GiNaC::info_funcp_3) (const ex &, const ex &, const ex &, unsigned)
```

5.1.1.64 eval_funcp_4

```
typedef ex(* GiNaC::eval_funcp_4) (const ex &, const ex &, const ex &, const ex &)
```

5.1.1.65 evalf_funcp_4

```
typedef ex(* GiNaC::evalf_funcp_4) (const ex &, const ex &, const ex &, const ex &)
```

5.1.1.66 conjugate_funcp_4

```
typedef ex(* GiNaC::conjugate_funcp_4) (const ex &, const ex &, const ex &, const ex &)
```

5.1.1.67 real_part_funcp_4

```
typedef ex(* GiNaC::real_part_funcp_4) (const ex &, const ex &, const ex &, const ex &)
```

5.1.1.68 imag_part_funcp_4

```
typedef ex(* GiNaC::imag_part_funcp_4) (const ex &, const ex &, const ex &, const ex &)
```

5.1.1.69 expand_funcp_4

```
typedef ex(* GiNaC::expand_funcp_4) (const ex &, const ex &, const ex &, const ex &, unsigned)
```

5.1.1.70 derivative_funcp_4

```
typedef ex(* GiNaC::derivative_funcp_4) (const ex &, const ex &, const ex &, const ex &, unsigned)
```

5.1.1.71 expl_derivative_funcp_4

```
typedef ex(* GiNaC::expl_derivative_funcp_4) (const ex &, const ex &, const ex &, const ex &,  
const symbol &)
```

5.1.1.72 power_funcp_4

```
typedef ex(* GiNaC::power_funcp_4) (const ex &, const ex &, const ex &, const ex &, const ex &)
```

5.1.1.73 series_funcp_4

```
typedef ex(* GiNaC::series_funcp_4) (const ex &, const ex &, const ex &, const ex &, const relational &, int, unsigned)
```

5.1.1.74 print_funcp_4

```
typedef void(* GiNaC::print_funcp_4) (const ex &, const ex &, const ex &, const ex &, const print_context &)
```

5.1.1.75 info_funcp_4

```
typedef bool(* GiNaC::info_funcp_4) (const ex &, const ex &, const ex &, const ex &, unsigned)
```

5.1.1.76 eval_funcp_5

```
typedef ex(* GiNaC::eval_funcp_5) (const ex &, const ex &, const ex &, const ex &, const ex &)
```

5.1.1.77 evalf_funcp_5

```
typedef ex(* GiNaC::evalf_funcp_5) (const ex &, const ex &, const ex &, const ex &, const ex &)
```

5.1.1.78 conjugate_funcp_5

```
typedef ex(* GiNaC::conjugate_funcp_5) (const ex &, const ex &, const ex &, const ex &, const ex &)
```

5.1.1.79 real_part_funcp_5

```
typedef ex(* GiNaC::real_part_funcp_5) (const ex &, const ex &, const ex &, const ex &, const ex &)
```

5.1.1.80 imag_part_funcp_5

```
typedef ex(* GiNaC::imag_part_funcp_5) (const ex &, const ex &, const ex &, const ex &, const ex &)
```

5.1.1.81 expand_funcp_5

```
typedef ex(* GiNaC::expand_funcp_5) (const ex &, const ex &, const ex &, const ex &, const ex &, unsigned)
```

5.1.1.82 derivative_funcp_5

```
typedef ex(* GiNaC::derivative_funcp_5) (const ex &, const ex &, const ex &, const ex &, const ex &, unsigned)
```

5.1.1.83 expl_derivative_funcp_5

```
typedef ex(* GiNaC::expl_derivative_funcp_5) (const ex &, const ex &, const ex &, const ex &, const ex &, const symbol &)
```

5.1.1.84 power_funcp_5

```
typedef ex(* GiNaC::power_funcp_5) (const ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
```

5.1.1.85 series_funcp_5

```
typedef ex(* GiNaC::series_funcp_5) (const ex &, const ex &, const ex &, const ex &, const ex &, const relational &, int, unsigned)
```

5.1.1.86 print_funcp_5

```
typedef void(* GiNaC::print_funcp_5) (const ex &, const ex &, const ex &, const ex &, const ex  
&, const print_context &)
```

5.1.1.87 info_funcp_5

```
typedef bool(* GiNaC::info_funcp_5) (const ex &, const ex &, const ex &, const ex &, const ex  
&, unsigned)
```

5.1.1.88 eval_funcp_6

```
typedef ex(* GiNaC::eval_funcp_6) (const ex &, const ex &, const ex &, const ex &, const ex &,  
const ex &)
```

5.1.1.89 evalf_funcp_6

```
typedef ex(* GiNaC::evalf_funcp_6) (const ex &, const ex &, const ex &, const ex &, const ex  
&, const ex &)
```

5.1.1.90 conjugate_funcp_6

```
typedef ex(* GiNaC::conjugate_funcp_6) (const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &)
```

5.1.1.91 real_part_funcp_6

```
typedef ex(* GiNaC::real_part_funcp_6) (const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &)
```

5.1.1.92 imag_part_funcp_6

```
typedef ex(* GiNaC::imag_part_funcp_6) (const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &)
```


5.1.1.93 expand_funcp_6

```
typedef ex(* GiNaC::expand_funcp_6) (const ex &, const ex &, const ex &, const ex &, const ex  
&, const ex &, unsigned)
```

5.1.1.94 derivative_funcp_6

```
typedef ex(* GiNaC::derivative_funcp_6) (const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &, unsigned)
```

5.1.1.95 expl_derivative_funcp_6

```
typedef ex(* GiNaC::expl_derivative_funcp_6) (const ex &, const ex &, const ex &, const ex &,  
const ex &, const ex &, const symbol &)
```

5.1.1.96 power_funcp_6

```
typedef ex(* GiNaC::power_funcp_6) (const ex &, const ex &, const ex &, const ex &, const ex  
&, const ex &, const ex &)
```

5.1.1.97 series_funcp_6

```
typedef ex(* GiNaC::series_funcp_6) (const ex &, const ex &, const ex &, const ex &, const ex  
&, const ex &, const relational &, int, unsigned)
```

5.1.1.98 print_funcp_6

```
typedef void(* GiNaC::print_funcp_6) (const ex &, const ex &, const ex &, const ex &, const ex  
&, const ex &, const print_context &)
```

5.1.1.99 info_funcp_6

```
typedef bool(* GiNaC::info_funcp_6) (const ex &, const ex &, const ex &, const ex &, const ex  
&, const ex &, unsigned)
```

5.1.1.100 eval_funcp_7

```
typedef ex(* GiNaC::eval_funcp_7) (const ex &, const ex &, const ex &, const ex &, const ex &,
const ex &, const ex &)
```

5.1.1.101 evalf_funcp_7

```
typedef ex(* GiNaC::evalf_funcp_7) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &)
```

5.1.1.102 conjugate_funcp_7

```
typedef ex(* GiNaC::conjugate_funcp_7) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &)
```

5.1.1.103 real_part_funcp_7

```
typedef ex(* GiNaC::real_part_funcp_7) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &)
```

5.1.1.104 imag_part_funcp_7

```
typedef ex(* GiNaC::imag_part_funcp_7) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &)
```

5.1.1.105 expand_funcp_7

```
typedef ex(* GiNaC::expand_funcp_7) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, unsigned)
```

5.1.1.106 derivative_funcp_7

```
typedef ex(* GiNaC::derivative_funcp_7) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, unsigned)
```

5.1.1.107 expl_derivative_funcp_7

```
typedef ex(* GiNaC::expl_derivative_funcp_7) (const ex &, const ex &, const ex &, const ex &,
const ex &, const ex &, const ex &, const symbol &)
```

5.1.1.108 power_funcp_7

```
typedef ex(* GiNaC::power_funcp_7) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &)
```

5.1.1.109 series_funcp_7

```
typedef ex(* GiNaC::series_funcp_7) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const relational &, int, unsigned)
```

5.1.1.110 print_funcp_7

```
typedef void(* GiNaC::print_funcp_7) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const print_context &)
```

5.1.1.111 info_funcp_7

```
typedef bool(* GiNaC::info_funcp_7) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, unsigned)
```

5.1.1.112 eval_funcp_8

```
typedef ex(* GiNaC::eval_funcp_8) (const ex &, const ex &, const ex &, const ex &, const ex &,
const ex &, const ex &, const ex &)
```

5.1.1.113 evalf_funcp_8

```
typedef ex(* GiNaC::evalf_funcp_8) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &)
```

5.1.1.114 conjugate_funcp_8

```
typedef ex(* GiNaC::conjugate_funcp_8) (const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &, const ex &, const ex &)
```

5.1.1.115 real_part_funcp_8

```
typedef ex(* GiNaC::real_part_funcp_8) (const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &, const ex &, const ex &)
```

5.1.1.116 imag_part_funcp_8

```
typedef ex(* GiNaC::imag_part_funcp_8) (const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &, const ex &, const ex &)
```

5.1.1.117 expand_funcp_8

```
typedef ex(* GiNaC::expand_funcp_8) (const ex &, const ex &, const ex &, const ex &, const ex  
&, const ex &, const ex &, const ex &, unsigned)
```

5.1.1.118 derivative_funcp_8

```
typedef ex(* GiNaC::derivative_funcp_8) (const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &, const ex &, const ex &, unsigned)
```

5.1.1.119 expl_derivative_funcp_8

```
typedef ex(* GiNaC::expl_derivative_funcp_8) (const ex &, const ex &, const ex &, const ex &,  
const ex &, const ex &, const ex &, const ex &, const symbol &)
```

5.1.1.120 power_funcp_8

```
typedef ex(* GiNaC::power_funcp_8) (const ex &, const ex &, const ex &, const ex &, const ex  
&, const ex &, const ex &, const ex &, const ex &)
```

5.1.1.121 series_funcp_8

```
typedef ex(* GiNaC::series_funcp_8) (const ex &, const ex &, const ex &, const ex &, const ex  
&, const ex &, const ex &, const ex &, const relational &, int, unsigned)
```

5.1.1.122 print_funcp_8

```
typedef void(* GiNaC::print_funcp_8) (const ex &, const ex &, const ex &, const ex &, const ex  
&, const ex &, const ex &, const ex &, const print_context &)
```

5.1.1.123 info_funcp_8

```
typedef bool(* GiNaC::info_funcp_8) (const ex &, const ex &, const ex &, const ex &, const ex  
&, const ex &, const ex &, const ex &, unsigned)
```

5.1.1.124 eval_funcp_9

```
typedef ex(* GiNaC::eval_funcp_9) (const ex &, const ex &, const ex &, const ex &, const ex &,  
const ex &, const ex &, const ex &, const ex &)
```

5.1.1.125 evalf_funcp_9

```
typedef ex(* GiNaC::evalf_funcp_9) (const ex &, const ex &, const ex &, const ex &, const ex  
&, const ex &, const ex &, const ex &, const ex &)
```

5.1.1.126 conjugate_funcp_9

```
typedef ex(* GiNaC::conjugate_funcp_9) (const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &, const ex &, const ex &, const ex &)
```

5.1.1.127 real_part_funcp_9

```
typedef ex(* GiNaC::real_part_funcp_9) (const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &, const ex &, const ex &, const ex &)
```

5.1.1.128 imag_part_funcp_9

```
typedef ex(* GiNaC::imag_part_funcp_9) (const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
```

5.1.1.129 expand_funcp_9

```
typedef ex(* GiNaC::expand_funcp_9) (const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, unsigned)
```

5.1.1.130 derivative_funcp_9

```
typedef ex(* GiNaC::derivative_funcp_9) (const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, unsigned)
```

5.1.1.131 expl_derivative_funcp_9

```
typedef ex(* GiNaC::expl_derivative_funcp_9) (const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const symbol &)
```

5.1.1.132 power_funcp_9

```
typedef ex(* GiNaC::power_funcp_9) (const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
```

5.1.1.133 series_funcp_9

```
typedef ex(* GiNaC::series_funcp_9) (const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const relational &, int, unsigned)
```

5.1.1.134 print_funcp_9

```
typedef void(* GiNaC::print_funcp_9) (const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const print_context &)
```

5.1.1.135 info_funcp_9

```
typedef bool(* GiNaC::info_funcp_9) (const ex &, const ex &, const ex &, const ex &, const ex  
&, const ex &, const ex &, const ex &, const ex &, unsigned)
```

5.1.1.136 eval_funcp_10

```
typedef ex(* GiNaC::eval_funcp_10) (const ex &, const ex &, const ex &, const ex &, const ex  
&, const ex &, const ex &, const ex &, const ex &, const ex &)
```

5.1.1.137 evalf_funcp_10

```
typedef ex(* GiNaC::evalf_funcp_10) (const ex &, const ex &, const ex &, const ex &, const ex  
&, const ex &, const ex &, const ex &, const ex &, const ex &)
```

5.1.1.138 conjugate_funcp_10

```
typedef ex(* GiNaC::conjugate_funcp_10) (const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
```

5.1.1.139 real_part_funcp_10

```
typedef ex(* GiNaC::real_part_funcp_10) (const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
```

5.1.1.140 imag_part_funcp_10

```
typedef ex(* GiNaC::imag_part_funcp_10) (const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
```

5.1.1.141 expand_funcp_10

```
typedef ex(* GiNaC::expand_funcp_10) (const ex &, const ex &, const ex &, const ex &, const ex  
&, const ex &, const ex &, const ex &, const ex &, const ex &, unsigned)
```

5.1.1.142 derivative_funcp_10

```
typedef ex(* GiNaC::derivative_funcp_10) (const ex &, const ex &, const ex &, const ex &,
const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, unsigned)
```

5.1.1.143 expl_derivative_funcp_10

```
typedef ex(* GiNaC::expl_derivative_funcp_10) (const ex &, const ex &, const ex &, const ex &,
const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const symbol &)
```

5.1.1.144 power_funcp_10

```
typedef ex(* GiNaC::power_funcp_10) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
```

5.1.1.145 series_funcp_10

```
typedef ex(* GiNaC::series_funcp_10) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const relational &, int,
unsigned)
```

5.1.1.146 print_funcp_10

```
typedef void(* GiNaC::print_funcp_10) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const print_context &)
```

5.1.1.147 info_funcp_10

```
typedef bool(* GiNaC::info_funcp_10) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const ex &, unsigned)
```

5.1.1.148 eval_funcp_11

```
typedef ex(* GiNaC::eval_funcp_11) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
```


5.1.1.149 evalf_funcp_11

```
typedef ex(* GiNaC::evalf_funcp_11) (const ex &, const ex &, const ex &, const ex &, const ex  
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
```

5.1.1.150 conjugate_funcp_11

```
typedef ex(* GiNaC::conjugate_funcp_11) (const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
```

5.1.1.151 real_part_funcp_11

```
typedef ex(* GiNaC::real_part_funcp_11) (const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
```

5.1.1.152 imag_part_funcp_11

```
typedef ex(* GiNaC::imag_part_funcp_11) (const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
```

5.1.1.153 expand_funcp_11

```
typedef ex(* GiNaC::expand_funcp_11) (const ex &, const ex &, const ex &, const ex &, const ex  
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, unsigned)
```

5.1.1.154 derivative_funcp_11

```
typedef ex(* GiNaC::derivative_funcp_11) (const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, unsigned)
```

5.1.1.155 expl_derivative_funcp_11

```
typedef ex(* GiNaC::expl_derivative_funcp_11) (const ex &, const ex &, const ex &, const ex  
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const  
symbol &)
```

5.1.1.156 power_funcp_11

```
typedef ex(* GiNaC::power_funcp_11) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
```

5.1.1.157 series_funcp_11

```
typedef ex(* GiNaC::series_funcp_11) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const relational &,
int, unsigned)
```

5.1.1.158 print_funcp_11

```
typedef void(* GiNaC::print_funcp_11) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const print_context
&)
```

5.1.1.159 info_funcp_11

```
typedef bool(* GiNaC::info_funcp_11) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, unsigned)
```

5.1.1.160 eval_funcp_12

```
typedef ex(* GiNaC::eval_funcp_12) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
```

5.1.1.161 evalf_funcp_12

```
typedef ex(* GiNaC::evalf_funcp_12) (const ex &, const ex &, const ex &, const ex &, const ex
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
```

5.1.1.162 conjugate_funcp_12

```
typedef ex(* GiNaC::conjugate_funcp_12) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
```

```
typedef ex(* GiNaC::real_part_funcp_12) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
```

```
typedef ex(* GiNaC::imag_part_funcp_12) (const ex &, const ex &, const ex &, const ex &, const
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &)
```

[illegible][illegible][illegible][illegible]

5.1.1.169 series_funcp_12

```
typedef ex(* GiNaC::series_funcp_12) (const ex &, const ex &, const ex &, const ex &, const ex  
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const  
relational &, int, unsigned)
```

5.1.1.170 print_funcp_12

```
typedef void(* GiNaC::print_funcp_12) (const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const  
print_context &)
```

5.1.1.171 info_funcp_12

```
typedef bool(* GiNaC::info_funcp_12) (const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const  
unsigned)
```

5.1.1.172 eval_funcp_13

```
typedef ex(* GiNaC::eval_funcp_13) (const ex &, const ex &, const ex &, const ex &, const ex  
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const  
ex &)
```

5.1.1.173 evalf_funcp_13

```
typedef ex(* GiNaC::evalf_funcp_13) (const ex &, const ex &, const ex &, const ex &, const ex  
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const  
ex &)
```

5.1.1.174 conjugate_funcp_13

```
typedef ex(* GiNaC::conjugate_funcp_13) (const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const  
const ex &)
```

5.1.1.175 real_part_funcp_13

```
typedef ex(* GiNaC::real_part_funcp_13) (const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const  
ex &)
```

5.1.1.176 imag_part_funcp_13

```
typedef ex(* GiNaC::imag_part_funcp_13) (const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const  
ex &)
```

5.1.1.177 expand_funcp_13

```
typedef ex(* GiNaC::expand_funcp_13) (const ex &, const ex &, const ex &, const ex &, const ex  
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const  
ex &, unsigned)
```

5.1.1.178 derivative_funcp_13

```
typedef ex(* GiNaC::derivative_funcp_13) (const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &, unsigned)
```

5.1.1.179 expl_derivative_funcp_13

```
typedef ex(* GiNaC::expl_derivative_funcp_13) (const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const  
&, const ex &, const symbol &)
```

5.1.1.180 power_funcp_13

```
typedef ex(* GiNaC::power_funcp_13) (const ex &, const ex &, const ex &, const ex &, const ex  
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &)
```

5.1.1.181 series_funcp_13

```
typedef ex(* GiNaC::series_funcp_13) (const ex &, const ex &, const ex &, const ex &, const ex  
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const  
ex &, const relational &, int, unsigned)
```

5.1.1.182 print_funcp_13

```
typedef void(* GiNaC::print_funcp_13) (const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const  
ex &, const print_context &)
```

5.1.1.183 info_funcp_13

```
typedef bool(* GiNaC::info_funcp_13) (const ex &, const ex &, const ex &, const ex &, const ex  
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const  
ex &, unsigned)
```

5.1.1.184 eval_funcp_14

```
typedef ex(* GiNaC::eval_funcp_14) (const ex &, const ex &, const ex &, const ex &, const ex  
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &)
```

5.1.1.185 evalf_funcp_14

```
typedef ex(* GiNaC::evalf_funcp_14) (const ex &, const ex &, const ex &, const ex &, const ex  
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &)
```

5.1.1.186 conjugate_funcp_14

```
typedef ex(* GiNaC::conjugate_funcp_14) (const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &)
```

5.1.1.187 real_part_funcp_14

```
typedef ex(* GiNaC::real_part_funcp_14) (const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &)
```

5.1.1.188 imag_part_funcp_14

```
typedef ex(* GiNaC::imag_part_funcp_14) (const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &)
```

5.1.1.189 expand_funcp_14

```
typedef ex(* GiNaC::expand_funcp_14) (const ex &, const ex &, const ex &, const ex &, const ex  
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &, unsigned)
```

5.1.1.190 derivative_funcp_14

```
typedef ex(* GiNaC::derivative_funcp_14) (const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &, const ex &, unsigned)
```

5.1.1.191 expl_derivative_funcp_14

```
typedef ex(* GiNaC::expl_derivative_funcp_14) (const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &, const ex &, const symbol &)
```

5.1.1.192 power_funcp_14

```
typedef ex(* GiNaC::power_funcp_14) (const ex &, const ex &, const ex &, const ex &, const ex  
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &, const ex &)
```

5.1.1.193 series_funcp_14

```
typedef ex(* GiNaC::series_funcp_14) (const ex &, const ex &, const ex &, const ex &, const ex  
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &, const relational &, int, unsigned)
```

5.1.1.194 print_funcp_14

```
typedef void(* GiNaC::print_funcp_14) (const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &, const print_context &)
```

5.1.1.195 info_funcp_14

```
typedef bool(* GiNaC::info_funcp_14) (const ex &, const ex &, const ex &, const ex &, const ex  
&, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const ex &, const  
ex &, const ex &, unsigned)
```

5.1.1.196 eval_funcp_exvector

```
typedef ex(* GiNaC::eval_funcp_exvector) (const exvector &)
```

5.1.1.197 evalf_funcp_exvector

```
typedef ex(* GiNaC::evalf_funcp_exvector) (const exvector &)
```

5.1.1.198 conjugate_funcp_exvector

```
typedef ex(* GiNaC::conjugate_funcp_exvector) (const exvector &)
```

5.1.1.199 real_part_funcp_exvector

```
typedef ex(* GiNaC::real_part_funcp_exvector) (const exvector &)
```


5.1.1.200 imag_part_funcp_exvector

```
typedef ex(* GiNaC::imag_part_funcp_exvector) (const exvector &)
```

5.1.1.201 expand_funcp_exvector

```
typedef ex(* GiNaC::expand_funcp_exvector) (const exvector &, unsigned)
```

5.1.1.202 derivative_funcp_exvector

```
typedef ex(* GiNaC::derivative_funcp_exvector) (const exvector &, unsigned)
```

5.1.1.203 expl_derivative_funcp_exvector

```
typedef ex(* GiNaC::expl_derivative_funcp_exvector) (const exvector &, const symbol &)
```

5.1.1.204 power_funcp_exvector

```
typedef ex(* GiNaC::power_funcp_exvector) (const exvector &, const ex &)
```

5.1.1.205 series_funcp_exvector

```
typedef ex(* GiNaC::series_funcp_exvector) (const exvector &, const relational &, int, unsigned)
```

5.1.1.206 print_funcp_exvector

```
typedef void(* GiNaC::print_funcp_exvector) (const exvector &, const print_context &)
```

5.1.1.207 info_funcp_exvector

```
typedef bool(* GiNaC::info_funcp_exvector) (const exvector &, unsigned)
```

5.1.1.208 exhashmap

```
template<typename T , class Hash = std::hash<ex>, class KeyEqual = std::equal_to<ex>, class
Allocator = std::allocator<std::pair<const ex, T>>>
using GiNaC::exhashmap = typedef std::unordered_map<ex, T, Hash, KeyEqual, Allocator>
```

5.1.1.209 spmap

```
typedef std::map<spmapkey, ex> GiNaC::spmap
```

5.1.1.210 lookup_map

```
typedef map<error_and_integral, ex, error_and_integral_is_less> GiNaC::lookup_map
```

5.1.1.211 lst

```
typedef container< std::list > GiNaC::lst
```

5.1.1.212 uintvector

```
typedef std::vector<std::size_t> GiNaC::uintvector
```

5.1.1.213 unsignedvector

```
typedef std::vector<unsigned> GiNaC::unsignedvector
```

5.1.1.214 exvectorvector

```
typedef std::vector<exvector> GiNaC::exvectorvector
```

5.1.1.215 sym_desc_vec

```
typedef std::vector<sym_desc> GiNaC::sym_desc_vec
```

5.1.1.216 digits_changed_callback

```
typedef void(* GiNaC::digits_changed_callback) (long)
```

Function pointer to implement callbacks in the case 'Digits' gets changed.

Main purpose of such callbacks is to adjust look-up tables of certain functions to the new precision. Parameter contains the signed difference between new Digits and old Digits.

5.1.1.217 print_context_class_info

```
typedef class_info<print_context_options> GiNaC::print_context_class_info
```

5.1.1.218 registered_class_info

```
typedef class_info<registered_class_options> GiNaC::registered_class_info
```

5.1.2 Enumeration Type Documentation**5.1.2.1 anonymous enum**

```
anonymous enum
```

Enumerator

callback_registered

5.1.3 Function Documentation**5.1.3.1 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [1/33]**

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
    add ,
```

```

        expairseq ,
        print_func< print_context > &::do_print. print_func< print_latex > &::do_↵
print_latex. print_func< print_csrc > &::do_print_csrc. print_func< print_tree > &::do_↵
print_tree. print_func< print_python_repr > &::do_print_python_repr )

```

5.1.3.2 GINAC_BIND_UNARCHIVER() [1/49]

```

GiNaC::GINAC_BIND_UNARCHIVER (
    add )

```

5.1.3.3 GINAC_DECLARE_UNARCHIVER() [1/51]

```

GiNaC::GINAC_DECLARE_UNARCHIVER (
    add )

```

5.1.3.4 write_unsigned()

```

static void GiNaC::write_unsigned (
    std::ostream & os,
    unsigned val ) [static]

```

Write unsigned integer quantity to stream.

5.1.3.5 read_unsigned()

```

static unsigned GiNaC::read_unsigned (
    std::istream & is ) [static]

```

Read unsigned integer quantity from stream.

5.1.3.6 operator<<() [1/16]

```

std::ostream & GiNaC::operator<< (
    std::ostream & os,
    const archive_node & n )

```

Write [archive_node](#) to binary data stream.

5.1.3.7 operator<<() [2/16]

```
std::ostream & GiNaC::operator<< (
    std::ostream & os,
    const archive & ar )
```

Write archive to binary data stream.

5.1.3.8 operator>>() [1/3]

```
std::istream & GiNaC::operator>> (
    std::istream & is,
    archive_node & n )
```

Read [archive_node](#) from binary data stream.

5.1.3.9 operator>>() [2/3]

```
std::istream & GiNaC::operator>> (
    std::istream & is,
    archive & ar )
```

Read archive from binary data stream.

5.1.3.10 find_factory_fcn()

```
static synthesize_func GiNaC::find_factory_fcn (
    const std::string & name ) [static]
```

References [GiNaC::unarchive_table_t::find\(\)](#).

Referenced by [GiNaC::archive_node::unarchive\(\)](#).

5.1.3.11 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [2/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
    basic ,
    void ,
    print_func< print_context > &::do_print. print_func< print_tree > &::do_print←
_tree. print_func< print_python_repr > &::do_print_python_repr )
```

basic copy constructor: implicitly assumes that the other class is of the exact same type (as it's used by `duplicate()`), so it can copy the `tinfo_key` and the hash value.

5.1.3.12 is_a() [1/3]

```
template<class T >
bool GiNaC::is_a (
    const basic & obj ) [inline]
```

Check if *obj* is a T, including base classes.

Referenced by [GiNaC::container< C >::subs\(\)](#).

5.1.3.13 is_exactly_a() [1/2]

```
template<class T >
bool GiNaC::is_exactly_a (
    const basic & obj ) [inline]
```

Check if *obj* is a T, not including base classes.

5.1.3.14 dynallocate() [1/2]

```
template<class B , typename... Args>
B & GiNaC::dynallocate (
    Args &&... args ) [inline]
```

Constructs a new (class basic or derived) B object on the heap.

This function picks the object's ctor based on the given argument types.

This helps the constructor of *ex* from basic (or a derived class B) because then the constructor doesn't have to duplicate the object onto the heap. See [ex::construct_from_basic\(const basic &\)](#) for more information.

References [GiNaC::status_flags::dynallocated](#).

5.1.3.15 dynallocate() [2/2]

```
template<class B >
B & GiNaC::dynallocate (
    std::initializer_list< ex > il ) [inline]
```

Constructs a new (class basic or derived) B object on the heap.

This function is needed for [GiNaC](#) classes which have public ctors from initializer lists of expressions (which are not a type and not captured by the variadic template version).

References [GiNaC::status_flags::dynallocated](#).

5.1.3.16 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [3/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
    clifford ,
    indexed ,
    print_func< print_dflt > &::do_print_dflt. print_func< print_latex > &::do_←
print_latex. print_func< print_tree > &::do_print_tree )
```

5.1.3.17 print_func< print_dflt >() [1/3]

```
GiNaC::print_func< print_dflt > (
    &diracone::do_print ) &
```

5.1.3.18 GINAC_BIND_UNARCHIVER() [2/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    clifford )
```

5.1.3.19 GINAC_BIND_UNARCHIVER() [3/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    cliffordunit )
```

5.1.3.20 GINAC_BIND_UNARCHIVER() [4/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    diracone )
```

5.1.3.21 GINAC_BIND_UNARCHIVER() [5/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    diracgamma )
```

5.1.3.22 GINAC_BIND_UNARCHIVER() [6/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    diracgamma5 )
```

5.1.3.23 GINAC_BIND_UNARCHIVER() [7/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    diracgammaL )
```

5.1.3.24 GINAC_BIND_UNARCHIVER() [8/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    diracgammaR )
```

5.1.3.25 is_dirac_slash()

```
static bool GiNaC::is_dirac_slash (
    const ex & seq0 ) [static]
```

Referenced by [GiNaC::clifford::do_print_dflt\(\)](#), and [GiNaC::clifford::do_print_latex\(\)](#).

5.1.3.26 base_and_index()

```
static void GiNaC::base_and_index (
    const ex & c,
    ex & b,
    ex & i ) [static]
```

This function decomposes $\gamma_\mu \rightarrow (1, \mu)$ and $a \rightarrow (a.ix, ix)$

5.1.3.27 dirac_ONE()

```
ex GiNaC::dirac_ONE (
    unsigned char r1 = 0 )
```

Create a Clifford unity object.

Parameters

<i>rl</i>	Representation label
-----------	----------------------

Returns

newly constructed object

Referenced by [GiNaC::add::coeff\(\)](#).

5.1.3.28 get_dim_uint()

```
static unsigned GiNaC::get_dim_uint (
    const ex & e ) [static]
```

5.1.3.29 clifford_unit()

```
ex GiNaC::clifford_unit (
    const ex & mu,
    const ex & metr,
    unsigned char rl = 0 )
```

Create a Clifford unit object.

Parameters

<i>mu</i>	Index (must be of class varidx or a derived class)
<i>metr</i>	Metric (should be indexed, tensmetric or a derived class, or a matrix)
<i>rl</i>	Representation label

Returns

newly constructed Clifford unit object

5.1.3.30 dirac_gamma()

```
ex GiNaC::dirac_gamma (
    const ex & mu,
    unsigned char rl = 0 )
```

Create a Dirac gamma object.

Parameters

<i>mu</i>	Index (must be of class <code>varidx</code> or a derived class)
<i>rl</i>	Representation label

Returns

newly constructed gamma object

5.1.3.31 `dirac_gamma5()`

```
ex GiNaC::dirac_gamma5 (
    unsigned char rl = 0 )
```

Create a Dirac gamma5 object.

Parameters

<i>rl</i>	Representation label
-----------	----------------------

Returns

newly constructed object

5.1.3.32 `dirac_gammaL()`

```
ex GiNaC::dirac_gammaL (
    unsigned char rl = 0 )
```

Create a Dirac gammaL object.

Parameters

<i>rl</i>	Representation label
-----------	----------------------

Returns

newly constructed object

5.1.3.33 `dirac_gammaR()`

```
ex GiNaC::dirac_gammaR (
    unsigned char rl = 0 )
```

Create a Dirac gammaR object.

Parameters

<i>rl</i>	Representation label
-----------	----------------------

Returns

newly constructed object

5.1.3.34 `dirac_slash()`

```
ex GiNaC::dirac_slash (
    const ex & e,
    const ex & dim,
    unsigned char rl = 0 )
```

Create a term of the form $e_\mu * \gamma_\mu$ with a unique index μ .

Parameters

<i>e</i>	Original expression
<i>dim</i>	Dimension of index
<i>rl</i>	Representation label

5.1.3.35 `get_representation_label()` [1/2]

```
static unsigned char GiNaC::get_representation_label (
    const return_type_t & ti ) [static]
```

Extract representation label from tinfo key (as returned by `return_type_tinfo()`).

Referenced by [color_trace\(\)](#), [GiNaC::su3f::contract_with\(\)](#), and [GiNaC::su3d::contract_with\(\)](#).

5.1.3.36 `trace_string()`

```
static ex GiNaC::trace_string (
    exvector::const_iterator ix,
    size_t num ) [static]
```

Take trace of a string of an even number of Dirac gammas given a vector of indices.

5.1.3.37 `dirac_trace()` [1/3]

```
ex GiNaC::dirac_trace (
    const ex & e,
    const std::set< unsigned char > & rls,
    const ex & trONE = 4 )
```

Calculate dirac traces over the specified set of representation labels.

The computed trace is a linear functional that is equal to the usual trace only in $D = 4$ dimensions. In particular, the functional is not always cyclic in $D \neq 4$ dimensions when γ_5 is involved.

Parameters

<i>e</i>	Expression to take the trace of
<i>rls</i>	Set of representation labels
<i>trONE</i>	Expression to be returned as the trace of the unit matrix

5.1.3.38 `dirac_trace()` [2/3]

```
ex GiNaC::dirac_trace (
    const ex & e,
    const lst & rll,
    const ex & trONE = 4 )
```

Calculate dirac traces over the specified list of representation labels.

The computed trace is a linear functional that is equal to the usual trace only in $D = 4$ dimensions. In particular, the functional is not always cyclic in $D \neq 4$ dimensions when γ_5 is involved.

Parameters

<i>e</i>	Expression to take the trace of
<i>rll</i>	List of representation labels
<i>trONE</i>	Expression to be returned as the trace of the unit matrix

5.1.3.39 `dirac_trace()` [3/3]

```
ex GiNaC::dirac_trace (
    const ex & e,
    unsigned char rl = 0,
    const ex & trONE = 4 )
```

Calculate the trace of an expression containing gamma objects with a specified representation label.

The computed trace is a linear functional that is equal to the usual trace only in $D = 4$ dimensions. In particular, the functional is not always cyclic in $D \neq 4$ dimensions when γ_5 is involved.

Parameters

<i>e</i>	Expression to take the trace of
<i>rl</i>	Representation label
<i>trONE</i>	Expression to be returned as the trace of the unit matrix

5.1.3.40 canonicalize_clifford()

```
ex GiNaC::canonicalize_clifford (
    const ex & e )
```

Bring all products of clifford objects in an expression into a canonical order.

This is not necessarily the most simple form but it will allow to check two expressions for equality.

5.1.3.41 clifford_star_bar()

```
ex GiNaC::clifford_star_bar (
    const ex & e,
    bool do_bar,
    unsigned options )
```

An auxillary function performing [clifford_star\(\)](#) and [clifford_bar\(\)](#).

Referenced by [clifford_bar\(\)](#), and [clifford_star\(\)](#).

5.1.3.42 clifford_prime()

```
ex GiNaC::clifford_prime (
    const ex & e )
```

Automorphism of the Clifford algebra, simply changes signs of all clifford units.

5.1.3.43 remove_dirac_ONE()

```
ex GiNaC::remove_dirac_ONE (
    const ex & e,
    unsigned char rl = 0,
    unsigned options = 0 )
```

Replaces `dirac_ONE`'s (with a `representation_label` no less than `rl`) in `e` with 1.

For the default value `rl = 0` remove all of them. Aborts if `e` contains any `clifford_unit` with `representation_label` to be removed.

Parameters

<i>e</i>	Expression to be processed
<i>rl</i>	Value of representation label
<i>options</i>	Defines some internal use

5.1.3.44 clifford_max_label()

```
int GiNaC::clifford_max_label (
    const ex & e,
    bool ignore_ONE = false )
```

Returns the maximal representation label of a clifford object if e contains at least one, otherwise returns -1.

Parameters

<i>e</i>	Expression to be processed
<i>ignore_ONE</i>	defines if clifford_ONE should be ignored in the search

Referenced by [GiNaC::add::coeff\(\)](#).

5.1.3.45 clifford_norm()

```
ex GiNaC::clifford_norm (
    const ex & e )
```

Calculation of the norm in the Clifford algebra.

5.1.3.46 clifford_inverse()

```
ex GiNaC::clifford_inverse (
    const ex & e )
```

Calculation of the inverse in the Clifford algebra.

5.1.3.47 lst_to_clifford() [1/2]

```
ex GiNaC::lst_to_clifford (
    const ex & v,
    const ex & mu,
    const ex & metr,
    unsigned char rl = 0 )
```

List or vector conversion into the Clifford vector.

Parameters

<i>v</i>	List or vector of coordinates
<i>mu</i>	Index (must be of class varidx or a derived class)
<i>metr</i>	Metric (should be indexed, tensmetric or a derived class, or a matrix)
<i>rl</i>	Representation label

Returns

Clifford vector with given components

5.1.3.48 `lst_to_clifford()` [2/2]

```
ex GiNaC::lst_to_clifford (
    const ex & v,
    const ex & e )
```

List or vector conversion into the Clifford vector.

Parameters

<i>v</i>	List or vector of coordinates
<i>e</i>	Clifford unit object

Returns

Clifford vector with given components

5.1.3.49 `get_clifford_comp()`

```
static ex GiNaC::get_clifford_comp (
    const ex & e,
    const ex & c,
    bool root = true ) [static]
```

Auxiliary structure to define a function for stripping one Clifford unit from vectors.

Used in `clifford_to_lst()`.

5.1.3.50 clifford_to_lst()

```
lst GiNaC::clifford_to_lst (
    const ex & e,
    const ex & c,
    bool algebraic = true )
```

An inverse function to [lst_to_clifford\(\)](#).

For given Clifford vector extracts its components with respect to given Clifford unit. Obtained components may contain Clifford units with a different metric. Extraction is based on the algebraic formula $(e * c.i + c.i * e) / \text{pow}(e.i, 2)$ for non-degenerate cases (i.e. neither $\text{pow}(e.i, 2) = 0$).

Parameters

<i>e</i>	Clifford expression to be decomposed into components
<i>c</i>	Clifford unit defining the metric for splitting (should have numeric dimension of indices)
<i>algebraic</i>	Use algebraic or symbolic algorithm for extractions

Returns

List of components of a Clifford vector

5.1.3.51 `clifford_moebius_map()` [1/2]

```
ex GiNaC::clifford_moebius_map (
    const ex & a,
    const ex & b,
    const ex & c,
    const ex & d,
    const ex & v,
    const ex & G,
    unsigned char rl = 0 )
```

Calculations of Moebius transformations (conformal map) defined by a 2x2 Clifford matrix (a b\c d) in linear spaces with arbitrary signature.

The expression is $(a * x + b)/(c * x + d)$, where x is a vector build from list v with metric G. (see Jan Cnops. An introduction to {D}irac operators on manifolds, v.24 of Progress in Mathematical Physics. Birkhauser Boston Inc., Boston, MA, 2002.)

Parameters

<i>a</i>	(1,1) entry of the defining matrix
<i>b</i>	(1,2) entry of the defining matrix
<i>c</i>	(2,1) entry of the defining matrix
<i>d</i>	(2,2) entry of the defining matrix
<i>v</i>	Vector to be transformed
<i>G</i>	Metric of the surrounding space, may be a Clifford unit then the next parameter is ignored
<i>rl</i>	Representation label

Returns

List of components of the transformed vector

5.1.3.52 `clifford_moebius_map()` [2/2]

```
ex GiNaC::clifford_moebius_map (
    const ex & M,
```

```
const ex & v,
const ex & G,
unsigned char rl = 0 )
```

The second form of Moebius transformations defined by a 2x2 Clifford matrix M This function takes the transformation matrix M as a single entity.

Parameters

<i>M</i>	the defining matrix
<i>v</i>	Vector to be transformed
<i>G</i>	Metric of the surrounding space, may be a Clifford unit then the next parameter is ignored
<i>rl</i>	Representation label

Returns

List of components of the transformed vector

5.1.3.53 GINAC_DECLARE_UNARCHIVER() [2/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    clifford )
```

5.1.3.54 GINAC_DECLARE_UNARCHIVER() [3/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    diracone )
```

5.1.3.55 GINAC_DECLARE_UNARCHIVER() [4/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    cliffordunit )
```

5.1.3.56 GINAC_DECLARE_UNARCHIVER() [5/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    diracgamma )
```

5.1.3.57 GINAC_DECLARE_UNARCHIVER() [6/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    diracgamma5 )
```

5.1.3.58 GINAC_DECLARE_UNARCHIVER() [7/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    diracgammaL )
```

5.1.3.59 GINAC_DECLARE_UNARCHIVER() [8/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    diracgammaR )
```

5.1.3.60 is_clifford_tinfo()

```
bool GiNaC::is_clifford_tinfo (
    const return\_type\_t & ti ) [inline]
```

Check whether a given [return_type_t](#) object (as returned by `return_type_tinfo()`) is that of a clifford object (with an arbitrary representation label).

Parameters

<i>ti</i>	tinfo key
-----------	-----------

References [GiNaC::return_type_t::tinfo](#).

Referenced by [GiNaC::ncmul::conjugate\(\)](#).

5.1.3.61 clifford_bar()

```
ex GiNaC::clifford_bar (
    const ex & e ) [inline]
```

Main anti-automorphism of the Clifford algebra: makes reversion and changes signs of all clifford units.

References [clifford_star_bar\(\)](#).

5.1.3.62 clifford_star()

```
ex GiNaC::clifford_star (
    const ex & e ) [inline]
```

Reversion of the Clifford algebra, reverse the order of all clifford units in ncmul.

References [clifford_star_bar\(\)](#).

5.1.3.63 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [4/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
    su3one ,
    tensor ,
    print_func< print_dflt > &::do_print. print_func< print_latex > &::do_print_↵
    latex )
```

5.1.3.64 print_func< print_dflt >() [2/3]

```
GiNaC::print_func< print_dflt > (
    &su3t::do_print ) &
```

5.1.3.65 GINAC_BIND_UNARCHIVER() [9/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    color )
```

5.1.3.66 GINAC_BIND_UNARCHIVER() [10/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    su3one )
```

5.1.3.67 GINAC_BIND_UNARCHIVER() [11/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    su3t )
```

5.1.3.68 GINAC_BIND_UNARCHIVER() [12/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    su3f )
```

5.1.3.69 GINAC_BIND_UNARCHIVER() [13/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    su3d )
```

5.1.3.70 permute_free_index_to_front()

```
static ex GiNaC::permute_free_index_to_front (
    const exvector & iv3,
    const exvector & iv2,
    int & sig ) [static]
```

Given a vector *iv3* of three indices and a vector *iv2* of two indices that is a subset of *iv3*, return the (free) index that is in *iv3* but not in *iv2* and the sign introduced by permuting that index to the front.

Parameters

<i>iv3</i>	Vector of 3 indices
<i>iv2</i>	Vector of 2 indices, must be a subset of <i>iv3</i>
<i>sig</i>	Returns sign introduced by index permutation

Returns

the free index (the one that is in *iv3* but not in *iv2*)

References [GINAC_ASSERT](#), and [TEST_PERMUTATION](#).

Referenced by [GiNaC::su3f::contract_with\(\)](#), and [GiNaC::su3d::contract_with\(\)](#).

5.1.3.71 color_ONE()

```
ex GiNaC::color_ONE (
    unsigned char r1 = 0 )
```

Create the $\text{su}(3)$ unity element.

This is an indexed object, although it has no indices.

Parameters

<i>rl</i>	Representation label
-----------	----------------------

Returns

newly constructed unity element

Referenced by [GiNaC::su3t::contract_with\(\)](#).

5.1.3.72 **color_T()**

```
ex GiNaC::color_T (
    const ex & a,
    unsigned char rl = 0 )
```

Create an su(3) generator.

Parameters

<i>a</i>	Index
<i>rl</i>	Representation label

Returns

newly constructed unity generator

Referenced by [color_trace\(\)](#), [GiNaC::su3f::contract_with\(\)](#), and [GiNaC::su3d::contract_with\(\)](#).

5.1.3.73 **color_f()**

```
ex GiNaC::color_f (
    const ex & a,
    const ex & b,
    const ex & c )
```

Create an su(3) antisymmetric structure constant.

Parameters

<i>a</i>	First index
<i>b</i>	Second index
<i>c</i>	Third index

Returns

newly constructed structure constant

References [antisymmetric3\(\)](#), and [c](#).

Referenced by [color_h\(\)](#).

5.1.3.74 color_d()

```
ex GiNaC::color_d (
    const ex & a,
    const ex & b,
    const ex & c )
```

Create an su(3) symmetric structure constant.

Parameters

<i>a</i>	First index
<i>b</i>	Second index
<i>c</i>	Third index

Returns

newly constructed structure constant

References [c](#), and [symmetric3\(\)](#).

Referenced by [color_h\(\)](#).

5.1.3.75 color_h()

```
ex GiNaC::color_h (
    const ex & a,
    const ex & b,
    const ex & c )
```

This returns the linear combination d.a.b.c+l*f.a.b.c.

References [c](#), [color_d\(\)](#), [color_f\(\)](#), and [l](#).

Referenced by [color_trace\(\)](#).

5.1.3.76 `is_color_tinfo()`

```
static bool GiNaC::is_color_tinfo (
    const return\_type\_t & ti ) [static]
```

Check whether a given tinfo key (as returned by `return_type_tinfo()`) is that of a color object (with an arbitrary representation label).

References [GiNaC::return_type_t::tinfo](#).

Referenced by [color_trace\(\)](#).

5.1.3.77 `get_representation_label()` [2/2]

```
static unsigned char GiNaC::get_representation_label (
    const return\_type\_t & ti ) [static]
```

Extract representation label from tinfo key (as returned by `return_type_tinfo()`).

References [GiNaC::return_type_t::rl](#).

5.1.3.78 `color_trace()` [1/3]

```
ex GiNaC::color_trace (
    const ex & e,
    const std::set< unsigned char > & rls )
```

Calculate color traces over the specified set of representation labels.

Parameters

<i>e</i>	Expression to take the trace of
<i>rls</i>	Set of representation labels

References [_ex0](#), [_ex1](#), [_ex3](#), [color_h\(\)](#), [color_T\(\)](#), [color_trace\(\)](#), [delta_tensor\(\)](#), [GiNaC::ex::expand\(\)](#), [get_representation_label\(\)](#), [is_color_tinfo\(\)](#), [GiNaC::ex::map\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), and [GiNaC::ex::return_type_tinfo\(\)](#)

Referenced by [color_trace\(\)](#), and [GiNaC::su3t::contract_with\(\)](#).

5.1.3.79 `color_trace()` [2/3]

```
ex GiNaC::color_trace (
    const ex & e,
    const lst & rls )
```

Calculate color traces over the specified list of representation labels.

Parameters

<i>e</i>	Expression to take the trace of
<i>rl</i>	List of representation labels

References [color_trace\(\)](#), [GiNaC::info_flags::nonnegint](#), and [to_int\(\)](#).

5.1.3.80 color_trace() [3/3]

```
ex GiNaC::color_trace (
    const ex & e,
    unsigned char rl = 0 )
```

Calculate the trace of an expression containing color objects with a specified representation label.

Parameters

<i>e</i>	Expression to take the trace of
<i>rl</i>	Representation label

References [color_trace\(\)](#).

5.1.3.81 GINAC_DECLARE_UNARCHIVER() [9/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    color )
```

5.1.3.82 GINAC_DECLARE_UNARCHIVER() [10/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    su3one )
```

5.1.3.83 GINAC_DECLARE_UNARCHIVER() [11/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    su3t )
```

5.1.3.84 GINAC_DECLARE_UNARCHIVER() [12/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    su3f )
```

5.1.3.85 GINAC_DECLARE_UNARCHIVER() [13/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    su3d )
```

5.1.3.86 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [5/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
    constant ,
    basic ,
    print_func< print_context > &::do_print. print_func< print_latex > &::do_↵
print_latex. print_func< print_tree > &::do_print_tree. print_func< print_python_repr > &↵
::do_print_python_repr ) const
```

References [GiNaC::status_flags::evaluated](#), and [GiNaC::status_flags::expanded](#).

5.1.3.87 GINAC_BIND_UNARCHIVER() [14/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    constant )
```

5.1.3.88 GINAC_DECLARE_UNARCHIVER() [14/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    constant )
```

5.1.3.89 crc32()

```
static unsigned GiNaC::crc32 (
    const char * c,
    const unsigned len,
    const unsigned crcinit ) [static]
```

References [c](#), [crctab](#), and [len](#).

5.1.3.90 are_ex_trivially_equal()

```
bool GiNaC::are_ex_trivially_equal (
    const ex & e1,
    const ex & e2 ) [inline]
```

Compare two objects of class quickly without doing a deep tree traversal.

Returns

"true" if they are equal "false" if equality cannot be established quickly (e1 and e2 may still be equal, in this case).

Referenced by [GiNaC::expair::conjugate\(\)](#), [GiNaC::add::conjugate\(\)](#), [GiNaC::container< C >::conjugate\(\)](#), [GiNaC::expairseq::conjugate\(\)](#), [GiNaC::integral::conjugate\(\)](#), [GiNaC::matrix::conjugate\(\)](#), [GiNaC::mul::conjugate\(\)](#), [GiNaC::power::conjugate\(\)](#), [GiNaC::pseries::conjugate\(\)](#), [GiNaC::pseries::eval_integ\(\)](#), [GiNaC::integral::evalf\(\)](#), [GiNaC::pseries::evalm\(\)](#), [GiNaC::indexed::expand\(\)](#), [GiNaC::integral::expand\(\)](#), [GiNaC::power::expand\(\)](#), [GiNaC::expairseq::expand\(\)](#), [GiNaC::mul::expandchildren\(\)](#), [GiNaC::ncmul::expandchildren\(\)](#), [GiNaC::expairseq::make_flat\(\)](#), [GiNaC::make_flat_inserter::make_flat\(\)](#), [GiNaC::basic::map\(\)](#), [GiNaC::idx::map\(\)](#), [GiNaC::power::map\(\)](#), [GiNaC::relational::map\(\)](#), [GiNaC::internal::_iter_rep::operator==\(\)](#), [GiNaC::const_iterator::operator==\(\)](#), [GiNaC::basic::subs\(\)](#), [GiNaC::clifford::subs\(\)](#), [GiNaC::idx::subs\(\)](#), [GiNaC::power::subs\(\)](#), [GiNaC::relational::subs\(\)](#), [GiNaC::container< C >::subschildren\(\)](#), and [GiNaC::expairseq::subschildren\(\)](#).

5.1.3.91 operator<<() [3/16]

```
std::ostream & GiNaC::operator<< (
    std::ostream & os,
    const exvector & e )
```

References [get_print_context\(\)](#).

5.1.3.92 operator<<() [4/16]

```
std::ostream & GiNaC::operator<< (
    std::ostream & os,
    const exset & e )
```

References [get_print_context\(\)](#).

5.1.3.93 operator<<() [5/16]

```
std::ostream & GiNaC::operator<< (
    std::ostream & os,
    const exmap & e )
```

References [get_print_context\(\)](#).

5.1.3.94 nops() [1/2]

```
size_t GiNaC::nops (
    const ex & thisex ) [inline]
```

References [GiNaC::ex::nops\(\)](#).

Referenced by [GiNaC::basic::calchash\(\)](#), [GiNaC::basic::derivative\(\)](#), [GiNaC::basic::do_print_tree\(\)](#), [GiNaC::container< C >::do_print\(\)](#), [GiNaC::basic::eval_integ\(\)](#), [GiNaC::basic::evalf\(\)](#), [GiNaC::basic::evalm\(\)](#), [GiNaC::basic::expand\(\)](#), [GiNaC::basic::has\(\)](#), [GiNaC::container< C >::let_op\(\)](#), [GiNaC::basic::map\(\)](#), [GiNaC::basic::match\(\)](#), [GiNaC::container< C >::op\(\)](#), and [GiNaC::basic::subs\(\)](#).

5.1.3.95 expand() [1/2]

```
ex GiNaC::expand (
    const ex & thisex,
    unsigned options = 0 ) [inline]
```

References [GiNaC::ex::expand\(\)](#), and [options](#).

Referenced by [GiNaC::basic::collect\(\)](#), [divide\(\)](#), [divide_in_z\(\)](#), [gcd\(\)](#), [gcd_pf_pow\(\)](#), [log_expand\(\)](#), [prem\(\)](#), [quo\(\)](#), [rem\(\)](#), and [sprem\(\)](#).

5.1.3.96 conjugate()

```
ex GiNaC::conjugate (
    const ex & thisex ) [inline]
```

References [GiNaC::ex::conjugate\(\)](#).

Referenced by [conjugate_expl_derivative\(\)](#).

5.1.3.97 real_part()

```
ex GiNaC::real_part (
    const ex & thisex ) [inline]
```

References [GiNaC::ex::real_part\(\)](#).

Referenced by [cos_imag_part\(\)](#), [cos_real_part\(\)](#), [cosh_imag_part\(\)](#), [cosh_real_part\(\)](#), [exp_imag_part\(\)](#), [exp_real_part\(\)](#), [log_imag_part\(\)](#), [real_part_expl_derivative\(\)](#), [sin_imag_part\(\)](#), [sin_real_part\(\)](#), [sinh_imag_part\(\)](#), [sinh_real_part\(\)](#), [tan_imag_part\(\)](#), [tan_real_part\(\)](#), [tanh_imag_part\(\)](#), and [tanh_real_part\(\)](#).

5.1.3.98 `imag_part()`

```
ex GiNaC::imag_part (
    const ex & thisex ) [inline]
```

References [GiNaC::ex::imag_part\(\)](#).

Referenced by [cos_imag_part\(\)](#), [cos_real_part\(\)](#), [cosh_imag_part\(\)](#), [cosh_real_part\(\)](#), [exp_imag_part\(\)](#), [exp_real_part\(\)](#), [imag_part_expl_derivative\(\)](#), [log_imag_part\(\)](#), [sin_imag_part\(\)](#), [sin_real_part\(\)](#), [sinh_imag_part\(\)](#), [sinh_real_part\(\)](#), [tan_imag_part\(\)](#), [tan_real_part\(\)](#), [tanh_imag_part\(\)](#), and [tanh_real_part\(\)](#).

5.1.3.99 `has()`

```
bool GiNaC::has (
    const ex & thisex,
    const ex & pattern,
    unsigned options = 0 ) [inline]
```

References [GiNaC::ex::has\(\)](#), and [options](#).

Referenced by [GiNaC::basic::is_polynomial\(\)](#).

5.1.3.100 `find()`

```
bool GiNaC::find (
    const ex & thisex,
    const ex & pattern,
    exset & found ) [inline]
```

References [GiNaC::ex::find\(\)](#).

5.1.3.101 `is_polynomial()`

```
bool GiNaC::is_polynomial (
    const ex & thisex,
    const ex & vars ) [inline]
```

References [GiNaC::ex::is_polynomial\(\)](#).

5.1.3.102 degree()

```
int GiNaC::degree (
    const ex & thisex,
    const ex & s ) [inline]
```

References [GiNaC::ex::degree\(\)](#).

Referenced by [GiNaC::basic::collect\(\)](#), [replace_with_symbol\(\)](#), and [sqrfree_parfrac\(\)](#).

5.1.3.103 ldegree()

```
int GiNaC::ldegree (
    const ex & thisex,
    const ex & s ) [inline]
```

References [GiNaC::ex::ldegree\(\)](#).

Referenced by [GiNaC::basic::collect\(\)](#).

5.1.3.104 coeff()

```
ex GiNaC::coeff (
    const ex & thisex,
    const ex & s,
    int n = 1 ) [inline]
```

References [GiNaC::ex::coeff\(\)](#), and [n](#).

Referenced by [GiNaC::basic::collect\(\)](#), [GiNaC::make_flat_inserter::handle_factor\(\)](#), [iterated_integral_evalf_impl\(\)](#), [log_series\(\)](#), and [sqrfree_parfrac\(\)](#).

5.1.3.105 numer() [1/2]

```
ex GiNaC::numer (
    const ex & thisex ) [inline]
```

References [GiNaC::ex::numer\(\)](#).

Referenced by [decomp_rational\(\)](#), [GiNaC::power::imag_part\(\)](#), [GiNaC::add::integer_content\(\)](#), [print_real_csrc\(\)](#), [GiNaC::power::real_part\(\)](#), [replace_with_symbol\(\)](#), and [sqrfree_parfrac\(\)](#).

5.1.3.106 `denom()` [1/2]

```
ex GiNaC::denom (
    const ex & thisex ) [inline]
```

References [GiNaC::ex::denom\(\)](#).

Referenced by [decomp_rational\(\)](#), [GiNaC::add::integer_content\(\)](#), [lcmcoeff\(\)](#), [print_real_csrc\(\)](#), [replace_with_symbol\(\)](#), and [sqrfree_parfrac\(\)](#).

5.1.3.107 `numer_denom()`

```
ex GiNaC::numer_denom (
    const ex & thisex ) [inline]
```

References [GiNaC::ex::numer_denom\(\)](#).

Referenced by [decomp_rational\(\)](#), and [sqrfree_parfrac\(\)](#).

5.1.3.108 `normal()`

```
ex GiNaC::normal (
    const ex & thisex ) [inline]
```

References [GiNaC::ex::normal\(\)](#).

Referenced by [fsolve\(\)](#), [GiNaC::normal_map_function::operator\(\)\(\)](#), and [replace_with_symbol\(\)](#).

5.1.3.109 `to_rational()`

```
ex GiNaC::to_rational (
    const ex & thisex,
    exmap & repl ) [inline]
```

References [GiNaC::ex::to_rational\(\)](#).

5.1.3.110 `to_polynomial()`

```
ex GiNaC::to_polynomial (
    const ex & thisex,
    exmap & repl ) [inline]
```

References [GiNaC::ex::to_polynomial\(\)](#).

5.1.3.111 collect()

```
ex GiNaC::collect (
    const ex & thisex,
    const ex & s,
    bool distributed = false ) [inline]
```

References [GiNaC::ex::collect\(\)](#).

Referenced by [GiNaC::basic::collect\(\)](#).

5.1.3.112 eval()

```
ex GiNaC::eval (
    const ex & thisex ) [inline]
```

References [GiNaC::ex::eval\(\)](#).

5.1.3.113 evalf() [1/2]

```
ex GiNaC::evalf (
    const ex & thisex ) [inline]
```

References [GiNaC::ex::evalf\(\)](#).

Referenced by [beta_evalf\(\)](#), [eta_evalf\(\)](#), [GiNaC::evalf_map_function::operator\(\)\(\)](#), and [zeta2_evalf\(\)](#).

5.1.3.114 evalm()

```
ex GiNaC::evalm (
    const ex & thisex ) [inline]
```

References [GiNaC::ex::evalm\(\)](#).

Referenced by [GiNaC::evalm_map_function::operator\(\)\(\)](#).

5.1.3.115 eval_integ()

```
ex GiNaC::eval_integ (
    const ex & thisex ) [inline]
```

References [GiNaC::ex::eval_integ\(\)](#).

Referenced by [GiNaC::eval_integ_map_function::operator\(\)\(\)](#).

5.1.3.116 diff()

```
ex GiNaC::diff (
    const ex & thisex,
    const symbol & s,
    unsigned nth = 1 ) [inline]
```

References [GiNaC::ex::diff\(\)](#).

Referenced by [GiNaC::derivative_map_function::operator\(\)\(\)](#).

5.1.3.117 series()

```
ex GiNaC::series (
    const ex & thisex,
    const ex & r,
    int order,
    unsigned options = 0 ) [inline]
```

References [options](#), [order](#), [r](#), and [GiNaC::ex::series\(\)](#).

Referenced by [atan_series\(\)](#), [atanh_series\(\)](#), [Li2_series\(\)](#), and [log_series\(\)](#).

5.1.3.118 match()

```
bool GiNaC::match (
    const ex & thisex,
    const ex & pattern,
    exmap & repl_lst ) [inline]
```

References [GiNaC::ex::match\(\)](#).

Referenced by [GiNaC::basic::has\(\)](#), and [GiNaC::basic::subs_one_level\(\)](#).

5.1.3.119 simplify_indexed() [1/3]

```
ex GiNaC::simplify_indexed (
    const ex & thisex,
    unsigned options = 0 ) [inline]
```

References [options](#), and [GiNaC::ex::simplify_indexed\(\)](#).

Referenced by [GiNaC::ex::simplify_indexed\(\)](#).

5.1.3.120 `simplify_indexed()` [2/3]

```
ex GiNaC::simplify_indexed (
    const ex & thisex,
    const scalar_products & sp,
    unsigned options = 0 ) [inline]
```

References [options](#), and [GiNaC::ex::simplify_indexed\(\)](#).

5.1.3.121 `symmetrize()` [1/4]

```
ex GiNaC::symmetrize (
    const ex & thisex ) [inline]
```

References [GiNaC::ex::symmetrize\(\)](#).

Referenced by [idx_symmetrization\(\)](#), [GiNaC::ex::symmetrize\(\)](#), [symmetrize\(\)](#), and [symmetrize_cyclic\(\)](#).

5.1.3.122 `symmetrize()` [2/4]

```
ex GiNaC::symmetrize (
    const ex & thisex,
    const lst & l ) [inline]
```

References [GiNaC::ex::symmetrize\(\)](#).

5.1.3.123 `antisymmetrize()` [1/4]

```
ex GiNaC::antisymmetrize (
    const ex & thisex ) [inline]
```

References [GiNaC::ex::antisymmetrize\(\)](#).

Referenced by [GiNaC::ex::antisymmetrize\(\)](#), and [antisymmetrize\(\)](#).

5.1.3.124 `antisymmetrize()` [2/4]

```
ex GiNaC::antisymmetrize (
    const ex & thisex,
    const lst & l ) [inline]
```

References [GiNaC::ex::antisymmetrize\(\)](#).

5.1.3.125 symmetrize_cyclic() [1/4]

```
ex GiNaC::symmetrize_cyclic (
    const ex & thisex ) [inline]
```

References [GiNaC::ex::symmetrize_cyclic\(\)](#).

Referenced by [GiNaC::ex::symmetrize_cyclic\(\)](#).

5.1.3.126 symmetrize_cyclic() [2/4]

```
ex GiNaC::symmetrize_cyclic (
    const ex & thisex,
    const lst & l ) [inline]
```

References [GiNaC::ex::symmetrize_cyclic\(\)](#).

5.1.3.127 op()

```
ex GiNaC::op (
    const ex & thisex,
    size_t i ) [inline]
```

References [GiNaC::ex::op\(\)](#).

Referenced by [GiNaC::basic::calchash\(\)](#), [GiNaC::basic::do_print_tree\(\)](#), [GiNaC::basic::has\(\)](#), [Li2_series\(\)](#), [GiNaC::basic::map\(\)](#), [GiNaC::basic::match\(\)](#), [GiNaC::basic::operator\[\]\(\)](#), [rename_dummy_indices\(\)](#), and [GiNaC::basic::subs\(\)](#).

5.1.3.128 lhs()

```
ex GiNaC::lhs (
    const ex & thisex ) [inline]
```

References [GiNaC::ex::lhs\(\)](#).

5.1.3.129 rhs()

```
ex GiNaC::rhs (
    const ex & thisex ) [inline]
```

References [GiNaC::ex::rhs\(\)](#).

Referenced by [lsolve\(\)](#), [GiNaC::ptr< T >::operator!=\(\)](#), [GiNaC::ptr< T >::operator==\(\)](#), [GiNaC::matrix::solve\(\)](#), and [sqrfree_parfrac\(\)](#).

5.1.3.130 is_zero() [1/2]

```
bool GiNaC::is_zero (
    const ex & thisex ) [inline]
```

References [GiNaC::ex::is_zero\(\)](#).

Referenced by [cosh_eval\(\)](#), [GiNaC::matrix::determinant\(\)](#), [GiNaC::matrix::determinant_minor\(\)](#), [GiNaC::tensepsilon::eval_indexed\(\)](#), [GiNaC::matrix::fraction_free_elimination\(\)](#), [GiNaC::matrix::gauss_elimination\(\)](#), [GiNaC::matrix::markowitz_elimination\(\)](#), [GiNaC::matrix::mul\(\)](#), [GiNaC::relational::operator safe_bool\(\)](#), [GiNaC::matrix::pivot\(\)](#), [sinh_eval\(\)](#), and [tanh_eval\(\)](#).

5.1.3.131 swap() [1/2]

```
void GiNaC::swap (
    ex & e1,
    ex & e2 ) [inline]
```

References [GiNaC::ex::swap\(\)](#).

Referenced by [permutation_sign\(\)](#), and [GiNaC::matrix::pivot\(\)](#).

5.1.3.132 subs() [1/3]

```
ex GiNaC::subs (
    const ex & thisex,
    const exmap & m,
    unsigned options = 0 ) [inline]
```

References [m](#), [options](#), and [GiNaC::ex::subs\(\)](#).

Referenced by [Li2_series\(\)](#).

5.1.3.133 subs() [2/3]

```
ex GiNaC::subs (
    const ex & thisex,
    const lst & ls,
    const lst & lr,
    unsigned options = 0 ) [inline]
```

References [lr](#), [options](#), and [GiNaC::ex::subs\(\)](#).

5.1.3.134 subs() [3/3]

```

ex GiNaC::subs (
    const ex & thisex,
    const ex & e,
    unsigned options = 0 ) [inline]

```

References [options](#), and [GiNaC::ex::subs\(\)](#).

5.1.3.135 is_a() [2/3]

```

template<class T >
bool GiNaC::is_a (
    const ex & obj ) [inline]

```

Check if *ex* is a handle to a *T*, including base classes.

5.1.3.136 is_exactly_a() [2/2]

```

template<class T >
bool GiNaC::is_exactly_a (
    const ex & obj ) [inline]

```

Check if *ex* is a handle to a *T*, not including base classes.

5.1.3.137 ex_to()

```

template<class T >
const T & GiNaC::ex_to (
    const ex & e ) [inline]

```

Return a reference to the basic-derived class *T* object embedded in an expression.

This is fast but unsafe: the result is undefined if the expression does not contain a *T* object at its top level. Hence, you should generally check the type of *e* first. Also, you shouldn't cache the returned reference because [GiNaC's](#) garbage collector may destroy the referenced object any time it's used in another expression.

Parameters

<i>e</i>	expression
----------	------------

Returns

reference to object of class *T*

See also

[is_exactly_a<class T>\(\)](#)

5.1.3.138 compile_ex() [1/3]

```
void GiNaC::compile_ex (
    const ex & expr,
    const symbol & sym,
    FUNCP\_1P & fp,
    const std::string filename = "" )
```

Takes an expression and produces a function pointer to the compiled and linked C code equivalent in double precision.

The function pointer has type `FUNCP_1P`.

Parameters

<i>expr</i>	Expression to be compiled
<i>sym</i>	Symbol from the expression to become the function parameter
<i>fp</i>	Returned function pointer
<i>filename</i>	Name of the intermediate source code and so-file. If supplied, these intermediate files will not be deleted

5.1.3.139 compile_ex() [2/3]

```
void GiNaC::compile_ex (
    const ex & expr,
    const symbol & sym1,
    const symbol & sym2,
    FUNCP\_2P & fp,
    const std::string filename = "" )
```

Takes an expression and produces a function pointer to the compiled and linked C code equivalent in double precision.

The function pointer has type `FUNCP_2P`.

Parameters

<i>expr</i>	Expression to be compiled
<i>sym1</i>	Symbol from the expression to become the first function parameter
<i>sym2</i>	Symbol from the expression to become the second function parameter
<i>fp</i>	Returned function pointer
<i>filename</i>	Name of the intermediate source code and so-file. If supplied, these intermediate files will not be deleted

5.1.3.140 compile_ex() [3/3]

```
void GiNaC::compile_ex (
    const lst & exprs,
    const lst & syms,
    FUNCP_CUBA & fp,
    const std::string filename = "" )
```

Takes an expression and produces a function pointer to the compiled and linked C code equivalent in double precision.

The function pointer has type FUNCP_CUBA.

Parameters

<i>exprs</i>	List of expression to be compiled
<i>syms</i>	Symbols from the expression to become the function parameters
<i>fp</i>	Returned function pointer
<i>filename</i>	Name of the intermediate source code and so-file. If supplied, these intermediate files will not be deleted

5.1.3.141 link_ex() [1/3]

```
void GiNaC::link_ex (
    const std::string filename,
    FUNCP_1P & fp )
```

Opens an existing so-file and returns a function pointer of type FUNCP_1P to the contained function.

The so-file has to be generated by compile_ex in advance.

Parameters

<i>filename</i>	Name of the so-file to open and link
<i>fp</i>	Returned function pointer

5.1.3.142 link_ex() [2/3]

```
void GiNaC::link_ex (
    const std::string filename,
    FUNCP_2P & fp )
```

Opens an existing so-file and returns a function pointer of type FUNCP_2P to the contained function.

The so-file has to be generated by compile_ex in advance.

Parameters

<i>filename</i>	Name of the so-file to open and link
<i>fp</i>	Returned function pointer

5.1.3.143 link_ex() [3/3]

```
void GiNaC::link_ex (
    const std::string filename,
    FUNCP_CUBA & fp )
```

Opens an existing so-file and returns a function pointer of type FUNCP_CUBA to the contained function.

The so-file has to be generated by compile_ex in advance.

Parameters

<i>filename</i>	Name of the so-file to open and link
<i>fp</i>	Returned function pointer

5.1.3.144 unlink_ex()

```
void GiNaC::unlink_ex (
    const std::string filename )
```

Closes all linked .so files that have the supplied filename.

Parameters

<i>filename</i>	Name of the so-file to close
-----------------	------------------------------

5.1.3.145 swap() [2/2]

```
void GiNaC::swap (
    expair & e1,
    expair & e2 ) [inline]
```

References [GiNaC::expair::swap\(\)](#).

5.1.3.146 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [6/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
    expairseq ,
    basic ,
    print_func< print_context > &::do_print. print_func< print_tree > &::do_print←
    _tree )
```

5.1.3.147 conjugateepvector()

```
epvector * GiNaC::conjugateepvector (
    const epvector & )
```

Complex conjugate every element of an epvector.

Returns zero if this does not change anything.

References [GiNaC::ex::conjugate\(\)](#), [GiNaC::ex::is_equal\(\)](#), and [x](#).

Referenced by [GiNaC::expairseq::conjugate\(\)](#), and [GiNaC::pseries::conjugate\(\)](#).

5.1.3.148 factor()

```
ex GiNaC::factor (
    const ex & poly,
    unsigned options )
```

Interface function to the outside world.

Factorizes univariate and multivariate polynomials.

It uses [factor1\(\)](#) on each of the explicitly present factors of poly.

The default option is [factor_options::polynomial](#), which means that [factor\(\)](#) will only factorize an expression if it is a proper polynomial (i.e. the flag [info_flags::polynomial](#) is set). Given the option [factor_options::all](#), [factor\(\)](#) will factorize all subexpressions, e.g. polynomials containing functions or polynomials inside function arguments.

Parameters

in	<i>poly</i>	expression to factorize
in	<i>options</i>	see GiNaC::factor_options

Returns

factorized expression

References [options](#), [poly](#), and [pow\(\)](#).

Referenced by [algebraic_match_mul_with_mul\(\)](#), [collect_common_factors\(\)](#), [GiNaC::ncmul::eval\(\)](#), [GiNaC::power::expand_add\(\)](#), [GiNaC::mul::expandchildren\(\)](#), [find_common_factor\(\)](#), [GiNaC::mul::find_real_imag\(\)](#), [GiNaC::mul::info\(\)](#), [GiNaC::mul::series\(\)](#), and [sqrfree_parfrac\(\)](#).

5.1.3.149 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [7/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
    fail ,
    basic ,
    print_func< print_context > &::do_print.  print_func< print_tree > &::do_print↵
    _tree )
```

5.1.3.150 GINAC_DECLARE_UNARCHIVER() [15/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    fail )
```

5.1.3.151 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [8/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
    fderivative ,
    function ,
    print_func< print_context > &::do_print.  print_func< print_latex > &::do_↵
    print_latex.  print_func< print_csrc > &::do_print_csrc.  print_func< print_tree > &::do_↵
    print_tree )
```

5.1.3.152 GINAC_BIND_UNARCHIVER() [15/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    fderivative )
```

5.1.3.153 GINAC_DECLARE_UNARCHIVER() [16/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    fderivative )
```

5.1.3.154 GINAC_BIND_UNARCHIVER() [16/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    function )
```

5.1.3.155 GINAC_DECLARE_UNARCHIVER() [17/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    function )
```

5.1.3.156 is_the_function()

```
template<typename T >
bool GiNaC::is_the_function (
    const ex & x ) [inline]
```

References [x](#).

5.1.3.157 make_hash_seed()

```
static unsigned GiNaC::make_hash_seed (
    const std::type_info & tinfo ) [inline], [static]
```

We need a hash function which gives different values for objects of different types.

Hence we need some unique integer for each type. Fortunately, standard C++ RTTI class 'type_info' stores a pointer to mangled type name. Normally this pointer is the same for all objects of the same type (although it changes from run to run), so it can be used for computing hashes. However, on some platforms (such as woe32) the pointer returned by type_info::name() might be different even for objects of the same type! Hence we need to resort to comparing string representation of the (mangled) type names. This is quite expensive, so we compare crc32 hashes of those strings. We might get more hash collisions (and slower evaluation as a result), but being a bit slower is much better than being wrong.

References [golden_ratio_hash\(\)](#).

Referenced by [GiNaC::expairseq::calchash\(\)](#), [GiNaC::function::calchash\(\)](#), [GiNaC::idx::calchash\(\)](#), [GiNaC::relational::calchash\(\)](#), [GiNaC::symbol::calchash\(\)](#), [GiNaC::symmetry::calchash\(\)](#), and [GiNaC::wildcard::calchash\(\)](#).

5.1.3.158 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [9/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
    idx ,
    basic ,
    print_func< print_context > &::do_print. print_func< print_latex > &::do_↵
print_latex. print_func< print_csrc > &::do_print_csrc. print_func< print_tree > &::do_↵
print_tree )
```

5.1.3.159 print_func< print_context >()

```
GiNaC::print_func< print_context > (
    &varidx::do_print ) &
```

5.1.3.160 GINAC_BIND_UNARCHIVER() [17/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    idx )
```

5.1.3.161 GINAC_BIND_UNARCHIVER() [18/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    varidx )
```

5.1.3.162 GINAC_BIND_UNARCHIVER() [19/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    spinidx )
```

5.1.3.163 is_dummy_pair() [1/2]

```
bool GiNaC::is_dummy_pair (
    const idx & i1,
    const idx & i2 )
```

Check whether two indices form a dummy pair.

References [GiNaC::idx::is_dummy_pair_same_type\(\)](#).

Referenced by [GiNaC::matrix::contract_with\(\)](#), [GiNaC::spinmetric::contract_with\(\)](#), [GiNaC::matrix::eval_indexed\(\)](#), [GiNaC::tensdelta::eval_indexed\(\)](#), [find_free_and_dummy\(\)](#), [GiNaC::indexed::has_dummy_index_for\(\)](#), [is_dummy_pair\(\)](#), [GiNaC::is_summation_idx::operator\(\)](#), and [GiNaC::tensor::replace_contr_index\(\)](#).

5.1.3.164 is_dummy_pair() [2/2]

```
bool GiNaC::is_dummy_pair (
    const ex & e1,
    const ex & e2 )
```

Check whether two expressions form a dummy index pair.

References [is_dummy_pair\(\)](#).

5.1.3.165 find_free_and_dummy() [1/2]

```
void GiNaC::find_free_and_dummy (
    exvector::const_iterator it,
    exvector::const_iterator itend,
    exvector & out_free,
    exvector & out_dummy )
```

Given a vector of indices, split them into two vectors, one containing the free indices, the other containing the dummy indices (numeric indices are neither free nor dummy ones).

Parameters

<i>it</i>	Pointer to start of index vector
<i>itend</i>	Pointer to end of index vector
<i>out_free</i>	Vector of free indices (returned, sorted)
<i>out_dummy</i>	Vector of dummy indices (returned, sorted)

References [is_dummy_pair\(\)](#), [last](#), and [shaker_sort\(\)](#).

Referenced by [GiNaC::su3d::contract_with\(\)](#), [count_dummy_indices\(\)](#), [count_free_indices\(\)](#), [find_dummy_indices\(\)](#), [find_free_and_dummy\(\)](#), [get_all_dummy_indices_safely\(\)](#), [GiNaC::indexed::get_dummy_indices\(\)](#), [GiNaC::indexed::get_free_indices\(\)](#), [GiNaC::mul::get_free_indices\(\)](#), and [GiNaC::ncmul::get_free_indices\(\)](#).

5.1.3.166 minimal_dim()

```
ex GiNaC::minimal_dim (
    const ex & dim1,
    const ex & dim2 )
```

Return the minimum of two index dimensions.

If this is undecidable, throw an exception. Numeric dimensions are always considered "smaller" than symbolic dimensions.

References [GiNaC::ex::is_equal\(\)](#).

Referenced by [GiNaC::idx::minimal_dim\(\)](#).

5.1.3.167 GINAC_DECLARE_UNARCHIVER() [18/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    idx )
```

5.1.3.168 GINAC_DECLARE_UNARCHIVER() [19/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    varidx )
```

5.1.3.169 GINAC_DECLARE_UNARCHIVER() [20/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    spinidx )
```

5.1.3.170 find_free_and_dummy() [2/2]

```
void GiNaC::find_free_and_dummy (
    const exvector & v,
    exvector & out_free,
    exvector & out_dummy ) [inline]
```

Given a vector of indices, split them into two vectors, one containing the free indices, the other containing the dummy indices (numeric indices are neither free nor dummy ones).

Parameters

<i>v</i>	Index vector
<i>out_free</i>	Vector of free indices (returned, sorted)
<i>out_dummy</i>	Vector of dummy indices (returned, sorted)

References [find_free_and_dummy\(\)](#).

5.1.3.171 find_dummy_indices()

```
void GiNaC::find_dummy_indices (
    const exvector & v,
    exvector & out_dummy ) [inline]
```

Given a vector of indices, find the dummy indices.

Parameters

<i>v</i>	Index vector
<i>out_dummy</i>	Vector of dummy indices (returned, sorted)

References [find_free_and_dummy\(\)](#).

Referenced by [GiNaC::indexed::get_dummy_indices\(\)](#).

5.1.3.172 count_dummy_indices()

```
size_t GiNaC::count_dummy_indices (
    const exvector & v ) [inline]
```

Count the number of dummy index pairs in an index vector.

References [find_free_and_dummy\(\)](#).

5.1.3.173 count_free_indices()

```
size_t GiNaC::count_free_indices (
    const exvector & v ) [inline]
```

Count the number of dummy index pairs in an index vector.

References [find_free_and_dummy\(\)](#).

5.1.3.174 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [10/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
    indexed ,
    exprseq ,
    print_func< print\_context > &::do_print, print_func< print\_latex > &::do_↵
    print_latex, print_func< print\_tree > &::do_print_tree )
```

5.1.3.175 GINAC_BIND_UNARCHIVER() [20/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    indexed )
```

5.1.3.176 indices_consistent()

```
static bool GiNaC::indices_consistent (
    const exvector & v1,
    const exvector & v2 ) [static]
```

Check whether two sorted index vectors are consistent (i.e. equal).

Referenced by [GiNaC::add::get_free_indices\(\)](#).

5.1.3.177 number_of_type()

```
template<class T >
size_t GiNaC::number_of_type (
    const exvector & v )
```

5.1.3.178 rename_dummy_indices()

```
template<class T >
static ex GiNaC::rename_dummy_indices (
    const ex & e,
    exvector & global_dummy_indices,
    exvector & local_dummy_indices ) [static]
```

Rename dummy indices in an expression.

Parameters

<i>e</i>	Expression to work on
<i>local_dummy_indices</i>	The set of dummy indices that appear in the expression "e"
<i>global_dummy_indices</i>	The set of dummy indices that have appeared before and which we would like to use in "e", too. This gets updated by the function

References [GiNaC::ex::begin\(\)](#), [GINAC_ASSERT](#), [GiNaC::subs_options::no_pattern](#), [op\(\)](#), [shaker_sort\(\)](#), and [GiNaC::ex::subs\(\)](#).

5.1.3.179 find_variant_indices()

```
static void GiNaC::find_variant_indices (
    const exvector & v,
    exvector & variant_indices ) [static]
```

Given a set of indices, extract those of class `varidx`.

5.1.3.180 reposition_dummy_indices()

```
bool GiNaC::reposition_dummy_indices (
    ex & e,
    exvector & variant_dummy_indices,
    exvector & moved_indices )
```

Raise/lower dummy indices in a single indexed objects to canonicalize their variance.

Parameters

<i>e</i>	Object to work on
<i>variant_dummy_indices</i>	The set of indices that might need repositioning (will be changed by this function)
<i>moved_indices</i>	The set of indices that have been repositioned (will be changed by this function)

Returns

true if 'e' was changed

5.1.3.181 product_to_exvector()

```
static void GiNaC::product_to_exvector (
    const ex & e,
    exvector & v,
    bool & non_commutative ) [static]
```

References [_ex2](#), [GINAC_ASSERT](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::ex::nops\(\)](#), and [GiNaC::ex::op\(\)](#).

Referenced by [get_all_dummy_indices\(\)](#).

5.1.3.182 idx_symmetrization()

```
template<class T >
ex GiNaC::idx_symmetrization (
    const ex & r,
    const exvector & local_dummy_indices )
```

References [r](#), and [symmetrize\(\)](#).

5.1.3.183 simplify_indexed() [3/3]

```
ex GiNaC::simplify_indexed (
    const ex & e,
    exvector & free_indices,
    exvector & dummy_indices,
    const scalar_products & sp )
```

Simplify indexed expression, return list of free indices.

5.1.3.184 `simplify_indexed_product()`

```
ex GiNaC::simplify_indexed_product (
    const ex & e,
    exvector & free_indices,
    exvector & dummy_indices,
    const scalar_products & sp )
```

Simplify product of indexed expressions (commutative, noncommutative and simple squares), return list of free indices.

5.1.3.185 `hasindex()`

```
bool GiNaC::hasindex (
    const ex & x,
    const ex & sym )
```

References [hasindex\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), and [x](#).

Referenced by [hasindex\(\)](#).

5.1.3.186 `get_all_dummy_indices_safely()`

```
exvector GiNaC::get_all_dummy_indices_safely (
    const ex & e )
```

More reliable version of the form.

The former assumes that e is an expanded expression.

References [find_free_and_dummy\(\)](#), [get_all_dummy_indices_safely\(\)](#), [GiNaC::ex::get_free_indices\(\)](#), [GiNaC::ex::nops\(\)](#), and [GiNaC::ex::op\(\)](#).

Referenced by [GiNaC::mul::expand\(\)](#), [get_all_dummy_indices_safely\(\)](#), [GiNaC::make_flat_inserter::handle_factor\(\)](#), and [rename_dummy_indices_uniquely\(\)](#).

5.1.3.187 `get_all_dummy_indices()`

```
exvector GiNaC::get_all_dummy_indices (
    const ex & e )
```

Returns all dummy indices from the exvector.

Returns all dummy indices from the expression.

References [product_to_exvector\(\)](#).

Referenced by [expand_dummy_sum\(\)](#), and [GiNaC::power::expand_mul\(\)](#).

5.1.3.188 rename_dummy_indices_uniquely() [1/4]

```
lst GiNaC::rename_dummy_indices_uniquely (
    const exvector & va,
    const exvector & vb )
```

Similar to above, where va and vb are the same and the return value is a list of two lists for substitution in b.

References [GiNaC::container_storage< C >::reserve\(\)](#).

Referenced by [GiNaC::expairseq::construct_from_2_ex\(\)](#), [GiNaC::mul::expand\(\)](#), [GiNaC::ncmul::expand\(\)](#), [GiNaC::power::expand_mul\(\)](#), [GiNaC::make_flat_inserter::handle_factor\(\)](#), and [rename_dummy_indices_uniquely\(\)](#).

5.1.3.189 rename_dummy_indices_uniquely() [2/4]

```
ex GiNaC::rename_dummy_indices_uniquely (
    const exvector & va,
    const exvector & vb,
    const ex & b )
```

Same as above, where va and vb contain the indices of a and b and are sorted.

References [GiNaC::subs_options::no_index_renaming](#), [GiNaC::subs_options::no_pattern](#), [GiNaC::ex::nops\(\)](#), [GiNaC::container< C >::op\(\)](#), [rename_dummy_indices_uniquely\(\)](#), and [GiNaC::ex::subs\(\)](#).

5.1.3.190 rename_dummy_indices_uniquely() [3/4]

```
ex GiNaC::rename_dummy_indices_uniquely (
    const ex & a,
    const ex & b )
```

Returns b with all dummy indices, which are common with a, renamed.

References [get_all_dummy_indices_safely\(\)](#), [GiNaC::subs_options::no_index_renaming](#), [GiNaC::subs_options::no_pattern](#), [GiNaC::ex::nops\(\)](#), [GiNaC::container< C >::op\(\)](#), [rename_dummy_indices_uniquely\(\)](#), and [GiNaC::ex::subs\(\)](#).

5.1.3.191 rename_dummy_indices_uniquely() [4/4]

```
ex GiNaC::rename_dummy_indices_uniquely (
    exvector & va,
    const ex & b,
    bool modify_va )
```

Returns b with all dummy indices, which are listed in va, renamed if modify_va is set to TRUE all dummy indices of b will be appended to va.

References [GiNaC::ex::begin\(\)](#), [GiNaC::ex::end\(\)](#), [get_all_dummy_indices_safely\(\)](#), [GiNaC::subs_options::no_index_renaming](#), [GiNaC::subs_options::no_pattern](#), [GiNaC::ex::nops\(\)](#), [GiNaC::container< C >::op\(\)](#), [rename_dummy_indices_uniquely\(\)](#), and [GiNaC::ex::subs\(\)](#).

5.1.3.192 expand_dummy_sum()

```
ex GiNaC::expand_dummy_sum (
    const ex & e,
    bool subs_idx = false )
```

This function returns the given expression with expanded sums for all dummy index summations, where the dimensionality of the dummy index is a nonnegative integer.

Optionally all indices with a variance will be substituted by indices with the corresponding numeric values without variance.

Parameters

<i>e</i>	the given expression
<i>subs_idx</i>	indicates if variance of dummy indices should be neglected

References [GiNaC::ex::expand\(\)](#), [expand_dummy_sum\(\)](#), [get_all_dummy_indices\(\)](#), [GiNaC::ex::map\(\)](#), [GiNaC::info_flags::nonnegint](#), and [GiNaC::ex::subs\(\)](#).

Referenced by [expand_dummy_sum\(\)](#).

5.1.3.193 GINAC_DECLARE_UNARCHIVER() [21/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    indexed )
```

5.1.3.194 conjugate_evalf()

```
static ex GiNaC::conjugate_evalf (
    const ex & arg ) [static]
```

References [GiNaC::ex::conjugate\(\)](#).

5.1.3.195 conjugate_eval()

```
static ex GiNaC::conjugate_eval (
    const ex & arg ) [static]
```

References [GiNaC::ex::conjugate\(\)](#).

5.1.3.196 conjugate_print_latex()

```
static void GiNaC::conjugate_print_latex (
    const ex & arg,
    const print\_context & c ) [static]
```

References [c](#), and [GiNaC::ex::print\(\)](#).

5.1.3.197 conjugate_conjugate()

```
static ex GiNaC::conjugate_conjugate (
    const ex & arg ) [static]
```

5.1.3.198 conjugate_expl_derivative()

```
static ex GiNaC::conjugate_expl_derivative (
    const ex & arg,
    const symbol & s ) [static]
```

References [conjugate\(\)](#), [GiNaC::ex::diff\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::symbol::info\(\)](#), and [GiNaC::info_flags::real](#).

5.1.3.199 conjugate_real_part()

```
static ex GiNaC::conjugate_real_part (
    const ex & arg ) [static]
```

References [GiNaC::ex::real_part\(\)](#).

5.1.3.200 conjugate_imag_part()

```
static ex GiNaC::conjugate_imag_part (
    const ex & arg ) [static]
```

References [GiNaC::ex::imag_part\(\)](#).

5.1.3.201 func_arg_info()

```
static bool GiNaC::func_arg_info (
    const ex & arg,
    unsigned inf ) [static]
```

References [GiNaC::info_flags::integer](#), [GiNaC::info_flags::integer_polynomial](#), [GiNaC::info_flags::crational](#), [GiNaC::info_flags::crational_polynomial](#), [GiNaC::info_flags::even](#), [GiNaC::info_flags::has_indices](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::integer](#), [GiNaC::info_flags::integer_polynomial](#), [GiNaC::info_flags::negative](#), [GiNaC::info_flags::negint](#), [GiNaC::info_flags::nonnegative](#), [GiNaC::info_flags::nonnegint](#), [GiNaC::info_flags::odd](#), [GiNaC::info_flags::polynomial](#), [GiNaC::info_flags::posint](#), [GiNaC::info_flags::positive](#), [GiNaC::info_flags::prime](#), [GiNaC::info_flags::rational](#), [GiNaC::info_flags::rational_function](#), [GiNaC::info_flags::rational_polynomial](#), and [GiNaC::info_flags::real](#).

Referenced by [conjugate_info\(\)](#).

5.1.3.202 conjugate_info()

```
static bool GiNaC::conjugate_info (
    const ex & arg,
    unsigned inf ) [static]
```

References [func_arg_info\(\)](#).

5.1.3.203 REGISTER_FUNCTION() [1/36]

```
GiNaC::REGISTER_FUNCTION (
    conjugate_function ,
    eval_func(conjugate\_eval). evalf_func(conjugate\_evalf). expl_derivative_↵
func(conjugate\_expl\_derivative). info_func(conjugate\_info). print_func< print\_latex >(conjugate\_print\_latex
conjugate_func(conjugate\_conjugate). real_part_func(conjugate\_real\_part). imag_part_func(conjugate\_imag\_part
set_name("conjugate","conjugate") )
```

5.1.3.204 real_part_evalf()

```
static ex GiNaC::real_part_evalf (
    const ex & arg ) [static]
```

5.1.3.205 real_part_eval()

```
static ex GiNaC::real_part_eval (
    const ex & arg ) [static]
```

References [GiNaC::ex::real_part\(\)](#).

5.1.3.206 real_part_print_latex()

```
static void GiNaC::real_part_print_latex (
    const ex & arg,
    const print\_context & c ) [static]
```

References [c](#), and [GiNaC::ex::print\(\)](#).

5.1.3.207 real_part_conjugate()

```
static ex GiNaC::real_part_conjugate (
    const ex & arg ) [static]
```

5.1.3.208 real_part_real_part()

```
static ex GiNaC::real_part_real_part (
    const ex & arg ) [static]
```

5.1.3.209 real_part_imag_part()

```
static ex GiNaC::real_part_imag_part (
    const ex & arg ) [static]
```

5.1.3.210 real_part_expl_derivative()

```
static ex GiNaC::real_part_expl_derivative (
    const ex & arg,
    const symbol & s ) [static]
```

References [GiNaC::ex::diff\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::symbol::info\(\)](#), [GiNaC::info_flags::real](#), and [real_part\(\)](#).

5.1.3.211 REGISTER_FUNCTION() [2/36]

```
GiNaC::REGISTER_FUNCTION (
    real_part_function ,
    eval_func(real\_part\_eval). evalf_func(real\_part\_evalf). expl_derivative_↵
func(real\_part\_expl\_derivative). print_func< print\_latex >(real\_part\_print\_latex). conjugate_↵
_func(real\_part\_conjugate). real_part_func(real\_part\_real\_part). imag_part_func(real\_part\_imag\_part).
set_name("real_part","real_part") )
```

5.1.3.212 `imag_part_evalf()`

```
static ex GiNaC::imag_part_evalf (
    const ex & arg ) [static]
```

5.1.3.213 `imag_part_eval()`

```
static ex GiNaC::imag_part_eval (
    const ex & arg ) [static]
```

References [GiNaC::ex::imag_part\(\)](#).

5.1.3.214 `imag_part_print_latex()`

```
static void GiNaC::imag_part_print_latex (
    const ex & arg,
    const print\_context & c ) [static]
```

References [c](#), and [GiNaC::ex::print\(\)](#).

5.1.3.215 `imag_part_conjugate()`

```
static ex GiNaC::imag_part_conjugate (
    const ex & arg ) [static]
```

5.1.3.216 `imag_part_real_part()`

```
static ex GiNaC::imag_part_real_part (
    const ex & arg ) [static]
```

5.1.3.217 `imag_part_imag_part()`

```
static ex GiNaC::imag_part_imag_part (
    const ex & arg ) [static]
```


5.1.3.218 imag_part_expl_derivative()

```
static ex GiNaC::imag_part_expl_derivative (
    const ex & arg,
    const symbol & s ) [static]
```

References [GiNaC::ex::diff\(\)](#), [GiNaC::basic::hold\(\)](#), [imag_part\(\)](#), [GiNaC::symbol::info\(\)](#), and [GiNaC::info_flags::real](#).

5.1.3.219 REGISTER_FUNCTION() [3/36]

```
GiNaC::REGISTER_FUNCTION (
    imag_part_function ,
    eval_func(imag\_part\_eval). evalf_func(imag\_part\_evalf). expl_derivative_↔
func(imag\_part\_expl\_derivative). print_func< print\_latex >(imag\_part\_print\_latex). conjugate_↔
_func(imag\_part\_conjugate). real_part_func(imag\_part\_real\_part). imag_part_func(imag\_part\_imag\_part).
set_name("imag_part","imag_part") )
```

5.1.3.220 abs_evalf()

```
static ex GiNaC::abs_evalf (
    const ex & arg ) [static]
```

References [abs\(\)](#), and [GiNaC::basic::hold\(\)](#).

5.1.3.221 abs_eval()

```
static ex GiNaC::abs_eval (
    const ex & arg ) [static]
```

References [abs\(\)](#), [exp\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [is_ex_the_function](#), [GiNaC::info_flags::negative](#), [GiNaC::info_flags::nonnegative](#), [GiNaC::ex::op\(\)](#), [GiNaC::info_flags::positive](#), [pow\(\)](#), [GiNaC::info_flags::real](#), [GiNaC::ex::real_part\(\)](#), and [step\(\)](#).

5.1.3.222 abs_expand()

```
static ex GiNaC::abs_expand (
    const ex & arg,
    unsigned options ) [static]
```

References [abs\(\)](#), [GiNaC::ex::begin\(\)](#), [GiNaC::ex::end\(\)](#), [GiNaC::ex::expand\(\)](#), [GiNaC::expand_options::expand_function_args](#), [GiNaC::expand_options::expand_transcendental](#), [GiNaC::status_flags::expanded](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::nops\(\)](#), and [options](#).

5.1.3.223 `abs_expl_derivative()`

```
static ex GiNaC::abs_expl_derivative (
    const ex & arg,
    const symbol & s ) [static]
```

References [abs\(\)](#), [GiNaC::ex::conjugate\(\)](#), and [GiNaC::ex::diff\(\)](#).

5.1.3.224 `abs_print_latex()`

```
static void GiNaC::abs_print_latex (
    const ex & arg,
    const print\_context & c ) [static]
```

References [c](#), and [GiNaC::ex::print\(\)](#).

5.1.3.225 `abs_print_csrc_float()`

```
static void GiNaC::abs_print_csrc_float (
    const ex & arg,
    const print\_context & c ) [static]
```

References [c](#), and [GiNaC::ex::print\(\)](#).

5.1.3.226 `abs_conjugate()`

```
static ex GiNaC::abs_conjugate (
    const ex & arg ) [static]
```

References [abs\(\)](#), and [GiNaC::basic::hold\(\)](#).

5.1.3.227 `abs_real_part()`

```
static ex GiNaC::abs_real_part (
    const ex & arg ) [static]
```

References [abs\(\)](#), and [GiNaC::basic::hold\(\)](#).

5.1.3.228 abs_imag_part()

```
static ex GiNaC::abs_imag_part (
    const ex & arg ) [static]
```

5.1.3.229 abs_power()

```
static ex GiNaC::abs_power (
    const ex & arg,
    const ex & exp ) [static]
```

References [abs\(\)](#), [GiNaC::ex::conjugate\(\)](#), [GiNaC::info_flags::even](#), [exp\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::numeric::info\(\)](#), [GiNaC::ex::is_equal\(\)](#), [is_even\(\)](#), [pow\(\)](#), and [GiNaC::info_flags::real](#).

5.1.3.230 abs_info()

```
bool GiNaC::abs_info (
    const ex & arg,
    unsigned inf )
```

References [GiNaC::info_flags::even](#), [GiNaC::info_flags::has_indices](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::integer](#), [GiNaC::info_flags::negative](#), [GiNaC::info_flags::nonnegative](#), [GiNaC::info_flags::nonnegint](#), [GiNaC::info_flags::odd](#), [GiNaC::info_flags::positive](#), [GiNaC::info_flags::prime](#), and [GiNaC::info_flags::real](#).

5.1.3.231 REGISTER_FUNCTION() [4/36]

```
GiNaC::REGISTER_FUNCTION (
    abs ,
    eval_func(abs\_eval) . evalf_func(abs\_evalf) . expand_func(abs\_expand) . expl_↵
    derivative_func(abs\_expl\_derivative) . info_func(abs\_info) . print_func< print\_latex >(abs\_print\_latex) .
    print_func< print\_csrfloat >(abs\_print\_csrfloat) . print_func< print\_csrfdouble >(abs\_print\_csrfloat)
    conjugate_func(abs\_conjugate) . real_part_func(abs\_real\_part) . imag_part_func(abs\_imag\_part) .
    power_func(abs\_power) )
```

5.1.3.232 step_evalf()

```
static ex GiNaC::step_evalf (
    const ex & arg ) [static]
```

References [GiNaC::basic::hold\(\)](#), and [step\(\)](#).

5.1.3.233 `step_eval()`

```
static ex GiNaC::step_eval (
    const ex & arg ) [static]
```

References [GiNaC::basic::hold\(\)](#), [l](#), [GiNaC::numeric::imag\(\)](#), [GiNaC::numeric::is_real\(\)](#), [GiNaC::numeric::is_zero\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), [GiNaC::numeric::real\(\)](#), and [step\(\)](#).

5.1.3.234 `step_series()`

```
static ex GiNaC::step_series (
    const ex & arg,
    const relational & rel,
    int order,
    unsigned options ) [static]
```

References [_ex0](#), [GiNaC::ex::info\(\)](#), [GiNaC::subs_options::no_pattern](#), [GiNaC::info_flags::numeric](#), [options](#), [step\(\)](#), [GiNaC::ex::subs\(\)](#), and [GiNaC::series_options::suppress_branchcut](#).

5.1.3.235 `step_conjugate()`

```
static ex GiNaC::step_conjugate (
    const ex & arg ) [static]
```

References [GiNaC::basic::hold\(\)](#), and [step\(\)](#).

5.1.3.236 `step_real_part()`

```
static ex GiNaC::step_real_part (
    const ex & arg ) [static]
```

References [GiNaC::basic::hold\(\)](#), and [step\(\)](#).

5.1.3.237 `step_imag_part()`

```
static ex GiNaC::step_imag_part (
    const ex & arg ) [static]
```

5.1.3.238 REGISTER_FUNCTION() [5/36]

```
GiNaC::REGISTER_FUNCTION (
    step ,
    eval_func(step_eval). evalf_func(step_evalf). series_func(step_series). conjugate←
_func(step_conjugate). real_part_func(step_real_part). imag_part_func(step_imag_part) )
```

5.1.3.239 csgn_evalf()

```
static ex GiNaC::csgn_evalf (
    const ex & arg ) [static]
```

References [csgn\(\)](#).

5.1.3.240 csgn_eval()

```
static ex GiNaC::csgn_eval (
    const ex & arg ) [static]
```

References [csgn\(\)](#), [I](#), [GiNaC::numeric::imag\(\)](#), [GiNaC::numeric::is_real\(\)](#), [GiNaC::numeric::is_zero\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), and [GiNaC::numeric::real\(\)](#).

5.1.3.241 csgn_series()

```
static ex GiNaC::csgn_series (
    const ex & arg,
    const relational & rel,
    int order,
    unsigned options ) [static]
```

References [_ex0](#), [csgn\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::subs_options::no_pattern](#), [GiNaC::info_flags::numeric](#), [options](#), [GiNaC::ex::subs\(\)](#), and [GiNaC::series_options::suppress_branchcut](#).

5.1.3.242 csgn_conjugate()

```
static ex GiNaC::csgn_conjugate (
    const ex & arg ) [static]
```

References [csgn\(\)](#).

5.1.3.243 csgn_real_part()

```
static ex GiNaC::csgn_real_part (
    const ex & arg ) [static]
```

References [csgn\(\)](#).

5.1.3.244 csgn_imag_part()

```
static ex GiNaC::csgn_imag_part (
    const ex & arg ) [static]
```

5.1.3.245 csgn_power()

```
static ex GiNaC::csgn_power (
    const ex & arg,
    const ex & exp ) [static]
```

References [_ex2](#), [csgn\(\)](#), [exp\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::numeric::info\(\)](#), [is_odd\(\)](#), and [GiNaC::info_flags::positive](#).

5.1.3.246 REGISTER_FUNCTION() [6/36]

```
GiNaC::REGISTER_FUNCTION (
    csgn ,
    eval_func(csgn\_eval). evalf_func(csgn\_evalf). series_func(csgn\_series). conjugate↔
_func(csgn\_conjugate). real_part_func(csgn\_real\_part). imag_part_func(csgn\_imag\_part). power↔
_func(csgn\_power) )
```

5.1.3.247 eta_evalf()

```
static ex GiNaC::eta_evalf (
    const ex & x,
    const ex & y ) [static]
```

References [_ex0](#), [csgn\(\)](#), [evalf\(\)](#), [I](#), [imag\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::numeric::is_negative\(\)](#), [GiNaC::numeric::is_real\(\)](#), [GiNaC::info_flags::numeric](#), [Pi](#), [GiNaC::info_flags::positive](#), and [x](#).

5.1.3.248 eta_eval()

```
static ex GiNaC::eta_eval (
    const ex & x,
    const ex & y ) [static]
```

References [_ex0](#), [csgn\(\)](#), [I](#), [imag\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::numeric::is_negative\(\)](#), [GiNaC::numeric::is_real\(\)](#), [GiNaC::info_flags::numeric](#), [Pi](#), [GiNaC::info_flags::positive](#), and [x](#).

5.1.3.249 eta_series()

```
static ex GiNaC::eta_series (
    const ex & x,
    const ex & y,
    const relational & rel,
    int order,
    unsigned options ) [static]
```

References [_ex0](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::negative](#), [GiNaC::subs_options::no_pattern](#), [GiNaC::info_flags::numeric](#), [GiNaC::ex::subs\(\)](#), and [x](#).

5.1.3.250 eta_conjugate()

```
static ex GiNaC::eta_conjugate (
    const ex & x,
    const ex & y ) [static]
```

References [x](#).

5.1.3.251 eta_real_part()

```
static ex GiNaC::eta_real_part (
    const ex & x,
    const ex & y ) [static]
```

5.1.3.252 eta_imag_part()

```
static ex GiNaC::eta_imag_part (
    const ex & x,
    const ex & y ) [static]
```

References [GiNaC::basic::hold\(\)](#), [I](#), and [x](#).

5.1.3.253 REGISTER_FUNCTION() [7/36]

```
GiNaC::REGISTER_FUNCTION (
    eta ,
    eval_func(eta_eval). evalf_func(eta_evalf). series_func(eta_series). latex↵
_name("\\eta"). set_symmetry(sy_symm(0, 1)). conjugate_func(eta_conjugate). real_part_↵
func(eta_real_part). imag_part_func(eta_imag_part) )
```

5.1.3.254 Li2_evalf()

```
static ex GiNaC::Li2_evalf (
    const ex & x ) [static]
```

References [GiNaC::basic::hold\(\)](#), [Li2\(\)](#), and [x](#).

5.1.3.255 Li2_eval()

```
static ex GiNaC::Li2_eval (
    const ex & x ) [static]
```

References [_ex0](#), [_ex1](#), [_ex12](#), [_ex1_2](#), [_ex2](#), [_ex6](#), [_ex_1](#), [_ex_1_2](#), [_ex_48](#), [Catalan](#), [GiNaC::info_flags::crational](#), [GiNaC::basic::hold\(\)](#), [I](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::ex::is_zero\(\)](#), [Li2\(\)](#), [log\(\)](#), [GiNaC::info_flags::numeric](#), [Pi](#), and [x](#).

5.1.3.256 Li2_deriv()

```
static ex GiNaC::Li2_deriv (
    const ex & x,
    unsigned deriv_param ) [static]
```

References [_ex1](#), [GINAC_ASSERT](#), [log\(\)](#), and [x](#).

5.1.3.257 Li2_series() [1/2]

```
static ex GiNaC::Li2_series (
    const ex & x,
    const relational & rel,
    int order,
    unsigned options ) [static]
```

References [_ex0](#), [_ex1](#), [_ex2](#), [_num2_p](#), [I](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is_equal\(\)](#), [is_real\(\)](#), [GiNaC::ex::is_zero\(\)](#), [GiNaC::relational::lhs\(\)](#), [Li2\(\)](#), [log\(\)](#), [GiNaC::subs_options::no_pattern](#), [GiNaC::ex::nops\(\)](#), [GiNaC::info_flags::numeric](#), [op\(\)](#), [GiNaC::ex::op\(\)](#), [options](#), [order](#), [Pi](#), [pow\(\)](#), [GiNaC::relational::rhs\(\)](#), [GiNaC::ex::series\(\)](#), [series\(\)](#), [subs\(\)](#), [GiNaC::ex::subs\(\)](#), [GiNaC::series_options::suppress_branchcut](#), [x](#), and [zeta\(\)](#).

Referenced by [Li2_projection\(\)](#).

5.1.3.258 Li2_conjugate()

```
static ex GiNaC::Li2_conjugate (
    const ex & x ) [static]
```

References [_num1_p](#), [GiNaC::ex::conjugate\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::imag_part\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is_zero\(\)](#), [Li2\(\)](#), [GiNaC::info_flags::negative](#), and [x](#).

5.1.3.259 REGISTER_FUNCTION() [8/36]

```
GiNaC::REGISTER_FUNCTION (
    Li2 ,
    eval_func(Li2\_eval). evalf_func(Li2\_evalf). derivative_func(Li2\_deriv). series↔
_func(Li2\_series). conjugate_func(Li2\_conjugate). latex_name("\\mathrm{Li}_2") )
```

5.1.3.260 Li3_eval()

```
static ex GiNaC::Li3_eval (
    const ex & x ) [static]
```

References [GiNaC::ex::is_zero\(\)](#), and [x](#).

5.1.3.261 REGISTER_FUNCTION() [9/36]

```
GiNaC::REGISTER_FUNCTION (
    Li3 ,
    eval_func(Li3\_eval). latex_name("\\mathrm{Li}_3") )
```

5.1.3.262 zetaderiv_eval()

```
static ex GiNaC::zetaderiv_eval (
    const ex & n,
    const ex & x ) [static]
```

References [GiNaC::basic::hold\(\)](#), [n](#), [GiNaC::info_flags::numeric](#), [x](#), and [zeta\(\)](#).

5.1.3.263 zetaderiv_deriv()

```
static ex GiNaC::zetaderiv_deriv (
    const ex & n,
    const ex & x,
    unsigned deriv_param ) [static]
```

References [GINAC_ASSERT](#), [n](#), and [x](#).

5.1.3.264 REGISTER_FUNCTION() [10/36]

```
GiNaC::REGISTER_FUNCTION (
    zetaderiv ,
    eval_func(zetaderiv_eval). derivative_func(zetaderiv_deriv). latex_name("\\zeta^\\prime")
)
```

5.1.3.265 factorial_evalf()

```
static ex GiNaC::factorial_evalf (
    const ex & x ) [static]
```

References [factorial\(\)](#), [GiNaC::basic::hold\(\)](#), and [x](#).

5.1.3.266 factorial_eval()

```
static ex GiNaC::factorial_eval (
    const ex & x ) [static]
```

References [factorial\(\)](#), [GiNaC::basic::hold\(\)](#), and [x](#).

5.1.3.267 factorial_print_dflt_latex()

```
static void GiNaC::factorial_print_dflt_latex (
    const ex & x,
    const print_context & c ) [static]
```

References [c](#), [GiNaC::ex::print\(\)](#), and [x](#).

5.1.3.268 factorial_conjugate()

```
static ex GiNaC::factorial_conjugate (  
    const ex & x ) [static]
```

References [factorial\(\)](#), [GiNaC::basic::hold\(\)](#), and [x](#).

5.1.3.269 factorial_real_part()

```
static ex GiNaC::factorial_real_part (  
    const ex & x ) [static]
```

References [factorial\(\)](#), [GiNaC::basic::hold\(\)](#), and [x](#).

5.1.3.270 factorial_imag_part()

```
static ex GiNaC::factorial_imag_part (  
    const ex & x ) [static]
```

5.1.3.271 REGISTER_FUNCTION() [11/36]

```
GiNaC::REGISTER_FUNCTION (  
    factorial ,  
    eval_func(factorial\_eval). evalf_func(factorial\_evalf). print_func< print\_dflt  
>(factorial\_print\_dflt\_latex). print_func< print\_latex >(factorial\_print\_dflt\_latex). conjugate←  
_func(factorial\_conjugate). real_part_func(factorial\_real\_part). imag_part_func(factorial\_imag\_part)  
)
```

5.1.3.272 binomial_evalf()

```
static ex GiNaC::binomial_evalf (  
    const ex & x,  
    const ex & y ) [static]
```

References [binomial\(\)](#), [GiNaC::basic::hold\(\)](#), and [x](#).

5.1.3.273 `binomial_sym()`

```
static ex GiNaC::binomial_sym (  
    const ex & x,  
    const numeric & y ) [static]
```

References [_ex0](#), [_ex1](#), [binomial\(\)](#), [GiNaC::ex::expand\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::numeric::is_integer\(\)](#), [GiNaC::numeric::is_nonneg_integer\(\)](#), [GiNaC::numeric::to_int\(\)](#), and [x](#).

Referenced by [binomial_eval\(\)](#).

5.1.3.274 `binomial_eval()`

```
static ex GiNaC::binomial_eval (  
    const ex & x,  
    const ex & y ) [static]
```

References [binomial\(\)](#), [binomial_sym\(\)](#), [GiNaC::basic::hold\(\)](#), [is_integer\(\)](#), and [x](#).

5.1.3.275 `binomial_conjugate()`

```
static ex GiNaC::binomial_conjugate (  
    const ex & x,  
    const ex & y ) [static]
```

References [binomial\(\)](#), [GiNaC::basic::hold\(\)](#), and [x](#).

5.1.3.276 `binomial_real_part()`

```
static ex GiNaC::binomial_real_part (  
    const ex & x,  
    const ex & y ) [static]
```

References [binomial\(\)](#), [GiNaC::basic::hold\(\)](#), and [x](#).

5.1.3.277 `binomial_imag_part()`

```
static ex GiNaC::binomial_imag_part (  
    const ex & x,  
    const ex & y ) [static]
```

5.1.3.278 REGISTER_FUNCTION() [12/36]

```
GiNaC::REGISTER_FUNCTION (
    binomial ,
    eval_func(binomial_eval). evalf_func(binomial_evalf). conjugate_func(binomial_conjugate).
    real_part_func(binomial_real_part). imag_part_func(binomial_imag_part) )
```

5.1.3.279 Order_eval()

```
static ex GiNaC::Order_eval (
    const ex & x ) [static]
```

References [_ex0](#), [_ex1](#), [GiNaC::ex::is_zero\(\)](#), [m](#), and [x](#).

5.1.3.280 Order_series()

```
static ex GiNaC::Order_series (
    const ex & x,
    const relational & r,
    int order,
    unsigned options ) [static]
```

References [_ex1](#), [GINAC_ASSERT](#), [GiNaC::ex::ldegree\(\)](#), [order](#), [r](#), and [x](#).

5.1.3.281 Order_conjugate()

```
static ex GiNaC::Order_conjugate (
    const ex & x ) [static]
```

References [x](#).

5.1.3.282 Order_real_part()

```
static ex GiNaC::Order_real_part (
    const ex & x ) [static]
```

References [x](#).

5.1.3.283 Order_imag_part()

```
static ex GiNaC::Order_imag_part (
    const ex & x ) [static]
```

References [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::real](#), and [x](#).

5.1.3.284 Order_power()

```
static ex GiNaC::Order_power (
    const ex & x,
    const ex & e ) [static]
```

References [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::posint](#), [pow\(\)](#), and [x](#).

5.1.3.285 Order_expl_derivative()

```
static ex GiNaC::Order_expl_derivative (
    const ex & arg,
    const symbol & s ) [static]
```

References [GiNaC::ex::diff\(\)](#).

5.1.3.286 REGISTER_FUNCTION() [13/36]

```
GiNaC::REGISTER_FUNCTION (
    Order ,
    eval_func(Order\_eval). series_func(Order\_series). latex_name("\\mathcal{O}").
    expl_derivative_func(Order\_expl\_derivative). conjugate_func(Order\_conjugate). real_part_↔
    func(Order\_real\_part). imag_part_func(Order\_imag\_part). power_func(Order\_power) )
```

5.1.3.287 Isolve()

```
ex GiNaC::lsolve (
    const ex & eqns,
    const ex & symbols,
    unsigned options = solve\_algo::automatic )
```

Factorial function.

Binomial function. Order term function (for truncated power series).

References [GiNaC::container< C >::append\(\)](#), [c](#), [GiNaC::ex::coeff\(\)](#), [GiNaC::matrix::cols\(\)](#), [GiNaC::ex::expand\(\)](#), [GiNaC::info_flags::exprseq](#), [GINAC_ASSERT](#), [GiNaC::symbolset::has\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::list](#), [Isolve\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), [options](#), [r](#), [GiNaC::info_flags::relation_equal](#), [rhs\(\)](#), [GiNaC::matrix::rows\(\)](#), [GiNaC::matrix::solve\(\)](#), [GiNaC::info_flags::symbol](#), and [syms](#).

Referenced by [Isolve\(\)](#).

5.1.3.288 fsolve()

```
const numeric GiNaC::fsolve (
    const ex & f,
    const symbol & x,
    const numeric & x1,
    const numeric & x2 )
```

Find a real root of real-valued function $f(x)$ numerically within a given interval.

The function must change sign across interval. Uses Newton- Raphson method combined with bisection in order to guarantee convergence.

Parameters

f	Function $f(x)$
x	Symbol $f(x)$
$x1$	lower interval limit
$x2$	upper interval limit

Exceptions

<code>runtime_error</code>	(if interval is invalid).
----------------------------	---------------------------

References [GiNaC::ex::diff\(\)](#), [GiNaC::ex::evalf\(\)](#), [GiNaC::numeric::is_real\(\)](#), [is_real\(\)](#), [GiNaC::numeric::is_zero\(\)](#), [GiNaC::ex::lhs\(\)](#), [normal\(\)](#), [GiNaC::ex::rhs\(\)](#), [GiNaC::ex::subs\(\)](#), and [x](#).

5.1.3.289 zeta() [1/3]

```
template<typename T1 >
function GiNaC::zeta (
    const T1 & p1 ) [inline]
```

References [GiNaC::zeta1_SERIAL::serial](#).

Referenced by [Li2_series\(\)](#), [Li_eval\(\)](#), [psi2_eval\(\)](#), [S_eval\(\)](#), [zeta1_eval\(\)](#), [zeta1_evalf\(\)](#), [zeta2_eval\(\)](#), [zeta2_evalf\(\)](#), and [zetaderiv_eval\(\)](#).

5.1.3.290 zeta() [2/3]

```
template<typename T1 , typename T2 >
function GiNaC::zeta (
    const T1 & p1,
    const T2 & p2 ) [inline]
```

References [GiNaC::zeta2_SERIAL::serial](#).

5.1.3.291 is_the_function< zeta_SERIAL >()

```
template<>
bool GiNaC::is_the_function< zeta_SERIAL > (
    const ex & x ) [inline]
```

References [x](#).

5.1.3.292 G() [1/2]

```
template<typename T1 , typename T2 >
function GiNaC::G (
    const T1 & x,
    const T2 & y ) [inline]
```

References [GiNaC::G2_SERIAL::serial](#), and [x](#).

Referenced by [G2_eval\(\)](#), [G2_evalf\(\)](#), [G3_eval\(\)](#), and [G3_evalf\(\)](#).

5.1.3.293 G() [2/2]

```
template<typename T1 , typename T2 , typename T3 >
function GiNaC::G (
    const T1 & x,
    const T2 & s,
    const T3 & y ) [inline]
```

References [GiNaC::G3_SERIAL::serial](#), and [x](#).

5.1.3.294 is_the_function< G_SERIAL >()

```
template<>
bool GiNaC::is_the_function< G_SERIAL > (
    const ex & x ) [inline]
```

References [x](#).

5.1.3.295 psi() [1/4]

```
template<typename T1 >
function GiNaC::psi (
    const T1 & p1 ) [inline]
```

References [GiNaC::psi1_SERIAL::serial](#).

Referenced by [beta_deriv\(\)](#), [lgamma_deriv\(\)](#), [psi1_deriv\(\)](#), [psi1_eval\(\)](#), [psi1_evalf\(\)](#), [psi1_series\(\)](#), [psi2_deriv\(\)](#), [psi2_eval\(\)](#), [psi2_evalf\(\)](#), [psi2_series\(\)](#), [sr_gcd\(\)](#), and [tgamma_deriv\(\)](#).

5.1.3.296 psi() [2/4]

```
template<typename T1 , typename T2 >
function GiNaC::psi (
    const T1 & p1,
    const T2 & p2 ) [inline]
```

References [GiNaC::psi2_SERIAL::serial](#).

5.1.3.297 is_the_function< psi_SERIAL >()

```
template<>
bool GiNaC::is_the_function< psi_SERIAL > (
    const ex & x ) [inline]
```

References [x](#).

5.1.3.298 iterated_integral() [1/2]

```
template<typename T1 , typename T2 >
function GiNaC::iterated_integral (
    const T1 & kernel_lst,
    const T2 & lambda ) [inline]
```

References [GiNaC::iterated_integral2_SERIAL::serial](#).

Referenced by [iterated_integral2_eval\(\)](#), [iterated_integral3_eval\(\)](#), and [iterated_integral_evalf_impl\(\)](#).

5.1.3.299 iterated_integral() [2/2]

```
template<typename T1 , typename T2 , typename T3 >
function GiNaC::iterated_integral (
    const T1 & kernel_lst,
    const T2 & lambda,
    const T3 & N_trunc ) [inline]
```

References [GiNaC::iterated_integral3_SERIAL::serial](#).

5.1.3.300 is_the_function< iterated_integral_SERIAL >()

```
template<>
bool GiNaC::is_the_function< iterated_integral_SERIAL > (
    const ex & x ) [inline]
```

References [x](#).

5.1.3.301 is_order_function()

```
bool GiNaC::is_order_function (
    const ex & e ) [inline]
```

Check whether a function is the Order ($O(n)$) function.

References [is_ex_the_function](#).

Referenced by [GiNaC::pseries::add_series\(\)](#), [GiNaC::pseries::convert_to_poly\(\)](#), [GiNaC::pseries::derivative\(\)](#), [GiNaC::pseries::is_terminating\(\)](#), [GiNaC::pseries::mul_const\(\)](#), [GiNaC::pseries::mul_series\(\)](#), [GiNaC::pseries::op\(\)](#), [GiNaC::pseries::power_const\(\)](#), [GiNaC::pseries::print_series\(\)](#), [GiNaC::pseries::pseries\(\)](#), and [GiNaC::integral::series\(\)](#).

5.1.3.302 convert_H_to_Li()

```
ex GiNaC::convert_H_to_Li (
    const ex & parameterlst,
    const ex & arg )
```

Converts a given list containing parameters for H in Remiddi/Vermaseren notation into the corresponding [GiNaC](#) functions.

References [m](#), and [x](#).

5.1.3.303 EllipticK_evalf()

```
static ex GiNaC::EllipticK_evalf (
    const ex & k ) [static]
```

References [GiNaC::ex::evalf\(\)](#), [k](#), [GiNaC::info_flags::numeric](#), [Pi](#), and [sqrt\(\)](#).

5.1.3.304 EllipticK_eval()

```
static ex GiNaC::EllipticK_eval (
    const ex & k ) [static]
```

References [_ex0](#), [GiNaC::info_flags::crational](#), [GiNaC::constant::evalf\(\)](#), [k](#), [GiNaC::info_flags::numeric](#), and [Pi](#).

5.1.3.305 EllipticK_deriv()

```
static ex GiNaC::EllipticK_deriv (
    const ex & k,
    unsigned deriv_param ) [static]
```

References [k](#).

5.1.3.306 EllipticK_series()

```
static ex GiNaC::EllipticK_series (
    const ex & k,
    const relational & rel,
    int order,
    unsigned options ) [static]
```

References [_ex0](#), [_ex1](#), [_ex_1](#), [k](#), [GiNaC::subs_options::no_pattern](#), [order](#), [Pi](#), [pow\(\)](#), [GiNaC::ex::series\(\)](#), and [GiNaC::ex::subs\(\)](#).

5.1.3.307 EllipticK_print_latex()

```
static void GiNaC::EllipticK_print_latex (
    const ex & k,
    const print_context & c ) [static]
```

References [c](#), and [k](#).

5.1.3.308 REGISTER_FUNCTION() [14/36]

```
GiNaC::REGISTER_FUNCTION (
    EllipticK ,
    evalf_func(EllipticK\_evalf). eval_func(EllipticK\_eval). derivative_func(EllipticK\_deriv).
    series_func(EllipticK\_series). print_func< print_latex >(EllipticK\_print\_latex). do_not_↵
    evalf_params() )
```

5.1.3.309 EllipticE_evalf()

```
static ex GiNaC::EllipticE_evalf (
    const ex & k ) [static]
```

References [GiNaC::ex::evalf\(\)](#), [k](#), [GiNaC::info_flags::numeric](#), [Pi](#), and [sqrt\(\)](#).

5.1.3.310 EllipticE_eval()

```
static ex GiNaC::EllipticE_eval (
    const ex & k ) [static]
```

References [_ex0](#), [_ex1](#), [_ex_1](#), [GiNaC::info_flags::crational](#), [GiNaC::constant::evalf\(\)](#), [k](#), [GiNaC::info_flags::numeric](#), and [Pi](#).

5.1.3.311 EllipticE_deriv()

```
static ex GiNaC::EllipticE_deriv (
    const ex & k,
    unsigned deriv_param ) [static]
```

References [k](#).

5.1.3.312 EllipticE_series()

```
static ex GiNaC::EllipticE_series (
    const ex & k,
    const relational & rel,
    int order,
    unsigned options ) [static]
```

References [_ex0](#), [_ex1](#), [_ex_1](#), [k](#), [GiNaC::subs_options::no_pattern](#), [order](#), [Pi](#), [pow\(\)](#), [GiNaC::ex::series\(\)](#), and [GiNaC::ex::subs\(\)](#).

5.1.3.313 EllipticE_print_latex()

```
static void GiNaC::EllipticE_print_latex (
    const ex & k,
    const print\_context & c ) [static]
```

References [c](#), and [k](#).

5.1.3.314 REGISTER_FUNCTION() [15/36]

```
GiNaC::REGISTER_FUNCTION (
    EllipticE ,
    evalf_func(EllipticE\_evalf). eval_func(EllipticE\_eval). derivative_func(EllipticE\_deriv).
    series_func(EllipticE\_series). print_func< print\_latex >(EllipticE\_print\_latex). do_not_↔
    evalf_params() )
```

5.1.3.315 iterated_integral_evalf_impl()

```
static ex GiNaC::iterated_integral_evalf_impl (
    const ex & kernel_lst,
    const ex & lambda,
    const ex & N_trunc ) [static]
```

References [coeff\(\)](#), [Digits](#), [GiNaC::ex::evalf\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [iterated_integral\(\)](#), [GiNaC::info_flags::list](#), [GiNaC::info_flags::nonnegint](#), [GiNaC::container< C >::nops\(\)](#), [GiNaC::info_flags::numeric](#), and [one](#).

Referenced by [iterated_integral2_evalf\(\)](#), and [iterated_integral3_evalf\(\)](#).

5.1.3.316 iterated_integral2_evalf()

```
static ex GiNaC::iterated_integral2_evalf (
    const ex & kernel_lst,
    const ex & lambda ) [static]
```

References [iterated_integral_evalf_impl\(\)](#).

5.1.3.317 iterated_integral3_evalf()

```
static ex GiNaC::iterated_integral3_evalf (
    const ex & kernel_lst,
    const ex & lambda,
    const ex & N_trunc ) [static]
```

References [iterated_integral_evalf_impl\(\)](#).

5.1.3.318 iterated_integral2_eval()

```
static ex GiNaC::iterated_integral2_eval (
    const ex & kernel_lst,
    const ex & lambda ) [static]
```

References [GiNaC::info_flags::crational](#), [GiNaC::function::evalf\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [iterated_integral\(\)](#), and [GiNaC::info_flags::numeric](#).

5.1.3.319 iterated_integral3_eval()

```
static ex GiNaC::iterated_integral3_eval (
    const ex & kernel_lst,
    const ex & lambda,
    const ex & N_trunc ) [static]
```

References [GiNaC::info_flags::crational](#), [GiNaC::function::evalf\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [iterated_integral\(\)](#), and [GiNaC::info_flags::numeric](#).

5.1.3.320 lgamma_evalf()

```
static ex GiNaC::lgamma_evalf (
    const ex & x ) [static]
```

References [lgamma\(\)](#), and [x](#).

5.1.3.321 lgamma_eval()

```
static ex GiNaC::lgamma_eval (
    const ex & x ) [static]
```

Evaluation of $\lgamma(x)$, the natural logarithm of the Gamma function.

Handles integer arguments as a special case.

Exceptions

<code>GiNaC::pole_error("lgamma_eval()"</code>	logarithmic pole",0)
--	----------------------

References [_ex_1](#), [factorial\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::integer](#), [is_rational\(\)](#), [lgamma\(\)](#), [log\(\)](#), [GiNaC::info_flags::numeric](#), [GiNaC::info_flags::posint](#), and [x](#).

5.1.3.322 lgamma_deriv()

```
static ex GiNaC::lgamma_deriv (
    const ex & x,
    unsigned deriv_param ) [static]
```

References [GINAC_ASSERT](#), [psi\(\)](#), and [x](#).

5.1.3.323 lgamma_series()

```
static ex GiNaC::lgamma_series (
    const ex & arg,
    const relational & rel,
    int order,
    unsigned options ) [static]
```

References [_ex1](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::integer](#), [lgamma\(\)](#), [log\(\)](#), [m](#), [GiNaC::subs_options::no_pattern](#), [options](#), [order](#), [GiNaC::info_flags::positive](#), [GiNaC::basic::series\(\)](#), and [GiNaC::ex::subs\(\)](#).

5.1.3.324 lgamma_conjugate()

```
static ex GiNaC::lgamma_conjugate (
    const ex & x ) [static]
```

References [GiNaC::ex::conjugate\(\)](#), [GiNaC::ex::imag_part\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is_zero\(\)](#), [lgamma\(\)](#), [GiNaC::info_flags::positive](#), and [x](#).

5.1.3.325 REGISTER_FUNCTION() [16/36]

```
GiNaC::REGISTER_FUNCTION (
    lgamma ,
    eval_func(lgamma\_eval) . evalf_func(lgamma\_evalf) . derivative_func(lgamma\_deriv) .
    series_func(lgamma\_series) . conjugate_func(lgamma\_conjugate) . latex_name("\\log \\Gamma") )
```

5.1.3.326 tgamma_evalf()

```
static ex GiNaC::tgamma_evalf (
    const ex & x ) [static]
```

References [tgamma\(\)](#), and [x](#).

5.1.3.327 tgamma_eval()

```
static ex GiNaC::tgamma_eval (
    const ex & x ) [static]
```

Evaluation of $\text{tgamma}(x)$, the true Gamma function.

Knows about integer arguments, half-integer arguments and that's it. Somebody ought to provide some good numerical evaluation some day...

Exceptions

<code>pole_error("tgamma_eval() simple pole",0)</code>
--

References [_num1_2_p](#), [_num1_p](#), [_num2_p](#), [_num_2_p](#), [abs\(\)](#), [GiNaC::numeric::div\(\)](#), [doublefactorial\(\)](#), [factorial\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::numeric::is_even\(\)](#), [GiNaC::numeric::is_integer\(\)](#), [GiNaC::numeric::is_positive\(\)](#), [is_rational\(\)](#), [n](#), [GiNaC::info_flags::numeric](#), [Pi](#), [pow\(\)](#), [sqrt\(\)](#), [tgamma\(\)](#), and [x](#).

5.1.3.328 tgamma_deriv()

```
static ex GiNaC::tgamma_deriv (
    const ex & x,
    unsigned deriv_param ) [static]
```

References [GINAC_ASSERT](#), [psi\(\)](#), [tgamma\(\)](#), and [x](#).

5.1.3.329 tgamma_series()

```
static ex GiNaC::tgamma_series (
    const ex & arg,
    const relational & rel,
    int order,
    unsigned options ) [static]
```

References [_ex1](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::integer](#), [m](#), [GiNaC::subs_options::no_pattern](#), [options](#), [order](#), [GiNaC::info_flags::positive](#), [GiNaC::ex::series\(\)](#), [GiNaC::ex::subs\(\)](#), and [tgamma\(\)](#).

5.1.3.330 `tgamma_conjugate()`

```
static ex GiNaC::tgamma_conjugate (
    const ex & x ) [static]
```

References [GiNaC::ex::conjugate\(\)](#), [tgamma\(\)](#), and [x](#).

5.1.3.331 `REGISTER_FUNCTION()` [17/36]

```
GiNaC::REGISTER_FUNCTION (
    tgamma ,
    eval_func(tgamma\_eval) . evalf_func(tgamma\_evalf) . derivative_func(tgamma\_deriv) .
    series_func(tgamma\_series) . conjugate_func(tgamma\_conjugate) . latex_name("\\Gamma") )
```

5.1.3.332 `beta_evalf()`

```
static ex GiNaC::beta_evalf (
    const ex & x,
    const ex & y ) [static]
```

References [exp\(\)](#), [lgamma\(\)](#), and [x](#).

5.1.3.333 `beta_eval()`

```
static ex GiNaC::beta_eval (
    const ex & x,
    const ex & y ) [static]
```

References [_ex0](#), [_ex1](#), [_num_1_p](#), [evalf\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::numeric::is_integer\(\)](#), [is_integer\(\)](#), [GiNaC::numeric::is_negative\(\)](#), [is_positive\(\)](#), [is_rational\(\)](#), [GiNaC::numeric::is_real\(\)](#), [is_real\(\)](#), [GiNaC::info_flags::numeric](#), [pow\(\)](#), [tgamma\(\)](#), and [x](#).

5.1.3.334 `beta_deriv()`

```
static ex GiNaC::beta_deriv (
    const ex & x,
    const ex & y,
    unsigned deriv_param ) [static]
```

References [GINAC_ASSERT](#), [psi\(\)](#), and [x](#).

5.1.3.335 beta_series()

```
static ex GiNaC::beta_series (
    const ex & arg1,
    const ex & arg2,
    const relational & rel,
    int order,
    unsigned options ) [static]
```

References [GINAC_ASSERT](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::integer](#), [GiNaC::relational::lhs\(\)](#), [GiNaC::subs_options::no_pattern](#), [options](#), [order](#), [GiNaC::info_flags::positive](#), [GiNaC::ex::subs\(\)](#), and [tgamma\(\)](#).

5.1.3.336 REGISTER_FUNCTION() [18/36]

```
GiNaC::REGISTER_FUNCTION (
    beta ,
    eval_func(beta_eval). evalf_func(beta_evalf). derivative_func(beta_deriv).
    series_func(beta_series). latex_name("\\mathrm{B}"). set_symmetry(sy_symm(0, 1)) )
```

5.1.3.337 psi1_evalf()

```
static ex GiNaC::psi1_evalf (
    const ex & x ) [static]
```

References [GiNaC::basic::hold\(\)](#), [psi\(\)](#), and [x](#).

5.1.3.338 psi1_eval()

```
static ex GiNaC::psi1_eval (
    const ex & x ) [static]
```

Evaluation of digamma-function $\psi(x)$.

Somebody ought to provide some good numerical evaluation some day...

References [_ex1_2](#), [_ex2](#), [_num2_p](#), [_num_1_p](#), [Euler](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::numeric::inverse\(\)](#), [GiNaC::numeric::is_integer\(\)](#), [is_integer\(\)](#), [GiNaC::numeric::is_positive\(\)](#), [log\(\)](#), [GiNaC::info_flags::numeric](#), [pow\(\)](#), [psi\(\)](#), and [x](#).

5.1.3.339 `psi1_deriv()`

```
static ex GiNaC::psi1_deriv (
    const ex & x,
    unsigned deriv_param ) [static]
```

References [_ex1](#), [GINAC_ASSERT](#), [psi\(\)](#), and [x](#).

5.1.3.340 `psi1_series()`

```
static ex GiNaC::psi1_series (
    const ex & arg,
    const relational & rel,
    int order,
    unsigned options ) [static]
```

References [_ex1](#), [_ex_1](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::integer](#), [m](#), [GiNaC::subs_options::no_pattern](#), [options](#), [order](#), [GiNaC::info_flags::positive](#), [psi\(\)](#), [GiNaC::power::series\(\)](#), and [GiNaC::ex::subs\(\)](#).

5.1.3.341 `psi2_evalf()`

```
static ex GiNaC::psi2_evalf (
    const ex & n,
    const ex & x ) [static]
```

References [GiNaC::basic::hold\(\)](#), [n](#), [psi\(\)](#), and [x](#).

5.1.3.342 `psi2_eval()`

```
static ex GiNaC::psi2_eval (
    const ex & n,
    const ex & x ) [static]
```

Evaluation of polygamma-function $\psi(n,x)$.

Somebody ought to provide some good numerical evaluation some day...

References [_ex1](#), [_ex1_2](#), [_ex_1](#), [_num1_2_p](#), [_num1_p](#), [_num2_p](#), [_num_1_p](#), [factorial\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::numeric::is_equal\(\)](#), [GiNaC::numeric::is_integer\(\)](#), [is_integer\(\)](#), [GiNaC::numeric::is_positive\(\)](#), [log\(\)](#), [m](#), [n](#), [GiNaC::info_flags::numeric](#), [GiNaC::info_flags::posint](#), [pow\(\)](#), [psi\(\)](#), [tgamma\(\)](#), [x](#), and [zeta\(\)](#).

5.1.3.343 psi2_deriv()

```
static ex GiNaC::psi2_deriv (
    const ex & n,
    const ex & x,
    unsigned deriv_param ) [static]
```

References [_ex1](#), [GINAC_ASSERT](#), [n](#), [psi\(\)](#), and [x](#).

5.1.3.344 psi2_series()

```
static ex GiNaC::psi2_series (
    const ex & n,
    const ex & arg,
    const relational & rel,
    int order,
    unsigned options ) [static]
```

References [_ex1](#), [_ex_1](#), [factorial\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::integer](#), [m](#), [n](#), [GiNaC::subs_options::no_pattern](#), [options](#), [order](#), [GiNaC::info_flags::positive](#), [psi\(\)](#), and [GiNaC::ex::subs\(\)](#).

5.1.3.345 G2_evalf()

```
static ex GiNaC::G2_evalf (
    const ex & x_,
    const ex & y ) [static]
```

References [_ex0](#), [_ex1](#), [factorial\(\)](#), [G\(\)](#), [GiNaC::basic::hold\(\)](#), [imag\(\)](#), [GiNaC::ex::info\(\)](#), [is_real\(\)](#), [log\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::info_flags::numeric](#), [GiNaC::ex::op\(\)](#), [GiNaC::info_flags::positive](#), [pow\(\)](#), and [x](#).

5.1.3.346 G2_eval()

```
static ex GiNaC::G2_eval (
    const ex & x_,
    const ex & y ) [static]
```

References [_ex0](#), [_ex1](#), [GiNaC::info_flags::crational](#), [factorial\(\)](#), [G\(\)](#), [GiNaC::basic::hold\(\)](#), [imag\(\)](#), [GiNaC::ex::info\(\)](#), [is_real\(\)](#), [log\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::info_flags::numeric](#), [GiNaC::ex::op\(\)](#), [GiNaC::info_flags::positive](#), [pow\(\)](#), and [x](#).

5.1.3.347 G3_evalf()

```
static ex GiNaC::G3_evalf (
    const ex & x_,
    const ex & s_,
    const ex & y ) [static]
```

References [_ex0](#), [_ex1](#), [GiNaC::container< C >::begin\(\)](#), [GiNaC::ex::begin\(\)](#), [GiNaC::ex::end\(\)](#), [factorial\(\)](#), [G\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [log\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::container< C >::nops\(\)](#), [GiNaC::info_flags::numeric](#), [GiNaC::ex::op\(\)](#), [GiNaC::info_flags::positive](#), [pow\(\)](#), [GiNaC::info_flags::real](#), and [x](#).

5.1.3.348 G3_eval()

```
static ex GiNaC::G3_eval (
    const ex & x_,
    const ex & s_,
    const ex & y ) [static]
```

References [_ex0](#), [_ex1](#), [GiNaC::container< C >::begin\(\)](#), [GiNaC::ex::begin\(\)](#), [GiNaC::info_flags::crational](#), [GiNaC::ex::end\(\)](#), [factorial\(\)](#), [G\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [log\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::container< C >::nops\(\)](#), [GiNaC::info_flags::numeric](#), [GiNaC::ex::op\(\)](#), [GiNaC::info_flags::positive](#), [pow\(\)](#), [GiNaC::info_flags::real](#), and [x](#).

5.1.3.349 Li_evalf()

```
static ex GiNaC::Li_evalf (
    const ex & m_,
    const ex & x_ ) [static]
```

References [_ex0](#), [_ex1](#), [GiNaC::ex::begin\(\)](#), [GiNaC::ex::evalf\(\)](#), [GiNaC::ex::info\(\)](#), [m](#), [GiNaC::ex::nops\(\)](#), [GiNaC::info_flags::numeric](#), [GiNaC::ex::op\(\)](#), [GiNaC::info_flags::posint](#), and [x](#).

5.1.3.350 Li_eval()

```
static ex GiNaC::Li_eval (
    const ex & m_,
    const ex & x_ ) [static]
```

References [_ex0](#), [_ex1](#), [_ex2](#), [_ex_1](#), [_ex_48](#), [GiNaC::container< C >::append\(\)](#), [GiNaC::ex::begin\(\)](#), [Catalan](#), [GiNaC::info_flags::crational](#), [GINAC_ASSERT](#), [I](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is_equal\(\)](#), [log\(\)](#), [m](#), [GiNaC::ex::nops\(\)](#), [GiNaC::info_flags::numeric](#), [Pi](#), [GiNaC::info_flags::posint](#), [pow\(\)](#), [GiNaC::numeric::to_int\(\)](#), [x](#), and [zeta\(\)](#).

5.1.3.351 Li_series()

```
static ex GiNaC::Li_series (
    const ex & m,
    const ex & x,
    const relational & rel,
    int order,
    unsigned options ) [static]
```

References [_ex1](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is_zero\(\)](#), [m](#), [GiNaC::subs_options::no_pattern](#), [GiNaC::info_flags::numeric](#), [order](#), [pow\(\)](#), [GiNaC::ex::series\(\)](#), [GiNaC::ex::subs\(\)](#), and [x](#).

5.1.3.352 Li_deriv()

```
static ex GiNaC::Li_deriv (
    const ex & m_,
    const ex & x_,
    unsigned deriv_param ) [static]
```

References [_ex0](#), [GINAC_ASSERT](#), [m](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), and [x](#).

5.1.3.353 Li_print_latex()

```
static void GiNaC::Li_print_latex (
    const ex & m_,
    const ex & x_,
    const print\_context & c ) [static]
```

References [GiNaC::ex::begin\(\)](#), [c](#), [GiNaC::ex::end\(\)](#), [m](#), and [x](#).

5.1.3.354 REGISTER_FUNCTION() [19/36]

```
GiNaC::REGISTER_FUNCTION (
    Li ,
    evalf_func(Li_evalf). eval_func(Li_eval). series_func(Li_series). derivative_↔
func(Li_deriv). print_func< print\_latex >(Li_print_latex). do_not_evalf_params() )
```

5.1.3.355 S_evalf()

```
static ex GiNaC::S_evalf (
    const ex & n,
    const ex & p,
    const ex & x ) [static]
```

References [GiNaC::ex::evalf\(\)](#), [GiNaC::ex::info\(\)](#), [n](#), [GiNaC::info_flags::posint](#), and [x](#).

5.1.3.356 S_eval()

```
static ex GiNaC::S_eval (
    const ex & n,
    const ex & p,
    const ex & x ) [static]
```

References [_ex0](#), [GiNaC::info_flags::crational](#), [factorial\(\)](#), [GiNaC::ex::info\(\)](#), [log\(\)](#), [m](#), [n](#), [GiNaC::info_flags::numeric](#), [GiNaC::info_flags::posint](#), [pow\(\)](#), [to_int\(\)](#), [x](#), and [zeta\(\)](#).

5.1.3.357 S_series()

```
static ex GiNaC::S_series (
    const ex & n,
    const ex & p,
    const ex & x,
    const relational & rel,
    int order,
    unsigned options ) [static]
```

References [_ex1](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is_zero\(\)](#), [n](#), [GiNaC::subs_options::no_pattern](#), [GiNaC::info_flags::numeric](#), [options](#), [order](#), [GiNaC::info_flags::posint](#), [pow\(\)](#), [GiNaC::ex::series\(\)](#), [GiNaC::ex::subs\(\)](#), and [x](#).

5.1.3.358 S_deriv()

```
static ex GiNaC::S_deriv (
    const ex & n,
    const ex & p,
    const ex & x,
    unsigned deriv_param ) [static]
```

References [_ex0](#), [GINAC_ASSERT](#), [n](#), and [x](#).

5.1.3.359 S_print_latex()

```
static void GiNaC::S_print_latex (
    const ex & n,
    const ex & p,
    const ex & x,
    const print\_context & c ) [static]
```

References [c](#), [n](#), [GiNaC::ex::print\(\)](#), and [x](#).

5.1.3.360 REGISTER_FUNCTION() [20/36]

```
GiNaC::REGISTER_FUNCTION (
    S ,
    evalf_func(S_evalf). eval_func(S_eval). series_func(S_series). derivative_↵
func(S_deriv). print_func< print_latex >(S_print_latex). do_not_evalf_params() )
```

5.1.3.361 H_evalf()

```
static ex GiNaC::H_evalf (
    const ex & x1,
    const ex & x2 ) [static]
```

References [GiNaC::container< C >::begin\(\)](#), [GiNaC::container< C >::end\(\)](#), [GiNaC::ex::evalf\(\)](#), [l](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::integer](#), [m](#), [GiNaC::ex::nops\(\)](#), [GiNaC::container< C >::nops\(\)](#), [GiNaC::ex::op\(\)](#), [GiNaC::container< C >::op\(\)](#), [Pi](#), [GiNaC::ex::subs\(\)](#), [to_int\(\)](#), and [x](#).

5.1.3.362 H_eval()

```
static ex GiNaC::H_eval (
    const ex & m_,
    const ex & x ) [static]
```

References [_ex0](#), [_ex1](#), [_ex_1](#), [GiNaC::info_flags::crational](#), [GiNaC::ex::evalf\(\)](#), [factorial\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::integer](#), [log\(\)](#), [m](#), [n](#), [GiNaC::info_flags::numeric](#), [pow\(\)](#), [step\(\)](#), and [x](#).

5.1.3.363 H_series()

```
static ex GiNaC::H_series (
    const ex & m,
    const ex & x,
    const relational & rel,
    int order,
    unsigned options ) [static]
```

References [m](#), and [x](#).

5.1.3.364 H_deriv()

```
static ex GiNaC::H_deriv (
    const ex & m_,
    const ex & x,
    unsigned deriv_param ) [static]
```

References [_ex0](#), [_ex1](#), [_ex_1](#), [GINAC_ASSERT](#), [m](#), and [x](#).

5.1.3.365 H_print_latex()

```
static void GiNaC::H_print_latex (
    const ex & m_,
    const ex & x,
    const print\_context & c ) [static]
```

References [c](#), [m](#), [GiNaC::ex::print\(\)](#), and [x](#).

5.1.3.366 REGISTER_FUNCTION() [21/36]

```
GiNaC::REGISTER_FUNCTION (
    H ,
    evalf_func(H\_evalf). eval_func(H\_eval). series_func(H\_series). derivative_↔
func(H\_deriv). print_func< print\_latex >(H\_print\_latex). do_not_evalf_params() )
```

5.1.3.367 zeta1_evalf()

```
static ex GiNaC::zeta1_evalf (
    const ex & x ) [static]
```

References [GiNaC::container< C >::begin\(\)](#), [Digits](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::info_flags::posint](#), [r](#), [x](#), and [zeta\(\)](#).

Referenced by [zeta1_eval\(\)](#).

5.1.3.368 zeta1_eval()

```
static ex GiNaC::zeta1_eval (
    const ex & m ) [static]
```

References [_ex0](#), [_ex_1_2](#), [_num1_p](#), [_num2_p](#), [abs\(\)](#), [bernoulli\(\)](#), [GiNaC::info_flags::crational](#), [factorial\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::numeric::info\(\)](#), [GiNaC::numeric::is_equal\(\)](#), [GiNaC::numeric::is_integer\(\)](#), [GiNaC::numeric::is_zero\(\)](#), [m](#), [GiNaC::info_flags::numeric](#), [GiNaC::info_flags::odd](#), [Pi](#), [GiNaC::info_flags::posint](#), [pow\(\)](#), [zeta\(\)](#), and [zeta1_evalf\(\)](#).

5.1.3.369 zeta1_deriv()

```
static ex GiNaC::zeta1_deriv (
    const ex & m,
    unsigned deriv\_param ) [static]
```

References [_ex0](#), [_ex1](#), [GINAC_ASSERT](#), and [m](#).

5.1.3.370 zeta1_print_latex()

```
static void GiNaC::zeta1_print_latex (
    const ex & m_,
    const print\_context & c ) [static]
```

References [c](#), [m](#), and [GiNaC::ex::print\(\)](#).

5.1.3.371 zeta2_evalf()

```
static ex GiNaC::zeta2_evalf (
    const ex & x,
    const ex & s ) [static]
```

References [GiNaC::container< C >::begin\(\)](#), [evalf\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::info_flags::posint](#), [x](#), and [zeta\(\)](#).

5.1.3.372 zeta2_eval()

```
static ex GiNaC::zeta2_eval (
    const ex & m,
    const ex & s_ ) [static]
```

References [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [m](#), [GiNaC::info_flags::positive](#), and [zeta\(\)](#).

5.1.3.373 zeta2_deriv()

```
static ex GiNaC::zeta2_deriv (
    const ex & m,
    const ex & s,
    unsigned deriv_param ) [static]
```

References [_ex0](#), [_ex1](#), [GINAC_ASSERT](#), [GiNaC::ex::info\(\)](#), [m](#), [GiNaC::ex::op\(\)](#), and [GiNaC::info_flags::positive](#).

5.1.3.374 zeta2_print_latex()

```
static void GiNaC::zeta2_print_latex (
    const ex & m_,
    const ex & s_,
    const print\_context & c ) [static]
```

References [GiNaC::container< C >::begin\(\)](#), [c](#), and [m](#).

5.1.3.375 exp_evalf()

```
static ex GiNaC::exp_evalf (
    const ex & x ) [static]
```

References [exp\(\)](#), [GiNaC::basic::hold\(\)](#), and [x](#).

5.1.3.376 exp_eval()

```
static ex GiNaC::exp_eval (
    const ex & x ) [static]
```

References [_ex1](#), [_ex2](#), [_ex_1](#), [_num0_p](#), [_num1_p](#), [_num2_p](#), [_num3_p](#), [_num4_p](#), [GiNaC::info_flags::crational](#), [exp\(\)](#), [GiNaC::basic::hold\(\)](#), [I](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::integer](#), [GiNaC::numeric::is_equal\(\)](#), [is_ex_the_function](#), [GiNaC::ex::is_zero\(\)](#), [log\(\)](#), [mod\(\)](#), [GiNaC::info_flags::numeric](#), [GiNaC::ex::op\(\)](#), [Pi](#), and [x](#).

5.1.3.377 exp_expand()

```
static ex GiNaC::exp_expand (
    const ex & arg,
    unsigned options ) [static]
```

References [GiNaC::ex::begin\(\)](#), [GiNaC::ex::end\(\)](#), [exp\(\)](#), [GiNaC::ex::expand\(\)](#), [GiNaC::expand_options::expand_function_args](#), [GiNaC::expand_options::expand_transcendental](#), [GiNaC::status_flags::expanded](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::nops\(\)](#), and [options](#).

5.1.3.378 exp_deriv()

```
static ex GiNaC::exp_deriv (
    const ex & x,
    unsigned deriv_param ) [static]
```

References [exp\(\)](#), [GINAC_ASSERT](#), and [x](#).

5.1.3.379 exp_real_part()

```
static ex GiNaC::exp_real_part (
    const ex & x ) [static]
```

References [cos\(\)](#), [exp\(\)](#), [imag_part\(\)](#), [real_part\(\)](#), and [x](#).

5.1.3.380 exp_imag_part()

```
static ex GiNaC::exp_imag_part (
    const ex & x ) [static]
```

References [exp\(\)](#), [imag_part\(\)](#), [real_part\(\)](#), [sin\(\)](#), and [x](#).

5.1.3.381 exp_conjugate()

```
static ex GiNaC::exp_conjugate (
    const ex & x ) [static]
```

References [GiNaC::ex::conjugate\(\)](#), [exp\(\)](#), and [x](#).

5.1.3.382 exp_power()

```
static ex GiNaC::exp_power (
    const ex & x,
    const ex & a ) [static]
```

References [_ex_1](#), [exp\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::integer](#), [GiNaC::info_flags::negative](#), [GiNaC::info_flags::nonnegative](#), [GiNaC::info_flags::real](#), and [x](#).

5.1.3.383 exp_info()

```
static bool GiNaC::exp_info (
    const ex & x,
    unsigned inf ) [static]
```

References [GiNaC::info_flags::expanded](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::nonnegative](#), [GiNaC::info_flags::positive](#), [GiNaC::info_flags::real](#), and [x](#).

5.1.3.384 REGISTER_FUNCTION() [22/36]

```
GiNaC::REGISTER_FUNCTION (
    exp ,
    eval_func(exp\_eval). evalf_func(exp\_evalf). info_func(exp\_info). expand_↵
func(exp\_expand). derivative_func(exp\_deriv). real_part_func(exp\_real\_part). imag_part_↵
func(exp\_imag\_part). conjugate_func(exp\_conjugate). power_func(exp\_power). latex_name("\\exp")
)
```

5.1.3.385 log_evalf()

```
static ex GiNaC::log_evalf (
    const ex & x ) [static]
```

References [GiNaC::basic::hold\(\)](#), [log\(\)](#), and [x](#).

5.1.3.386 log_eval()

```
static ex GiNaC::log_eval (
    const ex & x ) [static]
```

References [_ex0](#), [_ex1](#), [_ex1_2](#), [_ex_1_2](#), [GiNaC::info_flags::crational](#), [exp\(\)](#), [GiNaC::basic::hold\(\)](#), [I](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is_equal\(\)](#), [is_ex_the_function](#), [GiNaC::ex::is_zero\(\)](#), [log\(\)](#), [GiNaC::info_flags::negative](#), [GiNaC::info_flags::numeric](#), [GiNaC::ex::op\(\)](#), [Pi](#), [GiNaC::info_flags::rational](#), [GiNaC::info_flags::real](#), and [x](#).

5.1.3.387 log_deriv()

```
static ex GiNaC::log_deriv (
    const ex & x,
    unsigned deriv_param ) [static]
```

References [_ex_1](#), [GINAC_ASSERT](#), and [x](#).

5.1.3.388 log_series()

```
static ex GiNaC::log_series (
    const ex & arg,
    const relational & rel,
    int order,
    unsigned options ) [static]
```

References [_ex0](#), [_ex1](#), [_ex_1](#), [GiNaC::pseries::add_series\(\)](#), [GiNaC::pseries::coeff\(\)](#), [coeff\(\)](#), [csgn\(\)](#), [GiNaC::ex::diff\(\)](#), [GINAC_ASSERT](#), [I](#), [GiNaC::ex::info\(\)](#), [GiNaC::pseries::is_terminating\(\)](#), [GiNaC::ex::is_zero\(\)](#), [GiNaC::pseries::ldegree\(\)](#), [GiNaC::relational::lhs\(\)](#), [log\(\)](#), [n](#), [GiNaC::info_flags::negative](#), [GiNaC::subs_options::no_pattern](#), [GiNaC::pseries::nops\(\)](#), [options](#), [order](#), [Pi](#), [GiNaC::info_flags::positive](#), [pow\(\)](#), [GiNaC::relational::rhs\(\)](#), [GiNaC::ex::series\(\)](#), [series\(\)](#), [GiNaC::ex::subs\(\)](#), and [GiNaC::series_options::suppress_branchcut](#).

5.1.3.389 log_real_part()

```
static ex GiNaC::log_real_part (
    const ex & x ) [static]
```

References [abs\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [log\(\)](#), [GiNaC::info_flags::nonnegative](#), and [x](#).

5.1.3.390 log_imag_part()

```
static ex GiNaC::log_imag_part (
    const ex & x ) [static]
```

References [imag_part\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::nonnegative](#), [real_part\(\)](#), and [x](#).

5.1.3.391 log_expand()

```
static ex GiNaC::log_expand (
    const ex & arg,
    unsigned options ) [static]
```

References [_ex1](#), [_ex_1](#), [GiNaC::ex::begin\(\)](#), [GiNaC::ex::end\(\)](#), [expand\(\)](#), [GiNaC::ex::expand\(\)](#), [GiNaC::expand_options::expand_func](#), [GiNaC::expand_options::expand_transcendental](#), [GiNaC::basic::hold\(\)](#), [GiNaC::info_flags::indefinite](#), [GiNaC::ex::info\(\)](#), [log\(\)](#), [GiNaC::info_flags::negative](#), [GiNaC::ex::nops\(\)](#), [options](#), [GiNaC::info_flags::positive](#), [GiNaC::status_flags::purely_indefinite](#), and [GiNaC::basic::setflag\(\)](#).

5.1.3.392 log_conjugate()

```
static ex GiNaC::log_conjugate (
    const ex & x ) [static]
```

References [GiNaC::ex::conjugate\(\)](#), [GiNaC::ex::imag_part\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is_zero\(\)](#), [log\(\)](#), [GiNaC::info_flags::positive](#), and [x](#).

5.1.3.393 log_info()

```
static bool GiNaC::log_info (
    const ex & x,
    unsigned inf ) [static]
```

References [GiNaC::info_flags::expanded](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::positive](#), [GiNaC::info_flags::real](#), and [x](#).

5.1.3.394 REGISTER_FUNCTION() [23/36]

```
GiNaC::REGISTER_FUNCTION (
    log ,
    eval_func(log\_eval). evalf_func(log\_evalf). info_func(log\_info). expand_↵
func(log\_expand). derivative_func(log\_deriv). series_func(log\_series). real_part_func(log\_real\_part).
imag_part_func(log\_imag\_part). conjugate_func(log\_conjugate). latex_name("\\ln" ) )
```

5.1.3.395 `sin_evalf()`

```
static ex GiNaC::sin_evalf (
    const ex & x ) [static]
```

References [GiNaC::basic::hold\(\)](#), [sin\(\)](#), and [x](#).

5.1.3.396 `sin_eval()`

```
static ex GiNaC::sin_eval (
    const ex & x ) [static]
```

References [_ex0](#), [_ex1](#), [_ex1_2](#), [_ex1_3](#), [_ex1_4](#), [_ex2](#), [_ex3](#), [_ex5](#), [_ex6](#), [_ex60](#), [_ex_1](#), [_ex_1_2](#), [_ex_1_3](#), [_ex_1_4](#), [_num0_p](#), [_num10_p](#), [_num120_p](#), [_num15_p](#), [_num18_p](#), [_num20_p](#), [_num25_p](#), [_num30_p](#), [_num5_p](#), [_num60_p](#), [_num6_p](#), [acos\(\)](#), [asin\(\)](#), [atan\(\)](#), [GiNaC::info_flags::crational](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::integer](#), [GiNaC::numeric::is_equal\(\)](#), [is_ex_the_function](#), [mod\(\)](#), [GiNaC::info_flags::negative](#), [GiNaC::info_flags::numeric](#), [GiNaC::ex::op\(\)](#), [Pi](#), [sin\(\)](#), [sqrt\(\)](#), and [x](#).

5.1.3.397 `sin_deriv()`

```
static ex GiNaC::sin_deriv (
    const ex & x,
    unsigned deriv_param ) [static]
```

References [cos\(\)](#), [GINAC_ASSERT](#), and [x](#).

5.1.3.398 `sin_real_part()`

```
static ex GiNaC::sin_real_part (
    const ex & x ) [static]
```

References [cosh\(\)](#), [imag_part\(\)](#), [real_part\(\)](#), [sin\(\)](#), and [x](#).

5.1.3.399 `sin_imag_part()`

```
static ex GiNaC::sin_imag_part (
    const ex & x ) [static]
```

References [cos\(\)](#), [imag_part\(\)](#), [real_part\(\)](#), [sinh\(\)](#), and [x](#).

5.1.3.400 sin_conjugate()

```
static ex GiNaC::sin_conjugate (
    const ex & x ) [static]
```

References [GiNaC::ex::conjugate\(\)](#), [sin\(\)](#), and [x](#).

5.1.3.401 trig_info()

```
static bool GiNaC::trig_info (
    const ex & x,
    unsigned inf ) [static]
```

References [GiNaC::info_flags::expanded](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::real](#), and [x](#).

5.1.3.402 REGISTER_FUNCTION() [24/36]

```
GiNaC::REGISTER_FUNCTION (
    sin ,
    eval_func(sin\_eval). evalf_func(sin\_evalf). info_func(trig\_info). derivative_↵
func(sin\_deriv). real_part_func(sin\_real\_part). imag_part_func(sin\_imag\_part). conjugate_↵
func(sin\_conjugate). latex_name("\\sin" ) )
```

5.1.3.403 cos_evalf()

```
static ex GiNaC::cos_evalf (
    const ex & x ) [static]
```

References [cos\(\)](#), [GiNaC::basic::hold\(\)](#), and [x](#).

5.1.3.404 cos_eval()

```
static ex GiNaC::cos_eval (
    const ex & x ) [static]
```

References [_ex0](#), [_ex1](#), [_ex1_2](#), [_ex1_3](#), [_ex1_4](#), [_ex2](#), [_ex3](#), [_ex5](#), [_ex6](#), [_ex60](#), [_ex_1](#), [_ex_1_2](#), [_ex_1_3](#), [_ex_1_4](#), [_num0_p](#), [_num10_p](#), [_num120_p](#), [_num12_p](#), [_num15_p](#), [_num20_p](#), [_num24_p](#), [_num25_p](#), [_num30_p](#), [_num5_p](#), [_num60_p](#), [acos\(\)](#), [asin\(\)](#), [atan\(\)](#), [cos\(\)](#), [GiNaC::info_flags::crational](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::integer](#), [GiNaC::numeric::is_equal\(\)](#), [is_ex_the_function](#), [mod\(\)](#), [GiNaC::info_flags::negative](#), [GiNaC::info_flags::numeric](#), [GiNaC::ex::op\(\)](#), [Pi](#), [sqrt\(\)](#), and [x](#).

5.1.3.405 cos_deriv()

```
static ex GiNaC::cos_deriv (
    const ex & x,
    unsigned deriv_param ) [static]
```

References [GINAC_ASSERT](#), [sin\(\)](#), and [x](#).

5.1.3.406 cos_real_part()

```
static ex GiNaC::cos_real_part (
    const ex & x ) [static]
```

References [cos\(\)](#), [cosh\(\)](#), [imag_part\(\)](#), [real_part\(\)](#), and [x](#).

5.1.3.407 cos_imag_part()

```
static ex GiNaC::cos_imag_part (
    const ex & x ) [static]
```

References [imag_part\(\)](#), [real_part\(\)](#), [sin\(\)](#), [sinh\(\)](#), and [x](#).

5.1.3.408 cos_conjugate()

```
static ex GiNaC::cos_conjugate (
    const ex & x ) [static]
```

References [GiNaC::ex::conjugate\(\)](#), [cos\(\)](#), and [x](#).

5.1.3.409 REGISTER_FUNCTION() [25/36]

```
GiNaC::REGISTER_FUNCTION (
    cos ,
    eval_func(cos\_eval). info_func(trig\_info). evalf_func(cos\_evalf). derivative_↵
func(cos\_deriv). real_part_func(cos\_real\_part). imag_part_func(cos\_imag\_part). conjugate_↵
func(cos\_conjugate). latex_name("\\cos" ) )
```


5.1.3.410 `tan_evalf()`

```
static ex GiNaC::tan_evalf (
    const ex & x ) [static]
```

References [GiNaC::basic::hold\(\)](#), [tan\(\)](#), and [x](#).

5.1.3.411 `tan_eval()`

```
static ex GiNaC::tan_eval (
    const ex & x ) [static]
```

References [_ex0](#), [_ex1](#), [_ex1_3](#), [_ex2](#), [_ex3](#), [_ex60](#), [_ex_1](#), [_ex_1_2](#), [_num0_p](#), [_num10_p](#), [_num15_p](#), [_num20_p](#), [_num25_p](#), [_num30_p](#), [_num5_p](#), [_num60_p](#), [acos\(\)](#), [asin\(\)](#), [atan\(\)](#), [GiNaC::info_flags::crational](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::integer](#), [GiNaC::numeric::is_equal\(\)](#), [is_ex_the_function](#), [mod\(\)](#), [GiNaC::info_flags::negative](#), [GiNaC::info_flags::numeric](#), [GiNaC::ex::op\(\)](#), [Pi](#), [sqrt\(\)](#), [tan\(\)](#), and [x](#).

5.1.3.412 `tan_deriv()`

```
static ex GiNaC::tan_deriv (
    const ex & x,
    unsigned deriv_param ) [static]
```

References [_ex1](#), [_ex2](#), [GINAC_ASSERT](#), [tan\(\)](#), and [x](#).

5.1.3.413 `tan_real_part()`

```
static ex GiNaC::tan_real_part (
    const ex & x ) [static]
```

References [imag_part\(\)](#), [real_part\(\)](#), [tan\(\)](#), and [x](#).

5.1.3.414 `tan_imag_part()`

```
static ex GiNaC::tan_imag_part (
    const ex & x ) [static]
```

References [imag_part\(\)](#), [real_part\(\)](#), [tan\(\)](#), [tanh\(\)](#), and [x](#).

5.1.3.415 tan_series()

```
static ex GiNaC::tan_series (
    const ex & x,
    const relational & rel,
    int order,
    unsigned options ) [static]
```

References [cos\(\)](#), [GINAC_ASSERT](#), [GiNaC::relational::lhs\(\)](#), [GiNaC::subs_options::no_pattern](#), [GiNaC::info_flags::odd](#), [options](#), [order](#), [Pi](#), [sin\(\)](#), [GiNaC::ex::subs\(\)](#), and [x](#).

5.1.3.416 tan_conjugate()

```
static ex GiNaC::tan_conjugate (
    const ex & x ) [static]
```

References [GiNaC::ex::conjugate\(\)](#), [tan\(\)](#), and [x](#).

5.1.3.417 REGISTER_FUNCTION() [26/36]

```
GiNaC::REGISTER_FUNCTION (
    tan ,
    eval_func(tan_eval). evalf_func(tan_evalf). info_func(trig_info). derivative↵
    _func(tan_deriv). series_func(tan_series). real_part_func(tan_real_part). imag_part_↵
    func(tan_imag_part). conjugate_func(tan_conjugate). latex_name("\\tan") )
```

5.1.3.418 asin_evalf()

```
static ex GiNaC::asin_evalf (
    const ex & x ) [static]
```

References [asin\(\)](#), [GiNaC::basic::hold\(\)](#), and [x](#).

5.1.3.419 asin_eval()

```
static ex GiNaC::asin_eval (
    const ex & x ) [static]
```

References [_ex1](#), [_ex1_2](#), [_ex_1](#), [_ex_1_2](#), [asin\(\)](#), [GiNaC::info_flags::crational](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::ex::is_zero\(\)](#), [GiNaC::info_flags::negative](#), [GiNaC::info_flags::numeric](#), [Pi](#), and [x](#).

5.1.3.420 `asin_deriv()`

```
static ex GiNaC::asin_deriv (
    const ex & x,
    unsigned deriv_param ) [static]
```

References [_ex2](#), [_ex_1_2](#), [GINAC_ASSERT](#), and [x](#).

5.1.3.421 `asin_conjugate()`

```
static ex GiNaC::asin_conjugate (
    const ex & x ) [static]
```

References [_num1_p](#), [_num_1_p](#), [asin\(\)](#), [GiNaC::ex::conjugate\(\)](#), [GiNaC::ex::imag_part\(\)](#), [GiNaC::ex::is_zero\(\)](#), and [x](#).

5.1.3.422 `asin_info()`

```
static bool GiNaC::asin_info (
    const ex & x,
    unsigned inf ) [static]
```

References [GiNaC::info_flags::expanded](#), [GiNaC::ex::info\(\)](#), and [x](#).

5.1.3.423 `REGISTER_FUNCTION()` [27/36]

```
GiNaC::REGISTER_FUNCTION (
    asin ,
    eval_func(asin_eval). evalf_func(asin_evalf). info_func(asin_info). derivative↔
_func(asin_deriv). conjugate_func(asin_conjugate). latex_name("\\arcsin") )
```

5.1.3.424 `acos_evalf()`

```
static ex GiNaC::acos_evalf (
    const ex & x ) [static]
```

References [acos\(\)](#), [GiNaC::basic::hold\(\)](#), and [x](#).

5.1.3.425 acos_eval()

```
static ex GiNaC::acos_eval (
    const ex & x ) [static]
```

References [_ex0](#), [_ex1](#), [_ex1_2](#), [_ex1_3](#), [_ex_1](#), [_ex_1_2](#), [acos\(\)](#), [GiNaC::info_flags::crational](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::ex::is_zero\(\)](#), [GiNaC::info_flags::negative](#), [GiNaC::info_flags::numeric](#), [Pi](#), and [x](#).

5.1.3.426 acos_deriv()

```
static ex GiNaC::acos_deriv (
    const ex & x,
    unsigned deriv_param ) [static]
```

References [_ex2](#), [_ex_1_2](#), [GINAC_ASSERT](#), and [x](#).

5.1.3.427 acos_conjugate()

```
static ex GiNaC::acos_conjugate (
    const ex & x ) [static]
```

References [_num1_p](#), [_num_1_p](#), [acos\(\)](#), [GiNaC::ex::conjugate\(\)](#), [GiNaC::ex::imag_part\(\)](#), [GiNaC::ex::is_zero\(\)](#), and [x](#).

5.1.3.428 REGISTER_FUNCTION() [28/36]

```
GiNaC::REGISTER_FUNCTION (
    acos ,
    eval_func(acos\_eval). evalf_func(acos\_evalf). info_func(asin\_info). derivative↔
_func(acos\_deriv). conjugate_func(acos\_conjugate). latex_name("\\arccos") )
```

5.1.3.429 atan_evalf()

```
static ex GiNaC::atan_evalf (
    const ex & x ) [static]
```

References [atan\(\)](#), [GiNaC::basic::hold\(\)](#), and [x](#).

5.1.3.430 atan_eval()

```
static ex GiNaC::atan_eval (
    const ex & x ) [static]
```

References [_ex0](#), [_ex1](#), [_ex1_4](#), [_ex_1](#), [_ex_1_4](#), [atan\(\)](#), [GiNaC::info_flags::crational](#), [GiNaC::basic::hold\(\)](#), [I](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::ex::is_zero\(\)](#), [GiNaC::info_flags::negative](#), [GiNaC::info_flags::numeric](#), [Pi](#), and [x](#).

5.1.3.431 atan_deriv()

```
static ex GiNaC::atan_deriv (
    const ex & x,
    unsigned deriv_param ) [static]
```

References [_ex1](#), [_ex2](#), [_ex_1](#), [GINAC_ASSERT](#), and [x](#).

5.1.3.432 atan_series()

```
static ex GiNaC::atan_series (
    const ex & arg,
    const relational & rel,
    int order,
    unsigned options ) [static]
```

References [_ex0](#), [_ex1](#), [_ex1_2](#), [_ex_1](#), [_ex_1_2](#), [abs\(\)](#), [atan\(\)](#), [csgn\(\)](#), [GINAC_ASSERT](#), [I](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::relational::lhs\(\)](#), [log\(\)](#), [GiNaC::subs_options::no_pattern](#), [GiNaC::ex::op\(\)](#), [options](#), [order](#), [Pi](#), [GiNaC::info_flags::real](#), [GiNaC::relational::rhs\(\)](#), [series\(\)](#), [GiNaC::ex::subs\(\)](#), and [GiNaC::series_options::suppress_branchcut](#).

5.1.3.433 atan_conjugate()

```
static ex GiNaC::atan_conjugate (
    const ex & x ) [static]
```

References [_num1_p](#), [_num_1_p](#), [atan\(\)](#), [GiNaC::ex::conjugate\(\)](#), [GiNaC::ex::imag_part\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::numeric::is_zero\(\)](#), [GiNaC::info_flags::real](#), [GiNaC::ex::real_part\(\)](#), and [x](#).

5.1.3.434 atan_info()

```
static bool GiNaC::atan_info (
    const ex & x,
    unsigned inf ) [static]
```

References [GiNaC::info_flags::expanded](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::negative](#), [GiNaC::info_flags::nonnegative](#), [GiNaC::info_flags::positive](#), [GiNaC::info_flags::real](#), and [x](#).

5.1.3.435 REGISTER_FUNCTION() [29/36]

```
GiNaC::REGISTER_FUNCTION (
    atan ,
    eval_func(atan_eval). evalf_func(atan_evalf). info_func(atan_info). derivative↔
_func(atan_deriv). series_func(atan_series). conjugate_func(atan_conjugate). latex_name("\\arctan")
)
```

5.1.3.436 atan2_evalf()

```
static ex GiNaC::atan2_evalf (
    const ex & y,
    const ex & x ) [static]
```

References [atan\(\)](#), and [x](#).

5.1.3.437 atan2_eval()

```
static ex GiNaC::atan2_eval (
    const ex & y,
    const ex & x ) [static]
```

References [_ex0](#), [_ex1_2](#), [_ex1_4](#), [_ex_1_2](#), [_ex_1_4](#), [atan\(\)](#), [GiNaC::info_flags::crational](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::ex::is_zero\(\)](#), [GiNaC::info_flags::negative](#), [Pi](#), [GiNaC::info_flags::positive](#), [GiNaC::info_flags::real](#), and [x](#).

5.1.3.438 atan2_deriv()

```
static ex GiNaC::atan2_deriv (
    const ex & y,
    const ex & x,
    unsigned deriv_param ) [static]
```

References [_ex2](#), [_ex_1](#), [GINAC_ASSERT](#), and [x](#).

5.1.3.439 atan2_info()

```
static bool GiNaC::atan2_info (
    const ex & y,
    const ex & x,
    unsigned inf ) [static]
```

References [GiNaC::info_flags::expanded](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::negative](#), [GiNaC::info_flags::nonnegative](#), [GiNaC::info_flags::positive](#), [GiNaC::info_flags::real](#), and [x](#).

5.1.3.440 REGISTER_FUNCTION() [30/36]

```
GiNaC::REGISTER_FUNCTION (
    atan2 ,
    eval_func(atan2_eval). evalf_func(atan2_evalf). info_func(atan2_info). evalf_←
func(atan2_evalf). derivative_func(atan2_deriv) )
```

5.1.3.441 sinh_evalf()

```
static ex GiNaC::sinh_evalf (
    const ex & x ) [static]
```

References [GiNaC::basic::hold\(\)](#), [sinh\(\)](#), and [x](#).

5.1.3.442 sinh_eval()

```
static ex GiNaC::sinh_eval (
    const ex & x ) [static]
```

References [_ex0](#), [_ex1](#), [_ex2](#), [_ex_1_2](#), [acosh\(\)](#), [asinh\(\)](#), [atanh\(\)](#), [GiNaC::info_flags::crational](#), [GiNaC::basic::hold\(\)](#), [I](#), [GiNaC::ex::info\(\)](#), [is_ex_the_function](#), [GiNaC::ex::is_zero\(\)](#), [is_zero\(\)](#), [GiNaC::info_flags::negative](#), [GiNaC::info_flags::numeric](#), [GiNaC::ex::op\(\)](#), [Pi](#), [real\(\)](#), [sin\(\)](#), [sinh\(\)](#), [sqrt\(\)](#), and [x](#).

5.1.3.443 sinh_deriv()

```
static ex GiNaC::sinh_deriv (
    const ex & x,
    unsigned deriv_param ) [static]
```

References [cosh\(\)](#), [GINAC_ASSERT](#), and [x](#).

5.1.3.444 sinh_real_part()

```
static ex GiNaC::sinh_real_part (
    const ex & x ) [static]
```

References [cos\(\)](#), [imag_part\(\)](#), [real_part\(\)](#), [sinh\(\)](#), and [x](#).

5.1.3.445 sinh_imag_part()

```
static ex GiNaC::sinh_imag_part (
    const ex & x ) [static]
```

References [cosh\(\)](#), [imag_part\(\)](#), [real_part\(\)](#), [sin\(\)](#), and [x](#).

5.1.3.446 sinh_conjugate()

```
static ex GiNaC::sinh_conjugate (
    const ex & x ) [static]
```

References [GiNaC::ex::conjugate\(\)](#), [sinh\(\)](#), and [x](#).

5.1.3.447 REGISTER_FUNCTION() [31/36]

```
GiNaC::REGISTER_FUNCTION (
    sinh ,
    eval_func(sinh_eval). evalf_func(sinh_evalf). info_func(atan_info). derivative↔
    _func(sinh_deriv). real_part_func(sinh_real_part). imag_part_func(sinh_imag_part). conjugate↔
    _func(sinh_conjugate). latex_name("\\sinh") )
```

5.1.3.448 cosh_evalf()

```
static ex GiNaC::cosh_evalf (
    const ex & x ) [static]
```

References [cosh\(\)](#), [GiNaC::basic::hold\(\)](#), and [x](#).

5.1.3.449 cosh_eval()

```
static ex GiNaC::cosh_eval (
    const ex & x ) [static]
```

References [_ex1](#), [_ex2](#), [_ex_1_2](#), [acosh\(\)](#), [asinh\(\)](#), [atanh\(\)](#), [cos\(\)](#), [cosh\(\)](#), [GiNaC::info_flags::crational](#), [GiNaC::basic::hold\(\)](#), [I](#), [GiNaC::ex::info\(\)](#), [is_ex_the_function](#), [GiNaC::ex::is_zero\(\)](#), [is_zero\(\)](#), [GiNaC::info_flags::negative](#), [GiNaC::info_flags::numeric](#), [GiNaC::ex::op\(\)](#), [Pi](#), [real\(\)](#), [sqrt\(\)](#), and [x](#).

5.1.3.450 cosh_deriv()

```
static ex GiNaC::cosh_deriv (
    const ex & x,
    unsigned deriv_param ) [static]
```

References [GINAC_ASSERT](#), [sinh\(\)](#), and [x](#).

5.1.3.451 cosh_real_part()

```
static ex GiNaC::cosh_real_part (
    const ex & x ) [static]
```

References [cos\(\)](#), [cosh\(\)](#), [imag_part\(\)](#), [real_part\(\)](#), and [x](#).

5.1.3.452 cosh_imag_part()

```
static ex GiNaC::cosh_imag_part (
    const ex & x ) [static]
```

References [imag_part\(\)](#), [real_part\(\)](#), [sin\(\)](#), [sinh\(\)](#), and [x](#).

5.1.3.453 cosh_conjugate()

```
static ex GiNaC::cosh_conjugate (
    const ex & x ) [static]
```

References [GiNaC::ex::conjugate\(\)](#), [cosh\(\)](#), and [x](#).

5.1.3.454 REGISTER_FUNCTION() [32/36]

```
GiNaC::REGISTER_FUNCTION (
    cosh ,
    eval_func(cosh\_eval), evalf_func(cosh\_evalf), info_func(exp\_info), derivative←
_func(cosh\_deriv), real_part_func(cosh\_real\_part), imag_part_func(cosh\_imag\_part), conjugate←
_func(cosh\_conjugate), latex_name("\\cosh") )
```

5.1.3.455 tanh_evalf()

```
static ex GiNaC::tanh_evalf (
    const ex & x ) [static]
```

References [GiNaC::basic::hold\(\)](#), [tanh\(\)](#), and [x](#).

5.1.3.456 tanh_eval()

```
static ex GiNaC::tanh_eval (
    const ex & x ) [static]
```

References [_ex0](#), [_ex1](#), [_ex2](#), [_ex_1](#), [_ex_1_2](#), [acosh\(\)](#), [asinh\(\)](#), [atanh\(\)](#), [GiNaC::info_flags::crational](#), [GiNaC::basic::hold\(\)](#), [I](#), [GiNaC::ex::info\(\)](#), [is_ex_the_function](#), [GiNaC::ex::is_zero\(\)](#), [is_zero\(\)](#), [GiNaC::info_flags::negative](#), [GiNaC::info_flags::numeric](#), [GiNaC::ex::op\(\)](#), [Pi](#), [real\(\)](#), [sqrt\(\)](#), [tan\(\)](#), [tanh\(\)](#), and [x](#).

5.1.3.457 tanh_deriv()

```
static ex GiNaC::tanh_deriv (
    const ex & x,
    unsigned deriv_param ) [static]
```

References [_ex1](#), [_ex2](#), [GINAC_ASSERT](#), [tanh\(\)](#), and [x](#).

5.1.3.458 tanh_series()

```
static ex GiNaC::tanh_series (
    const ex & x,
    const relational & rel,
    int order,
    unsigned options ) [static]
```

References [cosh\(\)](#), [GINAC_ASSERT](#), [I](#), [GiNaC::relational::lhs\(\)](#), [GiNaC::subs_options::no_pattern](#), [GiNaC::info_flags::odd](#), [options](#), [order](#), [Pi](#), [sinh\(\)](#), [GiNaC::ex::subs\(\)](#), and [x](#).

5.1.3.459 tanh_real_part()

```
static ex GiNaC::tanh_real_part (
    const ex & x ) [static]
```

References [imag_part\(\)](#), [real_part\(\)](#), [tan\(\)](#), [tanh\(\)](#), and [x](#).

5.1.3.460 tanh_imag_part()

```
static ex GiNaC::tanh_imag_part (
    const ex & x ) [static]
```

References [imag_part\(\)](#), [real_part\(\)](#), [tan\(\)](#), [tanh\(\)](#), and [x](#).

5.1.3.461 tanh_conjugate()

```
static ex GiNaC::tanh_conjugate (
    const ex & x ) [static]
```

References [GiNaC::ex::conjugate\(\)](#), [tanh\(\)](#), and [x](#).

5.1.3.462 REGISTER_FUNCTION() [33/36]

```
GiNaC::REGISTER_FUNCTION (
    tanh ,
    eval_func(tanh\_eval). evalf_func(tanh\_evalf). info_func(atan\_info). derivative↔
    _func(tanh\_deriv). series_func(tanh\_series). real_part_func(tanh\_real\_part). imag_part_↔
    func(tanh\_imag\_part). conjugate_func(tanh\_conjugate). latex_name("\\tanh") )
```

5.1.3.463 asinh_evalf()

```
static ex GiNaC::asinh_evalf (
    const ex & x ) [static]
```

References [asinh\(\)](#), [GiNaC::basic::hold\(\)](#), and [x](#).

5.1.3.464 asinh_eval()

```
static ex GiNaC::asinh_eval (
    const ex & x ) [static]
```

References [_ex0](#), [asinh\(\)](#), [GiNaC::info_flags::crational](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is_zero\(\)](#), [GiNaC::info_flags::negative](#), [GiNaC::info_flags::numeric](#), and [x](#).

5.1.3.465 asinh_deriv()

```
static ex GiNaC::asinh_deriv (
    const ex & x,
    unsigned deriv_param ) [static]
```

References [_ex1](#), [_ex2](#), [_ex_1_2](#), [GINAC_ASSERT](#), and [x](#).

5.1.3.466 asinh_conjugate()

```
static ex GiNaC::asinh_conjugate (
    const ex & x ) [static]
```

References [_num1_p](#), [_num_1_p](#), [asinh\(\)](#), [GiNaC::ex::conjugate\(\)](#), [GiNaC::ex::imag_part\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::numeric::is_zero\(\)](#), [GiNaC::info_flags::real](#), [GiNaC::ex::real_part\(\)](#), and [x](#).

5.1.3.467 REGISTER_FUNCTION() [34/36]

```
GiNaC::REGISTER_FUNCTION (
    asinh ,
    eval_func(asinh\_eval) . evalf_func(asinh\_evalf) . info_func(atan\_info) . derivative←
_func(asinh\_deriv) . conjugate_func(asinh\_conjugate) )
```

5.1.3.468 acosh_evalf()

```
static ex GiNaC::acosh_evalf (
    const ex & x ) [static]
```

References [acosh\(\)](#), [GiNaC::basic::hold\(\)](#), and [x](#).

5.1.3.469 acosh_eval()

```
static ex GiNaC::acosh_eval (
    const ex & x ) [static]
```

References [_ex0](#), [_ex1](#), [_ex_1](#), [acosh\(\)](#), [GiNaC::info_flags::crational](#), [GiNaC::basic::hold\(\)](#), [I](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::ex::is_zero\(\)](#), [GiNaC::info_flags::negative](#), [GiNaC::info_flags::numeric](#), [Pi](#), and [x](#).

5.1.3.470 acosh_deriv()

```
static ex GiNaC::acosh_deriv (
    const ex & x,
    unsigned deriv_param ) [static]
```

References [_ex1](#), [_ex_1](#), [_ex_1_2](#), [GINAC_ASSERT](#), and [x](#).

5.1.3.471 acosh_conjugate()

```
static ex GiNaC::acosh_conjugate (
    const ex & x ) [static]
```

References [_num1_p](#), [acosh\(\)](#), [GiNaC::ex::conjugate\(\)](#), [GiNaC::ex::imag_part\(\)](#), [GiNaC::ex::is_zero\(\)](#), and [x](#).

5.1.3.472 REGISTER_FUNCTION() [35/36]

```
GiNaC::REGISTER_FUNCTION (
    acosh ,
    eval_func(acosh\_eval) . evalf_func(acosh\_evalf) . info_func(asin\_info) . derivative←
    _func(acosh\_deriv) . conjugate_func(acosh\_conjugate) )
```

5.1.3.473 atanh_evalf()

```
static ex GiNaC::atanh_evalf (
    const ex & x ) [static]
```

References [atanh\(\)](#), [GiNaC::basic::hold\(\)](#), and [x](#).

5.1.3.474 atanh_eval()

```
static ex GiNaC::atanh_eval (
    const ex & x ) [static]
```

References [_ex0](#), [_ex1](#), [_ex_1](#), [atanh\(\)](#), [GiNaC::info_flags::crational](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::ex::is_zero\(\)](#), [GiNaC::info_flags::negative](#), [GiNaC::info_flags::numeric](#), and [x](#).

5.1.3.475 atanh_deriv()

```
static ex GiNaC::atanh_deriv (
    const ex & x,
    unsigned deriv_param ) [static]
```

References [_ex1](#), [_ex2](#), [_ex_1](#), [GINAC_ASSERT](#), and [x](#).

5.1.3.476 atanh_series()

```
static ex GiNaC::atanh_series (
    const ex & arg,
    const relational & rel,
    int order,
    unsigned options ) [static]
```

References [_ex0](#), [_ex1](#), [_ex1_2](#), [_ex_1](#), [_ex_1_2](#), [abs\(\)](#), [atanh\(\)](#), [csgn\(\)](#), [GINAC_ASSERT](#), [I](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::relational::lhs\(\)](#), [log\(\)](#), [GiNaC::subs_options::no_pattern](#), [GiNaC::ex::op\(\)](#), [options](#), [order](#), [Pi](#), [GiNaC::info_flags::real](#), [GiNaC::relational::rhs\(\)](#), [series\(\)](#), [GiNaC::ex::subs\(\)](#), and [GiNaC::series_options::suppress_branchcut](#).

5.1.3.477 atanh_conjugate()

```
static ex GiNaC::atanh_conjugate (
    const ex & x ) [static]
```

References [_num1_p](#), [_num_1_p](#), [atanh\(\)](#), [GiNaC::ex::conjugate\(\)](#), [GiNaC::ex::imag_part\(\)](#), [GiNaC::ex::is_zero\(\)](#), and [x](#).

5.1.3.478 REGISTER_FUNCTION() [36/36]

```
GiNaC::REGISTER_FUNCTION (
    atanh ,
    eval_func(atanh\_eval). evalf_func(atanh\_evalf). info_func(asin\_info). derivative↔
_func(atanh\_deriv). series_func(atanh\_series). conjugate_func(atanh\_conjugate) )
```

5.1.3.479 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [11/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
    integral ,
    basic ,
    print_func< print\_dflt > &::do_print. print_func< print\_python > &::do_print.
    print_func< print\_latex > &::do_print_latex )
```

5.1.3.480 subsvalue()

```
ex GiNaC::subsvalue (
    const ex & var,
    const ex & value,
    const ex & fun )
```

References [GiNaC::ex::evalf\(\)](#), [GiNaC::ex::subs\(\)](#), and [value](#).

Referenced by [adaptivesimpson\(\)](#).

5.1.3.481 adaptivesimpson()

```
GiNaC::ex GiNaC::adaptivesimpson (
    const ex & x,
    const ex & a_in,
    const ex & b_in,
    const ex & f,
    const ex & error )
```

Numeric integration routine based upon the "Adaptive Quadrature" one in "Numerical Analysis" by Burden and Faires.

Parameters are integration variable, left boundary, right boundary, function to be integrated and the relative integration error. The function should evalf into a number after substituting the integration variable by a number. Another thing to note is that this implementation is no good at integrating functions with discontinuities.

References [abs\(\)](#), [GiNaC::ex::evalf\(\)](#), [GiNaC::integral::max_integration_level](#), [GiNaC::ex::subs\(\)](#), [subsvalue\(\)](#), and [x](#).

Referenced by [GiNaC::integral::evalf\(\)](#).

5.1.3.482 GINAC_BIND_UNARCHIVER() [21/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    integral )
```

5.1.3.483 GINAC_DECLARE_UNARCHIVER() [22/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    integral )
```

5.1.3.484 ifactor()

```
ex GiNaC::ifactor (
    const numeric & n )
```

Returns the decomposition of the positive integer n into prime numbers in the form $\text{lst}(\text{lst}(p_1, \dots, p_r), \text{lst}(a_1, \dots, a_r))$ such that $n = p_1^{a_1} \dots p_r^{a_r}$.

References [GiNaC::container< C >::append\(\)](#), [irem\(\)](#), n , and [GiNaC::info_flags::prime](#).

Referenced by [is_discriminant_of_quadratic_number_field\(\)](#), and [kronecker_symbol\(\)](#).

5.1.3.485 is_discriminant_of_quadratic_number_field()

```
bool GiNaC::is_discriminant_of_quadratic_number_field (
    const numeric & n )
```

Returns true if the integer n is either one or the discriminant of a quadratic number field.

Returns false otherwise.

Ref.: Toshitsune Miyake, Modular Forms, Chapter 3.1

References [abs\(\)](#), [ifactor\(\)](#), [is_discriminant_of_quadratic_number_field\(\)](#), [GiNaC::numeric::is_odd\(\)](#), [mod\(\)](#), n , [GiNaC::container< C >::nops\(\)](#), and [GiNaC::container< C >::op\(\)](#).

Referenced by [is_discriminant_of_quadratic_number_field\(\)](#).

5.1.3.486 kronecker_symbol()

```
numeric GiNaC::kronecker_symbol (
    const numeric & a,
    const numeric & n )
```

Returns the Kronecker symbol a : integer n : integer.

This routine defines $\text{kronecker_symbol}(1,0) = 1$ $\text{kronecker_symbol}(-1,0) = 1$ $\text{kronecker_symbol}(a,0) = 0$, $a \neq 1, -1$

In particular $\text{kronecker_symbol}(-1,0) = 1$ (in agreement with Sage)

Ref.: Toshitsune Miyake, Modular Forms, Chapter 3.1

References [GiNaC::container< C >::begin\(\)](#), [GiNaC::container< C >::end\(\)](#), [ifactor\(\)](#), [GiNaC::numeric::is_even\(\)](#), n , [GiNaC::container< C >::op\(\)](#), [pow\(\)](#), and [unit](#).

Referenced by [primitive_dirichlet_character\(\)](#).

5.1.3.487 primitive_dirichlet_character()

```
numeric GiNaC::primitive_dirichlet_character (
    const numeric & n,
    const numeric & a )
```

Defines a primitive Dirichlet character through the Kronecker symbol.

n: integer a: discriminant of a quadratic field $|a|$: conductor

The character takes the values -1,0,1.

References [kronecker_symbol\(\)](#), and [n](#).

Referenced by [dirichlet_character\(\)](#), and [generalised_Bernoulli_number\(\)](#).

5.1.3.488 dirichlet_character()

```
numeric GiNaC::dirichlet_character (
    const numeric & n,
    const numeric & a,
    const numeric & N )
```

Defines a Dirichlet character through the Kronecker symbol.

n: integer a: discriminant of a quadratic field $|a|$: conductor N: modulus, needs to be multiple of $|a|$

The character takes the values -1,0,1.

References [gcd\(\)](#), [n](#), and [primitive_dirichlet_character\(\)](#).

5.1.3.489 generalised_Bernoulli_number()

```
numeric GiNaC::generalised_Bernoulli_number (
    const numeric & k,
    const numeric & b )
```

The generalised Bernoulli number.

k: index / modular weight

b: discriminant of a quadratic field, defines primitive character ψ $M=|b|$: conductor of primitive character ψ

The generalised Bernoulli number is computed from the series expansion of the generating function. The generating function is given in eq.(34), arXiv:1704.08895

References [abs\(\)](#), [GiNaC::ex::coeff\(\)](#), [exp\(\)](#), [factorial\(\)](#), [k](#), [primitive_dirichlet_character\(\)](#), [GiNaC::ex::series\(\)](#), [series_to_poly\(\)](#), and [x](#).

5.1.3.490 Bernoulli_polynomial()

```
ex GiNaC::Bernoulli_polynomial (
    const numeric & k,
    const ex & x )
```

The Bernoulli polynomials.

References [GiNaC::ex::coeff\(\)](#), [exp\(\)](#), [factorial\(\)](#), [k](#), [GiNaC::ex::series\(\)](#), [series_to_poly\(\)](#), and [x](#).

Referenced by [GiNaC::Eisenstein_h_kernel::coefficient_a0\(\)](#).

5.1.3.491 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [12/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
    integration_kernel ,
    basic ,
    print_func< print_context > &::do_print )
```

5.1.3.492 GINAC_BIND_UNARCHIVER() [22/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    integration_kernel )
```

5.1.3.493 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [13/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
    basic_log_kernel ,
    integration_kernel ,
    print_func< print_context > &::do_print )
```

5.1.3.494 GINAC_BIND_UNARCHIVER() [23/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    basic_log_kernel )
```

5.1.3.495 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [14/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
    multiple_polylog_kernel ,
    integration_kernel ,
    print_func< print_context > &::do_print )
```

References [_ex1](#).

5.1.3.496 GINAC_BIND_UNARCHIVER() [24/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    multiple_polylog_kernel )
```

5.1.3.497 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [15/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
    ELi_kernel ,
    integration_kernel ,
    print_func< print_context > &::do_print )
```

5.1.3.498 GINAC_BIND_UNARCHIVER() [25/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    ELi_kernel )
```

5.1.3.499 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [16/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
    Ebar_kernel ,
    integration_kernel ,
    print_func< print_context > &::do_print )
```

5.1.3.500 GINAC_BIND_UNARCHIVER() [26/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    Ebar_kernel )
```

5.1.3.501 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [17/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
    Kronecker_dtau_kernel ,
    integration_kernel ,
    print_func< print_context > &::do_print )
```

5.1.3.502 GINAC_BIND_UNARCHIVER() [27/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    Kronecker_dtau_kernel )
```

5.1.3.503 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [18/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
    Kronecker_dz_kernel ,
    integration_kernel ,
    print_func< print_context > &::do_print )
```

5.1.3.504 GINAC_BIND_UNARCHIVER() [28/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    Kronecker_dz_kernel )
```

5.1.3.505 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [19/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
    Eisenstein_kernel ,
    integration_kernel ,
    print_func< print_context > &::do_print )
```

5.1.3.506 GINAC_BIND_UNARCHIVER() [29/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    Eisenstein_kernel )
```

5.1.3.507 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [20/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
    Eisenstein_h_kernel ,
    integration_kernel ,
    print_func< print_context > &::do_print )
```

5.1.3.508 GINAC_BIND_UNARCHIVER() [30/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    Eisenstein_h_kernel )
```

5.1.3.509 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [21/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
    modular_form_kernel ,
    integration_kernel ,
    print_func< print_context > &::do_print )
```

5.1.3.510 GINAC_BIND_UNARCHIVER() [31/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    modular_form_kernel )
```

5.1.3.511 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [22/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
    user_defined_kernel ,
    integration_kernel ,
    print_func< print_context > &::do_print )
```

5.1.3.512 GINAC_BIND_UNARCHIVER() [32/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    user_defined_kernel )
```

5.1.3.513 GINAC_DECLARE_UNARCHIVER() [23/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    integration_kernel )
```

5.1.3.514 GINAC_DECLARE_UNARCHIVER() [24/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    basic_log_kernel )
```

5.1.3.515 GINAC_DECLARE_UNARCHIVER() [25/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    multiple_polylog_kernel )
```

5.1.3.516 GINAC_DECLARE_UNARCHIVER() [26/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    ELi_kernel )
```

5.1.3.517 GINAC_DECLARE_UNARCHIVER() [27/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    Ebar_kernel )
```

5.1.3.518 GINAC_DECLARE_UNARCHIVER() [28/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    Kronecker_dtau_kernel )
```

5.1.3.519 GINAC_DECLARE_UNARCHIVER() [29/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    Kronecker_dz_kernel )
```

5.1.3.520 GINAC_DECLARE_UNARCHIVER() [30/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    Eisenstein_kernel )
```

5.1.3.521 GINAC_DECLARE_UNARCHIVER() [31/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    Eisenstein_h_kernel )
```

5.1.3.522 GINAC_DECLARE_UNARCHIVER() [32/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    modular_form_kernel )
```

5.1.3.523 GINAC_DECLARE_UNARCHIVER() [33/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    user_defined_kernel )
```

5.1.3.524 GINAC_DECLARE_UNARCHIVER() [34/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    lst )
```

5.1.3.525 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [23/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
    matrix ,
    basic ,
    print_func< print_context > &::do_print. print_func< print_latex > &::do_↵
print_latex. print_func< print_tree > &::do_print_tree. print_func< print_python_repr > &↵
::do_print_python_repr )
```

Default ctor.

Initializes to 1 x 1-dimensional zero-matrix.

References [GiNaC::status_flags::not_shareable](#).

5.1.3.526 GINAC_BIND_UNARCHIVER() [33/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    matrix )
```

5.1.3.527 lst_to_matrix()

```
ex GiNaC::lst_to_matrix (
    const lst & l )
```

Convert list of lists to matrix.

References [cols\(\)](#), [GiNaC::container< C >::nops\(\)](#), and [rows\(\)](#).

5.1.3.528 diag_matrix() [1/2]

```
ex GiNaC::diag_matrix (
    const lst & l )
```

Convert list of diagonal elements to matrix.

References [GiNaC::container< C >::nops\(\)](#).

5.1.3.529 diag_matrix() [2/2]

```
ex GiNaC::diag_matrix (
    std::initializer_list< ex > l )
```

5.1.3.530 unit_matrix() [1/2]

```
ex GiNaC::unit_matrix (
    unsigned r,
    unsigned c )
```

Create an r times c unit matrix.

References [_ex1](#), [c](#), [GiNaC::status_flags::evaluated](#), [r](#), and [GiNaC::basic::setflag\(\)](#).

Referenced by [unit_matrix\(\)](#).

5.1.3.531 symbolic_matrix() [1/2]

```
ex GiNaC::symbolic_matrix (
    unsigned r,
    unsigned c,
    const std::string & base_name,
    const std::string & tex_base_name )
```

Create an r times c matrix of newly generated symbols consisting of the given base name plus the numeric row/column position of each element.

The base name for LaTeX output is specified separately.

References [c](#), [GiNaC::status_flags::evaluated](#), [r](#), and [GiNaC::basic::setflag\(\)](#).

Referenced by [symbolic_matrix\(\)](#).

5.1.3.532 reduced_matrix()

```
ex GiNaC::reduced_matrix (
    const matrix & m,
    unsigned r,
    unsigned c )
```

Return the reduced matrix that is formed by deleting the r th row and c th column of matrix m .

The determinant of the result is the Minor r, c .

References [c](#), [cols\(\)](#), [GiNaC::status_flags::evaluated](#), [m](#), [r](#), [rows\(\)](#), and [GiNaC::basic::setflag\(\)](#).

5.1.3.533 sub_matrix()

```
ex GiNaC::sub_matrix (
    const matrix & m,
    unsigned r,
    unsigned nr,
    unsigned c,
    unsigned nc )
```

Return the nr times nc submatrix starting at position r, c of matrix m .

References [c](#), [GiNaC::status_flags::evaluated](#), [m](#), [r](#), and [GiNaC::basic::setflag\(\)](#).

5.1.3.534 GINAC_DECLARE_UNARCHIVER() [35/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    matrix )
```

5.1.3.535 nops() [2/2]

```
size_t GiNaC::nops (
    const matrix & m ) [inline]
```

References [m](#).

5.1.3.536 expand() [2/2]

```
ex GiNaC::expand (
    const matrix & m,
    unsigned options = 0 ) [inline]
```

References [m](#), and [options](#).

5.1.3.537 evalf() [2/2]

```
ex GiNaC::evalf (
    const matrix & m ) [inline]
```

References [m](#).

5.1.3.538 rows()

```
unsigned GiNaC::rows (
    const matrix & m ) [inline]
```

References [m](#).

Referenced by [lst_to_matrix\(\)](#), and [reduced_matrix\(\)](#).

5.1.3.539 cols()

```
unsigned GiNaC::cols (
    const matrix & m ) [inline]
```

References [m](#).

Referenced by [lst_to_matrix\(\)](#), and [reduced_matrix\(\)](#).

5.1.3.540 transpose()

```
matrix GiNaC::transpose (
    const matrix & m ) [inline]
```

References [m](#).

5.1.3.541 determinant()

```
ex GiNaC::determinant (
    const matrix & m,
    unsigned options = determinant_algo::automatic ) [inline]
```

References [m](#), and [options](#).

5.1.3.542 trace()

```
ex GiNaC::trace (
    const matrix & m ) [inline]
```

References [m](#).

5.1.3.543 charpoly()

```
ex GiNaC::charpoly (
    const matrix & m,
    const ex & lambda ) [inline]
```

References [m](#).

5.1.3.544 inverse() [1/3]

```
matrix GiNaC::inverse (
    const matrix & m ) [inline]
```

References [GiNaC::solve_algo::automatic](#), and [m](#).

5.1.3.545 inverse() [2/3]

```
matrix GiNaC::inverse (
    const matrix & m,
    unsigned algo ) [inline]
```

References [m](#).

5.1.3.546 rank() [1/2]

```
unsigned GiNaC::rank (
    const matrix & m ) [inline]
```

References [m](#).

5.1.3.547 rank() [2/2]

```
unsigned GiNaC::rank (
    const matrix & m,
    unsigned solve_algo ) [inline]
```

References [m](#).

5.1.3.548 unit_matrix() [2/2]

```
ex GiNaC::unit_matrix (
    unsigned x ) [inline]
```

Create a x times x unit matrix.

References [unit_matrix\(\)](#), and [x](#).

5.1.3.549 symbolic_matrix() [2/2]

```
ex GiNaC::symbolic_matrix (
    unsigned r,
    unsigned c,
    const std::string & base_name ) [inline]
```

Create an r times c matrix of newly generated symbols consisting of the given base name plus the numeric row/column position of each element.

References [c](#), [r](#), and [symbolic_matrix\(\)](#).

5.1.3.550 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [24/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
    mul ,
    expairseq ,
    print_func< print_context > &::do_print. print_func< print_latex > &::do_↵
print_latex. print_func< print_csrc > &::do_print_csrc. print_func< print_tree > &::do_↵
print_tree. print_func< print_python_repr > &::do_print_python_repr )
```

5.1.3.551 tryfactsubs()

```
bool GiNaC::tryfactsubs (
    const ex & origfactor,
    const ex & patternfactor,
    int & nummatches,
    exmap & repls )
```

References [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::integer](#), [GiNaC::ex::match\(\)](#), and [GiNaC::ex::op\(\)](#).

Referenced by [algebraic_match_mul_with_mul\(\)](#), [GiNaC::mul::algebraic_subs_mul\(\)](#), and [GiNaC::power::subs\(\)](#).

5.1.3.552 algebraic_match_mul_with_mul()

```
bool GiNaC::algebraic_match_mul_with_mul (
    const mul & e,
    const ex & pat,
    exmap & repls,
    int factor,
    int & nummatches,
    const std::vector< bool > & substed,
    std::vector< bool > & matched )
```

Checks whether e matches to the pattern pat and the (possibly to be updated) list of replacements repls.

This matching is in the sense of algebraic substitutions. Matching starts with pat.op(factor) of the pattern because the factors before this one have already been matched. The (possibly updated) number of matches is in nummatches. substed[i] is true for factors that already have been replaced by previous substitutions and matched[i] is true for factors that have been matched by the current match.

References [algebraic_match_mul_with_mul\(\)](#), [factor\(\)](#), [GINAC_ASSERT](#), [GiNaC::ex::nops\(\)](#), [GiNaC::expairseq::nops\(\)](#), [GiNaC::ex::op\(\)](#), [GiNaC::expairseq::op\(\)](#), and [tryfactsubs\(\)](#).

Referenced by [algebraic_match_mul_with_mul\(\)](#), [GiNaC::mul::algebraic_subs_mul\(\)](#), and [GiNaC::mul::has\(\)](#).

5.1.3.553 GINAC_BIND_UNARCHIVER() [34/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    mul )
```

5.1.3.554 GINAC_DECLARE_UNARCHIVER() [36/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    mul )
```

5.1.3.555 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [25/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
    ncmul ,
    exprseq ,
    print_func< print_context > &::do_print, print_func< print_tree > &::do_print↵
    _tree, print_func< print_csrc > &::do_print_csrc, print_func< print_python_repr > &::do_↵
    print_csrc )
```

5.1.3.556 reeval_ncmul()

```
ex GiNaC::reeval_ncmul (
    const exvector & v )
```

5.1.3.557 hold_ncmul()

```
ex GiNaC::hold_ncmul (
    const exvector & v )
```

Referenced by [GiNaC::basic::eval_ncmul\(\)](#), [GiNaC::color::eval_ncmul\(\)](#), and [GiNaC::structure< T, ComparisonPolicy >::eval_ncmul\(\)](#)

5.1.3.558 GINAC_BIND_UNARCHIVER() [35/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    ncmul )
```

5.1.3.559 GINAC_DECLARE_UNARCHIVER() [37/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    ncmul )
```

5.1.3.560 get_first_symbol()

```
static bool GiNaC::get_first_symbol (
    const ex & e,
    ex & x ) [static]
```

Return pointer to first symbol found in expression.

Due to [GiNaC](#)'s internal ordering of terms, it may not be obvious which symbol this function returns for a given expression.

Parameters

<i>e</i>	expression to search
<i>x</i>	first symbol found (returned)

Returns

"false" if no symbol was found, "true" otherwise

References [get_first_symbol\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), and [x](#).

Referenced by [divide\(\)](#), [frac_cancel\(\)](#), [get_first_symbol\(\)](#), and [GiNaC::ex::unit\(\)](#).

5.1.3.561 add_symbol()

```
static void GiNaC::add_symbol (
    const ex & s,
    sym\_desc\_vec & v ) [static]
```

Referenced by [collect_symbols\(\)](#).

5.1.3.562 collect_symbols()

```
static void GiNaC::collect_symbols (
    const ex & e,
    sym\_desc\_vec & v ) [static]
```

References [add_symbol\(\)](#), [collect_symbols\(\)](#), [GiNaC::ex::nops\(\)](#), and [GiNaC::ex::op\(\)](#).

Referenced by [collect_symbols\(\)](#), and [get_symbol_stats\(\)](#).

5.1.3.563 get_symbol_stats()

```
static void GiNaC::get_symbol_stats (
    const ex & a,
    const ex & b,
    sym\_desc\_vec & v ) [static]
```

Collect statistical information about symbols in polynomials.

This function fills in a vector of "sym_desc" structs which contain information about the highest and lowest degrees of all symbols that appear in two polynomials. The vector is then sorted by minimum degree (lowest to highest). The information gathered by this function is used by the GCD routines to identify trivial factors and to determine which variable to choose as the main variable for GCD computation.

Parameters

<i>a</i>	first multivariate polynomial
<i>b</i>	second multivariate polynomial
<i>v</i>	vector of sym_desc structs (filled in)

References [collect_symbols\(\)](#), [GiNaC::ex::degree\(\)](#), [GiNaC::ex::lcoeff\(\)](#), [GiNaC::ex::ldegree\(\)](#), and [GiNaC::ex::nops\(\)](#).

Referenced by [divide_in_z\(\)](#), [gcd\(\)](#), and [sqrfree\(\)](#).

5.1.3.564 lcmcoeff()

```
static numeric GiNaC::lcmcoeff (
    const ex & e,
    const numeric & l ) [static]
```

References [_num1_p](#), [c](#), [denom\(\)](#), [GiNaC::ex::info\(\)](#), [lcm\(\)](#), [lcmcoeff\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), [pow\(\)](#), and [GiNaC::info_flags::rational](#).

Referenced by [heur_gcd\(\)](#), [lcm_of_coefficients_denominators\(\)](#), [lcmcoeff\(\)](#), and [multiply_lcm\(\)](#).

5.1.3.565 lcm_of_coefficients_denominators()

```
static numeric GiNaC::lcm_of_coefficients_denominators (
    const ex & e ) [static]
```

Compute LCM of denominators of coefficients of a polynomial.

Given a polynomial with rational coefficients, this function computes the LCM of the denominators of all coefficients. This can be used to bring a polynomial from $\mathbb{Q}[X]$ to $\mathbb{Z}[X]$.

Parameters

<i>e</i>	multivariate polynomial (need not be expanded)
----------	--

Returns

LCM of denominators of coefficients

References [_num1_p](#), and [lcmcoeff\(\)](#).

Referenced by [frac_cancel\(\)](#), [heur_gcd\(\)](#), and [sqrfree\(\)](#).

5.1.3.566 multiply_lcm()

```
static ex GiNaC::multiply_lcm (
    const ex & e,
    const numeric & lcm ) [static]
```

Bring polynomial from $\mathbb{Q}[X]$ to $\mathbb{Z}[X]$ by multiplying in the previously determined LCM of the coefficient's denominators.

Parameters

<i>e</i>	multivariate polynomial (need not be expanded)
<i>lcm</i>	LCM to multiply in

References [_num1_p](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::numeric::is_rational\(\)](#), [lcm\(\)](#), [lcmcoeff\(\)](#), [multiply_lcm\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), and [pow\(\)](#).

Referenced by [frac_cancel\(\)](#), [multiply_lcm\(\)](#), and [sqrfree\(\)](#).

5.1.3.567 quo()

```
ex GiNaC::quo (
    const ex & a,
    const ex & b,
    const ex & x,
    bool check_args )
```

Quotient $q(x)$ of polynomials $a(x)$ and $b(x)$ in $\mathbb{Q}[x]$.

It satisfies $a(x)=b(x)*q(x)+r(x)$.

Parameters

<i>a</i>	first polynomial in x (dividend)
<i>b</i>	second polynomial in x (divisor)
<i>x</i>	a and b are polynomials in x
<i>check_args</i>	check whether a and b are polynomials with rational coefficients (defaults to "true")

Returns

quotient of a and b in $\mathbb{Q}[x]$

References [_ex1](#), [GiNaC::ex::coeff\(\)](#), [GiNaC::ex::degree\(\)](#), [divide\(\)](#), [expand\(\)](#), [GiNaC::ex::expand\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::ex::is_zero\(\)](#), [pow\(\)](#), *r*, [GiNaC::info_flags::rational_polynomial](#), and *x*.

Referenced by [decomp_rational\(\)](#), [GiNaC::ex::primpart\(\)](#), [sqrfree_parfrac\(\)](#), [sqrfree_yun\(\)](#), and [GiNaC::ex::unitcontprim\(\)](#).

5.1.3.568 rem()

```
ex GiNaC::rem (
    const ex & a,
    const ex & b,
    const ex & x,
    bool check_args )
```

Remainder $r(x)$ of polynomials $a(x)$ and $b(x)$ in $\mathbb{Q}[x]$.

It satisfies $a(x)=b(x)*q(x)+r(x)$.

Parameters

a	first polynomial in x (dividend)
b	second polynomial in x (divisor)
x	a and b are polynomials in x
$check_args$	check whether a and b are polynomials with rational coefficients (defaults to "true")

Returns

remainder of $a(x)$ and $b(x)$ in $\mathbb{Q}[x]$

References [_ex0](#), [GiNaC::ex::coeff\(\)](#), [GiNaC::ex::degree\(\)](#), [divide\(\)](#), [expand\(\)](#), [GiNaC::ex::expand\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::ex::is_zero\(\)](#), [pow\(\)](#), r , [GiNaC::info_flags::rational_polynomial](#), and x .

Referenced by [decomp_rational\(\)](#), and [sqrfree_parfrac\(\)](#).

5.1.3.569 decomp_rational()

```
ex GiNaC::decomp_rational (
    const ex & a,
    const ex & x )
```

Decompose rational function $a(x)=N(x)/D(x)$ into $P(x)+n(x)/D(x)$ with $\text{degree}(n, x) < \text{degree}(D, x)$.

Parameters

a	rational function in x
x	a is a function of x

Returns

decomposed function.

References [denom\(\)](#), [numer\(\)](#), [numer_denom\(\)](#), [GiNaC::ex::op\(\)](#), [quo\(\)](#), [rem\(\)](#), and x .

5.1.3.570 prem()

```
ex GiNaC::prem (
    const ex & a,
    const ex & b,
    const ex & x,
    bool check_args )
```

Pseudo-remainder of polynomials $a(x)$ and $b(x)$ in $\mathbb{Q}[x]$.

Parameters

<i>a</i>	first polynomial in x (dividend)
<i>b</i>	second polynomial in x (divisor)
<i>x</i>	a and b are polynomials in x
<i>check_args</i>	check whether a and b are polynomials with rational coefficients (defaults to "true")

Returns

pseudo-remainder of $a(x)$ and $b(x)$ in $\mathbb{Q}[x]$

References [_ex0](#), [_ex1](#), [GiNaC::ex::coeff\(\)](#), [GiNaC::ex::degree\(\)](#), [expand\(\)](#), [GiNaC::ex::expand\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is_zero\(\)](#), [pow\(\)](#), [r](#), [GiNaC::info_flags::rational_polynomial](#), and [x](#).

Referenced by [sr_gcd\(\)](#).

5.1.3.571 sprem()

```
ex GiNaC::sprem (
    const ex & a,
    const ex & b,
    const ex & x,
    bool check_args )
```

Sparse pseudo-remainder of polynomials $a(x)$ and $b(x)$ in $\mathbb{Q}[x]$.

Parameters

<i>a</i>	first polynomial in x (dividend)
<i>b</i>	second polynomial in x (divisor)
<i>x</i>	a and b are polynomials in x
<i>check_args</i>	check whether a and b are polynomials with rational coefficients (defaults to "true")

Returns

sparse pseudo-remainder of $a(x)$ and $b(x)$ in $\mathbb{Q}[x]$

References [_ex0](#), [_ex1](#), [GiNaC::ex::coeff\(\)](#), [GiNaC::ex::degree\(\)](#), [expand\(\)](#), [GiNaC::ex::expand\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is_zero\(\)](#), [pow\(\)](#), [r](#), [GiNaC::info_flags::rational_polynomial](#), and [x](#).

5.1.3.572 divide()

```
bool GiNaC::divide (
    const ex & a,
    const ex & b,
    ex & q,
    bool check_args )
```

Exact polynomial division of $a(X)$ by $b(X)$ in $\mathbb{Q}[X]$.

Parameters

<i>a</i>	first multivariate polynomial (dividend)
<i>b</i>	second multivariate polynomial (divisor)
<i>q</i>	quotient (returned)
<i>check_args</i>	check whether a and b are polynomials with rational coefficients (defaults to "true")

Returns

"true" when exact division succeeds (quotient returned in q), "false" otherwise (q left untouched)

References [_ex0](#), [_ex1](#), [GiNaC::ex::coeff\(\)](#), [GiNaC::ex::degree\(\)](#), [divide\(\)](#), [expand\(\)](#), [GiNaC::ex::expand\(\)](#), [get_first_symbol\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::ex::is_zero\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), [pow\(\)](#), [r](#), [GiNaC::info_flags::rational_polynomial](#), and [x](#).

Referenced by [divide\(\)](#), [find_common_factor\(\)](#), [GiNaC::matrix::fraction_free_elimination\(\)](#), [gcd\(\)](#), [quo\(\)](#), and [rem\(\)](#).

5.1.3.573 divide_in_z()

```
static bool GiNaC::divide_in_z (
    const ex & a,
    const ex & b,
    ex & q,
    sym_desc_vec::const_iterator var ) [static]
```

Exact polynomial division of $a(X)$ by $b(X)$ in $\mathbb{Z}[X]$.

This functions works like [divide\(\)](#) but the input and output polynomials are in $\mathbb{Z}[X]$ instead of $\mathbb{Q}[X]$ (i.e. they have integer coefficients). Unlike [divide\(\)](#), it doesn't check whether the input polynomials really are integer polynomials, so be careful of what you pass in. Also, you have to run [get_symbol_stats\(\)](#) over the input polynomials before calling this function and pass an iterator to the first element of the [sym_desc](#) vector. This function is used internally by the [heur_gcd\(\)](#).

Parameters

<i>a</i>	first multivariate polynomial (dividend)
<i>b</i>	second multivariate polynomial (divisor)
<i>q</i>	quotient (returned)
<i>var</i>	iterator to first element of vector of sym_desc structs

Returns

"true" when exact division succeeds (the quotient is returned in q), "false" otherwise.

See also

[get_symbol_stats](#), [heur_gcd](#)

References [_ex0](#), [_ex1](#), [_num0_p](#), [_num1_p](#), [GiNaC::ex::begin\(\)](#), [c](#), [GiNaC::ex::coeff\(\)](#), [GiNaC::ex::degree\(\)](#), [divide_in_z\(\)](#), [expand\(\)](#), [GiNaC::ex::expand\(\)](#), [GiNaC::ex::find\(\)](#), [get_symbol_stats\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::integer](#), [GiNaC::numeric::inverse\(\)](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::ex::is_zero\(\)](#), [k](#), [GiNaC::subs_options::no_pattern](#), [GiNaC::ex::op\(\)](#), [pow\(\)](#), [qbar](#), [r](#), [GiNaC::ex::subs\(\)](#), and [x](#).

Referenced by [divide_in_z\(\)](#), [heur_gcd_z\(\)](#), and [sr_gcd\(\)](#).

5.1.3.574 sr_gcd()

```
static ex GiNaC::sr_gcd (
    const ex & a,
    const ex & b,
    sym_desc_vec::const_iterator var ) [static]
```

Compute GCD of multivariate polynomials using the subresultant PRS algorithm.

This function is used internally by [gcd\(\)](#).

Parameters

<i>a</i>	first multivariate polynomial
<i>b</i>	second multivariate polynomial
<i>var</i>	iterator to first element of vector of sym_desc structs

Returns

the GCD as a new expression

See also

[gcd](#)

References [_ex0](#), [_ex1](#), [c](#), [GiNaC::ex::content\(\)](#), [GiNaC::ex::degree\(\)](#), [divide_in_z\(\)](#), [gcd\(\)](#), [pow\(\)](#), [prem\(\)](#), [GiNaC::ex::primpart\(\)](#), [psi\(\)](#), [r](#), and [x](#).

Referenced by [gcd\(\)](#).

5.1.3.575 interpolate()

```
static ex GiNaC::interpolate (
    const ex & gamma,
    const numeric & xi,
    const ex & x,
    int degree_hint = 1 ) [static]
```

xi-adic polynomial interpolation

References [GiNaC::numeric::inverse\(\)](#), [GiNaC::ex::is_zero\(\)](#), [pow\(\)](#), [GiNaC::ex::smod\(\)](#), and [x](#).

Referenced by [heur_gcd_z\(\)](#).

5.1.3.576 heur_gcd_z()

```
static bool GiNaC::heur_gcd_z (
    ex & res,
    const ex & a,
    const ex & b,
    ex * ca,
    ex * cb,
    sym_desc_vec::const_iterator var ) [static]
```

Compute GCD of multivariate polynomials using the heuristic GCD algorithm.

[get_symbol_stats\(\)](#) must have been called previously with the input polynomials and an iterator to the first element of the [sym_desc](#) vector passed in. This function is used internally by [gcd\(\)](#).

Parameters

<i>a</i>	first integer multivariate polynomial (expanded)
<i>b</i>	second integer multivariate polynomial (expanded)
<i>ca</i>	cofactor of polynomial a (returned), nullptr to suppress calculation of cofactor
<i>cb</i>	cofactor of polynomial b (returned), nullptr to suppress calculation of cofactor
<i>var</i>	iterator to first element of vector of sym_desc structs
<i>res</i>	the GCD (returned)

Returns

true if GCD was computed, false otherwise.

See also

[gcd](#)

Exceptions

<code>gcdheu_failed()</code>

References [GiNaC::ex::degree\(\)](#), [divide_in_z\(\)](#), [GiNaC::ex::expand\(\)](#), [gcd\(\)](#), [heur_gcd_z\(\)](#), [GiNaC::numeric::int_length\(\)](#), [GiNaC::ex::integer_content\(\)](#), [interpolate\(\)](#), [GiNaC::numeric::inverse\(\)](#), [iquo\(\)](#), [GiNaC::ex::is_zero\(\)](#), [isqrt\(\)](#), [GiNaC::ex::max_coefficient\(\)](#), [GiNaC::subs_options::no_pattern](#), [GiNaC::ex::subs\(\)](#), and [x](#).

Referenced by [heur_gcd\(\)](#), and [heur_gcd_z\(\)](#).

5.1.3.577 [heur_gcd\(\)](#)

```
static bool GiNaC::heur_gcd (
    ex & res,
    const ex & a,
    const ex & b,
    ex * ca,
    ex * cb,
    sym_desc_vec::const_iterator var ) [static]
```

Compute GCD of multivariate polynomials using the heuristic GCD algorithm.

[get_symbol_stats\(\)](#) must have been called previously with the input polynomials and an iterator to the first element of the [sym_desc](#) vector passed in. This function is used internally by [gcd\(\)](#).

Parameters

<i>a</i>	first rational multivariate polynomial (expanded)
<i>b</i>	second rational multivariate polynomial (expanded)
<i>ca</i>	cofactor of polynomial a (returned), nullptr to suppress calculation of cofactor
<i>cb</i>	cofactor of polynomial b (returned), nullptr to suppress calculation of cofactor
<i>var</i>	iterator to first element of vector of sym_desc structs
<i>res</i>	the GCD (returned)

Returns

true if GCD was computed, false otherwise.

See also

[heur_gcd_z](#)

[gcd](#)

References [heur_gcd_z\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::integer_polynomial](#), [lcm_of_coefficients_denominators\(\)](#), and [lcmcoeff\(\)](#).

Referenced by [gcd\(\)](#).

5.1.3.578 gcd_pf_pow()

```
static ex GiNaC::gcd_pf_pow (
    const ex & a,
    const ex & b,
    ex * ca,
    ex * cb ) [static]
```

References [_ex1](#), [expand\(\)](#), [gcd\(\)](#), [gcd_pf_pow\(\)](#), [gcd_pf_pow_pow\(\)](#), [GINAC_ASSERT](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::ex::lddegree\(\)](#), [GiNaC::ex::op\(\)](#), and [pow\(\)](#).

Referenced by [gcd\(\)](#), and [gcd_pf_pow\(\)](#).

5.1.3.579 gcd_pf_mul()

```
static ex GiNaC::gcd_pf_mul (
    const ex & a,
    const ex & b,
    ex * ca,
    ex * cb ) [static]
```

References [gcd\(\)](#), [gcd_pf_mul\(\)](#), [GINAC_ASSERT](#), [GiNaC::ex::nops\(\)](#), and [GiNaC::ex::op\(\)](#).

Referenced by [gcd\(\)](#), and [gcd_pf_mul\(\)](#).

5.1.3.580 gcd() [1/2]

```
ex GiNaC::gcd (
    const ex & a,
    const ex & b,
    ex * ca,
    ex * cb,
    bool check_args,
    unsigned options )
```

Compute GCD (Greatest Common Divisor) of multivariate polynomials $a(X)$ and $b(X)$ in $\mathbb{Z}[X]$.

Optionally also compute the cofactors of a and b , defined by $a = ca * \text{gcd}(a, b)$ and $b = cb * \text{gcd}(a, b)$.

Parameters

<i>a</i>	first multivariate polynomial
<i>b</i>	second multivariate polynomial
<i>ca</i>	pointer to expression that will receive the cofactor of a , or nullptr
<i>cb</i>	pointer to expression that will receive the cofactor of b , or nullptr
<i>check_args</i>	check whether a and b are polynomials with rational coefficients (defaults to "true")
<i>options</i>	see GiNaC::gcd_options

Returns

the GCD as a new expression

References [_ex0](#), [_ex1](#), [divide\(\)](#), [expand\(\)](#), [GiNaC::ex::expand\(\)](#), [gcd\(\)](#), [gcd_pf_mul\(\)](#), [gcd_pf_pow\(\)](#), [get_symbol_stats\(\)](#), [heur_gcd\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::integer_content\(\)](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::ex::is_zero\(\)](#), [GiNaC::numeric::is_zero\(\)](#), [n](#), [GiNaC::gcd_options::no_heur_gcd](#), [GiNaC::gcd_options::no_part_factored](#), [GiNaC::subs_options::no_pattern](#), [options](#), [pow\(\)](#), [GiNaC::info_flags::rational_polynomial](#), [sr_gcd\(\)](#), [GiNaC::ex::subs\(\)](#), [GiNaC::ex::unitcontprim\(\)](#), [GiNaC::gcd_options::use_sr_gcd](#), and [x](#).

Referenced by [GiNaC::ex::content\(\)](#), [dirichlet_character\(\)](#), [find_common_factor\(\)](#), [frac_cancel\(\)](#), [gcd\(\)](#), [gcd_pf_mul\(\)](#), [gcd_pf_pow\(\)](#), [gcd_pf_pow_pow\(\)](#), [heur_gcd_z\(\)](#), [GiNaC::add::integer_content\(\)](#), [lcm\(\)](#), [GiNaC::add::normal\(\)](#), [sqrfree_yun\(\)](#), and [sr_gcd\(\)](#).

5.1.3.581 gcd_pf_pow_pow()

```
static ex GiNaC::gcd_pf_pow_pow (
    const ex & a,
    const ex & b,
    ex * ca,
    ex * cb ) [static]
```

References [_ex1](#), [gcd\(\)](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::ex::op\(\)](#), and [pow\(\)](#).

Referenced by [gcd_pf_pow\(\)](#).

5.1.3.582 lcm() [1/2]

```
ex GiNaC::lcm (
    const ex & a,
    const ex & b,
    bool check_args )
```

Compute LCM (Least Common Multiple) of multivariate polynomials in $\mathbb{Z}[X]$.

Parameters

<i>a</i>	first multivariate polynomial
<i>b</i>	second multivariate polynomial
<i>check_args</i>	check whether a and b are polynomials with rational coefficients (defaults to "true")

Returns

the LCM as a new expression

References [gcd\(\)](#), [GiNaC::ex::info\(\)](#), [lcm\(\)](#), and [GiNaC::info_flags::rational_polynomial](#).

Referenced by [GiNaC::add::integer_content\(\)](#), [lcm\(\)](#), [lcmcoeff\(\)](#), [multiply_lcm\(\)](#), and [sqrfree\(\)](#).

5.1.3.583 `sqrfree_yun()`

```
static epvector GiNaC::sqrfree_yun (
    const ex & a,
    const symbol & x ) [static]
```

Compute square-free factorization of multivariate polynomial $a(x)$ using Yun's algorithm.

Used internally by [sqrfree\(\)](#).

Parameters

a	multivariate polynomial over $\mathbb{Z}[X]$, treated here as univariate polynomial in x (needs not be expanded).
x	variable to factor in

Returns

vector of expairs (factor, exponent), sorted by exponents

References [_ex1](#), [GiNaC::ex::diff\(\)](#), [factors](#), [gcd\(\)](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::ex::is_zero\(\)](#), [quo\(\)](#), and [x](#).

Referenced by [sqrfree\(\)](#), and [sqrfree_parfrac\(\)](#).

5.1.3.584 `sqrfree()`

```
ex GiNaC::sqrfree (
    const ex & a,
    const lst & l )
```

Compute a square-free factorization of a multivariate polynomial in $\mathbb{Q}[X]$.

Parameters

a	multivariate polynomial over $\mathbb{Q}[X]$ (needs not be expanded)
l	lst of variables to factor in, may be left empty for autodetection

Returns

a square-free factorization of a .

Note

A polynomial $p(X) \in C[X]$ is said *square-free* if, whenever any two polynomials $q(X)$ and $r(X)$ are such that

$$p(X) = q(X)^2 r(X),$$

we have $q(X) \in C$. This means that $p(X)$ has no repeated factors, apart eventually from constants. Given a polynomial $p(X) \in C[X]$, we say that the decomposition

$$p(X) = b \cdot p_1(X)^{a_1} \cdot p_2(X)^{a_2} \cdots p_r(X)^{a_r}$$

is a *square-free factorization* of $p(X)$ if the following conditions hold:

1. $b \in C$ and $b \neq 0$;
2. a_i is a positive integer for $i = 1, \dots, r$;
3. the degree of the polynomial p_i is strictly positive for $i = 1, \dots, r$;
4. the polynomial $\prod_{i=1}^r p_i(X)$ is square-free.

Square-free factorizations need not be unique. For example, if a_i is even, we could change the polynomial $p_i(X)$ into $-p_i(X)$. Observe also that the factors $p_i(X)$ need not be irreducible polynomials.

References [_ex0](#), [GiNaC::container< C >::append\(\)](#), [factors](#), [get_symbol_stats\(\)](#), [lcm\(\)](#), [lcm_of_coefficients_denominators\(\)](#), [multiply_lcm\(\)](#), [GiNaC::container< C >::nops\(\)](#), [GiNaC::container< C >::op\(\)](#), [GiNaC::container< C >::remove_first\(\)](#), [sqrfree\(\)](#), [sqrfree_yun\(\)](#), and [x](#).

Referenced by [sqrfree\(\)](#).

5.1.3.585 sqrfree_parfrac()

```
ex GiNaC::sqrfree_parfrac (
    const ex & a,
    const symbol & x )
```

Compute square-free partial fraction decomposition of rational function a(x).

Parameters

a	rational function over $\mathbb{Z}[x]$, treated as univariate polynomial in x
x	variable to factor in

Returns

decomposed rational function

References [_ex1](#), [GiNaC::basic::coeff\(\)](#), [GiNaC::ex::coeff\(\)](#), [coeff\(\)](#), [degree\(\)](#), [denom\(\)](#), [GiNaC::ex::expand\(\)](#), [factor\(\)](#), [GINAC_ASSERT](#), [k](#), [n](#), [numer\(\)](#), [numer_denom\(\)](#), [GiNaC::ex::op\(\)](#), [pow\(\)](#), [quo\(\)](#), [r](#), [rem\(\)](#), [rhs\(\)](#), [GiNaC::matrix::solve\(\)](#), [sqrfree_yun\(\)](#), [to_int\(\)](#), and [x](#).

5.1.3.586 replace_with_symbol() [1/2]

```
static ex GiNaC::replace_with_symbol (
    const ex & e,
    exmap & repl,
    exmap & rev_lookup,
    lst & modifier ) [static]
```

Create a symbol for replacing the expression "e" (or return a previously assigned symbol).

The symbol and expression are appended to repl, for a later application of [subs\(\)](#). An entry in the replacement table repl can be changed in some cases. If it was altered, we need to provide the modifier for the previously build expressions. The modifier is an (ordered) list, because those substitutions need to be done in the incremental order. As

an example let us consider a rationalisation of the expression $e = \exp(2x) \cdot \cos(\exp(2x) + 1) \cdot \exp(x)$. The first factor [GiNaC](#) denotes by something like `symbol1` and will record: `e = symbol1 * cos(symbol1 + 1) * exp(x)` `repl = {symbol1 : exp(2*x)}`. Similarly, the second factor would be denoted as `symbol2` and we will have `e = symbol1 * symbol2 * exp(x)` `repl = {symbol1 : exp(2*x), symbol2 : cos(symbol1 + 1)}`. Denoting the third term as `symbol3` [GiNaC](#) is willing to re-think `exp(2*x)` as `symbol3^2` rather than just `symbol1`. Here are two issues: 1) The replacement "`symbol1 -> symbol3^2`" in the previous part of the expression needs to be done outside of the present routine; 2) The pair "`symbol1 : exp(2*x)`" shall be deleted from the replacement table `repl`. However, this will create illegal substitution "`symbol2 : cos(symbol1 + 1)`" with undefined `symbol1`. These both problems are mitigated through the additions of the record "`symbol1 == symbol3^2`" to the list modifier. Changed length of the modifier signals to the calling code that the previous portion of the expression needs to be altered (it solves 1). Thus [GiNaC](#) can record now `e = symbol3^2 * symbol2 * symbol3` `repl = {symbol2 : cos(symbol1 + 1), symbol3 : exp(x)}` `modifier = {symbol1 == symbol3^2}`. Then, doing the backward substitutions the list modifier will be used to restore such iterative substitutions in the right way (this solves 2).

See also

[ex::normal](#)

References [_ex_1](#), [GiNaC::container< C >::append\(\)](#), [degree\(\)](#), [denom\(\)](#), [exp\(\)](#), [GiNaC::ex::find\(\)](#), [GiNaC::ex::is_equal\(\)](#), [is_ex_the_function](#), [is_integer\(\)](#), [is_rational\(\)](#), [GiNaC::subs_options::no_pattern](#), [normal\(\)](#), [numer\(\)](#), [GiNaC::ex::op\(\)](#), [pow\(\)](#), and [GiNaC::ex::subs\(\)](#).

Referenced by [GiNaC::basic::normal\(\)](#), [GiNaC::numeric::normal\(\)](#), [GiNaC::power::normal\(\)](#), [GiNaC::pseries::normal\(\)](#), [GiNaC::basic::to_polynomial\(\)](#), [GiNaC::numeric::to_polynomial\(\)](#), [GiNaC::power::to_polynomial\(\)](#), [GiNaC::basic::to_rational\(\)](#), [GiNaC::numeric::to_rational\(\)](#), and [GiNaC::power::to_rational\(\)](#).

5.1.3.587 `replace_with_symbol()` [2/2]

```
static ex GiNaC::replace_with_symbol (
    const ex & e,
    exmap & repl ) [static]
```

Create a symbol for replacing the expression "e" (or return a previously assigned symbol).

The symbol and expression are appended to `repl`, and the symbol is returned.

See also

[basic::to_rational](#)

[basic::to_polynomial](#)

References [GiNaC::subs_options::no_pattern](#), and [GiNaC::ex::subs\(\)](#).

5.1.3.588 `frac_cancel()`

```
static ex GiNaC::frac_cancel (
    const ex & n,
    const ex & d ) [static]
```

Fraction cancellation.

Parameters

<i>n</i>	numerator
<i>d</i>	denominator

Returns

cancelled fraction {n, d} as a list

References [_ex1](#), [_ex_1](#), [_num1_p](#), [GiNaC::numeric::denom\(\)](#), [GiNaC::ex::expand\(\)](#), [gcd\(\)](#), [get_first_symbol\(\)](#), [GINAC_ASSERT](#), [GiNaC::ex::is_equal\(\)](#), [is_negative\(\)](#), [GiNaC::ex::is_zero\(\)](#), [lcm_of_coefficients_denominators\(\)](#), [multiply_lcm\(\)](#), [n](#), [GiNaC::numeric::numer\(\)](#), [GiNaC::ex::unit\(\)](#), and [x](#).

Referenced by [GiNaC::add::normal\(\)](#), and [GiNaC::mul::normal\(\)](#).

5.1.3.589 find_common_factor()

```
static ex GiNaC::find_common_factor (
    const ex & e,
    ex & factor,
    exmap & repl ) [static]
```

Remove the common factor in the terms of a sum 'e' by calculating the GCD, and multiply it into the expression 'factor' (which needs to be initialized to 1, unless you're accumulating factors).

References [_ex0](#), [_ex1](#), [divide\(\)](#), [factor\(\)](#), [find_common_factor\(\)](#), [gcd\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::integer](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::ex::is_zero\(\)](#), [k](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), [pow\(\)](#), [GiNaC::ex::to_polynomial\(\)](#), and [x](#).

Referenced by [collect_common_factors\(\)](#), and [find_common_factor\(\)](#).

5.1.3.590 collect_common_factors()

```
ex GiNaC::collect_common_factors (
    const ex & e )
```

Collect common factors in sums.

This converts expressions like 'a*(b*x+b*y)' to 'a*b*(x+y)'.

References [factor\(\)](#), [find_common_factor\(\)](#), [GiNaC::subs_options::no_pattern](#), [r](#), and [GiNaC::ex::subs\(\)](#).

Referenced by [GiNaC::power::to_polynomial\(\)](#).

5.1.3.591 resultant()

```
ex GiNaC::resultant (
    const ex & e1,
    const ex & e2,
    const ex & s )
```

Resultant of two expressions e1,e2 with respect to symbol s.

Method: Compute determinant of Sylvester matrix of e1,e2,s.

References [GiNaC::ex::coeff\(\)](#), [GiNaC::ex::degree\(\)](#), [GiNaC::ex::expand\(\)](#), [GiNaC::ex::info\(\)](#), [k](#), [GiNaC::ex::lddegree\(\)](#), [m](#), and [GiNaC::info_flags::polynomial](#).

5.1.3.592 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [26/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
    numeric ,
    basic ,
    print_func< print_context > &::do_print. print_func< print_latex > &::do_↵
print_latex. print_func< print_csrc > &::do_print_csrc. print_func< print_csrc_cl_N > &↵
::do_print_csrc_cl_N. print_func< print_tree > &::do_print_tree. print_func< print_python_repr
> &::do_print_python_repr )
```

default ctor.

Numerically it initializes to an integer zero.

References [GiNaC::status_flags::evaluated](#), [GiNaC::status_flags::expanded](#), [GiNaC::basic::setflag\(\)](#), and [GiNaC::numeric::value](#).

5.1.3.593 make_real_float()

```
static const cln::cl_F GiNaC::make_real_float (
    const cln::cl_idcoded_float & dec ) [static]
```

Construct a floating point number from sign, mantissa, and exponent.

References [x](#).

Referenced by [read_real_float\(\)](#).

5.1.3.594 read_real_float()

```
static const cln::cl_F GiNaC::read_real_float (
    std::istream & s ) [static]
```

Read serialized floating point number.

References [make_real_float\(\)](#), and [x](#).

Referenced by [GiNaC::numeric::read_archive\(\)](#).

5.1.3.595 GINAC_BIND_UNARCHIVER() [36/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    numeric )
```

5.1.3.596 write_real_float()

```
static void GiNaC::write_real_float (
    std::ostream & s,
    const cln::cl_R & n ) [static]
```

References [n](#).

Referenced by [GiNaC::numeric::archive\(\)](#).

5.1.3.597 print_real_number()

```
static void GiNaC::print_real_number (
    const print_context & c,
    const cln::cl_R & x ) [static]
```

Helper function to print a real number in a nicer way than is CLN's default.

Instead of printing 42.0L0 this just prints 42.0 to ostream os and instead of 3.99168L7 it prints 3.99168E7. This is fine in [GiNaC](#) as long as it only uses `cl_LF` and no other floating point types that we might want to visibly distinguish from `cl_LF`.

See also

[numeric::print\(\)](#)

References [c](#), and [x](#).

Referenced by [GiNaC::numeric::print_numeric\(\)](#), and [print_real_cl_N\(\)](#).

5.1.3.598 `print_integer_csrc()`

```
static void GiNaC::print_integer_csrc (
    const print\_context & c,
    const cln::cl\_I & x ) [static]
```

Helper function to print integer number in C++ source format.

See also

[numeric::print\(\)](#)

References [c](#), and [x](#).

Referenced by [print_real_csrc\(\)](#).

5.1.3.599 `print_real_csrc()`

```
static void GiNaC::print_real_csrc (
    const print\_context & c,
    const cln::cl\_R & x ) [static]
```

Helper function to print real number in C++ source format.

See also

[numeric::print\(\)](#)

References [c](#), [denom\(\)](#), [numer\(\)](#), [print_integer_csrc\(\)](#), and [x](#).

Referenced by [GiNaC::numeric::do_print_csrc\(\)](#).

5.1.3.600 `coerce()`

```
template<typename T1 , typename T2 >
static bool GiNaC::coerce (
    T1 & dst,
    const T2 & arg ) [inline], [static]
```

Referenced by [print_real_cl_N\(\)](#).

5.1.3.601 coerce< int, cln::cl_I >()

```
template<>
bool GiNaC::coerce< int, cln::cl_I > (
    int & dst,
    const cln::cl_I & arg ) [inline]
```

Check if CLN integer can be converted into int.

See also

<https://www.ginac.de/pipermail/cln-list/2006-October/000248.html>

5.1.3.602 coerce< unsigned int, cln::cl_I >()

```
template<>
bool GiNaC::coerce< unsigned int, cln::cl_I > (
    unsigned int & dst,
    const cln::cl_I & arg ) [inline]
```

5.1.3.603 print_real_cl_N()

```
static void GiNaC::print_real_cl_N (
    const print_context & c,
    const cln::cl_R & x ) [static]
```

Helper function to print real number in C++ source format using cl_N types.

See also

[numeric::print\(\)](#)

References [c](#), [coerce\(\)](#), [Digits](#), [print_real_number\(\)](#), and [x](#).

Referenced by [GiNaC::numeric::do_print_csrc_cl_N\(\)](#).

5.1.3.604 exp()

```
const numeric GiNaC::exp (
    const numeric & x )
```

Exponential function.

Returns

arbitrary precision numerical exp(x).

References [x](#).

Referenced by [abs_eval\(\)](#), [abs_power\(\)](#), [Bernoulli_polynomial\(\)](#), [beta_evalf\(\)](#), [GiNaC::Eisenstein_h_kernel::coefficient_an\(\)](#), [csgn_power\(\)](#), [GiNaC::power::do_print_csrc\(\)](#), [exp_conjugate\(\)](#), [exp_deriv\(\)](#), [exp_eval\(\)](#), [exp_evalf\(\)](#), [exp_expand\(\)](#), [exp_imag_part\(\)](#), [exp_power\(\)](#), [exp_real_part\(\)](#), [generalised_Bernoulli_number\(\)](#), [GiNaC::Kronecker_dtau_kernel::get_numerical_val](#), [GiNaC::power::imag_part\(\)](#), [log_eval\(\)](#), [print_sym_pow\(\)](#), [GiNaC::power::real_part\(\)](#), [replace_with_symbol\(\)](#), [GiNaC::power::series\(\)](#), [GiNaC::Kronecker_dtau_kernel::series_coeff_impl\(\)](#), [GiNaC::Kronecker_dz_kernel::series_coeff_impl\(\)](#), and [tgamma\(\)](#).

5.1.3.605 `log()`

```
const numeric GiNaC::log (
    const numeric & x )
```

Natural logarithm.

Parameters

<code>x</code>	complex number
----------------	----------------

Returns

arbitrary precision numerical $\log(x)$.

Exceptions

<code>pole_error("log()"</code>	<code>logarithmic pole",0)</code>
---------------------------------	-----------------------------------

References [GiNaC::ex::is_zero\(\)](#), and [x](#).

Referenced by [atan_series\(\)](#), [atanh_series\(\)](#), [GiNaC::power::derivative\(\)](#), [GiNaC::integral::eval_integ\(\)](#), [exp_eval\(\)](#), [G2_eval\(\)](#), [G2_evalf\(\)](#), [G3_eval\(\)](#), [G3_evalf\(\)](#), [H_eval\(\)](#), [GiNaC::power::imag_part\(\)](#), [lgamma\(\)](#), [lgamma_eval\(\)](#), [lgamma_series\(\)](#), [Li2_deriv\(\)](#), [Li2_eval\(\)](#), [Li2_series\(\)](#), [Li_eval\(\)](#), [log_conjugate\(\)](#), [log_eval\(\)](#), [log_evalf\(\)](#), [log_expand\(\)](#), [log_real_part\(\)](#), [log_series\(\)](#), [psi1_eval\(\)](#), [psi2_eval\(\)](#), [GiNaC::power::real_part\(\)](#), [S_eval\(\)](#), and [GiNaC::power::series\(\)](#).

5.1.3.606 `sin()`

```
const numeric GiNaC::sin (
    const numeric & x )
```

Numeric sine (trigonometric function).

Returns

arbitrary precision numerical $\sin(x)$.

References [x](#).

Referenced by [GiNaC::Eisenstein_h_kernel::coefficient_a0\(\)](#), [cos_deriv\(\)](#), [cos_imag_part\(\)](#), [cosh_imag_part\(\)](#), [exp_imag_part\(\)](#), [GiNaC::power::imag_part\(\)](#), [lgamma\(\)](#), [sin_conjugate\(\)](#), [sin_eval\(\)](#), [sin_evalf\(\)](#), [sin_real_part\(\)](#), [sinh_eval\(\)](#), [sinh_imag_part\(\)](#), and [tan_series\(\)](#).

5.1.3.607 `cos()`

```
const numeric GiNaC::cos (
    const numeric & x )
```

Numeric cosine (trigonometric function).

Returns

arbitrary precision numerical $\cos(x)$.

References [x](#).

Referenced by [GiNaC::Eisenstein_h_kernel::coefficient_a0\(\)](#), [cos_conjugate\(\)](#), [cos_eval\(\)](#), [cos_evalf\(\)](#), [cos_real_part\(\)](#), [cosh_eval\(\)](#), [cosh_real_part\(\)](#), [exp_real_part\(\)](#), [GiNaC::power::real_part\(\)](#), [sin_deriv\(\)](#), [sin_imag_part\(\)](#), [sinh_real_part\(\)](#), and [tan_series\(\)](#).

5.1.3.608 `tan()`

```
const numeric GiNaC::tan (
    const numeric & x )
```

Numeric tangent (trigonometric function).

Returns

arbitrary precision numerical $\tan(x)$.

References [x](#).

Referenced by [tan_conjugate\(\)](#), [tan_deriv\(\)](#), [tan_eval\(\)](#), [tan_evalf\(\)](#), [tan_imag_part\(\)](#), [tan_real_part\(\)](#), [tanh_eval\(\)](#), [tanh_imag_part\(\)](#), and [tanh_real_part\(\)](#).

5.1.3.609 `asin()`

```
const numeric GiNaC::asin (
    const numeric & x )
```

Numeric inverse sine (trigonometric function).

Returns

arbitrary precision numerical $\arcsin(x)$.

References [x](#).

Referenced by [asin_conjugate\(\)](#), [asin_eval\(\)](#), [asin_evalf\(\)](#), [cos_eval\(\)](#), [sin_eval\(\)](#), and [tan_eval\(\)](#).

5.1.3.610 `acos()`

```
const numeric GiNaC::acos (
    const numeric & x )
```

Numeric inverse cosine (trigonometric function).

Returns

arbitrary precision numerical `acos(x)`.

References [x](#).

Referenced by [acos_conjugate\(\)](#), [acos_eval\(\)](#), [acos_evalf\(\)](#), [cos_eval\(\)](#), [sin_eval\(\)](#), and [tan_eval\(\)](#).

5.1.3.611 `atan()` [1/2]

```
const numeric GiNaC::atan (
    const numeric & x )
```

Numeric arcustangent.

Parameters

<i>x</i>	complex number
----------	----------------

Returns

`atan(x)`

Exceptions

<i>pole_error("atan()"</i>	<i>logarithmic pole",0)</i> if $x=1$ or $x=-1$.
----------------------------	--

References [_num1_p](#), [abs\(\)](#), [GiNaC::numeric::is_equal\(\)](#), [GiNaC::ex::is_zero\(\)](#), and [x](#).

Referenced by [atan2_eval\(\)](#), [atan2_evalf\(\)](#), [atan_conjugate\(\)](#), [atan_eval\(\)](#), [atan_evalf\(\)](#), [atan_series\(\)](#), [cos_eval\(\)](#), [sin_eval\(\)](#), and [tan_eval\(\)](#).

5.1.3.612 `atan()` [2/2]

```
const numeric GiNaC::atan (
    const numeric & y,
    const numeric & x )
```

Numeric arcustangent of two arguments, analytically continued in a suitable way.

Parameters

<i>y</i>	complex number
<i>x</i>	complex number

Returns

$-\mathrm{i} \cdot \log((x + \mathrm{i}y)/\sqrt{x^2 + y^2})$, which is equal to $\mathrm{atan}(y/x)$ if y and x are both real.

Exceptions

<i>pole_error("atan()", logarithmic pole", 0)</i>	if $y/x == +\mathrm{i}$ or $y/x == -\mathrm{i}$.
---	---

References [_num0_p](#), [GiNaC::numeric::is_real\(\)](#), [GiNaC::ex::is_zero\(\)](#), [GiNaC::numeric::is_zero\(\)](#), [GiNaC::numeric::to_cl_N\(\)](#), and [x](#).

5.1.3.613 sinh()

```
const numeric GiNaC::sinh (
    const numeric & x )
```

Numeric hyperbolic sine (trigonometric function).

Returns

arbitrary precision numerical $\sinh(x)$.

References [x](#).

Referenced by [cos_imag_part\(\)](#), [cosh_deriv\(\)](#), [cosh_imag_part\(\)](#), [sin_imag_part\(\)](#), [sinh_conjugate\(\)](#), [sinh_eval\(\)](#), [sinh_evalf\(\)](#), [sinh_real_part\(\)](#), and [tanh_series\(\)](#).

5.1.3.614 cosh()

```
const numeric GiNaC::cosh (
    const numeric & x )
```

Numeric hyperbolic cosine (trigonometric function).

Returns

arbitrary precision numerical $\cosh(x)$.

References [x](#).

Referenced by [cos_real_part\(\)](#), [cosh_conjugate\(\)](#), [cosh_eval\(\)](#), [cosh_evalf\(\)](#), [cosh_real_part\(\)](#), [sin_real_part\(\)](#), [sinh_deriv\(\)](#), [sinh_imag_part\(\)](#), and [tanh_series\(\)](#).

5.1.3.615 tanh()

```
const numeric GiNaC::tanh (  
    const numeric & x )
```

Numeric hyperbolic tangent (trigonometric function).

Returns

arbitrary precision numerical $\tanh(x)$.

References [x](#).

Referenced by [tan_imag_part\(\)](#), [tanh_conjugate\(\)](#), [tanh_deriv\(\)](#), [tanh_eval\(\)](#), [tanh_evalf\(\)](#), [tanh_imag_part\(\)](#), and [tanh_real_part\(\)](#).

5.1.3.616 asinh()

```
const numeric GiNaC::asinh (  
    const numeric & x )
```

Numeric inverse hyperbolic sine (trigonometric function).

Returns

arbitrary precision numerical $\operatorname{asinh}(x)$.

References [x](#).

Referenced by [asinh_conjugate\(\)](#), [asinh_eval\(\)](#), [asinh_evalf\(\)](#), [cosh_eval\(\)](#), [sinh_eval\(\)](#), and [tanh_eval\(\)](#).

5.1.3.617 acosh()

```
const numeric GiNaC::acosh (  
    const numeric & x )
```

Numeric inverse hyperbolic cosine (trigonometric function).

Returns

arbitrary precision numerical $\operatorname{acosh}(x)$.

References [x](#).

Referenced by [acosh_conjugate\(\)](#), [acosh_eval\(\)](#), [acosh_evalf\(\)](#), [cosh_eval\(\)](#), [sinh_eval\(\)](#), and [tanh_eval\(\)](#).

5.1.3.618 `atanh()`

```
const numeric GiNaC::atanh (
    const numeric & x )
```

Numeric inverse hyperbolic tangent (trigonometric function).

Returns

arbitrary precision numerical $\operatorname{atanh}(x)$.

References [x](#).

Referenced by [atanh_conjugate\(\)](#), [atanh_eval\(\)](#), [atanh_evalf\(\)](#), [atanh_series\(\)](#), [cosh_eval\(\)](#), [sinh_eval\(\)](#), and [tanh_eval\(\)](#).

5.1.3.619 `Li2_series()` [2/2]

```
static cln::cl_N GiNaC::Li2_series (
    const cln::cl_N & x,
    const cln::float_format_t & prec ) [static]
```

Numeric evaluation of Dilogarithm within circle of convergence (unit circle) using a power series.

References [x](#).

5.1.3.620 `Li2_projection()`

```
static cln::cl_N GiNaC::Li2_projection (
    const cln::cl_N & x,
    const cln::float_format_t & prec ) [static]
```

Folds Li_2 's argument inside a small rectangle to enhance convergence.

References [Li2_projection\(\)](#), [Li2_series\(\)](#), and [x](#).

Referenced by [Li2_\(\)](#), and [Li2_projection\(\)](#).

5.1.3.621 Li2_()

```
const cln::cl_N GiNaC::Li2_ (
    const cln::cl_N & value )
```

Numeric evaluation of Dilogarithm.

The domain is the entire complex plane, the branch cut lies along the positive real axis, starting at 1 and continuous with quadrant IV.

Returns

arbitrary precision numerical Li2(x).

References [Li2_projection\(\)](#), and [value](#).

Referenced by [Li2\(\)](#).

5.1.3.622 Li2()

```
const numeric GiNaC::Li2 (
    const numeric & x )
```

References [_num0_p](#), [Li2_\(\)](#), and [x](#).

Referenced by [Li2_conjugate\(\)](#), [Li2_eval\(\)](#), [Li2_evalf\(\)](#), and [Li2_series\(\)](#).

5.1.3.623 zeta() [3/3]

```
const numeric GiNaC::zeta (
    const numeric & x )
```

Numeric evaluation of Riemann's Zeta function.

Currently works only for integer arguments.

References [x](#).

5.1.3.624 guess_precision()

```
static cln::float_format_t GiNaC::guess_precision (
    const cln::cl_N & x ) [static]
```

References [x](#).

Referenced by [lgamma\(\)](#), and [tgamma\(\)](#).

5.1.3.625 lgamma() [1/2]

```
const cln::cl_N GiNaC::lgamma (
    const cln::cl_N & x )
```

The Gamma function.

Use the Lanczos approximation. If the coefficients used here are not sufficiently many or sufficiently accurate, more can be calculated using the program `doc/examples/lanczos.cpp`. In that case, be sure to read the comments in that file.

References [GiNaC::lanczos_coeffs::calc_lanczos_A\(\)](#), [GiNaC::lanczos_coeffs::get_order\(\)](#), [guess_precision\(\)](#), [lgamma\(\)](#), [log\(\)](#), [sin\(\)](#), [GiNaC::lanczos_coeffs::sufficiently_accurate\(\)](#), and [x](#).

Referenced by [beta_evalf\(\)](#), [lgamma\(\)](#), [lgamma_conjugate\(\)](#), [lgamma_eval\(\)](#), [lgamma_evalf\(\)](#), and [lgamma_series\(\)](#).

5.1.3.626 lgamma() [2/2]

```
const numeric GiNaC::lgamma (
    const numeric & x )
```

References [lgamma\(\)](#), and [x](#).

5.1.3.627 tgamma() [1/2]

```
const cln::cl_N GiNaC::tgamma (
    const cln::cl_N & x )
```

References [GiNaC::lanczos_coeffs::calc_lanczos_A\(\)](#), [exp\(\)](#), [GiNaC::lanczos_coeffs::get_order\(\)](#), [guess_precision\(\)](#), [sqrt\(\)](#), [GiNaC::lanczos_coeffs::sufficiently_accurate\(\)](#), [tgamma\(\)](#), and [x](#).

Referenced by [beta_eval\(\)](#), [beta_series\(\)](#), [psi2_eval\(\)](#), [tgamma\(\)](#), [tgamma_conjugate\(\)](#), [tgamma_deriv\(\)](#), [tgamma_eval\(\)](#), [tgamma_evalf\(\)](#), and [tgamma_series\(\)](#).

5.1.3.628 tgamma() [2/2]

```
const numeric GiNaC::tgamma (
    const numeric & x )
```

References [tgamma\(\)](#), and [x](#).

5.1.3.629 psi() [3/4]

```
const numeric GiNaC::psi (
    const numeric & x )
```

The psi function (aka polygamma function).

This is only a stub!

5.1.3.630 psi() [4/4]

```
const numeric GiNaC::psi (
    const numeric & n,
    const numeric & x )
```

The psi functions (aka polygamma functions).

This is only a stub!

5.1.3.631 factorial()

```
const numeric GiNaC::factorial (
    const numeric & n )
```

Factorial combinatorial function.

Parameters

n	integer argument ≥ 0
-----	---------------------------

Exceptions

<i>range_error</i>	(argument must be integer ≥ 0)
--------------------	--------------------------------------

References [n](#).

Referenced by [Bernoulli_polynomial\(\)](#), [factorial_conjugate\(\)](#), [factorial_eval\(\)](#), [factorial_evalf\(\)](#), [factorial_real_part\(\)](#), [G2_eval\(\)](#), [G2_evalf\(\)](#), [G3_eval\(\)](#), [G3_evalf\(\)](#), [generalised_Bernoulli_number\(\)](#), [H_eval\(\)](#), [lgamma_eval\(\)](#), [multinomial_coefficient\(\)](#), [psi2_eval\(\)](#), [psi2_series\(\)](#), [S_eval\(\)](#), [GiNaC::Kronecker_dtau_kernel::series_coeff_impl\(\)](#), [GiNaC::Kronecker_dz_kernel::series_coeff_impl\(\)](#), [symm\(\)](#), [tgamma_eval\(\)](#), and [zeta1_eval\(\)](#).

5.1.3.632 doublefactorial()

```
const numeric GiNaC::doublefactorial (
    const numeric & n )
```

The double factorial combinatorial function.

(Scarcely used, but still useful in cases, like for exact results of $tgamma(n+1/2)$ for instance.)

Parameters

<i>n</i>	integer argument ≥ -1
----------	----------------------------

Returns

$n!! == n * (n-2) * (n-4) * \dots * (\{1|2\})$ with $0!! == (-1)!! == 1$

Exceptions

<i>range_error</i>	(argument must be integer ≥ -1)
--------------------	---------------------------------------

References [_num1_p](#), [_num_1_p](#), and [n](#).

Referenced by [tgamma_eval\(\)](#).

5.1.3.633 binomial()

```
const numeric GiNaC::binomial (
    const numeric & n,
    const numeric & k )
```

The Binomial coefficients.

It computes the binomial coefficients. For integer n and k and positive n this is the number of ways of choosing k objects from n distinct objects. If n is a negative integer, the formula $\text{binomial}(n,k) == (-1)^k * \text{binomial}(k-n-1,k)$ (if $k \geq 0$) $\text{binomial}(n,k) == (-1)^{(n-k)} * \text{binomial}(-k-1,n-k)$ (otherwise) is used to compute the result.

References [_num0_p](#), [_num1_p](#), [_num_1_p](#), [binomial\(\)](#), [k](#), [n](#), and [GiNaC::numeric::power\(\)](#).

Referenced by [binomial\(\)](#), [binomial_conjugate\(\)](#), [binomial_eval\(\)](#), [binomial_evalf\(\)](#), [binomial_real_part\(\)](#), [binomial_sym\(\)](#), [GiNaC::power::expand_add\(\)](#), [GiNaC::power::imag_part\(\)](#), and [GiNaC::power::real_part\(\)](#).

5.1.3.634 bernoulli()

```
const numeric GiNaC::bernoulli (
    const numeric & nn )
```

Bernoulli number.

The n th Bernoulli number is the coefficient of $x^n/n!$ in the expansion of the function $x/(e^x-1)$.

Returns

the n th Bernoulli number (a rational number).

Exceptions

<code>range_error</code>	(argument must be integer ≥ 0)
--------------------------	--------------------------------------

References [_num1_p](#), [c](#), [GiNaC::numeric::is_integer\(\)](#), [GiNaC::numeric::is_negative\(\)](#), [k](#), [n](#), and [GiNaC::numeric::to_int\(\)](#).

Referenced by [GiNaC::Kronecker_dtau_kernel::series_coeff_impl\(\)](#), [GiNaC::Kronecker_dz_kernel::series_coeff_impl\(\)](#), and [zeta1_eval\(\)](#).

5.1.3.635 fibonacci()

```
const numeric GiNaC::fibonacci (
    const numeric & n )
```

Fibonacci number.

The nth Fibonacci number $F(n)$ is defined by the recurrence formula $F(n) = F(n-1) + F(n-2)$ with $F(0) = 0$ and $F(1) = 1$.

Parameters

n	an integer
-----	------------

Returns

the nth Fibonacci number $F(n)$ (an integer number)

Exceptions

<code>range_error</code>	(argument must be an integer)
--------------------------	-------------------------------

References [_num0_p](#), [fibonacci\(\)](#), [m](#), and [n](#).

Referenced by [fibonacci\(\)](#).

5.1.3.636 abs()

```
const numeric GiNaC::abs (
    const numeric & x )
```

Absolute value.

References [x](#).

Referenced by [abs_conjugate\(\)](#), [abs_eval\(\)](#), [abs_evalf\(\)](#), [abs_expand\(\)](#), [abs_expl_derivative\(\)](#), [abs_power\(\)](#), [abs_real_part\(\)](#), [adaptivesimpson\(\)](#), [atan\(\)](#), [atan_series\(\)](#), [atanh_series\(\)](#), [GiNaC::power::eval\(\)](#), [generalised_Bernoulli_number\(\)](#), [GiNaC::power::imag_part\(\)](#), [GiNaC::mul::integer_content\(\)](#), [GiNaC::numeric::integer_content\(\)](#), [is_discriminant_of_quadratic_number\(\)](#), [log_real_part\(\)](#), [GiNaC::add::max_coefficient\(\)](#), [GiNaC::mul::max_coefficient\(\)](#), [GiNaC::numeric::max_coefficient\(\)](#), [GiNaC::matrix::pivot\(\)](#), [GiNaC::power::real_part\(\)](#), [tgamma_eval\(\)](#), [GiNaC::ex::unitcontprim\(\)](#), and [zeta1_eval\(\)](#).

5.1.3.637 mod()

```
const numeric GiNaC::mod (
    const numeric & a,
    const numeric & b )
```

Modulus (in positive representation).

In general, `mod(a,b)` has the sign of `b` or is zero, and `rem(a,b)` has the sign of `a` or is zero. This is different from Maple's `modp`, where the sign of `b` is ignored. It is in agreement with Mathematica's `Mod`.

Returns

`a mod b` in the range `[0,abs(b)-1]` with sign of `b` if both are integer, 0 otherwise.

References [_num0_p](#), [GiNaC::numeric::is_integer\(\)](#), and [GiNaC::numeric::to_cl_N\(\)](#).

Referenced by [GiNaC::Eisenstein_h_kernel::coefficient_a0\(\)](#), [GiNaC::Eisenstein_h_kernel::coefficient_an\(\)](#), [cos_eval\(\)](#), [exp_eval\(\)](#), [is_discriminant_of_quadratic_number_field\(\)](#), [sin_eval\(\)](#), and [tan_eval\(\)](#).

5.1.3.638 smod()

```
const numeric GiNaC::smod (
    const numeric & a_,
    const numeric & b_ )
```

Modulus (in symmetric representation).

Returns

`a mod b` in the range `[-iquo(abs(b),2), iquo(abs(b),2)]`.

References [_num0_p](#), [GiNaC::numeric::is_integer\(\)](#), [m](#), and [GiNaC::numeric::to_cl_N\(\)](#).

Referenced by [GiNaC::add::smod\(\)](#), [GiNaC::mul::smod\(\)](#), and [GiNaC::numeric::smod\(\)](#).

5.1.3.639 irem() [1/2]

```
const numeric GiNaC::irem (
    const numeric & a,
    const numeric & b )
```

Numeric integer remainder.

Equivalent to Maple's `irem(a,b)` as far as sign conventions are concerned. In general, `mod(a,b)` has the sign of `b` or is zero, and `irem(a,b)` has the sign of `a` or is zero.

Returns

remainder of `a/b` if both are integer, 0 otherwise.

Exceptions

<code>overflow_error</code>	(division by zero) if b is zero.
-----------------------------	----------------------------------

References [_num0_p](#), [GiNaC::numeric::is_integer\(\)](#), [GiNaC::numeric::is_zero\(\)](#), and [GiNaC::numeric::to_cl_N\(\)](#).

Referenced by [GiNaC::Eisenstein_h_kernel::coefficient_a0\(\)](#), [GiNaC::Eisenstein_h_kernel::coefficient_an\(\)](#), and [ifactor\(\)](#).

5.1.3.640 irem() [2/2]

```
const numeric GiNaC::irem (
    const numeric & a,
    const numeric & b,
    numeric & q )
```

Numeric integer remainder.

Equivalent to Maple's `irem(a,b,'q')` it obeys the relation `irem(a,b,q) == a - q*b`. In general, `mod(a,b)` has the sign of b or is zero, and `irem(a,b)` has the sign of a or is zero.

Returns

remainder of a/b and quotient stored in q if both are integer, 0 otherwise.

Exceptions

<code>overflow_error</code>	(division by zero) if b is zero.
-----------------------------	----------------------------------

References [_num0_p](#), [GiNaC::numeric::is_integer\(\)](#), [GiNaC::numeric::is_zero\(\)](#), and [GiNaC::numeric::to_cl_N\(\)](#).

5.1.3.641 iquo() [1/2]

```
const numeric GiNaC::iquo (
    const numeric & a,
    const numeric & b )
```

Numeric integer quotient.

Equivalent to Maple's `iquo` as far as sign conventions are concerned.

Returns

truncated quotient of a/b if both are integer, 0 otherwise.

Exceptions

<code>overflow_error</code>	(division by zero) if b is zero.
-----------------------------	----------------------------------

References [_num0_p](#), [GiNaC::numeric::is_integer\(\)](#), [GiNaC::numeric::is_zero\(\)](#), and [GiNaC::numeric::to_cl_N\(\)](#).

Referenced by [GiNaC::power::eval\(\)](#), and [heur_gcd_z\(\)](#).

5.1.3.642 iquo() [2/2]

```
const numeric GiNaC::iquo (
    const numeric & a,
    const numeric & b,
    numeric & r )
```

Numeric integer quotient.

Equivalent to Maple's `iquo(a,b,'r')` it obeys the relation `r == a - iquo(a,b,r)*b`.

Returns

truncated quotient of `a/b` and remainder stored in `r` if both are integer, 0 otherwise.

Exceptions

<code>overflow_error</code>	(division by zero) if b is zero.
-----------------------------	----------------------------------

References [_num0_p](#), [GiNaC::numeric::is_integer\(\)](#), [GiNaC::numeric::is_zero\(\)](#), `r`, and [GiNaC::numeric::to_cl_N\(\)](#).

5.1.3.643 gcd() [2/2]

```
const numeric GiNaC::gcd (
    const numeric & a,
    const numeric & b )
```

Greatest Common Divisor.

Returns

The GCD of two numbers if both are integer, a numerical 1 if they are not.

References [_num1_p](#), [GiNaC::numeric::is_integer\(\)](#), and [GiNaC::numeric::to_cl_N\(\)](#).

5.1.3.644 lcm() [2/2]

```
const numeric GiNaC::lcm (
    const numeric & a,
    const numeric & b )
```

Least Common Multiple.

Returns

The LCM of two numbers if both are integer, the product of those two numbers if they are not.

References [GiNaC::numeric::is_integer\(\)](#), [GiNaC::numeric::mul\(\)](#), and [GiNaC::numeric::to_cl_N\(\)](#).

5.1.3.645 sqrt() [1/2]

```
const numeric GiNaC::sqrt (
    const numeric & x )
```

Numeric square root.

If possible, sqrt(x) should respect squares of exact numbers, i.e. sqrt(4) should return integer 2.

Parameters

x	numeric argument
-----	------------------

Returns

square root of x . Branch cut along negative real axis, the negative real axis itself where $\text{imag}(x)=0$ and $\text{real}(x)<0$ belongs to the upper part where $\text{imag}(x)>0$.

References [x](#).

Referenced by [cos_eval\(\)](#), [cosh_eval\(\)](#), [EllipticE_evalf\(\)](#), [EllipticK_evalf\(\)](#), [GiNaC::su3f::eval_indexed\(\)](#), [GiNaC::su3d::eval_indexed\(\)](#), [sin_eval\(\)](#), [sinh_eval\(\)](#), [tan_eval\(\)](#), [tanh_eval\(\)](#), [tgamma\(\)](#), and [tgamma_eval\(\)](#).

5.1.3.646 isqrt()

```
const numeric GiNaC::isqrt (
    const numeric & x )
```

Integer numeric square root.

References [_num0_p](#), and [x](#).

Referenced by [heur_gcd_z\(\)](#).

5.1.3.647 PiEvalf()

```
ex GiNaC::PiEvalf ( )
```

Floating point evaluation of Archimedes' constant Pi.

5.1.3.648 EulerEvalf()

```
ex GiNaC::EulerEvalf ( )
```

Floating point evaluation of Euler's constant gamma.

5.1.3.649 CatalanEvalf()

```
ex GiNaC::CatalanEvalf ( )
```

Floating point evaluation of Catalan's constant.

5.1.3.650 operator<<() [6/16]

```
std::ostream & GiNaC::operator<< (
    std::ostream & os,
    const _numeric_digits & e )
```

References [GiNaC::_numeric_digits::print\(\)](#).

5.1.3.651 GINAC_DECLARE_UNARCHIVER() [38/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    numeric )
```

5.1.3.652 pow() [1/3]

```
const numeric GiNaC::pow (
    const numeric & x,
    const numeric & y ) [inline]
```

References [x](#).

Referenced by [abs_eval\(\)](#), [abs_power\(\)](#), [GiNaC::mul::algebraic_subs_mul\(\)](#), [beta_eval\(\)](#), [GiNaC::Eisenstein_h_kernel::coefficient_and_derivative\(\)](#), [GiNaC::basic::collect\(\)](#), [GiNaC::mul::combine_ex_with_coeff_to_pair\(\)](#), [GiNaC::mul::combine_pair_with_coeff_to_pair\(\)](#), [GiNaC::pseries::convert_to_poly\(\)](#), [GiNaC::mul::derivative\(\)](#), [GiNaC::power::derivative\(\)](#), [divide\(\)](#), [divide_in_z\(\)](#), [EllipticE_series\(\)](#), [EllipticK_series\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::power::evalm\(\)](#), [GiNaC::power::expand\(\)](#), [GiNaC::power::expand_add\(\)](#), [factor\(\)](#), [find_common_factor\(\)](#), [G2_eval\(\)](#), [G2_evalf\(\)](#), [G3_eval\(\)](#), [G3_evalf\(\)](#), [gcd\(\)](#), [gcd_pf_pow\(\)](#), [gcd_pf_pow_pow\(\)](#), [GiNaC::Kronecker_dtau_kernel::get_numerical_value\(\)](#), [GiNaC::Kronecker_dz_kernel::get_numerical_value\(\)](#), [H_eval\(\)](#), [GiNaC::power::imag_part\(\)](#), [interpolate\(\)](#), [kronecker_symbol\(\)](#), [GiNaC::integration_kernel::Laurent_series\(\)](#), [lcmcoeff\(\)](#), [Li2_series\(\)](#), [Li_eval\(\)](#), [Li_series\(\)](#), [log_series\(\)](#), [multiply_lcm\(\)](#), [GiNaC::power::normal\(\)](#), [GiNaC::pseries::op\(\)](#), [Order_power\(\)](#), [GiNaC::pseries::power_const\(\)](#), [prem\(\)](#), [GiNaC::pseries::print_series\(\)](#), [psi1_eval\(\)](#), [psi2_eval\(\)](#), [GiNaC::Eisenstein_h_kernel::q_expansion_modular_form\(\)](#), [quo\(\)](#), [GiNaC::power::real_part\(\)](#), [rem\(\)](#), [replace_with_symbol\(\)](#), [S_eval\(\)](#), [S_series\(\)](#), [GiNaC::modular_form_kernel::series\(\)](#), [GiNaC::Kronecker_dz_kernel::series_coeff_impl\(\)](#), [sprem\(\)](#), [sqrfree_parfrac\(\)](#), [sr_gcd\(\)](#), [GiNaC::power::subs\(\)](#), [tgamma_eval\(\)](#), [GiNaC::power::to_polynomial\(\)](#), [GiNaC::power::to_rational\(\)](#), and [zeta1_eval\(\)](#).

5.1.3.653 inverse() [3/3]

```
const numeric GiNaC::inverse (
    const numeric & x ) [inline]
```

References [x](#).

5.1.3.654 step()

```
numeric GiNaC::step (
    const numeric & x ) [inline]
```

References [x](#).

Referenced by [abs_eval\(\)](#), [H_eval\(\)](#), [step_conjugate\(\)](#), [step_eval\(\)](#), [step_evalf\(\)](#), [step_real_part\(\)](#), and [step_series\(\)](#).

5.1.3.655 csgn()

```
int GiNaC::csgn (
    const numeric & x ) [inline]
```

References [x](#).

Referenced by [atan_series\(\)](#), [atanh_series\(\)](#), [csgn_conjugate\(\)](#), [csgn_eval\(\)](#), [csgn_evalf\(\)](#), [csgn_power\(\)](#), [csgn_real_part\(\)](#), [csgn_series\(\)](#), [eta_eval\(\)](#), [eta_evalf\(\)](#), and [log_series\(\)](#).

5.1.3.656 is_zero() [2/2]

```
bool GiNaC::is_zero (
    const numeric & x ) [inline]
```

References [GiNaC::ex::is_zero\(\)](#), and [x](#).

5.1.3.657 is_positive()

```
bool GiNaC::is_positive (
    const numeric & x ) [inline]
```

References [x](#).

Referenced by [beta_eval\(\)](#).

5.1.3.658 is_negative()

```
bool GiNaC::is_negative (
    const numeric & x ) [inline]
```

References [x](#).

Referenced by [GiNaC::power::do_print_latex\(\)](#), [GiNaC::power::eval\(\)](#), and [frac_cancel\(\)](#).

5.1.3.659 is_integer()

```
bool GiNaC::is_integer (
    const numeric & x ) [inline]
```

References [x](#).

Referenced by [beta_eval\(\)](#), [binomial_eval\(\)](#), [GiNaC::power::coeff\(\)](#), [GiNaC::power::degree\(\)](#), [GiNaC::power::expand\(\)](#), [GiNaC::power::ldegree\(\)](#), [GiNaC::pseries::power_const\(\)](#), [psi1_eval\(\)](#), [psi2_eval\(\)](#), [replace_with_symbol\(\)](#), and [GiNaC::power::series\(\)](#).

5.1.3.660 is_pos_integer()

```
bool GiNaC::is_pos_integer (
    const numeric & x ) [inline]
```

References [x](#).

Referenced by [GiNaC::power::expand_add\(\)](#), and [GiNaC::power::expand_add_2\(\)](#).

5.1.3.661 `is_nonneg_integer()`

```
bool GiNaC::is_nonneg_integer (
    const numeric & x ) [inline]
```

References [x](#).

5.1.3.662 `is_even()`

```
bool GiNaC::is_even (
    const numeric & x ) [inline]
```

References [x](#).

Referenced by [abs_power\(\)](#), and [GiNaC::Kronecker_dz_kernel::series_coeff_impl\(\)](#).

5.1.3.663 `is_odd()`

```
bool GiNaC::is_odd (
    const numeric & x ) [inline]
```

References [x](#).

Referenced by [csgn_power\(\)](#).

5.1.3.664 `is_prime()`

```
bool GiNaC::is_prime (
    const numeric & x ) [inline]
```

References [x](#).

5.1.3.665 `is_rational()`

```
bool GiNaC::is_rational (
    const numeric & x ) [inline]
```

References [x](#).

Referenced by [beta_eval\(\)](#), [lgamma_eval\(\)](#), [replace_with_symbol\(\)](#), and [tgamma_eval\(\)](#).

5.1.3.666 is_real()

```
bool GiNaC::is_real (
    const numeric & x ) [inline]
```

References [x](#).

Referenced by [beta_eval\(\)](#), [fsolve\(\)](#), [G2_eval\(\)](#), [G2_evalf\(\)](#), and [Li2_series\(\)](#).

5.1.3.667 is_cinteger()

```
bool GiNaC::is_cinteger (
    const numeric & x ) [inline]
```

References [x](#).

5.1.3.668 is_crational()

```
bool GiNaC::is_crational (
    const numeric & x ) [inline]
```

References [x](#).

5.1.3.669 to_int()

```
int GiNaC::to_int (
    const numeric & x ) [inline]
```

References [x](#).

Referenced by [color_trace\(\)](#), [H_evalf\(\)](#), [GiNaC::basic::operator\[\]\(\)](#), [GiNaC::pseries::power_const\(\)](#), [S_eval\(\)](#), [GiNaC::power::series\(\)](#), and [sqrfree_parfrac\(\)](#).

5.1.3.670 to_long()

```
long GiNaC::to_long (
    const numeric & x ) [inline]
```

References [x](#).

5.1.3.671 to_double()

```
double GiNaC::to_double (
    const numeric & x ) [inline]
```

References [x](#).

5.1.3.672 real()

```
const numeric GiNaC::real (
    const numeric & x ) [inline]
```

References [x](#).

Referenced by [cosh_eval\(\)](#), [sinh_eval\(\)](#), and [tanh_eval\(\)](#).

5.1.3.673 imag()

```
const numeric GiNaC::imag (
    const numeric & x ) [inline]
```

References [x](#).

Referenced by [eta_eval\(\)](#), [eta_evalf\(\)](#), [G2_eval\(\)](#), and [G2_evalf\(\)](#).

5.1.3.674 numer() [2/2]

```
const numeric GiNaC::numer (
    const numeric & x ) [inline]
```

References [GiNaC::ex::numer\(\)](#), and [x](#).

5.1.3.675 denom() [2/2]

```
const numeric GiNaC::denom (
    const numeric & x ) [inline]
```

References [GiNaC::ex::denom\(\)](#), and [x](#).

5.1.3.676 exadd()

```
static const ex GiNaC::exadd (
    const ex & lh,
    const ex & rh ) [inline], [static]
```

Used internally by [operator+\(\)](#) to add two ex objects.

Referenced by [operator+\(\)](#), [operator++\(\)](#), [operator+=\(\)](#), [operator-\(\)](#), [operator--\(\)](#), and [operator-=\(\)](#).

5.1.3.677 exmul()

```
static const ex GiNaC::exmul (
    const ex & lh,
    const ex & rh ) [inline], [static]
```

Used internally by [operator*\(\)](#) to multiply two ex objects.

References [GiNaC::return_types::commutative](#), and [GiNaC::ex::return_type\(\)](#).

Referenced by [operator*\(\)](#), [operator*=\(\(\)\)](#), [operator/\(\)](#), and [operator/=\(\(\)\)](#).

5.1.3.678 exminus()

```
static const ex GiNaC::exminus (
    const ex & lh ) [inline], [static]
```

Used internally by [operator-\(\)](#) and friends to change the sign of an argument.

References [_ex_1](#).

Referenced by [operator-\(\)](#), and [operator-=\(\)](#).

5.1.3.679 operator+() [1/4]

```
const ex GiNaC::operator+ (
    const ex & lh,
    const ex & rh )
```

References [exadd\(\)](#).

5.1.3.680 `operator-()` [1/4]

```
const ex GiNaC::operator- (
    const ex & lh,
    const ex & rh )
```

References [exadd\(\)](#), and [exminus\(\)](#).

5.1.3.681 `operator*()` [1/2]

```
const ex GiNaC::operator* (
    const ex & lh,
    const ex & rh )
```

References [exmul\(\)](#).

5.1.3.682 `operator/()` [1/2]

```
const ex GiNaC::operator/ (
    const ex & lh,
    const ex & rh )
```

References [_ex_1](#), and [exmul\(\)](#).

5.1.3.683 `operator+()` [2/4]

```
const numeric GiNaC::operator+ (
    const numeric & lh,
    const numeric & rh )
```

References [GiNaC::numeric::add\(\)](#).

5.1.3.684 `operator-()` [2/4]

```
const numeric GiNaC::operator- (
    const numeric & lh,
    const numeric & rh )
```

References [GiNaC::numeric::sub\(\)](#).

5.1.3.685 operator*() [2/2]

```
const numeric GiNaC::operator* (
    const numeric & lh,
    const numeric & rh )
```

References [GiNaC::numeric::mul\(\)](#).

5.1.3.686 operator/() [2/2]

```
const numeric GiNaC::operator/ (
    const numeric & lh,
    const numeric & rh )
```

References [GiNaC::numeric::div\(\)](#).

5.1.3.687 operator+=() [1/2]

```
ex & GiNaC::operator+= (
    ex & lh,
    const ex & rh )
```

References [exadd\(\)](#).

5.1.3.688 operator-=() [1/2]

```
ex & GiNaC::operator-= (
    ex & lh,
    const ex & rh )
```

References [exadd\(\)](#), and [exminus\(\)](#).

5.1.3.689 operator*=() [1/2]

```
ex & GiNaC::operator*= (
    ex & lh,
    const ex & rh )
```

References [exmul\(\)](#).

5.1.3.690 operator/=() [1/2]

```
ex & GiNaC::operator/= (
    ex & lh,
    const ex & rh )
```

References [_ex_1](#), and [exmul\(\)](#).

5.1.3.691 operator+=() [2/2]

```
numeric & GiNaC::operator+= (
    numeric & lh,
    const numeric & rh )
```

References [GiNaC::numeric::add\(\)](#).

5.1.3.692 operator-=() [2/2]

```
numeric & GiNaC::operator-= (
    numeric & lh,
    const numeric & rh )
```

References [GiNaC::numeric::sub\(\)](#).

5.1.3.693 operator*=() [2/2]

```
numeric & GiNaC::operator*= (
    numeric & lh,
    const numeric & rh )
```

References [GiNaC::numeric::mul\(\)](#).

5.1.3.694 operator/=() [2/2]

```
numeric & GiNaC::operator/= (
    numeric & lh,
    const numeric & rh )
```

References [GiNaC::numeric::div\(\)](#).

5.1.3.695 operator+() [3/4]

```
const ex GiNaC::operator+ (
    const ex & lh )
```

5.1.3.696 operator-() [3/4]

```
const ex GiNaC::operator- (
    const ex & lh )
```

References [exminus\(\)](#).

5.1.3.697 operator+() [4/4]

```
const numeric GiNaC::operator+ (
    const numeric & lh )
```

5.1.3.698 operator-() [4/4]

```
const numeric GiNaC::operator- (
    const numeric & lh )
```

References [_num_1_p](#), and [GiNaC::numeric::mul\(\)](#).

5.1.3.699 operator++() [1/4]

```
ex & GiNaC::operator++ (
    ex & rh )
```

Expression prefix increment.

Adds 1 and returns incremented *ex*.

References [_ex1](#), and [exadd\(\)](#).

5.1.3.700 operator--() [1/4]

```
ex & GiNaC::operator-- (
    ex & rh )
```

Expression prefix decrement.

Subtracts 1 and returns decremented ex.

References [_ex_1](#), and [exadd\(\)](#).

5.1.3.701 operator++() [2/4]

```
const ex GiNaC::operator++ (
    ex & lh,
    int )
```

Expression postfix increment.

Returns the ex and leaves the original incremented by 1.

References [_ex1](#), and [exadd\(\)](#).

5.1.3.702 operator--() [2/4]

```
const ex GiNaC::operator-- (
    ex & lh,
    int )
```

Expression postfix decrement.

Returns the ex and leaves the original decremented by 1.

References [_ex_1](#), and [exadd\(\)](#).

5.1.3.703 operator++() [3/4]

```
numeric & GiNaC::operator++ (
    numeric & rh )
```

Numeric prefix increment.

Adds 1 and returns incremented number.

References [_num1_p](#), and [GiNaC::numeric::add\(\)](#).

5.1.3.704 operator--() [3/4]

```
numeric & GiNaC::operator-- (
    numeric & rh )
```

Numeric prefix decrement.

Subtracts 1 and returns decremented number.

References [_num_1_p](#), and [GiNaC::numeric::add\(\)](#).

5.1.3.705 operator++() [4/4]

```
const numeric GiNaC::operator++ (
    numeric & lh,
    int )
```

Numeric postfix increment.

Returns the number and leaves the original incremented by 1.

References [_num1_p](#), and [GiNaC::numeric::add\(\)](#).

5.1.3.706 operator--() [4/4]

```
const numeric GiNaC::operator-- (
    numeric & lh,
    int )
```

Numeric postfix decrement.

Returns the number and leaves the original decremented by 1.

References [_num_1_p](#), and [GiNaC::numeric::add\(\)](#).

5.1.3.707 operator==()

```
const relational GiNaC::operator==(
    const ex & lh,
    const ex & rh )
```

References [GiNaC::relational::equal](#).

5.1.3.708 operator"!=()

```
const relational GiNaC::operator!= (
    const ex & lh,
    const ex & rh )
```

References [GiNaC::relational::not_equal](#).

5.1.3.709 operator<()

```
const relational GiNaC::operator< (
    const ex & lh,
    const ex & rh )
```

References [GiNaC::relational::less](#).

5.1.3.710 operator<=()

```
const relational GiNaC::operator<= (
    const ex & lh,
    const ex & rh )
```

References [GiNaC::relational::less_or_equal](#).

5.1.3.711 operator>()

```
const relational GiNaC::operator> (
    const ex & lh,
    const ex & rh )
```

References [GiNaC::relational::greater](#).

5.1.3.712 operator>=()

```
const relational GiNaC::operator>= (
    const ex & lh,
    const ex & rh )
```

References [GiNaC::relational::greater_or_equal](#).

5.1.3.713 `my_ios_index()`

```
static int GiNaC::my_ios_index ( ) [static]
```

Referenced by [get_print_context\(\)](#), and [set_print_context\(\)](#).

5.1.3.714 `my_ios_callback()`

```
static void GiNaC::my_ios_callback (
    std::ios_base::event ev,
    std::ios_base & s,
    int i ) [static]
```

Referenced by [set_print_context\(\)](#).

5.1.3.715 `get_print_context()`

```
static print_context * GiNaC::get_print_context (
    std::ios_base & s ) [inline], [static]
```

References [my_ios_index\(\)](#).

Referenced by [get_print_options\(\)](#), [operator<<\(\)](#), and [set_print_options\(\)](#).

5.1.3.716 `set_print_context()`

```
static void GiNaC::set_print_context (
    std::ios_base & s,
    const print_context & c ) [static]
```

References [c](#), [callback_registered](#), [my_ios_callback\(\)](#), [my_ios_index\(\)](#), [options](#), and [GiNaC::print_context::options](#).

Referenced by [csrc\(\)](#), [csrc_cl_N\(\)](#), [csrc_double\(\)](#), [csrc_float\(\)](#), [dflt\(\)](#), [latex\(\)](#), [python\(\)](#), [python_repr\(\)](#), [set_print_options\(\)](#), and [tree\(\)](#).

5.1.3.717 `get_print_options()`

```
static unsigned GiNaC::get_print_options (
    std::ios_base & s ) [inline], [static]
```

References [get_print_context\(\)](#), and [GiNaC::print_context::options](#).

Referenced by [index_dimensions\(\)](#), and [no_index_dimensions\(\)](#).

5.1.3.718 `set_print_options()`

```
static void GiNaC::set_print_options (
    std::ostream & s,
    unsigned options ) [static]
```

References [get_print_context\(\)](#), [options](#), [GiNaC::print_context::options](#), and [set_print_context\(\)](#).

Referenced by [dflt\(\)](#), [index_dimensions\(\)](#), and [no_index_dimensions\(\)](#).

5.1.3.719 `operator<<()` [7/16]

```
std::ostream & GiNaC::operator<< (
    std::ostream & os,
    const ex & e )
```

References [get_print_context\(\)](#), and [GiNaC::ex::print\(\)](#).

5.1.3.720 `operator>>()` [3/3]

```
std::istream & GiNaC::operator>> (
    std::istream & is,
    ex & e )
```

5.1.3.721 `dflt()`

```
std::ostream & GiNaC::dflt (
    std::ostream & os )
```

References [set_print_context\(\)](#), and [set_print_options\(\)](#).

5.1.3.722 `latex()`

```
std::ostream & GiNaC::latex (
    std::ostream & os )
```

References [set_print_context\(\)](#).

5.1.3.723 python()

```
std::ostream & GiNaC::python (
    std::ostream & os )
```

References [set_print_context\(\)](#).

5.1.3.724 python_repr()

```
std::ostream & GiNaC::python_repr (
    std::ostream & os )
```

References [set_print_context\(\)](#).

5.1.3.725 tree()

```
std::ostream & GiNaC::tree (
    std::ostream & os )
```

References [set_print_context\(\)](#).

Referenced by [GiNaC::class_info< OPT >::dump_hierarchy\(\)](#).

5.1.3.726 csrc()

```
std::ostream & GiNaC::csrc (
    std::ostream & os )
```

References [set_print_context\(\)](#).

5.1.3.727 csrc_float()

```
std::ostream & GiNaC::csrc_float (
    std::ostream & os )
```

References [set_print_context\(\)](#).

5.1.3.728 csrc_double()

```
std::ostream & GiNaC::csrc_double (
    std::ostream & os )
```

References [set_print_context\(\)](#).

5.1.3.729 csrc_cl_N()

```
std::ostream & GiNaC::csrc_cl_N (
    std::ostream & os )
```

References [set_print_context\(\)](#).

5.1.3.730 index_dimensions()

```
std::ostream & GiNaC::index_dimensions (
    std::ostream & os )
```

References [get_print_options\(\)](#), [GiNaC::print_options::print_index_dimensions](#), and [set_print_options\(\)](#).

5.1.3.731 no_index_dimensions()

```
std::ostream & GiNaC::no_index_dimensions (
    std::ostream & os )
```

References [get_print_options\(\)](#), [GiNaC::print_options::print_index_dimensions](#), and [set_print_options\(\)](#).

5.1.3.732 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [27/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
    power ,
    basic ,
    print_func< print_dflt > &::do_print_dflt. print_func< print_latex > &::do_↵
_print_latex. print_func< print_csrc > &::do_print_csrc. print_func< print_python > &↵
::do_print_python. print_func< print_python_repr > &::do_print_python_repr. print_func<
print_csrc_cl_N > &::do_print_csrc_cl_N )
```

5.1.3.733 print_sym_pow()

```
static void GiNaC::print_sym_pow (
    const print_context & c,
    const symbol & x,
    int exp ) [static]
```

References [c](#), [exp\(\)](#), [GiNaC::ex::print\(\)](#), [print_sym_pow\(\)](#), and [x](#).

Referenced by [GiNaC::power::do_print_csrc\(\)](#), and [print_sym_pow\(\)](#).

5.1.3.734 GINAC_BIND_UNARCHIVER() [37/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    power )
```

5.1.3.735 GINAC_DECLARE_UNARCHIVER() [39/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    power )
```

5.1.3.736 pow() [2/3]

```
ex GiNaC::pow (
    const ex & b,
    const ex & e ) [inline]
```

Symbolic exponentiation.

Returns a power-object as a new expression.

Parameters

<i>b</i>	the basis expression
<i>e</i>	the exponent expression

5.1.3.737 pow() [3/3]

```
template<typename T1 , typename T2 >
ex GiNaC::pow (
```

```
const T1 & b,
const T2 & e ) [inline]
```

5.1.3.738 `sqrt()` [2/2]

```
ex GiNaC::sqrt (
    const ex & a ) [inline]
```

Square root expression.

Returns a power-object with exponent 1/2.

References [_ex1_2](#).

5.1.3.739 `is_a()` [3/3]

```
template<class T >
bool GiNaC::is_a (
    const print_context & obj ) [inline]
```

Check if obj is a T, including base classes.

5.1.3.740 `GINAC_IMPLEMENT_REGISTERED_CLASS_OPT()` [28/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
    pseries ,
    basic ,
    print_func< print_context > &::do_print. print_func< print_latex > &::do_↵
print_latex. print_func< print_tree > &::do_print_tree. print_func< print_python > &::do_↵
print_python. print_func< print_python_repr > &::do_print_python_repr )
```

5.1.3.741 `GINAC_BIND_UNARCHIVER()` [38/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    pseries )
```

5.1.3.742 `GINAC_DECLARE_UNARCHIVER()` [40/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    pseries )
```

5.1.3.743 `series_to_poly()`

```
ex GiNaC::series_to_poly (
    const ex & e ) [inline]
```

Convert the pseries object embedded in an expression to an ordinary polynomial in the expansion variable.

The result is undefined if the expression does not contain a pseries object at its top level.

Parameters

<i>e</i>	expression
----------	------------

Returns

polynomial expression

See also

[is_a<>](#)

[pseries::convert_to_poly](#)

Referenced by [Bernoulli_polynomial\(\)](#), [generalised_Bernoulli_number\(\)](#), [GiNaC::modular_form_kernel::is_numeric\(\)](#), and [GiNaC::modular_form_kernel::Laurent_series\(\)](#).

5.1.3.744 is_terminating()

```
bool GiNaC::is_terminating (
    const pseries & s ) [inline]
```

References [GiNaC::pseries::is_terminating\(\)](#).

5.1.3.745 make_return_type_t()

```
template<typename T >
return_type_t GiNaC::make_return_type_t (
    const unsigned rl = 0 ) [inline]
```

References [GiNaC::return_type_t::rl](#), and [GiNaC::return_type_t::tinfo](#).

5.1.3.746 set_print_func() [1/2]

```
template<class Alg , class Ctx , class T , class C >
void GiNaC::set_print_func (
    void fconst T &, const C &c, unsigned )
```

Add or replace a print method.

References [options](#).

5.1.3.747 set_print_func() [2/2]

```
template<class Alg , class Ctx , class T , class C >
void GiNaC::set_print_func (
    void(T::*)(const C &, unsigned) f )
```

Add or replace a print method.

References [options](#).

5.1.3.748 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [29/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
    relational ,
    basic ,
    print_func< print_context > &::do_print. print_func< print_tree > &::do_print↵
    _tree. print_func< print_python_repr > &::do_print_python_repr )
```

5.1.3.749 GINAC_BIND_UNARCHIVER() [39/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    relational )
```

5.1.3.750 print_operator()

```
static void GiNaC::print_operator (
    const print_context & c,
    relational::operators o ) [static]
```

References [c](#), [GiNaC::relational::equal](#), [GiNaC::relational::greater](#), [GiNaC::relational::greater_or_equal](#), [GiNaC::relational::less](#), [GiNaC::relational::less_or_equal](#), and [GiNaC::relational::not_equal](#).

Referenced by [GiNaC::relational::do_print\(\)](#), and [GiNaC::relational::do_print_python_repr\(\)](#).

5.1.3.751 GINAC_DECLARE_UNARCHIVER() [41/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    relational )
```

5.1.3.752 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [30/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
    symbol ,
    basic ,
    print_func< print_context > &::do_print. print_func< print_latex > &::do_↵
print_latex. print_func< print_tree > &::do_print_tree. print_func< print_python_repr > &↵
::do_print_python_repr )
```

References [GiNaC::status_flags::evaluated](#), and [GiNaC::status_flags::expanded](#).

5.1.3.753 get_default_TeX_name()

```
static const std::string & GiNaC::get_default_TeX_name (
    const std::string & name ) [static]
```

Return default TeX name for symbol.

This recognizes some greek letters.

Referenced by [GiNaC::symbol::do_print_latex\(\)](#), and [GiNaC::symbol::get_TeX_name\(\)](#).

5.1.3.754 GINAC_BIND_UNARCHIVER() [40/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    symbol )
```

5.1.3.755 GINAC_BIND_UNARCHIVER() [41/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    realsymbol )
```

5.1.3.756 GINAC_BIND_UNARCHIVER() [42/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    possymbol )
```

5.1.3.757 GINAC_DECLARE_UNARCHIVER() [42/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    symbol )
```

5.1.3.758 GINAC_DECLARE_UNARCHIVER() [43/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    realsymbol )
```

5.1.3.759 GINAC_DECLARE_UNARCHIVER() [44/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    possymbol )
```

5.1.3.760 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [31/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
    symmetry ,
    basic ,
    print_func< print\_context > &::do_print, print_func< print\_tree > &::do_print↵
    _tree )
```

References [GiNaC::status_flags::evaluated](#), and [GiNaC::status_flags::expanded](#).

5.1.3.761 GINAC_BIND_UNARCHIVER() [43/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    symmetry )
```

5.1.3.762 index0()

```
static const symmetry & GiNaC::index0 ( ) [static]
```

Referenced by [antisymmetric2\(\)](#), [antisymmetric3\(\)](#), [antisymmetric4\(\)](#), [symmetric2\(\)](#), [symmetric3\(\)](#), and [symmetric4\(\)](#).

5.1.3.763 index1()

```
static const symmetry & GiNaC::index1 ( ) [static]
```

Referenced by [antisymmetric2\(\)](#), [antisymmetric3\(\)](#), [antisymmetric4\(\)](#), [symmetric2\(\)](#), [symmetric3\(\)](#), and [symmetric4\(\)](#).

5.1.3.764 index2()

```
static const symmetry & GiNaC::index2 ( ) [static]
```

Referenced by [antisymmetric3\(\)](#), [antisymmetric4\(\)](#), [symmetric3\(\)](#), and [symmetric4\(\)](#).

5.1.3.765 index3()

```
static const symmetry & GiNaC::index3 ( ) [static]
```

Referenced by [antisymmetric4\(\)](#), and [symmetric4\(\)](#).

5.1.3.766 not_symmetric()

```
const symmetry & GiNaC::not_symmetric ( )
```

Referenced by [GiNaC::indexed::indexed\(\)](#), and [GiNaC::indexed::read_archive\(\)](#).

5.1.3.767 symmetric2()

```
const symmetry & GiNaC::symmetric2 ( )
```

References [index0\(\)](#), [index1\(\)](#), and [GiNaC::symmetry::symmetric](#).

Referenced by [delta_tensor\(\)](#), [GiNaC::clifford::get_metric\(\)](#), [lorentz_g\(\)](#), and [metric_tensor\(\)](#).

5.1.3.768 symmetric3()

```
const symmetry & GiNaC::symmetric3 ( )
```

References [index0\(\)](#), [index1\(\)](#), [index2\(\)](#), and [GiNaC::symmetry::symmetric](#).

Referenced by [color_d\(\)](#).

5.1.3.769 symmetric4()

```
const symmetry & GiNaC::symmetric4 ( )
```

References [index0\(\)](#), [index1\(\)](#), [index2\(\)](#), [index3\(\)](#), and [GiNaC::symmetry::symmetric](#).

5.1.3.770 antisymmetric2()

```
const symmetry & GiNaC::antisymmetric2 ( )
```

References [GiNaC::symmetry::antisymmetric](#), [index0\(\)](#), and [index1\(\)](#).

Referenced by [epsilon_tensor\(\)](#), and [spinor_metric\(\)](#).

5.1.3.771 antisymmetric3()

```
const symmetry & GiNaC::antisymmetric3 ( )
```

References [GiNaC::symmetry::antisymmetric](#), [index0\(\)](#), [index1\(\)](#), and [index2\(\)](#).

Referenced by [color_f\(\)](#), and [epsilon_tensor\(\)](#).

5.1.3.772 antisymmetric4()

```
const symmetry & GiNaC::antisymmetric4 ( )
```

References [GiNaC::symmetry::antisymmetric](#), [index0\(\)](#), [index1\(\)](#), [index2\(\)](#), and [index3\(\)](#).

Referenced by [lorentz_eps\(\)](#).

5.1.3.773 canonicalize()

```
int GiNaC::canonicalize (
    exvector::iterator v,
    const symmetry & symm )
```

Canonicalize the order of elements of an expression vector, according to the symmetry properties defined in a symmetry tree.

Parameters

<i>v</i>	Start of expression vector
<i>symm</i>	Root node of symmetry tree

Returns

the overall sign introduced by the reordering (+1, -1 or 0) or `numeric_limits<int>::max()` if nothing changed

Referenced by [GiNaC::function::eval\(\)](#), and [GiNaC::indexed::eval\(\)](#).

5.1.3.774 symm()

```
static ex GiNaC::symm (
    const ex & e,
    exvector::const_iterator first,
    exvector::const_iterator last,
    bool asymmetric ) [static]
```

References [GiNaC::container< C >::append\(\)](#), [factorial\(\)](#), [last](#), [GiNaC::subs_options::no_index_renaming](#), [GiNaC::subs_options::no_pattern](#), [GiNaC::container< C >::op\(\)](#), [permutation_sign\(\)](#), and [GiNaC::ex::subs\(\)](#).

Referenced by [antisymmetrize\(\)](#), [GiNaC::ex::antisymmetrize\(\)](#), [GiNaC::indexed::read_archive\(\)](#), [symmetrize\(\)](#), and [GiNaC::ex::symmetrize\(\)](#).

5.1.3.775 symmetrize() [3/4]

```
ex GiNaC::symmetrize (
    const ex & e,
    exvector::const_iterator first,
    exvector::const_iterator last )
```

Symmetrize expression over a set of objects (symbols, indices).

References [last](#), and [symm\(\)](#).

5.1.3.776 antisymmetrize() [3/4]

```
ex GiNaC::antisymmetrize (
    const ex & e,
    exvector::const_iterator first,
    exvector::const_iterator last )
```

Antisymmetrize expression over a set of objects (symbols, indices).

References [last](#), and [symm\(\)](#).

5.1.3.777 symmetrize_cyclic() [3/4]

```
ex GiNaC::symmetrize_cyclic (
    const ex & e,
    exvector::const_iterator first,
    exvector::const_iterator last )
```

Symmetrize expression by cyclic permutation over a set of objects (symbols, indices).

References [GiNaC::container< C >::append\(\)](#), [last](#), [GiNaC::subs_options::no_index_renaming](#), [GiNaC::subs_options::no_pattern](#), [GiNaC::container< C >::op\(\)](#), [GiNaC::container< C >::remove_first\(\)](#), and [GiNaC::ex::subs\(\)](#).

5.1.3.778 GINAC_DECLARE_UNARCHIVER() [45/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    symmetry )
```

5.1.3.779 sy_none() [1/4]

```
symmetry GiNaC::sy_none ( ) [inline]
```

5.1.3.780 sy_none() [2/4]

```
symmetry GiNaC::sy_none (
    const symmetry & c1,
    const symmetry & c2 ) [inline]
```

References [GiNaC::symmetry::none](#).

5.1.3.781 sy_none() [3/4]

```
symmetry GiNaC::sy_none (
    const symmetry & c1,
    const symmetry & c2,
    const symmetry & c3 ) [inline]
```

References [GiNaC::symmetry::add\(\)](#), and [GiNaC::symmetry::none](#).

5.1.3.782 sy_none() [4/4]

```
symmetry GiNaC::sy_none (
    const symmetry & c1,
    const symmetry & c2,
    const symmetry & c3,
    const symmetry & c4 ) [inline]
```

References [GiNaC::symmetry::add\(\)](#), and [GiNaC::symmetry::none](#).

5.1.3.783 sy_symm() [1/4]

```
symmetry GiNaC::sy_symm ( ) [inline]
```

References [GiNaC::symmetry::set_type\(\)](#), and [GiNaC::symmetry::symmetric](#).

Referenced by [GiNaC::indexed::read_archive\(\)](#).

5.1.3.784 sy_symm() [2/4]

```
symmetry GiNaC::sy_symm (
    const symmetry & c1,
    const symmetry & c2 ) [inline]
```

References [GiNaC::symmetry::symmetric](#).

5.1.3.785 sy_symm() [3/4]

```
symmetry GiNaC::sy_symm (
    const symmetry & c1,
    const symmetry & c2,
    const symmetry & c3 ) [inline]
```

References [GiNaC::symmetry::add\(\)](#), and [GiNaC::symmetry::symmetric](#).

5.1.3.786 sy_symm() [4/4]

```
symmetry GiNaC::sy_symm (
    const symmetry & c1,
    const symmetry & c2,
    const symmetry & c3,
    const symmetry & c4 ) [inline]
```

References [GiNaC::symmetry::add\(\)](#), and [GiNaC::symmetry::symmetric](#).

5.1.3.787 sy_anti() [1/4]

```
symmetry GiNaC::sy_anti ( ) [inline]
```

References [GiNaC::symmetry::antisymmetric](#), and [GiNaC::symmetry::set_type\(\)](#).

Referenced by [GiNaC::indexed::read_archive\(\)](#).

5.1.3.788 sy_anti() [2/4]

```
symmetry GiNaC::sy_anti (
    const symmetry & c1,
    const symmetry & c2 ) [inline]
```

References [GiNaC::symmetry::antisymmetric](#).

5.1.3.789 sy_anti() [3/4]

```
symmetry GiNaC::sy_anti (
    const symmetry & c1,
    const symmetry & c2,
    const symmetry & c3 ) [inline]
```

References [GiNaC::symmetry::add\(\)](#), and [GiNaC::symmetry::antisymmetric](#).

5.1.3.790 sy_anti() [4/4]

```
symmetry GiNaC::sy_anti (
    const symmetry & c1,
    const symmetry & c2,
    const symmetry & c3,
    const symmetry & c4 ) [inline]
```

References [GiNaC::symmetry::add\(\)](#), and [GiNaC::symmetry::antisymmetric](#).

5.1.3.791 sy_cycl() [1/4]

```
symmetry GiNaC::sy_cycl ( ) [inline]
```

References [GiNaC::symmetry::cyclic](#), and [GiNaC::symmetry::set_type\(\)](#).

5.1.3.792 sy_cycl() [2/4]

```
symmetry GiNaC::sy_cycl (
    const symmetry & c1,
    const symmetry & c2 ) [inline]
```

References [GiNaC::symmetry::cyclic](#).

5.1.3.793 sy_cycl() [3/4]

```
symmetry GiNaC::sy_cycl (
    const symmetry & c1,
    const symmetry & c2,
    const symmetry & c3 ) [inline]
```

References [GiNaC::symmetry::add\(\)](#), and [GiNaC::symmetry::cyclic](#).

5.1.3.794 sy_cycl() [4/4]

```
symmetry GiNaC::sy_cycl (
    const symmetry & c1,
    const symmetry & c2,
    const symmetry & c3,
    const symmetry & c4 ) [inline]
```

References [GiNaC::symmetry::add\(\)](#), and [GiNaC::symmetry::cyclic](#).

5.1.3.795 symmetrize() [4/4]

```
ex GiNaC::symmetrize (
    const ex & e,
    const exvector & v ) [inline]
```

Symmetrize expression over a set of objects (symbols, indices).

References [GiNaC::ex::begin\(\)](#), and [symmetrize\(\)](#).

5.1.3.796 antisymmetrize() [4/4]

```
ex GiNaC::antisymmetrize (
    const ex & e,
    const exvector & v ) [inline]
```

Antisymmetrize expression over a set of objects (symbols, indices).

References [antisymmetrize\(\)](#), and [GiNaC::ex::begin\(\)](#).

5.1.3.797 symmetrize_cyclic() [4/4]

```
ex GiNaC::symmetrize_cyclic (
    const ex & e,
    const exvector & v ) [inline]
```

Symmetrize expression by cyclic permutation over a set of objects (symbols, indices).

References [GiNaC::ex::begin\(\)](#), and [symmetrize\(\)](#).

5.1.3.798 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [32/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
    tensdelta ,
    tensor ,
    print_func< print_dflt > &::do_print. print_func< print_latex > &::do_print_↵
    latex )
```

5.1.3.799 print_func< print_dflt >() [3/3]

```
GiNaC::print_func< print_dflt > (
    &tensmetric::do_print ) &
```

References [GiNaC::status_flags::evaluated](#), and [GiNaC::status_flags::expanded](#).

5.1.3.800 GINAC_BIND_UNARCHIVER() [44/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    minkmetric )
```

5.1.3.801 GINAC_BIND_UNARCHIVER() [45/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    tensepsilon )
```

5.1.3.802 GINAC_BIND_UNARCHIVER() [46/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    tensdelta )
```


5.1.3.803 GINAC_BIND_UNARCHIVER() [47/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    tensmetric )
```

5.1.3.804 GINAC_BIND_UNARCHIVER() [48/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    spinmetric )
```

5.1.3.805 delta_tensor()

```
ex GiNaC::delta_tensor (
    const ex & i1,
    const ex & i2 )
```

Create a delta tensor with specified indices.

The indices must be of class `idx` or a subclass. The delta tensor is always symmetric and its trace is the dimension of the index space.

Parameters

<i>i1</i>	First index
<i>i2</i>	Second index

Returns

newly constructed delta tensor

References [symmetric2\(\)](#).

Referenced by [color_trace\(\)](#), [GiNaC::su3f::contract_with\(\)](#), [GiNaC::su3d::contract_with\(\)](#), [GiNaC::spinmetric::contract_with\(\)](#), [GiNaC::tensepsilon::contract_with\(\)](#), and [GiNaC::tensmetric::eval_indexed\(\)](#).

5.1.3.806 metric_tensor()

```
ex GiNaC::metric_tensor (
    const ex & i1,
    const ex & i2 )
```

Create a symmetric metric tensor with specified indices.

The indices must be of class `varidx` or a subclass. A metric tensor with one covariant and one contravariant index is equivalent to the delta tensor.

Parameters

<i>i1</i>	First index
<i>i2</i>	Second index

Returns

newly constructed metric tensor

References [symmetric2\(\)](#).

Referenced by [GiNaC::tensepsilon::contract_with\(\)](#).

5.1.3.807 lorentz_g()

```
ex GiNaC::lorentz_g (
    const ex & i1,
    const ex & i2,
    bool pos_sig = false )
```

Create a Minkowski metric tensor with specified indices.

The indices must be of class `varidx` or a subclass. The Lorentz metric is a symmetric tensor with a matrix representation of `diag(1,-1,-1,...)` (negative signature, the default) or `diag(-1,1,1,...)` (positive signature).

Parameters

<i>i1</i>	First index
<i>i2</i>	Second index
<i>pos_sig</i>	Whether the signature is positive

Returns

newly constructed Lorentz metric tensor

References [symmetric2\(\)](#).

Referenced by [GiNaC::tensepsilon::contract_with\(\)](#).

5.1.3.808 spinor_metric()

```
ex GiNaC::spinor_metric (
    const ex & i1,
    const ex & i2 )
```

Create a spinor metric tensor with specified indices.

The indices must be of class `spinidx` or a subclass and have a dimension of 2. The spinor metric is an antisymmetric tensor with a matrix representation of `[[[0, 1], [-1, 0]]]`.

Parameters

<i>i1</i>	First index
<i>i2</i>	Second index

Returns

newly constructed spinor metric tensor

References [antisymmetric2\(\)](#).

5.1.3.809 epsilon_tensor() [1/2]

```
ex GiNaC::epsilon_tensor (
    const ex & i1,
    const ex & i2 )
```

Create an epsilon tensor in a Euclidean space with two indices.

The indices must be of class `idx` or a subclass, and have a dimension of 2.

Parameters

<i>i1</i>	First index
<i>i2</i>	Second index

Returns

newly constructed epsilon tensor

References [_ex2](#), [antisymmetric2\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::is_equal\(\)](#), and [GiNaC::ex::op\(\)](#).

5.1.3.810 epsilon_tensor() [2/2]

```
ex GiNaC::epsilon_tensor (
    const ex & i1,
    const ex & i2,
    const ex & i3 )
```

Create an epsilon tensor in a Euclidean space with three indices.

The indices must be of class `idx` or a subclass, and have a dimension of 3.

Parameters

<i>i1</i>	First index
<i>i2</i>	Second index
<i>i3</i>	Third index

Returns

newly constructed epsilon tensor

References [_ex3](#), [antisymmetric3\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::is_equal\(\)](#), and [GiNaC::ex::op\(\)](#).

5.1.3.811 lorentz_eps()

```
ex GiNaC::lorentz_eps (
    const ex & i1,
    const ex & i2,
    const ex & i3,
    const ex & i4,
    bool pos_sig = false )
```

Create an epsilon tensor in a Minkowski space with four indices.

The indices must be of class varidx or a subclass, and have a dimension of 4.

Parameters

<i>i1</i>	First index
<i>i2</i>	Second index
<i>i3</i>	Third index
<i>i4</i>	Fourth index
<i>pos_sig</i>	Whether the signature of the metric is positive

Returns

newly constructed epsilon tensor

References [_ex4](#), [antisymmetric4\(\)](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::is_equal\(\)](#), and [GiNaC::ex::op\(\)](#).

5.1.3.812 GINAC_DECLARE_UNARCHIVER() [46/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    tensdelta )
```

5.1.3.813 GINAC_DECLARE_UNARCHIVER() [47/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    tensmetric )
```

5.1.3.814 GINAC_DECLARE_UNARCHIVER() [48/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    minkmetric )
```

5.1.3.815 GINAC_DECLARE_UNARCHIVER() [49/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    spinmetric )
```

5.1.3.816 GINAC_DECLARE_UNARCHIVER() [50/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    tensepsilon )
```

5.1.3.817 log2()

```
unsigned GiNaC::log2 (
    unsigned n )
```

Integer binary logarithm.

References [k](#), and [n](#).

Referenced by [GiNaC::remember_table::remember_table\(\)](#).

5.1.3.818 multinomial_coefficient()

```
const numeric GiNaC::multinomial_coefficient (
    const std::vector< unsigned > & p )
```

Compute the multinomial coefficient $n!/(p_1! * p_2! * \dots * p_k!)$ where $n = p_1 + p_2 + \dots + p_k$, i.e.

p is a partition of *n*.

References [GiNaC::numeric::div\(\)](#), [factorial\(\)](#), and [n](#).

Referenced by [GiNaC::power::expand_add\(\)](#).

5.1.3.819 rotate_left()

```
unsigned GiNaC::rotate_left (
    unsigned n ) [inline]
```

Rotate bits of unsigned value by one bit to the left.

This can be necessary if the user wants to define its own hashes.

References [n](#).

Referenced by [GiNaC::basic::calchash\(\)](#), [GiNaC::expairseq::calchash\(\)](#), [GiNaC::function::calchash\(\)](#), [GiNaC::idx::calchash\(\)](#), [GiNaC::relational::calchash\(\)](#), and [GiNaC::symmetry::calchash\(\)](#).

5.1.3.820 compare_pointers()

```
template<class T >
int GiNaC::compare_pointers (
    const T * a,
    const T * b ) [inline]
```

Compare two pointers (just to establish some sort of canonical order).

Returns

-1, 0, or 1

Referenced by [GiNaC::basic::compare_same_type\(\)](#).

5.1.3.821 golden_ratio_hash()

```
unsigned GiNaC::golden_ratio_hash (
    uintptr_t n ) [inline]
```

Truncated multiplication with golden ratio, for computing hash values.

References [n](#).

Referenced by [GiNaC::constant::calchash\(\)](#), [GiNaC::function::calchash\(\)](#), [GiNaC::numeric::calchash\(\)](#), [GiNaC::symbol::calchash\(\)](#), [GiNaC::wildcard::calchash\(\)](#), and [make_hash_seed\(\)](#).

5.1.3.822 permutation_sign() [1/2]

```
template<class It >
int GiNaC::permutation_sign (
    It first,
    It last )
```

References [last](#), [swap\(\)](#), and [std::swap\(\)](#).

Referenced by [GiNaC::matrix::determinant\(\)](#), [GiNaC::tensepsilon::eval_indexed\(\)](#), and [symm\(\)](#).

5.1.3.823 permutation_sign() [2/2]

```
template<class It , class Cmp , class Swap >
int GiNaC::permutation_sign (
    It first,
    It last,
    Cmp comp,
    Swap swapit )
```

References [last](#).

5.1.3.824 shaker_sort()

```
template<class It , class Cmp , class Swap >
void GiNaC::shaker_sort (
    It first,
    It last,
    Cmp comp,
    Swap swapit )
```

References [last](#).

Referenced by [find_free_and_dummy\(\)](#), and [rename_dummy_indices\(\)](#).

5.1.3.825 cyclic_permutation()

```
template<class It , class Swap >
void GiNaC::cyclic_permutation (
    It first,
    It last,
    It new_first,
    Swap swapit )
```

References [last](#).

5.1.3.826 format_index_value() [1/2]

```
template<typename T >
std::enable_if< has\_distance< T >::value, typename std::iterator_traits< T >::difference_type
>::type GiNaC::format_index_value (
    const T & a,
    const T & b )
```

For printing a multi-index: If the templates are used, where T is an iterator, printing the address where the iterator points to is not meaningful.

However, we may print the difference to the starting point.

Referenced by [operator<<\(\)](#).

5.1.3.827 format_index_value() [2/2]

```
template<typename T >
std::enable_if<!has\_distance< T >::value, T >::type GiNaC::format_index_value (
    const T & a,
    const T & b )
```

For all other cases we simply print the value.

5.1.3.828 operator<<() [8/16]

```
template<class T >
std::ostream & GiNaC::operator<< (
    std::ostream & os,
    const basic\_multi\_iterator< T > & v ) [inline]
```

Output operator.

A multi_iterator prints out as [basic_multi_iterator](#)(n_0, n_1, \dots).

References [GiNaC::basic_multi_iterator< T >::B](#), [format_index_value\(\)](#), and [GiNaC::basic_multi_iterator< T >::size\(\)](#).

5.1.3.829 operator<<() [9/16]

```
template<class T >
std::ostream & GiNaC::operator<< (
    std::ostream & os,
    const multi\_iterator\_ordered< T > & v ) [inline]
```

Output operator.

A [multi_iterator_ordered](#) prints out as [multi_iterator_ordered](#)(n_0, n_1, \dots).

References [GiNaC::basic_multi_iterator< T >::B](#), [format_index_value\(\)](#), and [GiNaC::basic_multi_iterator< T >::size\(\)](#).

5.1.3.830 operator<<() [10/16]

```
template<class T >
std::ostream & GiNaC::operator<< (
    std::ostream & os,
    const multi_iterator_ordered_eq< T > & v ) [inline]
```

Output operator.

A `multi_iterator_ordered_eq` prints out as `multi_iterator_ordered_eq(n_0, n_1, \dots)`.

References [GiNaC::basic_multi_iterator< T >::B](#), [format_index_value\(\)](#), and [GiNaC::basic_multi_iterator< T >::size\(\)](#).

5.1.3.831 operator<<() [11/16]

```
template<class T >
std::ostream & GiNaC::operator<< (
    std::ostream & os,
    const multi_iterator_ordered_eq_indv< T > & v ) [inline]
```

Output operator.

A `multi_iterator_ordered_eq_indv` prints out as `multi_iterator_ordered_eq_indv(n_0, n_1, \dots)`.

References [GiNaC::basic_multi_iterator< T >::B](#), [format_index_value\(\)](#), and [GiNaC::basic_multi_iterator< T >::size\(\)](#).

5.1.3.832 operator<<() [12/16]

```
template<class T >
std::ostream & GiNaC::operator<< (
    std::ostream & os,
    const multi_iterator_counter< T > & v ) [inline]
```

Output operator.

A `multi_iterator_counter` prints out as `multi_iterator_counter(n_0, n_1, \dots)`.

References [GiNaC::basic_multi_iterator< T >::B](#), [format_index_value\(\)](#), and [GiNaC::basic_multi_iterator< T >::size\(\)](#).

5.1.3.833 operator<<() [13/16]

```
template<class T >
std::ostream & GiNaC::operator<< (
    std::ostream & os,
    const multi_iterator_counter_indv< T > & v ) [inline]
```

Output operator.

A `multi_iterator_counter_indv` prints out as `multi_iterator_counter_indv(n_0, n_1, \dots)`.

References [GiNaC::basic_multi_iterator< T >::B](#), [format_index_value\(\)](#), and [GiNaC::basic_multi_iterator< T >::size\(\)](#).

5.1.3.834 operator<<() [14/16]

```
template<class T >
std::ostream & GiNaC::operator<< (
    std::ostream & os,
    const multi_iterator_permutation< T > & v ) [inline]
```

Output operator.

A `multi_iterator_permutation` prints out as `multi_iterator_permutation(n_0, n_1, \dots)`.

References [GiNaC::basic_multi_iterator< T >::B](#), [format_index_value\(\)](#), and [GiNaC::basic_multi_iterator< T >::size\(\)](#).

5.1.3.835 operator<<() [15/16]

```
template<class T >
std::ostream & GiNaC::operator<< (
    std::ostream & os,
    const multi_iterator_shuffle< T > & v ) [inline]
```

Output operator.

A `multi_iterator_shuffle` prints out as `multi_iterator_shuffle(n_0, n_1, \dots)`.

References [GiNaC::basic_multi_iterator< T >::B](#), [format_index_value\(\)](#), and [GiNaC::basic_multi_iterator< T >::size\(\)](#).

5.1.3.836 operator<<() [16/16]

```
template<class T >
std::ostream & GiNaC::operator<< (
    std::ostream & os,
    const multi_iterator_shuffle_prime< T > & v ) [inline]
```

Output operator.

A `multi_iterator_shuffle_prime` prints out as `multi_iterator_shuffle_prime(n_0, n_1, \dots)`.

References [GiNaC::basic_multi_iterator< T >::B](#), [format_index_value\(\)](#), and [GiNaC::basic_multi_iterator< T >::size\(\)](#).

5.1.3.837 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT() [33/33]

```
GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT (
    wildcard ,
    basic ,
    print_func< print_context > &::do_print. print_func< print_tree > &::do_print↔
    _tree. print_func< print_python_repr > &::do_print_python_repr )
```

References [GiNaC::status_flags::evaluated](#), and [GiNaC::status_flags::expanded](#).

5.1.3.838 GINAC_BIND_UNARCHIVER() [49/49]

```
GiNaC::GINAC_BIND_UNARCHIVER (
    wildcard )
```

5.1.3.839 haswild()

```
bool GiNaC::haswild (
    const ex & x )
```

Check whether x has a wildcard anywhere as a subexpression.

References [haswild\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), and [x](#).

Referenced by [GiNaC::integral::eval\(\)](#), and [haswild\(\)](#).

5.1.3.840 GINAC_DECLARE_UNARCHIVER() [51/51]

```
GiNaC::GINAC_DECLARE_UNARCHIVER (
    wildcard )
```

5.1.3.841 wild()

```
ex GiNaC::wild (
    unsigned label = 0 ) [inline]
```

Create a wildcard object with the specified label.

5.1.4 Variable Documentation

5.1.4.1 unarch_table_instance

```
unarchive_table_t GiNaC::unarch_table_instance [static]
```

5.1.4.2 map_evalm

`GiNaC::evalm_map_function` `GiNaC::map_evalm`

Referenced by [GiNaC::basic::evalm\(\)](#).

5.1.4.3 map_eval_integ

`GiNaC::eval_integ_map_function` `GiNaC::map_eval_integ`

Referenced by [GiNaC::basic::eval_integ\(\)](#).

5.1.4.4 tensor

`GiNaC::tensor`

5.1.4.5 Pi

```
const constant GiNaC::Pi (
    "Pi" ,
    PiEvalf ,
    "\\pi" ,
    domain::positive )
```

Pi.

(3.14159...) Diverts straight into CLN for [evalf\(\)](#).

Referenced by [acos_eval\(\)](#), [acosh_eval\(\)](#), [asin_eval\(\)](#), [atan2_eval\(\)](#), [atan_eval\(\)](#), [atan_series\(\)](#), [atanh_series\(\)](#), [GiNaC::Eisenstein_h_kernel::coefficient_a0\(\)](#), [GiNaC::Eisenstein_h_kernel::coefficient_an\(\)](#), [cos_eval\(\)](#), [cosh_eval\(\)](#), [EllipticE_eval\(\)](#), [EllipticE_evalf\(\)](#), [EllipticE_series\(\)](#), [EllipticK_eval\(\)](#), [EllipticK_evalf\(\)](#), [EllipticK_series\(\)](#), [eta_eval\(\)](#), [eta_evalf\(\)](#), [exp_eval\(\)](#), [GiNaC::Kronecker_dtau_kernel::get_numerical_value\(\)](#), [GiNaC::Kronecker_dz_kernel::get_numerical_value\(\)](#), [H_evalf\(\)](#), [Li2_eval\(\)](#), [Li2_series\(\)](#), [Li_eval\(\)](#), [log_eval\(\)](#), [log_series\(\)](#), [GiNaC::constant::read_archive\(\)](#), [GiNaC::Kronecker_dtau_kernel::series_coeff_impl\(\)](#), [sin_eval\(\)](#), [sinh_eval\(\)](#), [tan_eval\(\)](#), [tan_series\(\)](#), [tanh_eval\(\)](#), [tanh_series\(\)](#), [tgamma_eval\(\)](#), and [zeta1_eval\(\)](#).

5.1.4.6 Euler

```
const constant GiNaC::Euler (
    "Euler" ,
    EulerEvalf ,
    "\\gamma_E" ,
    domain::positive )
```

Euler's constant.

(0.57721...) Sometimes called Euler-Mascheroni constant. Diverts straight into CLN for [evalf\(\)](#).

Referenced by [psi1_eval\(\)](#), and [GiNaC::constant::read_archive\(\)](#).

5.1.4.7 Catalan

```
const constant GiNaC::Catalan (
    "Catalan" ,
    CatalanEvalf ,
    "G" ,
    domain::positive )
```

Catalan's constant.

(0.91597...) Diverts straight into CLN for [evalf\(\)](#).

Referenced by [Li2_eval\(\)](#), [Li_eval\(\)](#), and [GiNaC::constant::read_archive\(\)](#).

5.1.4.8 crctab

```
unsigned const GiNaC::crctab[256] [static]
```

Referenced by [crc32\(\)](#).

5.1.4.9 library_initializer

```
library\_init GiNaC::library_initializer [static]
```

For construction of flyweights, etc.

5.1.4.10 _num0_bp

```
const basic * GiNaC::_num0_bp
```

Referenced by [GiNaC::library_init::library_init\(\)](#).

5.1.4.11 idx

```
GiNaC::idx
```

5.1.4.12 force_include_tgamma

```
unsigned GiNaC::force_include_tgamma = tgamma\_SERIAL::serial
```

5.1.4.13 `force_include_zeta1`

```
unsigned GiNaC::force_include_zeta1 = zeta1_SERIAL::serial
```

5.1.4.14 `GINAC_BIND_UNARCHIVER`

```
template<>
GINAC_IMPLEMENT_REGISTERED_CLASS_OPT_T(lst, basic, print_func< print_context >(&lst::do_print).
print_func< print_tree >(&lst::do_print_tree)) template<> bool lst GiNaC::GINAC_BIND_UNARCHIVER(lst)
(
    lst )
```

Specialization of `container::info()` for `lst`.

5.1.4.15 `I`

```
const numeric GiNaC::I = numeric(cln::complex(cln::cl_I(0),cln::cl_I(1)))
```

Imaginary unit.

This is not a constant but a numeric since we are natively handing complex numbers anyways, so in each expression containing an `I` it is automatically eval'ed away anyhow.

Referenced by `acosh_eval()`, `atan_eval()`, `atan_series()`, `atanh_series()`, `GiNaC::Eisenstein_h_kernel::coefficient_a0()`, `GiNaC::Eisenstein_h_kernel::coefficient_an()`, `color_h()`, `GiNaC::su3f::contract_with()`, `cosh_eval()`, `csgn_eval()`, `eta_eval()`, `eta_evalf()`, `eta_imag_part()`, `exp_eval()`, `GiNaC::Kronecker_dtau_kernel::get_numerical_value()`, `GiNaC::Kronecker_dz_kernel::get_numerical_value()`, `H_evalf()`, `GiNaC::numeric::has()`, `Li2_eval()`, `Li2_series()`, `Li_eval()`, `log_eval()`, `log_series()`, `GiNaC::numeric::normal()`, `GiNaC::Kronecker_dtau_kernel::series_coeff_impl()`, `GiNaC::Kronecker_dz_kernel::series_coeff_impl()`, `sinh_eval()`, `step_eval()`, `tanh_eval()`, `tanh_series()`, `GiNaC::numeric::to_polynomial()` and `GiNaC::numeric::to_rational()`.

5.1.4.16 `Digits`

```
_numeric_digits GiNaC::Digits
```

Accuracy in decimal digits.

Only object of this type! Can be set using assignment from C++ unsigned ints and evaluated like any built-in type.

Referenced by `GiNaC::integration_kernel::get_numerical_value_impl()`, `iterated_integral_evalf_impl()`, `GiNaC::numeric::numeric()`, `print_real_cl_N()`, and `zeta1_evalf()`.

5.1.4.17 next_print_context_id

```
unsigned GiNaC::next_print_context_id = 0
```

Next free ID for [print_context](#) types.

5.1.4.18 version_major

```
const int GiNaC::version_major = GINACLIB_MAJOR_VERSION
```

5.1.4.19 version_minor

```
const int GiNaC::version_minor = GINACLIB_MINOR_VERSION
```

5.1.4.20 version_micro

```
const int GiNaC::version_micro = GINACLIB_MICRO_VERSION
```

5.1.4.21 _num_120_p

```
const numeric * GiNaC::_num_120_p
```

Referenced by [GiNaC::library_init::library_init\(\)](#).

5.1.4.22 _ex_120

```
const ex GiNaC::_ex_120 = ex(*_num_120_p)
```

Referenced by [GiNaC::library_init::library_init\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.23 _num_60_p

```
const numeric * GiNaC::_num_60_p
```

Referenced by [GiNaC::library_init::library_init\(\)](#).

5.1.4.24 `_ex_60`

```
const ex GiNaC::_ex_60 = ex(*\_num\_60\_p)
```

Referenced by [GiNaC::library_init::library_init\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.25 `_num_48_p`

```
const numeric * GiNaC::_num_48_p
```

Referenced by [GiNaC::library_init::library_init\(\)](#).

5.1.4.26 `_ex_48`

```
const ex GiNaC::_ex_48 = ex(*\_num\_48\_p)
```

Referenced by [Li2_eval\(\)](#), [Li_eval\(\)](#), [GiNaC::library_init::library_init\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.27 `_num_30_p`

```
const numeric * GiNaC::_num_30_p
```

Referenced by [GiNaC::library_init::library_init\(\)](#).

5.1.4.28 `_ex_30`

```
const ex GiNaC::_ex_30 = ex(*\_num\_30\_p)
```

Referenced by [GiNaC::library_init::library_init\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.29 `_num_25_p`

```
const numeric * GiNaC::_num_25_p
```

Referenced by [GiNaC::library_init::library_init\(\)](#).

5.1.4.30 `_ex_25`

```
const ex GiNaC::_ex_25 = ex(*_num_25_p)
```

Referenced by [GiNaC::library_init::library_init\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.31 `_num_24_p`

```
const numeric * GiNaC::_num_24_p
```

Referenced by [GiNaC::library_init::library_init\(\)](#).

5.1.4.32 `_ex_24`

```
const ex GiNaC::_ex_24 = ex(*_num_24_p)
```

Referenced by [GiNaC::library_init::library_init\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.33 `_num_20_p`

```
const numeric * GiNaC::_num_20_p
```

Referenced by [GiNaC::library_init::library_init\(\)](#).

5.1.4.34 `_ex_20`

```
const ex GiNaC::_ex_20 = ex(*_num_20_p)
```

Referenced by [GiNaC::library_init::library_init\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.35 `_num_18_p`

```
const numeric * GiNaC::_num_18_p
```

Referenced by [GiNaC::library_init::library_init\(\)](#).

5.1.4.36 `_ex_18`

```
const ex GiNaC::_ex_18 = ex(*_num_18_p)
```

Referenced by [GiNaC::library_init::library_init\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.37 `_num_15_p`

```
const numeric * GiNaC::_num_15_p
```

Referenced by [GiNaC::library_init::library_init\(\)](#).

5.1.4.38 `_ex_15`

```
const ex GiNaC::_ex_15 = ex(*_num_15_p)
```

Referenced by [GiNaC::library_init::library_init\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.39 `_num_12_p`

```
const numeric * GiNaC::_num_12_p
```

Referenced by [GiNaC::ex::construct_from_int\(\)](#), [GiNaC::ex::construct_from_long\(\)](#), and [GiNaC::library_init::library_init\(\)](#).

5.1.4.40 `_ex_12`

```
const ex GiNaC::_ex_12 = ex(*_num_12_p)
```

Referenced by [GiNaC::library_init::library_init\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.41 `_num_11_p`

```
const numeric * GiNaC::_num_11_p
```

Referenced by [GiNaC::ex::construct_from_int\(\)](#), [GiNaC::ex::construct_from_long\(\)](#), and [GiNaC::library_init::library_init\(\)](#).

5.1.4.42 `_ex_11`

```
const ex GiNaC::_ex_11 = ex(*_num_11_p)
```

Referenced by [GiNaC::library_init::library_init\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.43 `_num_10_p`

```
const numeric * GiNaC::_num_10_p
```

Referenced by [GiNaC::ex::construct_from_int\(\)](#), [GiNaC::ex::construct_from_long\(\)](#), and [GiNaC::library_init::library_init\(\)](#).

5.1.4.44 `_ex_10`

```
const ex GiNaC::_ex_10 = ex(*_num_10_p)
```

Referenced by [GiNaC::library_init::library_init\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.45 `_num_9_p`

```
const numeric * GiNaC::_num_9_p
```

Referenced by [GiNaC::ex::construct_from_int\(\)](#), [GiNaC::ex::construct_from_long\(\)](#), and [GiNaC::library_init::library_init\(\)](#).

5.1.4.46 `_ex_9`

```
const ex GiNaC::_ex_9 = ex(*_num_9_p)
```

Referenced by [GiNaC::library_init::library_init\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.47 `_num_8_p`

```
const numeric * GiNaC::_num_8_p
```

Referenced by [GiNaC::ex::construct_from_int\(\)](#), [GiNaC::ex::construct_from_long\(\)](#), and [GiNaC::library_init::library_init\(\)](#).

5.1.4.48 `_ex_8`

```
const ex GiNaC::_ex_8 = ex(*_num_8_p)
```

Referenced by [GiNaC::library_init::library_init\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.49 `_num_7_p`

```
const numeric * GiNaC::_num_7_p
```

Referenced by [GiNaC::ex::construct_from_int\(\)](#), [GiNaC::ex::construct_from_long\(\)](#), and [GiNaC::library_init::library_init\(\)](#).

5.1.4.50 `_ex_7`

```
const ex GiNaC::_ex_7 = ex(*_num_7_p)
```

Referenced by [GiNaC::library_init::library_init\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.51 `_num_6_p`

```
const numeric * GiNaC::_num_6_p
```

Referenced by [GiNaC::ex::construct_from_int\(\)](#), [GiNaC::ex::construct_from_long\(\)](#), and [GiNaC::library_init::library_init\(\)](#).

5.1.4.52 `_ex_6`

```
const ex GiNaC::_ex_6 = ex(*_num_6_p)
```

Referenced by [GiNaC::su3d::eval_indexed\(\)](#), [GiNaC::library_init::library_init\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.53 `_num_5_p`

```
const numeric * GiNaC::_num_5_p
```

Referenced by [GiNaC::ex::construct_from_int\(\)](#), [GiNaC::ex::construct_from_long\(\)](#), and [GiNaC::library_init::library_init\(\)](#).

5.1.4.54 `_ex_5`

```
const ex GiNaC::_ex_5 = ex(*_num_5_p)
```

Referenced by [GiNaC::library_init::library_init\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.55 `_num_4_p`

```
const numeric * GiNaC::_num_4_p
```

Referenced by [GiNaC::ex::construct_from_int\(\)](#), [GiNaC::ex::construct_from_long\(\)](#), and [GiNaC::library_init::library_init\(\)](#).

5.1.4.56 `_ex_4`

```
const ex GiNaC::_ex_4 = ex(*_num_4_p)
```

Referenced by [GiNaC::library_init::library_init\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.57 `_num_3_p`

```
const numeric * GiNaC::_num_3_p
```

Referenced by [GiNaC::ex::construct_from_int\(\)](#), [GiNaC::ex::construct_from_long\(\)](#), and [GiNaC::library_init::library_init\(\)](#).

5.1.4.58 `_ex_3`

```
const ex GiNaC::_ex_3 = ex(*_num_3_p)
```

Referenced by [GiNaC::library_init::library_init\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.59 `_num_2_p`

```
const numeric * GiNaC::_num_2_p
```

Referenced by [GiNaC::ex::construct_from_int\(\)](#), [GiNaC::ex::construct_from_long\(\)](#), [GiNaC::library_init::library_init\(\)](#), and [tgamma_eval\(\)](#).

5.1.4.60 `_ex_2`

```
const ex GiNaC::_ex_2 = ex(*\_num\_2\_p)
```

Referenced by [GiNaC::spinmetric::contract_with\(\)](#), [GiNaC::library_init::library_init\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.61 `_num_1_p`

```
const numeric * GiNaC::_num_1_p
```

Referenced by [acos_conjugate\(\)](#), [asin_conjugate\(\)](#), [asinh_conjugate\(\)](#), [atan_conjugate\(\)](#), [atanh_conjugate\(\)](#), [beta_eval\(\)](#), [binomial\(\)](#), [GiNaC::ex::construct_from_int\(\)](#), [GiNaC::ex::construct_from_long\(\)](#), [GiNaC::add::do_print_csrc\(\)](#), [doublefactorial\(\)](#), [GiNaC::mul::eval\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::library_init::library_init\(\)](#), [operator-\(\)](#), [operator--\(\)](#), [GiNaC::add::print_add\(\)](#), [GiNaC::mul::print_overall_coeff\(\)](#), [psi1_eval\(\)](#), and [psi2_eval\(\)](#).

5.1.4.62 `_ex_1`

```
const ex GiNaC::_ex_1 = ex(*\_num\_1\_p)
```

Referenced by [acos_eval\(\)](#), [acosh_deriv\(\)](#), [acosh_eval\(\)](#), [asin_eval\(\)](#), [atan2_deriv\(\)](#), [atan_deriv\(\)](#), [atan_eval\(\)](#), [atan_series\(\)](#), [atanh_deriv\(\)](#), [atanh_eval\(\)](#), [atanh_series\(\)](#), [cos_eval\(\)](#), [GiNaC::power::derivative\(\)](#), [GiNaC::add::do_print_csrc\(\)](#), [GiNaC::mul::do_print_csrc\(\)](#), [GiNaC::power::do_print_csrc\(\)](#), [GiNaC::power::do_print_csrc_cl_N\(\)](#), [EllipticE_eval\(\)](#), [EllipticE_series\(\)](#), [EllipticK_series\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::minkmetric::eval_indexed\(\)](#), [GiNaC::spinmetric::eval_indexed\(\)](#), [exminus\(\)](#), [exp_eval\(\)](#), [exp_power\(\)](#), [GiNaC::power::expand\(\)](#), [frac_cancel\(\)](#), [H_deriv\(\)](#), [H_eval\(\)](#), [lgamma_eval\(\)](#), [Li2_eval\(\)](#), [Li_eval\(\)](#), [GiNaC::library_init::library_init\(\)](#), [log_deriv\(\)](#), [log_expand\(\)](#), [log_series\(\)](#), [operator-\(\)](#), [operator/\(\)](#), [operator/=\(\(\)\)](#), [psi1_series\(\)](#), [psi2_eval\(\)](#), [psi2_series\(\)](#), [replace_with_symbol\(\)](#), [sin_eval\(\)](#), [tan_eval\(\)](#), [tanh_eval\(\)](#), [GiNaC::power::to_polynomial\(\)](#), [GiNaC::ex::unit\(\)](#), [GiNaC::ex::unitcontprim\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.63 `_num_1_2_p`

```
const numeric * GiNaC::_num_1_2_p
```

Referenced by [GiNaC::library_init::library_init\(\)](#).

5.1.4.64 `_ex_1_2`

```
const ex GiNaC::_ex_1_2 = ex(*\_num\_1\_2\_p)
```

Referenced by [acos_deriv\(\)](#), [acos_eval\(\)](#), [acosh_deriv\(\)](#), [asin_deriv\(\)](#), [asin_eval\(\)](#), [asinh_deriv\(\)](#), [atan2_eval\(\)](#), [atan_series\(\)](#), [atanh_series\(\)](#), [cos_eval\(\)](#), [cosh_eval\(\)](#), [GiNaC::su3f::eval_indexed\(\)](#), [GiNaC::su3d::eval_indexed\(\)](#), [Li2_eval\(\)](#), [GiNaC::library_init::library_init\(\)](#), [log_eval\(\)](#), [sin_eval\(\)](#), [sinh_eval\(\)](#), [tan_eval\(\)](#), [tanh_eval\(\)](#), [zeta1_eval\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.65 `_num_1_3_p`

```
const numeric * GiNaC::_num_1_3_p
```

Referenced by [GiNaC::library_init::library_init\(\)](#).

5.1.4.66 `_ex_1_3`

```
const ex GiNaC::_ex_1_3 = ex(*_num_1_3_p)
```

Referenced by [cos_eval\(\)](#), [GiNaC::su3d::eval_indexed\(\)](#), [GiNaC::library_init::library_init\(\)](#), [sin_eval\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.67 `_num_1_4_p`

```
const numeric * GiNaC::_num_1_4_p
```

Referenced by [GiNaC::library_init::library_init\(\)](#).

5.1.4.68 `_ex_1_4`

```
const ex GiNaC::_ex_1_4 = ex(*_num_1_4_p)
```

Referenced by [atan2_eval\(\)](#), [atan_eval\(\)](#), [cos_eval\(\)](#), [GiNaC::library_init::library_init\(\)](#), [sin_eval\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.69 `_num0_p`

```
const numeric * GiNaC::_num0_p
```

Referenced by [GiNaC::numeric::add_dyn\(\)](#), [atan\(\)](#), [binomial\(\)](#), [GiNaC::ex::construct_from_int\(\)](#), [GiNaC::ex::construct_from_long\(\)](#), [GiNaC::ex::construct_from_uint\(\)](#), [GiNaC::ex::construct_from_ulong\(\)](#), [cos_eval\(\)](#), [divide_in_z\(\)](#), [GiNaC::power::eval\(\)](#), [exp_eval\(\)](#), [GiNaC::mul::expand\(\)](#), [fibonacci\(\)](#), [GiNaC::numeric::has\(\)](#), [GiNaC::add::integer_content\(\)](#), [iquo\(\)](#), [irem\(\)](#), [isqrt\(\)](#), [Li2\(\)](#), [GiNaC::library_init::library_init\(\)](#), [mod\(\)](#), [GiNaC::relational::operator safe_bool\(\)](#), [GiNaC::numeric::power\(\)](#), [GiNaC::numeric::power_dyn\(\)](#), [sin_eval\(\)](#), [smod\(\)](#), [GiNaC::numeric::sub_dyn\(\)](#), and [tan_eval\(\)](#).

5.1.4.70 `_ex0`

```
const ex GiNaC::_ex0 = ex(*\_num0\_p)
```

Referenced by [acos_eval\(\)](#), [acosh_eval\(\)](#), [GiNaC::add::add\(\)](#), [GiNaC::pseries::add_series\(\)](#), [asinh_eval\(\)](#), [atan2_eval\(\)](#), [atan_eval\(\)](#), [atan_series\(\)](#), [atanh_eval\(\)](#), [atanh_series\(\)](#), [beta_eval\(\)](#), [binomial_sym\(\)](#), [GiNaC::relational::canonical\(\)](#), [GiNaC::basic::coeff\(\)](#), [GiNaC::add::coeff\(\)](#), [GiNaC::mul::coeff\(\)](#), [GiNaC::ncmul::coeff\(\)](#), [GiNaC::numeric::coeff\(\)](#), [GiNaC::power::coeff\(\)](#), [GiNaC::pseries::coeff\(\)](#), [GiNaC::basic::collect\(\)](#), [color_trace\(\)](#), [GiNaC::ex::content\(\)](#), [cos_eval\(\)](#), [csgn_series\(\)](#), [GiNaC::expairseq::default_overall_coeff\(\)](#), [GiNaC::basic::derivative\(\)](#), [GiNaC::constant::derivative\(\)](#), [GiNaC::idx::derivative\(\)](#), [GiNaC::indexed::derivative\(\)](#), [GiNaC::symbol::derivative\(\)](#), [GiNaC::matrix::determinant\(\)](#), [GiNaC::matrix::determinant_minor\(\)](#), [divide\(\)](#), [divide_in_z\(\)](#), [GiNaC::matrix::division_free_elimination\(\)](#), [EllipticE_eval\(\)](#), [EllipticE_series\(\)](#), [EllipticK_eval\(\)](#), [EllipticK_series\(\)](#), [eta_eval\(\)](#), [eta_evalf\(\)](#), [eta_series\(\)](#), [GiNaC::function::eval\(\)](#), [GiNaC::indexed::eval\(\)](#), [GiNaC::integral::eval\(\)](#), [GiNaC::mul::eval\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::su3f::eval_indexed\(\)](#), [GiNaC::su3d::eval_indexed\(\)](#), [GiNaC::tensdelta::eval_indexed\(\)](#), [GiNaC::minkmetric::eval_indexed\(\)](#), [GiNaC::spinmetric::eval_indexed\(\)](#), [GiNaC::tensepsilon::eval_indexed\(\)](#), [GiNaC::indexed::expand\(\)](#), [find_common_factor\(\)](#), [GiNaC::matrix::fraction_free_elimination\(\)](#), [G2_eval\(\)](#), [G2_evalf\(\)](#), [G3_eval\(\)](#), [G3_evalf\(\)](#), [GiNaC::matrix::gauss_elimination\(\)](#), [gcd\(\)](#), [H_deriv\(\)](#), [H_eval\(\)](#), [GiNaC::ex::is_zero\(\)](#), [Li2_eval\(\)](#), [Li2_series\(\)](#), [Li_deriv\(\)](#), [Li_eval\(\)](#), [Li_evalf\(\)](#), [GiNaC::library_init::library_init\(\)](#), [log_eval\(\)](#), [log_series\(\)](#), [GiNaC::matrix::markowitz_elimination\(\)](#), [GiNaC::matrix::matrix\(\)](#), [GiNaC::pseries::mul_series\(\)](#), [Order_eval\(\)](#), [GiNaC::pseries::power_const\(\)](#), [prem\(\)](#), [GiNaC::ex::primpart\(\)](#), [rem\(\)](#), [S_deriv\(\)](#), [S_eval\(\)](#), [GiNaC::ex::series\(\)](#), [GiNaC::basic::series\(\)](#), [GiNaC::symbol::series\(\)](#), [sin_eval\(\)](#), [sinh_eval\(\)](#), [sprem\(\)](#), [sqrfree\(\)](#), [sr_gcd\(\)](#), [step_series\(\)](#), [tan_eval\(\)](#), [tanh_eval\(\)](#), [GiNaC::ex::unitcontprim\(\)](#), [zeta1_deriv\(\)](#), [zeta1_eval\(\)](#), [zeta2_deriv\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.71 `_num1_4_p`

```
const numeric * GiNaC::\_num1\_4\_p
```

Referenced by [GiNaC::library_init::library_init\(\)](#).

5.1.4.72 `_ex1_4`

```
const ex GiNaC::\_ex1\_4 = ex(*\_num1\_4\_p)
```

Referenced by [atan2_eval\(\)](#), [atan_eval\(\)](#), [cos_eval\(\)](#), [GiNaC::library_init::library_init\(\)](#), [sin_eval\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.73 `_num1_3_p`

```
const numeric * GiNaC::\_num1\_3\_p
```

Referenced by [GiNaC::library_init::library_init\(\)](#).

5.1.4.74 `_ex1_3`

```
const ex GiNaC::_ex1_3 = ex(*\_num1\_3\_p)
```

Referenced by [acos_eval\(\)](#), [cos_eval\(\)](#), [GiNaC::su3d::eval_indexed\(\)](#), [GiNaC::library_init::library_init\(\)](#), [sin_eval\(\)](#), [tan_eval\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.75 `_num1_2_p`

```
const numeric * GiNaC::_num1_2_p
```

Referenced by [GiNaC::library_init::library_init\(\)](#), [psi2_eval\(\)](#), and [tgamma_eval\(\)](#).

5.1.4.76 `_ex1_2`

```
const ex GiNaC::_ex1_2 = ex(*\_num1\_2\_p)
```

Referenced by [acos_eval\(\)](#), [asin_eval\(\)](#), [atan2_eval\(\)](#), [atan_series\(\)](#), [atanh_series\(\)](#), [cos_eval\(\)](#), [GiNaC::power::do_print_dflt\(\)](#), [GiNaC::power::do_print_latex\(\)](#), [GiNaC::su3f::eval_indexed\(\)](#), [GiNaC::su3d::eval_indexed\(\)](#), [GiNaC::clifford::get_metric\(\)](#), [Li2_eval\(\)](#), [GiNaC::library_init::library_init\(\)](#), [log_eval\(\)](#), [psi1_eval\(\)](#), [psi2_eval\(\)](#), [sin_eval\(\)](#), [sqrt\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.77 `_num1_p`

```
const numeric * GiNaC::_num1_p
```

Referenced by [acos_conjugate\(\)](#), [acosh_conjugate\(\)](#), [asin_conjugate\(\)](#), [asinh_conjugate\(\)](#), [atan\(\)](#), [atan_conjugate\(\)](#), [atanh_conjugate\(\)](#), [bernoulli\(\)](#), [binomial\(\)](#), [GiNaC::add::combine_pair_with_coeff_to_pair\(\)](#), [GiNaC::ex::construct_from_int\(\)](#), [GiNaC::ex::construct_from_long\(\)](#), [GiNaC::ex::construct_from_uint\(\)](#), [GiNaC::ex::construct_from_ulong\(\)](#), [GiNaC::numeric::denom\(\)](#), [GiNaC::numeric::div_dyn\(\)](#), [divide_in_z\(\)](#), [GiNaC::add::do_print_csrc\(\)](#), [doublefactorial\(\)](#), [GiNaC::mul::eval\(\)](#), [GiNaC::power::eval\(\)](#), [exp_eval\(\)](#), [GiNaC::power::expand_add\(\)](#), [frac_cancel\(\)](#), [gcd\(\)](#), [GiNaC::mul::info\(\)](#), [GiNaC::basic::integer_content\(\)](#), [GiNaC::add::integer_content\(\)](#), [lcm_of_coefficients_denominators\(\)](#), [lcmcoeff\(\)](#), [Li2_conjugate\(\)](#), [GiNaC::library_init::library_init\(\)](#), [GiNaC::basic::max_coefficient\(\)](#), [GiNaC::numeric::mul_dyn\(\)](#), [multiply_lcm\(\)](#), [operator++\(\)](#), [GiNaC::matrix::pow\(\)](#), [GiNaC::numeric::power\(\)](#), [GiNaC::numeric::power_dyn\(\)](#), [GiNaC::add::print_add\(\)](#), [GiNaC::mul::print_overall_coeff\(\)](#), [psi2_eval\(\)](#), [GiNaC::add::recombine_pair_to_ex\(\)](#), [tgamma_eval\(\)](#), and [zeta1_eval\(\)](#).

5.1.4.78 `_ex1`

```
const ex GiNaC::_ex1 = ex(*_num1_p)
```

Referenced by [acos_eval\(\)](#), [acosh_deriv\(\)](#), [acosh_eval\(\)](#), [GiNaC::pseries::add_series\(\)](#), [asin_eval\(\)](#), [asinh_deriv\(\)](#), [atan_deriv\(\)](#), [atan_eval\(\)](#), [atan_series\(\)](#), [atanh_deriv\(\)](#), [atanh_eval\(\)](#), [atanh_series\(\)](#), [beta_eval\(\)](#), [binomial_sym\(\)](#), [GiNaC::basic::coeff\(\)](#), [GiNaC::ncmul::coeff\(\)](#), [GiNaC::power::coeff\(\)](#), [GiNaC::basic::collect\(\)](#), [color_trace\(\)](#), [GiNaC::add::combine_ex_with_coeff_to_pair\(\)](#), [GiNaC::mul::combine_ex_with_coeff_to_pair\(\)](#), [GiNaC::add::combine_pair_with_coeff_to_pair\(\)](#), [GiNaC::mul::combine_pair_with_coeff_to_pair\(\)](#), [GiNaC::su3t::contract_with\(\)](#), [GiNaC::su3f::contract_with\(\)](#), [GiNaC::su3d::contract_with\(\)](#), [GiNaC::matrix::contract_with\(\)](#), [GiNaC::spinmetric::contract_with\(\)](#), [GiNaC::tensepsilon::contract_with\(\)](#), [cos_eval\(\)](#), [cosh_eval\(\)](#), [GiNaC::mul::default_overall_coeff\(\)](#), [GiNaC::mul::derivative\(\)](#), [GiNaC::power::derivative\(\)](#), [GiNaC::symbol::derivative\(\)](#), [GiNaC::matrix::determinant_minor\(\)](#), [divide\(\)](#), [divide_in_z\(\)](#), [GiNaC::add::do_print_csrc\(\)](#), [GiNaC::mul::do_print_csrc\(\)](#), [EllipticE_eval\(\)](#), [EllipticE_series\(\)](#), [EllipticK_series\(\)](#), [GiNaC::mul::eval\(\)](#), [GiNaC::ncmul::eval\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::tensdelta::eval_indexed\(\)](#), [GiNaC::minkmetric::eval_indexed\(\)](#), [GiNaC::spinmetric::eval_indexed\(\)](#), [GiNaC::mul::evalm\(\)](#), [exp_eval\(\)](#), [GiNaC::expairseq::expair_needs_further_processing\(\)](#), [GiNaC::mul::expair_needs_further_processing\(\)](#), [GiNaC::mul::expand\(\)](#), [GiNaC::ncmul::expand\(\)](#), [GiNaC::power::expand\(\)](#), [GiNaC::power::expand_add\(\)](#), [GiNaC::power::expand_add_mul\(\)](#), [find_common_factor\(\)](#), [frac_cancel\(\)](#), [GiNaC::matrix::fraction_free_elimination\(\)](#), [G2_eval\(\)](#), [G2_evalf\(\)](#), [G3_eval\(\)](#), [G3_evalf\(\)](#), [gcd\(\)](#), [gcd_pf_pow\(\)](#), [gcd_pf_pow_pow\(\)](#), [GINAC_IMPLEMENT_REGISTERED_CLASSES\(\)](#), [H_deriv\(\)](#), [H_eval\(\)](#), [GiNaC::power::imag_part\(\)](#), [GiNaC::matrix::inverse\(\)](#), [lgamma_series\(\)](#), [Li2_deriv\(\)](#), [Li2_eval\(\)](#), [Li2_series\(\)](#), [Li_eval\(\)](#), [Li_evalf\(\)](#), [Li_series\(\)](#), [GiNaC::library_init::library_init\(\)](#), [log_eval\(\)](#), [log_expand\(\)](#), [log_series\(\)](#), [GiNaC::expairseq::make_flat\(\)](#), [GiNaC::mul::mul\(\)](#), [GiNaC::pseries::mul_series\(\)](#), [GiNaC::basic::normal\(\)](#), [GiNaC::power::normal\(\)](#), [GiNaC::pseries::normal\(\)](#), [GiNaC::symbol::normal\(\)](#), [operator++\(\)](#), [Order_eval\(\)](#), [Order_series\(\)](#), [GiNaC::matrix::pow\(\)](#), [GiNaC::pseries::power_const\(\)](#), [prem\(\)](#), [GiNaC::ex::primpart\(\)](#), [GiNaC::pseries::print_series\(\)](#), [psi1_deriv\(\)](#), [psi1_series\(\)](#), [psi2_deriv\(\)](#), [psi2_eval\(\)](#), [psi2_series\(\)](#), [quo\(\)](#), [GiNaC::power::real_part\(\)](#), [GiNaC::mul::recombine_pair_to_tensor\(\)](#), [GiNaC::tensor::replace_contr_index\(\)](#), [S_series\(\)](#), [GiNaC::basic::series\(\)](#), [GiNaC::add::series\(\)](#), [GiNaC::integral::series\(\)](#), [GiNaC::pseries::series\(\)](#), [GiNaC::mul::series\(\)](#), [GiNaC::power::series\(\)](#), [GiNaC::symbol::series\(\)](#), [sin_eval\(\)](#), [sinh_eval\(\)](#), [GiNaC::expairseq::split_ex_to_pair\(\)](#), [GiNaC::add::split_ex_to_pair\(\)](#), [GiNaC::mul::split_ex_to_pair\(\)](#), [sprem\(\)](#), [sqrfree_parfrac\(\)](#), [sqrfree_yun\(\)](#), [sr_gcd\(\)](#), [tan_deriv\(\)](#), [tan_eval\(\)](#), [tanh_deriv\(\)](#), [tanh_eval\(\)](#), [tgamma_series\(\)](#), [GiNaC::expairseq::to_polynomial\(\)](#), [GiNaC::expairseq::to_rational\(\)](#), [GiNaC::ex::unit\(\)](#), [unit_matrix\(\)](#), [GiNaC::ex::unitcontprim\(\)](#), [zeta1_deriv\(\)](#), [zeta2_deriv\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.79 `_num2_p`

```
const numeric * GiNaC::_num2_p
```

Referenced by [GiNaC::ex::construct_from_int\(\)](#), [GiNaC::ex::construct_from_long\(\)](#), [GiNaC::ex::construct_from_uint\(\)](#), [GiNaC::ex::construct_from_ulong\(\)](#), [exp_eval\(\)](#), [GiNaC::power::expand_add_2\(\)](#), [Li2_series\(\)](#), [GiNaC::library_init::library_init\(\)](#), [GiNaC::matrix::pow\(\)](#), [psi1_eval\(\)](#), [psi2_eval\(\)](#), [tgamma_eval\(\)](#), and [zeta1_eval\(\)](#).

5.1.4.80 `_ex2`

```
const ex GiNaC::_ex2 = ex(*_num2_p)
```

Referenced by [acos_deriv\(\)](#), [asin_deriv\(\)](#), [asinh_deriv\(\)](#), [atan2_deriv\(\)](#), [atan_deriv\(\)](#), [atanh_deriv\(\)](#), [GiNaC::spinmetric::contract_with\(\)](#), [cos_eval\(\)](#), [cosh_eval\(\)](#), [csgn_power\(\)](#), [epsilon_tensor\(\)](#), [exp_eval\(\)](#), [GiNaC::power::expand_add_2\(\)](#), [Li2_eval\(\)](#), [Li2_series\(\)](#), [Li_eval\(\)](#), [GiNaC::library_init::library_init\(\)](#), [product_to_exvector\(\)](#), [psi1_eval\(\)](#), [sin_eval\(\)](#), [sinh_eval\(\)](#), [tan_deriv\(\)](#), [tan_eval\(\)](#), [tanh_deriv\(\)](#), [tanh_eval\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.81 `_num3_p`

```
const numeric * GiNaC::_num3_p
```

Referenced by [GiNaC::ex::construct_from_int\(\)](#), [GiNaC::ex::construct_from_long\(\)](#), [GiNaC::ex::construct_from_uint\(\)](#), [GiNaC::ex::construct_from_ulong\(\)](#), [exp_eval\(\)](#), and [GiNaC::library_init::library_init\(\)](#).

5.1.4.82 `_ex3`

```
const ex GiNaC::_ex3 = ex(*_num3_p)
```

Referenced by [color_trace\(\)](#), [cos_eval\(\)](#), [epsilon_tensor\(\)](#), [GiNaC::su3f::eval_indexed\(\)](#), [GiNaC::su3d::eval_indexed\(\)](#), [GiNaC::library_init::library_init\(\)](#), [sin_eval\(\)](#), [tan_eval\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.83 `_num4_p`

```
const numeric * GiNaC::_num4_p
```

Referenced by [GiNaC::ex::construct_from_int\(\)](#), [GiNaC::ex::construct_from_long\(\)](#), [GiNaC::ex::construct_from_uint\(\)](#), [GiNaC::ex::construct_from_ulong\(\)](#), [exp_eval\(\)](#), and [GiNaC::library_init::library_init\(\)](#).

5.1.4.84 `_ex4`

```
const ex GiNaC::_ex4 = ex(*_num4_p)
```

Referenced by [GiNaC::library_init::library_init\(\)](#), [lorentz_eps\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.85 `_num5_p`

```
const numeric * GiNaC::_num5_p
```

Referenced by [GiNaC::ex::construct_from_int\(\)](#), [GiNaC::ex::construct_from_long\(\)](#), [GiNaC::ex::construct_from_uint\(\)](#), [GiNaC::ex::construct_from_ulong\(\)](#), [cos_eval\(\)](#), [GiNaC::library_init::library_init\(\)](#), [sin_eval\(\)](#), and [tan_eval\(\)](#).

5.1.4.86 `_ex5`

```
const ex GiNaC::_ex5 = ex(*_num5_p)
```

Referenced by [cos_eval\(\)](#), [GiNaC::library_init::library_init\(\)](#), [sin_eval\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.87 `_num6_p`

```
const numeric * GiNaC::_num6_p
```

Referenced by [GiNaC::ex::construct_from_int\(\)](#), [GiNaC::ex::construct_from_long\(\)](#), [GiNaC::ex::construct_from_uint\(\)](#), [GiNaC::ex::construct_from_ulong\(\)](#), [GiNaC::library_init::library_init\(\)](#), and [sin_eval\(\)](#).

5.1.4.88 `_ex6`

```
const ex GiNaC::_ex6 = ex(*_num6_p)
```

Referenced by [cos_eval\(\)](#), [Li2_eval\(\)](#), [GiNaC::library_init::library_init\(\)](#), [sin_eval\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.89 `_num7_p`

```
const numeric * GiNaC::_num7_p
```

Referenced by [GiNaC::ex::construct_from_int\(\)](#), [GiNaC::ex::construct_from_long\(\)](#), [GiNaC::ex::construct_from_uint\(\)](#), [GiNaC::ex::construct_from_ulong\(\)](#), and [GiNaC::library_init::library_init\(\)](#).

5.1.4.90 `_ex7`

```
const ex GiNaC::_ex7 = ex(*_num7_p)
```

Referenced by [GiNaC::library_init::library_init\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.91 `_num8_p`

```
const numeric * GiNaC::_num8_p
```

Referenced by [GiNaC::ex::construct_from_int\(\)](#), [GiNaC::ex::construct_from_long\(\)](#), [GiNaC::ex::construct_from_uint\(\)](#), [GiNaC::ex::construct_from_ulong\(\)](#), and [GiNaC::library_init::library_init\(\)](#).

5.1.4.92 `_ex8`

```
const ex GiNaC::_ex8 = ex(*_num8_p)
```

Referenced by [GiNaC::library_init::library_init\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.93 `_num9_p`

```
const numeric * GiNaC::_num9_p
```

Referenced by [GiNaC::ex::construct_from_int\(\)](#), [GiNaC::ex::construct_from_long\(\)](#), [GiNaC::ex::construct_from_uint\(\)](#), [GiNaC::ex::construct_from_ulong\(\)](#), and [GiNaC::library_init::library_init\(\)](#).

5.1.4.94 `_ex9`

```
const ex GiNaC::_ex9 = ex(*_num9_p)
```

Referenced by [GiNaC::library_init::library_init\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.95 `_num10_p`

```
const numeric * GiNaC::_num10_p
```

Referenced by [GiNaC::ex::construct_from_int\(\)](#), [GiNaC::ex::construct_from_long\(\)](#), [GiNaC::ex::construct_from_uint\(\)](#), [GiNaC::ex::construct_from_ulong\(\)](#), [cos_eval\(\)](#), [GiNaC::library_init::library_init\(\)](#), [sin_eval\(\)](#), and [tan_eval\(\)](#).

5.1.4.96 `_ex10`

```
const ex GiNaC::_ex10 = ex(*_num10_p)
```

Referenced by [GiNaC::library_init::library_init\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.97 `_num11_p`

```
const numeric * GiNaC::_num11_p
```

Referenced by [GiNaC::ex::construct_from_int\(\)](#), [GiNaC::ex::construct_from_long\(\)](#), [GiNaC::ex::construct_from_uint\(\)](#), [GiNaC::ex::construct_from_ulong\(\)](#), and [GiNaC::library_init::library_init\(\)](#).

5.1.4.98 `_ex11`

```
const ex GiNaC::_ex11 = ex(*_num11_p)
```

Referenced by [GiNaC::library_init::library_init\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.99 `_num12_p`

```
const numeric * GiNaC::_num12_p
```

Referenced by [GiNaC::ex::construct_from_int\(\)](#), [GiNaC::ex::construct_from_long\(\)](#), [GiNaC::ex::construct_from_uint\(\)](#), [GiNaC::ex::construct_from_ulong\(\)](#), [cos_eval\(\)](#), and [GiNaC::library_init::library_init\(\)](#).

5.1.4.100 `_ex12`

```
const ex GiNaC::_ex12 = ex(*_num12_p)
```

Referenced by [Li2_eval\(\)](#), [GiNaC::library_init::library_init\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.101 `_num15_p`

```
const numeric * GiNaC::_num15_p
```

Referenced by [cos_eval\(\)](#), [GiNaC::library_init::library_init\(\)](#), [sin_eval\(\)](#), and [tan_eval\(\)](#).

5.1.4.102 `_ex15`

```
const ex GiNaC::_ex15 = ex(*_num15_p)
```

Referenced by [GiNaC::library_init::library_init\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.103 `_num18_p`

```
const numeric * GiNaC::_num18_p
```

Referenced by [GiNaC::library_init::library_init\(\)](#), and [sin_eval\(\)](#).

5.1.4.104 `_ex18`

```
const ex GiNaC::_ex18 = ex(*_num18_p)
```

Referenced by [GiNaC::library_init::library_init\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.105 `_num20_p`

```
const numeric * GiNaC::_num20_p
```

Referenced by [cos_eval\(\)](#), [GiNaC::library_init::library_init\(\)](#), [sin_eval\(\)](#), and [tan_eval\(\)](#).

5.1.4.106 `_ex20`

```
const ex GiNaC::_ex20 = ex(*_num20_p)
```

Referenced by [GiNaC::library_init::library_init\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.107 `_num24_p`

```
const numeric * GiNaC::_num24_p
```

Referenced by [cos_eval\(\)](#), and [GiNaC::library_init::library_init\(\)](#).

5.1.4.108 `_ex24`

```
const ex GiNaC::_ex24 = ex(*_num24_p)
```

Referenced by [GiNaC::library_init::library_init\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.109 `_num25_p`

```
const numeric * GiNaC::_num25_p
```

Referenced by [cos_eval\(\)](#), [GiNaC::library_init::library_init\(\)](#), [sin_eval\(\)](#), and [tan_eval\(\)](#).

5.1.4.110 `_ex25`

```
const ex GiNaC::_ex25 = ex(*_num25_p)
```

Referenced by [GiNaC::library_init::library_init\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.111 `_num30_p`

```
const numeric * GiNaC::_num30_p
```

Referenced by [cos_eval\(\)](#), [GiNaC::library_init::library_init\(\)](#), [sin_eval\(\)](#), and [tan_eval\(\)](#).

5.1.4.112 `_ex30`

```
const ex GiNaC::_ex30 = ex(*_num30_p)
```

Referenced by [GiNaC::library_init::library_init\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.113 `_num48_p`

```
const numeric * GiNaC::_num48_p
```

Referenced by [GiNaC::library_init::library_init\(\)](#).

5.1.4.114 `_ex48`

```
const ex GiNaC::_ex48 = ex(*_num48_p)
```

Referenced by [GiNaC::library_init::library_init\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.115 `_num60_p`

```
const numeric * GiNaC::_num60_p
```

Referenced by [cos_eval\(\)](#), [GiNaC::library_init::library_init\(\)](#), [sin_eval\(\)](#), and [tan_eval\(\)](#).

5.1.4.116 `_ex60`

```
const ex GiNaC::_ex60 = ex(*_num60_p)
```

Referenced by [cos_eval\(\)](#), [GiNaC::library_init::library_init\(\)](#), [sin_eval\(\)](#), [tan_eval\(\)](#), and [GiNaC::library_init::~~library_init\(\)](#).

5.1.4.117 `_num120_p`

```
const numeric * GiNaC::_num120_p
```

Referenced by `cos_eval()`, `GiNaC::library_init::library_init()`, and `sin_eval()`.

5.1.4.118 `_ex120`

```
const ex GiNaC::_ex120 = ex(*_num120_p)
```

Referenced by `GiNaC::library_init::library_init()`, and `GiNaC::library_init::~~library_init()`.

5.2 GiNaC::internal Namespace Reference

Classes

- struct `_iter_rep`

5.3 std Namespace Reference

Classes

- struct `equal_to< GiNaC::ex >`
Specialization of `std::equal_to()` for `ex` objects.
- struct `hash< GiNaC::ex >`
Specialization of `std::hash()` for `ex` objects.
- struct `less< GiNaC::ptr< T > >`
Specialization of `std::less` for `ptr< T >` to enable ordering of `ptr< T >` objects (e.g.

Functions

- template<> void `swap (GiNaC::ex &a, GiNaC::ex &b)`
Specialization of `std::swap()` for `ex` objects.

5.3.1 Function Documentation

5.3.1.1 `swap()`

```
template<>
void std::swap (
    GiNaC::ex & a,
    GiNaC::ex & b ) [inline]
```

Specialization of `std::swap()` for `ex` objects.

References `GiNaC::ex::swap()`.

Referenced by `GiNaC::su3f::eval_indexed()`, `GiNaC::su3d::eval_indexed()`, `GiNaC::matrix::markowitz_elimination()`, and `GiNaC::permutation_sign()`.

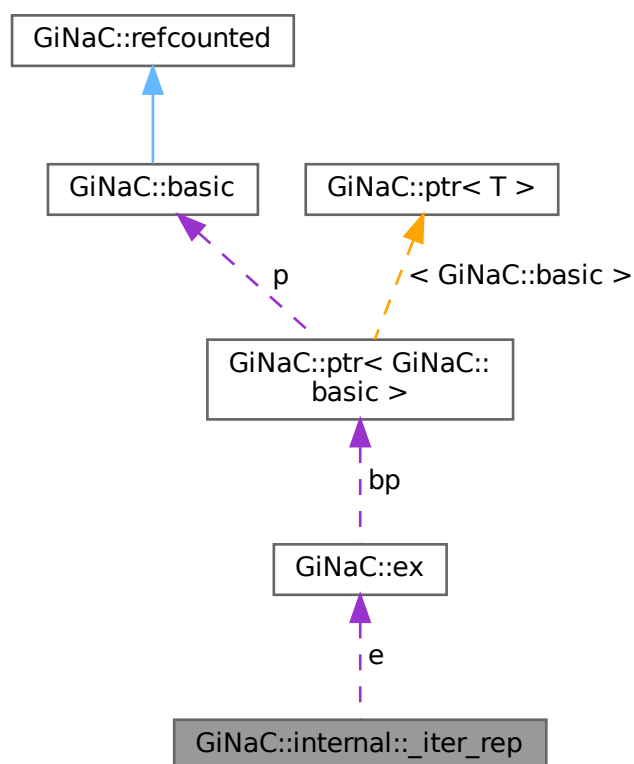
Chapter 6

Class Documentation

6.1 GiNaC::internal::_iter_rep Struct Reference

```
#include <ex.h>
```

Collaboration diagram for GiNaC::internal::_iter_rep:



Public Member Functions

- [_iter_rep](#) (const [ex](#) &[e_](#), [size_t](#) [i_](#), [size_t](#) [i_end_](#))
- bool [operator==](#) (const [_iter_rep](#) &[other](#)) const noexcept
- bool [operator!=](#) (const [_iter_rep](#) &[other](#)) const noexcept

Public Attributes

- [ex](#) [e](#)
- [size_t](#) [i](#)
- [size_t](#) [i_end](#)

6.1.1 Constructor & Destructor Documentation

6.1.1.1 [_iter_rep](#)()

```
GiNaC::internal::_iter_rep::_iter_rep (  
    const ex & e\_,  
    size\_t i\_,  
    size\_t i\_end\_ ) [inline]
```

6.1.2 Member Function Documentation

6.1.2.1 [operator==](#)()

```
bool GiNaC::internal::_iter_rep::operator== (  
    const \_iter\_rep & other ) const [inline], [noexcept]
```

References [GiNaC::are_ex_trivially_equal\(\)](#), [e](#), and [i](#).

6.1.2.2 [operator!=](#)()

```
bool GiNaC::internal::_iter_rep::operator!= (  
    const \_iter\_rep & other ) const [inline], [noexcept]
```

6.1.3 Member Data Documentation

6.1.3.1 e

```
ex GiNaC::internal::_iter_rep::e
```

Referenced by [GiNaC::const_postorder_iterator::descend\(\)](#), [GiNaC::const_preorder_iterator::increment\(\)](#), and [operator==\(\)](#).

6.1.3.2 i

```
size_t GiNaC::internal::_iter_rep::i
```

Referenced by [GiNaC::const_postorder_iterator::descend\(\)](#), [GiNaC::const_preorder_iterator::increment\(\)](#), and [operator==\(\)](#).

6.1.3.3 i_end

```
size_t GiNaC::internal::_iter_rep::i_end
```

Referenced by [GiNaC::const_preorder_iterator::increment\(\)](#).

The documentation for this struct was generated from the following file:

- [ex.h](#)

6.2 GiNaC::_numeric_digits Class Reference

This class is used to instantiate a global singleton object Digits which behaves just like Maple's Digits.

```
#include <numeric.h>
```

Public Member Functions

- [_numeric_digits](#) ()
_numeric_digits default ctor, checking for singleton invariance.
- [_numeric_digits](#) & [operator=](#) (long prec)
Assign a native long to global Digits object.
- [operator long](#) ()
Convert global Digits object to native type long.
- void [print](#) (std::ostream &os) const
Append global Digits object to ostream.
- void [add_callback](#) ([digits_changed_callback](#) callback)
Add a new callback function.

Private Attributes

- long [digits](#)
Number of decimal digits.
- `std::vector< digits_changed_callback > callbacklist`

Static Private Attributes

- static bool [too_late](#) = false
Already one object present.

6.2.1 Detailed Description

This class is used to instantiate a global singleton object Digits which behaves just like Maple's Digits.

We need an object rather than a dumbier basic type since as a side-effect we let it change `cl_default_float_format` when it gets changed. The only other meaningful thing to do with it is converting it to an unsigned, for temporarily storing its value e.g. The user must not create an own working object of this class! Since C++ forces us to make the class definition visible in order to use an object we put in a flag which prevents other objects of that class to be created.

6.2.2 Constructor & Destructor Documentation

6.2.2.1 `_numeric_digits()`

```
GiNaC::_numeric_digits::_numeric_digits ( )
```

[_numeric_digits](#) default ctor, checking for singleton invariance.

References [too_late](#).

6.2.3 Member Function Documentation

6.2.3.1 `operator=()`

```
\_numeric\_digits & GiNaC::_numeric_digits::operator= (
    long prec )
```

Assign a native long to global Digits object.

References [callbacklist](#), and [digits](#).

6.2.3.2 operator long()

```
GiNaC::_numeric_digits::operator long ( )
```

Convert global Digits object to native type long.

6.2.3.3 print()

```
void GiNaC::_numeric_digits::print (
    std::ostream & os ) const
```

Append global Digits object to ostream.

References [digits](#).

Referenced by [GiNaC::operator<<\(\)](#).

6.2.3.4 add_callback()

```
void GiNaC::_numeric_digits::add_callback (
    digits_changed_callback callback )
```

Add a new callback function.

References [callbacklist](#).

6.2.4 Member Data Documentation

6.2.4.1 digits

```
long GiNaC::_numeric_digits::digits [private]
```

Number of decimal digits.

Referenced by [operator=\(\)](#), and [print\(\)](#).

6.2.4.2 too_late

```
bool GiNaC::_numeric_digits::too_late = false [static], [private]
```

Already one object present.

Referenced by [_numeric_digits\(\)](#).

6.2.4.3 callbacklist

```
std::vector<digits_changed_callback> GiNaC::_numeric_digits::callbacklist [private]
```

Referenced by [add_callback\(\)](#), and [operator=\(\)](#).

The documentation for this class was generated from the following files:

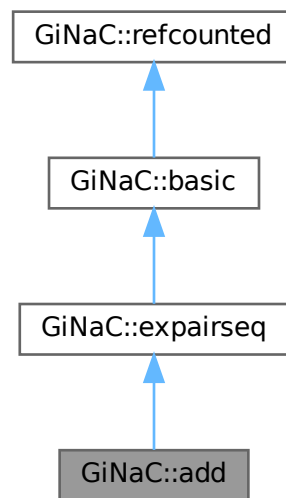
- [numeric.h](#)
- [numeric.cpp](#)

6.3 GiNaC::add Class Reference

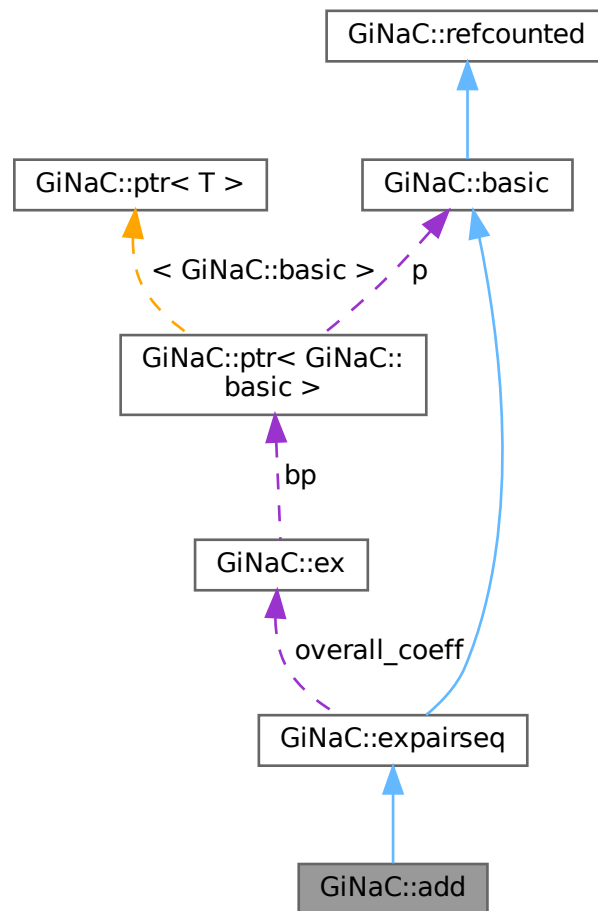
Sum of expressions.

```
#include <add.h>
```

Inheritance diagram for GiNaC::add:



Collaboration diagram for GiNaC::add:



Public Member Functions

- `add` (const `ex` &lh, const `ex` &rh)
- `add` (const `exvector` &v)
- `add` (const `epvector` &v)
- `add` (const `epvector` &v, const `ex` &oc)
- `add` (`epvector` &&v)
- `add` (`epvector` &&v, const `ex` &oc)
- unsigned `precedence` () const override
Return relative operator precedence (for parenthezing output).
- bool `info` (unsigned inf) const override
Information about the object.
- bool `is_polynomial` (const `ex` &var) const override
Check whether this is a polynomial in the given variables.
- int `degree` (const `ex` &s) const override
Return degree of highest power in object s.

- `int ldegree (const ex &s) const` override
Return degree of lowest power in object s.
- `ex coeff (const ex &s, int n=1) const` override
Return coefficient of degree n in object s.
- `ex eval ()` const override
Perform automatic term rewriting rules in this class.
- `ex evalm ()` const override
Evaluate sums, products and integer powers of matrices.
- `ex series (const relational &r, int order, unsigned options=0) const` override
Implementation of [ex::series\(\)](#) for sums.
- `ex normal (exmap &repl, exmap &rev_lookup, lst &modifier) const` override
Implementation of [ex::normal\(\)](#) for a sum.
- `numeric integer_content ()` const override
- `ex smod (const numeric &xi) const` override
Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- `numeric max_coefficient ()` const override
Implementation [ex::max_coefficient\(\)](#).
- `ex conjugate ()` const override
- `ex real_part ()` const override
- `ex imag_part ()` const override
- `exvector get_free_indices ()` const override
Return a vector containing the free indices of an expression.
- `ex eval_ncmul (const exvector &v) const` override

Public Member Functions inherited from [GiNaC::expairseq](#)

- `expairseq (const ex &lh, const ex &rh)`
- `expairseq (const exvector &v)`
- `expairseq (const epvector &v, const ex &oc, bool do_index_renaming=false)`
- `expairseq (epvector &&vp, const ex &oc, bool do_index_renaming=false)`
- `unsigned precedence ()` const override
Return relative operator precedence (for parenthezing output).
- `bool info (unsigned inf) const` override
Information about the object.
- `size_t nops ()` const override
Number of operands/members.
- `ex op (size_t i) const` override
Return operand/member at position i.
- `ex map (map_function &f) const` override
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- `ex eval ()` const override
Perform coefficient-wise automatic term rewriting rules in this class.
- `ex to_rational (exmap &repl) const` override
Implementation of [ex::to_rational\(\)](#) for expairseqs.
- `ex to_polynomial (exmap &repl) const` override
Implementation of [ex::to_polynomial\(\)](#) for expairseqs.
- `bool match (const ex &pattern, exmap &repl_lst) const` override
Check whether the expression matches a given pattern.
- `ex subs (const exmap &m, unsigned options=0) const` override
Substitute a set of objects by arbitrary expressions.
- `ex conjugate ()` const override
- `void archive (archive_node &n) const` override
Save (serialize) the object into archive node.
- `void read_archive (const archive_node &n, lst &syms) override`
Load (deserialize) the object from an archive node.

Public Member Functions inherited from [GiNaC::basic](#)

- virtual [~basic](#) ()
basic destructor, virtual because class ex will delete objects of derived classes via a basic.*
- [basic](#) (const [basic](#) &other)
- const [basic](#) & [operator=](#) (const [basic](#) &other)
basic assignment operator: the other object might be of a derived class.
- virtual [basic](#) * [duplicate](#) () const
Create a clone of this object on the heap.
- virtual [ex eval](#) () const
Perform automatic non-interruptive term rewriting rules.
- virtual [ex evalf](#) () const
Evaluate object numerically.
- virtual [ex evalm](#) () const
Evaluate sums, products and integer powers of matrices.
- virtual [ex eval_integ](#) () const
Evaluate integrals, if result is known.
- virtual [ex eval_indexed](#) (const [basic](#) &i) const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void [print](#) (const [print_context](#) &c, unsigned level=0) const
Output to stream.
- virtual void [dbgprint](#) () const
Little wrapper around print to be called within a debugger.
- virtual void [dbgprinttree](#) () const
Little wrapper around printtree to be called within a debugger.
- virtual unsigned [precedence](#) () const
Return relative operator precedence (for parenthezing output).
- virtual bool [info](#) (unsigned inf) const
Information about the object.
- virtual size_t [nops](#) () const
Number of operands/members.
- virtual [ex op](#) (size_t i) const
Return operand/member at position i.
- virtual [ex operator\[\]](#) (const [ex](#) &index) const
- virtual [ex operator\[\]](#) (size_t i) const
- virtual [ex](#) & [let_op](#) (size_t i)
Return modifiable operand/member at position i.
- virtual [ex](#) & [operator\[\]](#) (const [ex](#) &index)
- virtual [ex](#) & [operator\[\]](#) (size_t i)
- virtual bool [has](#) (const [ex](#) &other, unsigned [options](#)=0) const
Test for occurrence of a pattern.
- virtual bool [match](#) (const [ex](#) &pattern, [exmap](#) &repls) const
Check whether the expression matches a given pattern.
- virtual [ex subs](#) (const [exmap](#) &m, unsigned [options](#)=0) const
Substitute a set of objects by arbitrary expressions.
- virtual [ex map](#) ([map_function](#) &f) const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void [accept](#) ([GiNaC::visitor](#) &v) const
- virtual bool [is_polynomial](#) (const [ex](#) &var) const
Check whether this is a polynomial in the given variables.
- virtual int [degree](#) (const [ex](#) &s) const

- Return degree of highest power in object s.*

 - virtual int `ldegree` (const `ex` &s) const
- Return degree of lowest power in object s.*

 - virtual `ex coeff` (const `ex` &s, int `n`=1) const
- Return coefficient of degree n in object s.*

 - virtual `ex expand` (unsigned `options`=0) const
- Expand expression, i.e.*

 - virtual `ex collect` (const `ex` &s, bool `distributed`=false) const
- Sort expanded expression in terms of powers of some object(s).*

 - virtual `ex series` (const `relational` &r, int `order`, unsigned `options`=0) const
- Default implementation of `ex::series()`.*

 - virtual `ex normal` (`exmap` &repl, `exmap` &rev_lookup, `lst` &modifier) const
- Default implementation of `ex::normal()`.*

 - virtual `ex to_rational` (`exmap` &repl) const
- Default implementation of `ex::to_rational()`.*

 - virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const*

 - virtual `ex smod` (const `numeric` &xi) const
- Apply symmetric modular homomorphism to an expanded multivariate polynomial.*

 - virtual `numeric max_coefficient` () const
- Implementation `ex::max_coefficient()`.*

 - virtual `exvector get_free_indices` () const
- Return a vector containing the free indices of an expression.*

 - virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
- Add two indexed expressions.*

 - virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
- Multiply an indexed expression with a scalar.*

 - virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const
- Try to contract two indexed expressions that appear in the same product.*

 - virtual unsigned `return_type` () const
- virtual `return_type_t return_type_tinfo` () const*

 - virtual `ex conjugate` () const
- virtual `ex real_part` () const*

 - virtual `ex imag_part` () const
- template<class T >*

 - void `print_dispatch` (const `print_context` &c, unsigned `level`) const
- Like `print()`, but dispatch to the specified class.*

 - void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned `level`) const
- Like `print()`, but dispatch to the specified class.*

 - virtual void `archive` (`archive_node` &n) const
- Save (serialize) the object into archive node.*

 - virtual void `read_archive` (const `archive_node` &n, `lst` &syms)
- Load (deserialize) the object from an archive node.*

 - `ex subs_one_level` (const `exmap` &m, unsigned `options`) const
- Helper function for `subs()`.*

 - `ex diff` (const `symbol` &s, unsigned `nth`=1) const
- Default interface of nth derivative `ex::diff(s, n)`.*

 - int `compare` (const `basic` &other) const
- Compare objects syntactically to establish canonical ordering.*

 - bool `is_equal` (const `basic` &other) const
- Test for syntactic equality.*

- const [basic](#) & [hold](#) () const
Stop further evaluation.
- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const
Set some [status_flags](#).
- const [basic](#) & [clearflag](#) (unsigned f) const
Clear some [status_flags](#).

Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add_reference](#) () noexcept
- unsigned int [remove_reference](#) () noexcept
- unsigned int [get_refcount](#) () const noexcept
- void [set_refcount](#) (unsigned int r) noexcept

Protected Member Functions

- [ex derivative](#) (const [symbol](#) &s) const override
Implementation of [ex::diff\(\)](#) for a sum.
- unsigned [return_type](#) () const override
- [return_type_t](#) [return_type_tinfo](#) () const override
- [ex thisexpairseq](#) (const [epvector](#) &v, const [ex](#) &oc, bool do_index_renaming=false) const override
Create an object of this type.
- [ex thisexpairseq](#) ([epvector](#) &&vp, const [ex](#) &oc, bool do_index_renaming=false) const override
- [expair split_ex_to_pair](#) (const [ex](#) &e) const override
Form an [expair](#) from an [ex](#), using the corresponding semantics.
- [expair combine_ex_with_coeff_to_pair](#) (const [ex](#) &e, const [ex](#) &c) const override
- [expair combine_pair_with_coeff_to_pair](#) (const [expair](#) &p, const [ex](#) &c) const override
- [ex recombine_pair_to_ex](#) (const [expair](#) &p) const override
Form an [ex](#) out of an [expair](#), using the corresponding semantics.
- [ex expand](#) (unsigned [options](#)=0) const override
Expand expression, i.e.
- void [print_add](#) (const [print_context](#) &c, const char *openbrace, const char *closebrace, const char *mul_sym, unsigned level) const
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
- void [do_print_latex](#) (const [print_latex](#) &c, unsigned level) const
- void [do_print_csrc](#) (const [print_csrc](#) &c, unsigned level) const
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const

Protected Member Functions inherited from [GiNaC::expairseq](#)

- bool [is_equal_same_type](#) (const [basic](#) &other) const override
Returns true if two objects of same type are equal.
- unsigned [return_type](#) () const override
- unsigned [calchash](#) () const override
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- [ex expand](#) (unsigned [options](#)=0) const override
Expand expression, i.e.
- virtual [ex thisexpairseq](#) (const [epvector](#) &v, const [ex](#) &oc, bool do_index_renaming=false) const

Create an object of this type.

- virtual `ex thisexpairseq` (`epvector` &&vp, const `ex` &oc, bool do_index_renaming=false) const
- virtual void `printseq` (const `print_context` &c, char delim, unsigned this_precedence, unsigned upper_precedence) const
- virtual void `printpair` (const `print_context` &c, const `expair` &p, unsigned upper_precedence) const
- virtual `expair split_ex_to_pair` (const `ex` &e) const

Form an expair from an ex, using the corresponding semantics.

- virtual `expair combine_ex_with_coeff_to_pair` (const `ex` &e, const `ex` &c) const
- virtual `expair combine_pair_with_coeff_to_pair` (const `expair` &p, const `ex` &c) const
- virtual `ex recombine_pair_to_ex` (const `expair` &p) const

Form an ex out of an expair, using the corresponding semantics.

- virtual bool `expair_needs_further_processing` (`epp` it)
- virtual `ex default_overall_coeff` () const
- virtual void `combine_overall_coeff` (const `ex` &c)
- virtual void `combine_overall_coeff` (const `ex` &c1, const `ex` &c2)
- virtual bool `can_make_flat` (const `expair` &p) const
- void `do_print` (const `print_context` &c, unsigned level) const
- void `do_print_tree` (const `print_tree` &c, unsigned level) const
- void `construct_from_2_ex` (const `ex` &lh, const `ex` &rh)
- void `construct_from_2_expairseq` (const `expairseq` &s1, const `expairseq` &s2)
- void `construct_from_expairseq_ex` (const `expairseq` &s, const `ex` &e)
- void `construct_from_exvector` (const `exvector` &v)
- void `construct_from_epvector` (const `epvector` &v, bool do_index_renaming=false)
- void `construct_from_epvector` (`epvector` &&v, bool do_index_renaming=false)
- void `make_flat` (const `exvector` &v)

Combine this expairseq with argument exvector.

- void `make_flat` (const `epvector` &v, bool do_index_renaming=false)

Combine this expairseq with argument epvector.

- void `canonicalize` ()

Brings this expairseq into a sorted (canonical) form.

- void `combine_same_terms_sorted_seq` ()

Compact a presorted expairseq by combining all matching expairs to one each.

- bool `is_canonical` () const

Check if this expairseq is in sorted (canonical) form.

- `epvector expandchildren` (unsigned `options`) const

Member-wise expand the expairs in this sequence.

- `epvector evalchildren` () const

Member-wise evaluate the expairs in this sequence.

- `epvector subschildren` (const `exmap` &m, unsigned `options`=0) const

Member-wise substitute in this sequence.

Protected Member Functions inherited from `GiNaC::basic`

- `basic` ()
- virtual `ex eval_ncmul` (const `exvector` &v) const
- virtual bool `match_same_type` (const `basic` &other) const

Returns true if the attributes of two objects are similar enough for a match.

- virtual `ex derivative` (const `symbol` &s) const

Default implementation of `ex::diff()`.

- virtual int `compare_same_type` (const `basic` &other) const

Returns order relation between two objects of same type.

- virtual bool `is_equal_same_type` (const `basic` &other) const

- Returns true if two objects of same type are equal.*
- virtual unsigned `calchash` () const
Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.
- void `ensure_if_modifiable` () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void `do_print` (const `print_context` &c, unsigned level) const
Default output to stream.
- void `do_print_tree` (const `print_tree` &c, unsigned level) const
Tree output to stream.
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const
Python parsable output to stream.

Friends

- class `mul`
- class `power`

Additional Inherited Members

Protected Attributes inherited from `GiNaC::expairseq`

- `epvector seq`
- `ex overall_coeff`

Protected Attributes inherited from `GiNaC::basic`

- unsigned `flags`
of type `status_flags`
- unsigned `hashvalue`
hash value

6.3.1 Detailed Description

Sum of expressions.

6.3.2 Constructor & Destructor Documentation

6.3.2.1 `add()` [1/6]

```
GiNaC::add::add (
    const ex & lh,
    const ex & rh )
```

References `GiNaC::_ex0`, `GiNaC::expairseq::construct_from_2_ex()`, `GINAC_ASSERT`, `GiNaC::expairseq::is_canonical()`, and `GiNaC::expairseq::overall_coeff`.

6.3.2.2 add() [2/6]

```
GiNaC::add::add (
    const exvector & v )
```

References [GiNaC::_ex0](#), [GiNaC::expairseq::construct_from_exvector\(\)](#), [GINAC_ASSERT](#), [GiNaC::expairseq::is_canonical\(\)](#), and [GiNaC::expairseq::overall_coeff](#).

6.3.2.3 add() [3/6]

```
GiNaC::add::add (
    const epvector & v )
```

References [GiNaC::_ex0](#), [GiNaC::expairseq::construct_from_epvector\(\)](#), [GINAC_ASSERT](#), [GiNaC::expairseq::is_canonical\(\)](#), and [GiNaC::expairseq::overall_coeff](#).

6.3.2.4 add() [4/6]

```
GiNaC::add::add (
    const epvector & v,
    const ex & oc )
```

References [GiNaC::expairseq::construct_from_epvector\(\)](#), [GINAC_ASSERT](#), [GiNaC::expairseq::is_canonical\(\)](#), and [GiNaC::expairseq::overall_coeff](#).

6.3.2.5 add() [5/6]

```
GiNaC::add::add (
    epvector && v )
```

References [GiNaC::_ex0](#), [GiNaC::expairseq::construct_from_epvector\(\)](#), [GINAC_ASSERT](#), [GiNaC::expairseq::is_canonical\(\)](#), and [GiNaC::expairseq::overall_coeff](#).

6.3.2.6 add() [6/6]

```
GiNaC::add::add (
    epvector && v,
    const ex & oc )
```

References [GiNaC::expairseq::construct_from_epvector\(\)](#), [GINAC_ASSERT](#), [GiNaC::expairseq::is_canonical\(\)](#), and [GiNaC::expairseq::overall_coeff](#).

6.3.3 Member Function Documentation

6.3.3.1 precedence()

```
unsigned GiNaC::add::precedence ( ) const [inline], [override], [virtual]
```

Return relative operator precedence (for parenthezing output).

Reimplemented from [GiNaC::basic](#).

Referenced by [do_print_csrc\(\)](#), and [print_add\(\)](#).

6.3.3.2 info()

```
bool GiNaC::add::info (
    unsigned inf ) const [override], [virtual]
```

Information about the object.

See also

class [info_flags](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::info_flags::cinteger](#), [GiNaC::info_flags::cinteger_polynomial](#), [GiNaC::info_flags::crational](#), [GiNaC::info_flags::crational_polynomial](#), [GiNaC::info_flags::even](#), [GiNaC::ex::info\(\)](#), [info\(\)](#), [GiNaC::info_flags::integer](#), [GiNaC::info_flags::integer_polynomial](#), [GiNaC::ex::is_zero\(\)](#), [GiNaC::info_flags::nonnegative](#), [GiNaC::info_flags::nonnegint](#), [GiNaC::expairseq::overall_coeff](#), [GiNaC::info_flags::polynomial](#), [GiNaC::info_flags::posint](#), [GiNaC::info_flags::positive](#), [GiNaC::info_flags::rational](#), [GiNaC::info_flags::rational_function](#), [GiNaC::info_flags::rational_polynomial](#), [GiNaC::info_flags::real](#), [recombine_pair_to_ex\(\)](#), and [GiNaC::expairseq::seq](#).

Referenced by [info\(\)](#).

6.3.3.3 is_polynomial()

```
bool GiNaC::add::is_polynomial (
    const ex & var ) const [override], [virtual]
```

Check whether this is a polynomial in the given variables.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::expairseq::seq](#).

6.3.3.4 degree()

```
int GiNaC::add::degree (
    const ex & s ) const [override], [virtual]
```

Return degree of highest power in object s.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::ex::is_zero\(\)](#), [GiNaC::expairseq::overall_coeff](#), and [GiNaC::expairseq::seq](#).

6.3.3.5 ldegree()

```
int GiNaC::add::ldegree (
    const ex & s ) const [override], [virtual]
```

Return degree of lowest power in object s.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::ex::is_zero\(\)](#), [GiNaC::expairseq::overall_coeff](#), and [GiNaC::expairseq::seq](#).

6.3.3.6 coeff()

```
ex GiNaC::add::coeff (
    const ex & s,
    int n = 1 ) const [override], [virtual]
```

Return coefficient of degree n in object s.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex0](#), [GiNaC::clifford_max_label\(\)](#), [GiNaC::ex::coeff\(\)](#), [GiNaC::ncmul::coeff\(\)](#), [GiNaC::dirac_ONE\(\)](#), [GiNaC::ex::is_zero\(\)](#), [n](#), [GiNaC::expairseq::overall_coeff](#), and [GiNaC::expairseq::seq](#).

Referenced by [print_add\(\)](#), and [smod\(\)](#).

6.3.3.7 eval()

```
ex GiNaC::add::eval ( ) const [override], [virtual]
```

Perform automatic term rewriting rules in this class.

In the following x stands for a symbolic variables of type [ex](#) and c stands for such an expression that contain a plain number.

- $+(;c) \rightarrow c$
- $+(x;0) \rightarrow x$

Reimplemented from [GiNaC::basic](#).

References [GiNaC::return_types::commutative](#), [GiNaC::expairseq::evalchildren\(\)](#), [GiNaC::status_flags::evaluated](#), [GiNaC::basic::flags](#), [GINAC_ASSERT](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::is_zero\(\)](#), [GiNaC::expairseq::overall_coeff](#), [recombine_pair_to_ex\(\)](#), [GiNaC::expairseq::seq](#), and [unlikely](#).

6.3.3.8 evalm()

```
ex GiNaC::add::evalm ( ) const [override], [virtual]
```

Evaluate sums, products and integer powers of matrices.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::matrix::add\(\)](#), [GiNaC::ex::evalm\(\)](#), [m](#), [GiNaC::expairseq::overall_coeff](#), [recombine_pair_to_ex\(\)](#), [GiNaC::expairseq::seq](#), and [split_ex_to_pair\(\)](#).

6.3.3.9 series()

```
ex GiNaC::add::series (
    const relational & r,
    int order,
    unsigned options = 0 ) const [override], [virtual]
```

Implementation of [ex::series\(\)](#) for sums.

This performs series addition when adding pseries objects.

See also

[ex::series](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex1](#), [GiNaC::expairseq::op\(\)](#), [options](#), [order](#), [GiNaC::expairseq::overall_coeff](#), [r](#), [GiNaC::expairseq::seq](#), and [GiNaC::ex::series\(\)](#).

6.3.3.10 normal()

```
ex GiNaC::add::normal (
    exmap & repl,
    exmap & rev_lookup,
    lst & modifier ) const [override], [virtual]
```

Implementation of [ex::normal\(\)](#) for a sum.

It expands terms and performs fractional addition.

See also

[ex::normal](#)

Reimplemented from [GiNaC::basic](#).

References [expand\(\)](#), [GiNaC::frac_cancel\(\)](#), [GiNaC::gcd\(\)](#), [GINAC_ASSERT](#), [n](#), [GiNaC::subs_options::no_pattern](#), [GiNaC::container< C >::nops\(\)](#), [GiNaC::container< C >::op\(\)](#), [GiNaC::expairseq::overall_coeff](#), [recombine_pair_to_ex\(\)](#), and [GiNaC::expairseq::seq](#).

6.3.3.11 integer_content()

```
numeric GiNaC::add::integer_content ( ) const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_num0_p](#), [GiNaC::_num1_p](#), [c](#), [GiNaC::denom\(\)](#), [GiNaC::gcd\(\)](#), [GINAC_ASSERT](#), [GiNaC::lcm\(\)](#), [GiNaC::numer\(\)](#), [GiNaC::expairseq::overall_coeff](#), and [GiNaC::expairseq::seq](#).

6.3.3.12 smod()

```
ex GiNaC::add::smod (
    const numeric & xi ) const [override], [virtual]
```

Apply symmetric modular homomorphism to an expanded multivariate polynomial.

This function is usually used internally by [heur_gcd\(\)](#).

Parameters

xi	modulus
------	---------

Returns

mapped polynomial

See also

[heur_gcd](#)

Reimplemented from [GiNaC::basic](#).

References [coeff\(\)](#), [GINAC_ASSERT](#), [GiNaC::ex::is_zero\(\)](#), [GiNaC::expairseq::overall_coeff](#), [GiNaC::expairseq::seq](#), and [GiNaC::smod\(\)](#).

6.3.3.13 max_coefficient()

```
numeric GiNaC::add::max_coefficient ( ) const [override], [virtual]
```

Implementation [ex::max_coefficient\(\)](#).

See also

[heur_gcd](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::abs\(\)](#), [GINAC_ASSERT](#), [GiNaC::expairseq::overall_coeff](#), and [GiNaC::expairseq::seq](#).

6.3.3.14 conjugate()

```
ex GiNaC::add::conjugate ( ) const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::are_ex_trivially_equal\(\)](#), [GiNaC::ex::conjugate\(\)](#), [GiNaC::expairseq::nops\(\)](#), and [GiNaC::expairseq::op\(\)](#).

6.3.3.15 real_part()

```
ex GiNaC::add::real_part ( ) const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::ex::coeff\(\)](#), [GiNaC::ex::is_zero\(\)](#), [GiNaC::expairseq::overall_coeff](#), [GiNaC::info_flags::real](#), [GiNaC::ex::real_part\(\)](#), [recombine_pair_to_ex\(\)](#), [GiNaC::expairseq::seq](#), and [split_ex_to_pair\(\)](#).

6.3.3.16 imag_part()

```
ex GiNaC::add::imag_part ( ) const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::ex::coeff\(\)](#), [GiNaC::ex::imag_part\(\)](#), [GiNaC::ex::is_zero\(\)](#), [GiNaC::expairseq::overall_coeff](#), [GiNaC::info_flags::real](#), [recombine_pair_to_ex\(\)](#), [GiNaC::expairseq::seq](#), and [split_ex_to_pair\(\)](#).

6.3.3.17 get_free_indices()

```
exvector GiNaC::add::get_free_indices ( ) const [override], [virtual]
```

Return a vector containing the free indices of an expression.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::ex::get_free_indices\(\)](#), [GiNaC::indices_consistent\(\)](#), [GiNaC::expairseq::nops\(\)](#), and [GiNaC::expairseq::op\(\)](#).

6.3.3.18 eval_ncmul()

```
ex GiNaC::add::eval_ncmul (
    const exvector & v ) const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::expairseq::seq](#).

6.3.3.19 derivative()

```
ex GiNaC::add::derivative (
    const symbol & y ) const [override], [protected], [virtual]
```

Implementation of [ex::diff\(\)](#) for a sum.

It differentiates each term.

See also

[ex::diff](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::expairseq::seq](#).

6.3.3.20 return_type()

```
unsigned GiNaC::add::return_type ( ) const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::return_types::commutative](#), and [GiNaC::expairseq::seq](#).

6.3.3.21 return_type_tinfo()

```
return_type_t GiNaC::add::return_type_tinfo ( ) const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::expairseq::seq](#).

6.3.3.22 thisexpairseq() [1/2]

```
ex GiNaC::add::thisexpairseq (
    const evector & v,
    const ex & oc,
    bool do_index_renaming = false ) const [override], [protected], [virtual]
```

Create an object of this type.

This method works similar to a constructor. It is useful because `expairseq` has (at least) two possible different semantics but we want to inherit methods thus avoiding code duplication. Sometimes a method in `expairseq` has to create a new one of the same semantics, which cannot be done by a ctor because the name (`add`, `mul`,...) is unknown on the `expairseq` level. In order for this trick to work a derived class must of course override this definition.

Reimplemented from [GiNaC::expairseq](#).

6.3.3.23 thisexpairseq() [2/2]

```
ex GiNaC::add::thisexpairseq (
    epvector && vp,
    const ex & oc,
    bool do_index_renaming = false ) const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::expairseq](#).

6.3.3.24 split_ex_to_pair()

```
expair GiNaC::add::split_ex_to_pair (
    const ex & e ) const [override], [protected], [virtual]
```

Form an expair from an ex, using the corresponding semantics.

See also

[expairseq::recombine_pair_to_ex\(\)](#)

Reimplemented from [GiNaC::expairseq](#).

References [GiNaC::_ex1](#), [GiNaC::basic::clearflag\(\)](#), [GiNaC::status_flags::evaluated](#), [GiNaC::status_flags::hash_calculated](#), [GiNaC::ex::is_equal\(\)](#), and [GiNaC::expairseq::overall_coeff](#).

Referenced by [evalm\(\)](#), [imag_part\(\)](#), and [real_part\(\)](#).

6.3.3.25 combine_ex_with_coeff_to_pair()

```
expair GiNaC::add::combine_ex_with_coeff_to_pair (
    const ex & e,
    const ex & c ) const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::expairseq](#).

References [GiNaC::_ex1](#), [c](#), [GiNaC::basic::clearflag\(\)](#), [GiNaC::status_flags::evaluated](#), [GINAC_ASSERT](#), [GiNaC::status_flags::hash_calculated](#), [GiNaC::ex::is_equal\(\)](#), [likely](#), and [GiNaC::expairseq::overall_coeff](#).

6.3.3.26 combine_pair_with_coeff_to_pair()

```
expair GiNaC::add::combine_pair_with_coeff_to_pair (
    const expair & p,
    const ex & c ) const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::expairseq](#).

References [GiNaC::_ex1](#), [GiNaC::_num1_p](#), [c](#), [GiNaC::expair::coeff](#), [GINAC_ASSERT](#), and [GiNaC::expair::rest](#).

Referenced by [GiNaC::mul::eval\(\)](#), and [GiNaC::power::expand_add_2\(\)](#).

6.3.3.27 recombine_pair_to_ex()

```
ex GiNaC::add::recombine_pair_to_ex (
    const expair & p ) const [override], [protected], [virtual]
```

Form an ex out of an expair, using the corresponding semantics.

See also

[expairseq::split_ex_to_pair\(\)](#)

Reimplemented from [GiNaC::expairseq](#).

References [GiNaC::_num1_p](#), [GiNaC::expair::coeff](#), and [GiNaC::expair::rest](#).

Referenced by [eval\(\)](#), [evalm\(\)](#), [GiNaC::power::expand\(\)](#), [imag_part\(\)](#), [info\(\)](#), [normal\(\)](#), and [real_part\(\)](#).

6.3.3.28 expand()

```
ex GiNaC::add::expand (
    unsigned options = 0 ) const [override], [protected], [virtual]
```

Expand expression, i.e.

multiply it out and return the result as a new expression.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::expairseq::expandchildren\(\)](#), [GiNaC::status_flags::expanded](#), [options](#), [GiNaC::expairseq::overall_coeff](#), and [GiNaC::basic::setflag\(\)](#).

Referenced by [normal\(\)](#).

6.3.3.29 print_add()

```
void GiNaC::add::print_add (
    const print\_context & c,
    const char * openbrace,
    const char * closebrace,
    const char * mul_sym,
    unsigned level ) const [protected]
```

References [GiNaC::_num1_p](#), [GiNaC::_num_1_p](#), [c](#), [coeff\(\)](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::ex::is_zero\(\)](#), [GiNaC::expairseq::overall_coeff](#), [precedence\(\)](#), [GiNaC::basic::print\(\)](#), [GiNaC::ex::print\(\)](#), and [GiNaC::expairseq::seq](#).

Referenced by [do_print\(\)](#), and [do_print_latex\(\)](#).

6.3.3.30 do_print()

```
void GiNaC::add::do_print (
    const print\_context & c,
    unsigned level ) const [protected]
```

References [c](#), and [print_add\(\)](#).

6.3.3.31 do_print_latex()

```
void GiNaC::add::do_print_latex (
    const print\_latex & c,
    unsigned level ) const [protected]
```

References [c](#), and [print_add\(\)](#).

6.3.3.32 do_print_csrc()

```
void GiNaC::add::do_print_csrc (
    const print\_csrc & c,
    unsigned level ) const [protected]
```

References [GiNaC::_ex1](#), [GiNaC::_ex_1](#), [GiNaC::_num1_p](#), [GiNaC::_num_1_p](#), [c](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is_zero\(\)](#), [GiNaC::expairseq::overall_coeff](#), [GiNaC::info_flags::positive](#), [precedence\(\)](#), [GiNaC::ex::print\(\)](#), [GiNaC::info_flags::real](#), and [GiNaC::expairseq::seq](#).

6.3.3.33 do_print_python_repr()

```
void GiNaC::add::do_print_python_repr (
    const print\_python\_repr & c,
    unsigned level ) const [protected]
```

References [c](#), [GiNaC::expairseq::nops\(\)](#), [GiNaC::expairseq::op\(\)](#), and [GiNaC::ex::print\(\)](#).

6.3.4 Friends And Related Function Documentation**6.3.4.1 mul**

```
friend class mul [friend]
```

6.3.4.2 power

```
friend class power [friend]
```

The documentation for this class was generated from the following files:

- [add.h](#)
- [add.cpp](#)
- [indexed.cpp](#)
- [normal.cpp](#)
- [pseries.cpp](#)

6.4 GiNaC::archive Class Reference

This class holds archived versions of [GiNaC](#) expressions (class [ex](#)).

```
#include <archive.h>
```

Classes

- struct [archived_ex](#)
Archived expression descriptor.

Public Member Functions

- [archive](#) ()
Construct archive from expression using the default name "ex".
- [~archive](#) ()
- [archive](#) (const [ex](#) &e)
Construct archive from expression using the specified name.
- [archive](#) (const [ex](#) &e, const char *n)
Construct archive from expression using the specified name.
- void [archive_ex](#) (const [ex](#) &e, const char *name)
Archive an expression.
- [ex unarchive_ex](#) (const [lst](#) &sym_lst, const char *name) const
Retrieve expression from archive by name.
- [ex unarchive_ex](#) (const [lst](#) &sym_lst, unsigned index=0) const
Retrieve expression from archive by index.
- [ex unarchive_ex](#) (const [lst](#) &sym_lst, std::string &name, unsigned index=0) const
Retrieve expression and its name from archive by index.
- unsigned [num_expressions](#) () const
Return number of archived expressions.
- const [archive_node](#) & [get_top_node](#) (unsigned index=0) const
Return reference to top node of an expression specified by index.
- void [clear](#) ()
Clear all archived expressions.
- [archive_node_id](#) [add_node](#) (const [archive_node](#) &n)
Add [archive_node](#) to archive if the corresponding expression is not already archived.
- [archive_node](#) & [get_node](#) ([archive_node_id](#) id)

- Retrieve [archive_node](#) by ID.
- void [forget](#) ()
Delete cached unarchived expressions in all [archive_nodes](#) (mainly for debugging).
- void [prinraw](#) (std::ostream &os) const
Print archive to stream in ugly raw format (for debugging).
- [archive_atom](#) [atomize](#) (const std::string &s) const
Atomize a string (i.e.
- const std::string & [unatomize](#) ([archive_atom](#) id) const
Unatomize a string (i.e.

Private Types

- typedef std::map< std::string, [archive_atom](#) >::const_iterator [inv_at_cit](#)
The map of from strings to indices of the atoms vectors allows for faster archiving.

Private Attributes

- std::vector< [archive_node](#) > [nodes](#)
Vector of archived nodes.
- std::vector< [archived_ex](#) > [exprs](#)
Vector of archived expression descriptors.
- std::vector< std::string > [atoms](#)
Vector of atomized strings (using a vector allows faster unarchiving).
- std::map< std::string, [archive_atom](#) > [inverse_atoms](#)
- std::map< [ex](#), [archive_node_id](#), [ex_is_less](#) > [exprtable](#)
Map of stored expressions to nodes for faster archiving.

Friends

- std::ostream & [operator<<](#) (std::ostream &os, const [archive](#) &ar)
Write archive to binary data stream.
- std::istream & [operator>>](#) (std::istream &is, [archive](#) &ar)
Read archive from binary data stream.

6.4.1 Detailed Description

This class holds archived versions of [GiNaC](#) expressions (class [ex](#)).

An archive can be constructed from an expression and then written to a stream; or it can be read from a stream and then unarchived, yielding back the expression. Archives can hold multiple expressions which can be referred to by name or index number. The main component of the archive class is a vector of [archive_nodes](#) which each store one object of class [basic](#) (or a derived class).

6.4.2 Member Typedef Documentation

6.4.2.1 inv_at_cit

```
typedef std::map<std::string,archive_atom>::const_iterator GiNaC::archive::inv_at_cit [private]
```

The map of from strings to indices of the atoms vectors allows for faster archiving.

6.4.3 Constructor & Destructor Documentation

6.4.3.1 archive() [1/3]

```
GiNaC::archive::archive ( ) [inline]
```

6.4.3.2 ~archive()

```
GiNaC::archive::~~archive ( ) [inline]
```

6.4.3.3 archive() [2/3]

```
GiNaC::archive::archive (
    const ex & e ) [inline]
```

Construct archive from expression using the default name "ex".

References [archive_ex\(\)](#).

6.4.3.4 archive() [3/3]

```
GiNaC::archive::archive (
    const ex & e,
    const char * n ) [inline]
```

Construct archive from expression using the specified name.

References [archive_ex\(\)](#), and [n](#).

6.4.4 Member Function Documentation

6.4.4.1 archive_ex()

```
void GiNaC::archive::archive_ex (
    const ex & e,
    const char * name )
```

Archive an expression.

Parameters

<i>e</i>	the expression to be archived
<i>name</i>	name under which the expression is stored

References [add_node\(\)](#), [atomize\(\)](#), and [exprs](#).

Referenced by [archive\(\)](#).

6.4.4.2 unarchive_ex() [1/3]

```
ex GiNaC::archive::unarchive_ex (
    const lst & sym_lst,
    const char * name ) const
```

Retrieve expression from archive by name.

Parameters

<i>sym_lst</i>	list of pre-defined symbols
<i>name</i>	name of expression

References [atomize\(\)](#), [exprs](#), and [nodes](#).

6.4.4.3 unarchive_ex() [2/3]

```
ex GiNaC::archive::unarchive_ex (
    const lst & sym_lst,
    unsigned index = 0 ) const
```

Retrieve expression from archive by index.

Parameters

<i>sym_lst</i>	list of pre-defined symbols
<i>index</i>	index of expression

See also

[count_expressions](#)

References [exprs](#), and [nodes](#).

6.4.4.4 unarchive_ex() [3/3]

```
ex GiNaC::archive::unarchive_ex (
    const lst & sym_lst,
    std::string & name,
    unsigned index = 0 ) const
```

Retrieve expression and its name from archive by index.

Parameters

<i>sym_lst</i>	list of pre-defined symbols
<i>name</i>	receives the name of the expression
<i>index</i>	index of expression

See also

`count_expressions`

References [exprs](#), [nodes](#), and [unatomize\(\)](#).

6.4.4.5 num_expressions()

```
unsigned GiNaC::archive::num_expressions ( ) const
```

Return number of archived expressions.

References [exprs](#).

6.4.4.6 get_top_node()

```
const archive_node & GiNaC::archive::get_top_node (
    unsigned index = 0 ) const
```

Return reference to top node of an expression specified by index.

References [exprs](#), and [nodes](#).

6.4.4.7 clear()

```
void GiNaC::archive::clear ( )
```

Clear all archived expressions.

References [atoms](#), [exprs](#), [exprtable](#), [inverse_atoms](#), and [nodes](#).

6.4.4.8 add_node()

```
archive_node_id GiNaC::archive::add_node (
    const archive_node & n )
```

Add [archive_node](#) to archive if the corresponding expression is not already archived.

Returns

ID of archived node

References [exprtable](#), [n](#), and [nodes](#).

Referenced by [GiNaC::archive_node::add_ex\(\)](#), and [archive_ex\(\)](#).

6.4.4.9 get_node()

```
archive_node & GiNaC::archive::get_node (
    archive_node_id id )
```

Retrieve [archive_node](#) by ID.

References [nodes](#).

Referenced by [GiNaC::archive_node::find_ex\(\)](#), [GiNaC::archive_node::find_ex_by_loc\(\)](#), and [GiNaC::archive_node::find_ex_node\(\)](#).

6.4.4.10 forget()

```
void GiNaC::archive::forget ( )
```

Delete cached unarchived expressions in all [archive_nodes](#) (mainly for debugging).

References [GiNaC::archive_node::forget\(\)](#), and [nodes](#).

6.4.4.11 printraw()

```
void GiNaC::archive::printraw (
    std::ostream & os ) const
```

Print archive to stream in ugly raw format (for debugging).

References [atoms](#), [exprs](#), [nodes](#), and [unatomize\(\)](#).

6.4.4.12 atomize()

```
archive_atom GiNaC::archive::atomize (
    const std::string & s ) const
```

Atomize a string (i.e.

convert it into an ID number that uniquely represents the string).

References [atoms](#), and [inverse_atoms](#).

Referenced by [GiNaC::archive_node::add_bool\(\)](#), [GiNaC::archive_node::add_ex\(\)](#), [GiNaC::archive_node::add_string\(\)](#), [GiNaC::archive_node::add_unsigned\(\)](#), [archive_ex\(\)](#), [GiNaC::archive_node::find_bool\(\)](#), [GiNaC::archive_node::find_ex\(\)](#), [GiNaC::archive_node::find_ex_node\(\)](#), [GiNaC::archive_node::find_first\(\)](#), [GiNaC::archive_node::find_last\(\)](#), [GiNaC::archive_node::find_property_range\(\)](#), [GiNaC::archive_node::find_string\(\)](#), [GiNaC::archive_node::find_unsigned\(\)](#), and [unarchive_ex\(\)](#).

6.4.4.13 unatomize()

```
const std::string & GiNaC::archive::unatomize (
    archive_atom id ) const
```

Unatomize a string (i.e.

convert the ID number back to the string).

References [atoms](#).

Referenced by [GiNaC::archive_node::find_string\(\)](#), [GiNaC::archive_node::get_properties\(\)](#), [GiNaC::archive_node::printraw\(\)](#), [printraw\(\)](#), and [unarchive_ex\(\)](#).

6.4.5 Friends And Related Function Documentation

6.4.5.1 operator<<

```
std::ostream & operator<< (
    std::ostream & os,
    const archive & ar ) [friend]
```

Write archive to binary data stream.

6.4.5.2 operator>>

```
std::istream & operator>> (
    std::istream & is,
    archive & ar ) [friend]
```

Read archive from binary data stream.

6.4.6 Member Data Documentation

6.4.6.1 nodes

```
std::vector<archive_node> GiNaC::archive::nodes [private]
```

Vector of archived nodes.

Referenced by [add_node\(\)](#), [clear\(\)](#), [forget\(\)](#), [get_node\(\)](#), [get_top_node\(\)](#), [printraw\(\)](#), and [unarchive_ex\(\)](#).

6.4.6.2 exprs

```
std::vector<archived_ex> GiNaC::archive::exprs [private]
```

Vector of archived expression descriptors.

Referenced by [archive_ex\(\)](#), [clear\(\)](#), [get_top_node\(\)](#), [num_expressions\(\)](#), [printraw\(\)](#), and [unarchive_ex\(\)](#).

6.4.6.3 atoms

```
std::vector<std::string> GiNaC::archive::atoms [mutable], [private]
```

Vector of atomized strings (using a vector allows faster unarchiving).

Referenced by [atomize\(\)](#), [clear\(\)](#), [printraw\(\)](#), and [unatomize\(\)](#).

6.4.6.4 inverse_atoms

```
std::map<std::string, archive_atom> GiNaC::archive::inverse_atoms [mutable], [private]
```

Referenced by [atomize\(\)](#), and [clear\(\)](#).

6.4.6.5 exprtable

```
std::map<ex, archive_node_id, ex_is_less> GiNaC::archive::exprtable [mutable], [private]
```

Map of stored expressions to nodes for faster archiving.

Referenced by [add_node\(\)](#), and [clear\(\)](#).

The documentation for this class was generated from the following files:

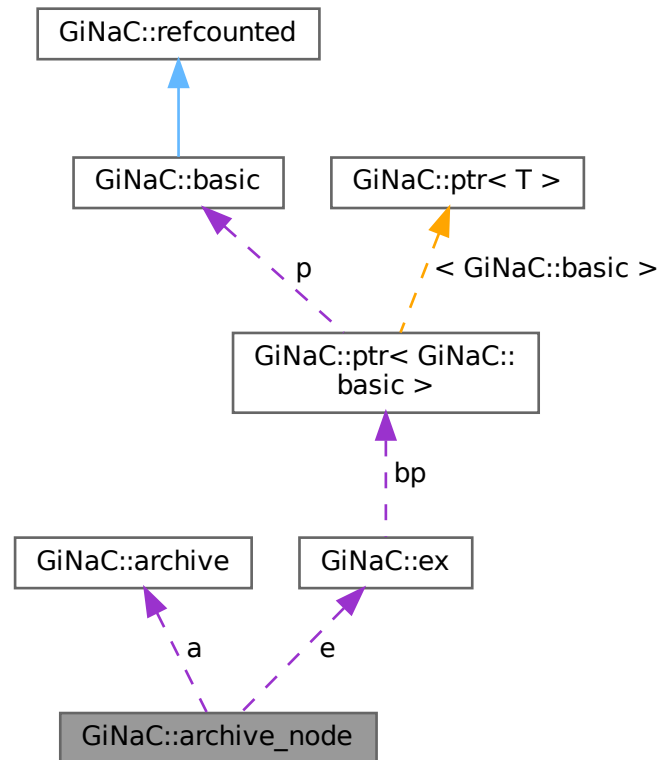
- [archive.h](#)
- [archive.cpp](#)

6.5 GiNaC::archive_node Class Reference

This class stores all properties needed to record/retrieve the state of one object of class basic (or a derived class).

```
#include <archive.h>
```

Collaboration diagram for GiNaC::archive_node:



Classes

- struct [archive_node_cit_range](#)
- struct [property](#)
Archived property (data type, name and associated data)
- struct [property_info](#)
Information about a stored property.

Public Types

- enum [property_type](#) { `PTYPE_BOOL`, `PTYPE_UNSIGNED`, `PTYPE_STRING`, `PTYPE_NODE` }
Property data types.
- typedef `std::vector< property_info >` [propinfovector](#)
- typedef `std::vector< property >::const_iterator` [archive_node_cit](#)

Public Member Functions

- [archive_node](#) ([archive](#) &ar)
- [archive_node](#) ([archive](#) &ar, const [ex](#) &expr)
Recursively construct archive node from expression.
- const [archive_node](#) & [operator=](#) (const [archive_node](#) &other)
Assignment operator of [archive_node](#).
- void [add_bool](#) (const std::string &name, bool [value](#))
Add property of type "bool" to node.
- void [add_unsigned](#) (const std::string &name, unsigned [value](#))
Add property of type "unsigned int" to node.
- void [add_string](#) (const std::string &name, const std::string &[value](#))
Add property of type "string" to node.
- void [add_ex](#) (const std::string &name, const [ex](#) &[value](#))
Add property of type "ex" to node.
- bool [find_bool](#) (const std::string &name, bool &ret, unsigned index=0) const
Retrieve property of type "bool" from node.
- bool [find_unsigned](#) (const std::string &name, unsigned &ret, unsigned index=0) const
Retrieve property of type "unsigned" from node.
- bool [find_string](#) (const std::string &name, std::string &ret, unsigned index=0) const
Retrieve property of type "string" from node.
- [archive_node_cit](#) [find_first](#) (const std::string &name) const
Find the location in the vector of properties of the first/last property with a given name.
- [archive_node_cit](#) [find_last](#) (const std::string &name) const
- [archive_node_cit_range](#) [find_property_range](#) (const std::string &name1, const std::string &name2) const
Find a range of locations in the vector of properties.
- bool [find_ex](#) (const std::string &name, [ex](#) &ret, [lst](#) &sym_lst, unsigned index=0) const
Retrieve property of type "ex" from node.
- void [find_ex_by_loc](#) ([archive_node_cit](#) loc, [ex](#) &ret, [lst](#) &sym_lst) const
Retrieve property of type "ex" from the node if it is known that this node in fact contains such a property at the given location.
- const [archive_node](#) & [find_ex_node](#) (const std::string &name, unsigned index=0) const
Retrieve property of type "ex" from node, returning the node of the sub-expression.
- void [get_properties](#) ([propinfovector](#) &v) const
Return vector of properties stored in node.
- [ex](#) [unarchive](#) ([lst](#) &sym_lst) const
Convert archive node to [GiNaC](#) expression.
- bool [has_same_ex_as](#) (const [archive_node](#) &other) const
Check if the [archive_node](#) stores the same expression as another [archive_node](#).
- bool [has_ex](#) () const
- [ex](#) [get_ex](#) () const
- void [forget](#) ()
Delete cached unarchived expressions from node (for debugging).
- void [prinraw](#) (std::ostream &os) const
Output [archive_node](#) to stream in ugly raw format (for debugging).

Private Attributes

- [archive](#) & [a](#)
Reference to the archive to which this node belongs.
- `std::vector< property > props`
Vector of stored properties.
- `bool has_expression`
Flag indicating whether a cached unarchived representation of this node exists.
- `ex e`
The cached unarchived representation of this node (if any).

Friends

- `std::ostream & operator<< (std::ostream &os, const archive_node &ar)`
Write [archive_node](#) to binary data stream.
- `std::istream & operator>> (std::istream &is, archive_node &ar)`
Read [archive_node](#) from binary data stream.

6.5.1 Detailed Description

This class stores all properties needed to record/retrieve the state of one object of class basic (or a derived class).

Each property is addressed by its name and data type.

6.5.2 Member Typedef Documentation

6.5.2.1 propinfovector

```
typedef std::vector<property\_info> GiNaC::archive\_node::propinfovector
```

6.5.2.2 archive_node_cit

```
typedef std::vector<property>::const_iterator GiNaC::archive\_node::archive\_node\_cit
```

6.5.3 Member Enumeration Documentation

6.5.3.1 property_type

```
enum GiNaC::archive\_node::property\_type
```

Property data types.

Enumerator

PTYPE_BOOL	
PTYPE_UNSIGNED	
PTYPE_STRING	
PTYPE_NODE	

6.5.4 Constructor & Destructor Documentation

6.5.4.1 archive_node() [1/2]

```
GiNaC::archive_node::archive_node (
    archive & ar ) [inline]
```

6.5.4.2 archive_node() [2/2]

```
GiNaC::archive_node::archive_node (
    archive & ar,
    const ex & expr )
```

Recursively construct archive node from expression.

References [GiNaC::ex::bp](#).

6.5.5 Member Function Documentation

6.5.5.1 operator=()

```
const archive_node & GiNaC::archive_node::operator= (
    const archive_node & other )
```

Assignment operator of [archive_node](#).

References [e](#), [has_expression](#), and [props](#).

6.5.5.2 add_bool()

```
void GiNaC::archive_node::add_bool (
    const std::string & name,
    bool value )
```

Add property of type "bool" to node.

References [a](#), [GiNaC::archive::atomize\(\)](#), [props](#), [PTYPE_BOOL](#), and [value](#).

6.5.5.3 add_unsigned()

```
void GiNaC::archive_node::add_unsigned (
    const std::string & name,
    unsigned value )
```

Add property of type "unsigned int" to node.

References [a](#), [GiNaC::archive::atomize\(\)](#), [props](#), [PTYPE_UNSIGNED](#), and [value](#).

6.5.5.4 add_string()

```
void GiNaC::archive_node::add_string (
    const std::string & name,
    const std::string & value )
```

Add property of type "string" to node.

References [a](#), [GiNaC::archive::atomize\(\)](#), [props](#), [PTYPE_STRING](#), and [value](#).

6.5.5.5 add_ex()

```
void GiNaC::archive_node::add_ex (
    const std::string & name,
    const ex & value )
```

Add property of type "ex" to node.

References [a](#), [GiNaC::archive::add_node\(\)](#), [GiNaC::archive::atomize\(\)](#), [props](#), [PTYPE_NODE](#), and [value](#).

Referenced by [GiNaC::container< C >::archive\(\)](#).

6.5.5.6 find_bool()

```
bool GiNaC::archive_node::find_bool (
    const std::string & name,
    bool & ret,
    unsigned index = 0 ) const
```

Retrieve property of type "bool" from node.

Returns

"true" if property was found, "false" otherwise

References [a](#), [GiNaC::archive::atomize\(\)](#), [props](#), and [PTYPE_BOOL](#).

6.5.5.7 find_unsigned()

```
bool GiNaC::archive_node::find_unsigned (
    const std::string & name,
    unsigned & ret,
    unsigned index = 0 ) const
```

Retrieve property of type "unsigned" from node.

Returns

"true" if property was found, "false" otherwise

References [a](#), [GiNaC::archive::atomize\(\)](#), [props](#), and [PTYPE_UNSIGNED](#).

6.5.5.8 find_string()

```
bool GiNaC::archive_node::find_string (
    const std::string & name,
    std::string & ret,
    unsigned index = 0 ) const
```

Retrieve property of type "string" from node.

Returns

"true" if property was found, "false" otherwise

References [a](#), [GiNaC::archive::atomize\(\)](#), [props](#), [PTYPE_STRING](#), and [GiNaC::archive::unatomize\(\)](#).

Referenced by [unarchive\(\)](#).

6.5.5.9 find_first()

```
archive_node::archive_node_cit GiNaC::archive_node::find_first (
    const std::string & name ) const
```

Find the location in the vector of properties of the first/last property with a given name.

References [a](#), [GiNaC::archive::atomize\(\)](#), and [props](#).

6.5.5.10 find_last()

```
archive_node::archive_node_cit GiNaC::archive_node::find_last (
    const std::string & name ) const
```

References [a](#), [GiNaC::archive::atomize\(\)](#), and [props](#).

6.5.5.11 find_property_range()

```
archive_node::archive_node_cit_range GiNaC::archive_node::find_property_range (
    const std::string & name1,
    const std::string & name2 ) const
```

Find a range of locations in the vector of properties.

The result begins at the first property with name1 and ends one past the last property with name2.

References [a](#), [GiNaC::archive::atomize\(\)](#), [GiNaC::archive_node::archive_node_cit_range::begin](#), [GiNaC::archive_node::archive_node_cit_range::end](#), and [props](#).

6.5.5.12 find_ex()

```
bool GiNaC::archive_node::find_ex (
    const std::string & name,
    ex & ret,
    lst & sym_lst,
    unsigned index = 0 ) const
```

Retrieve property of type "ex" from node.

Returns

"true" if property was found, "false" otherwise

References [a](#), [GiNaC::archive::atomize\(\)](#), [GiNaC::archive::get_node\(\)](#), [props](#), [PTYPE_NODE](#), and [unarchive\(\)](#).

6.5.5.13 find_ex_by_loc()

```
void GiNaC::archive_node::find_ex_by_loc (
    archive_node_cit loc,
    ex & ret,
    lst & sym_lst ) const
```

Retrieve property of type "ex" from the node if it is known that this node in fact contains such a property at the given location.

This is much more efficient than the preceding function.

References [a](#), [GiNaC::archive::get_node\(\)](#), and [unarchive\(\)](#).

6.5.5.14 find_ex_node()

```
const archive_node & GiNaC::archive_node::find_ex_node (
    const std::string & name,
    unsigned index = 0 ) const
```

Retrieve property of type "ex" from node, returning the node of the sub-expression.

References [a](#), [GiNaC::archive::atomize\(\)](#), [GiNaC::archive::get_node\(\)](#), [props](#), and [PTYPE_NODE](#).

6.5.5.15 get_properties()

```
void GiNaC::archive_node::get_properties (
    propinfovector & v ) const
```

Return vector of properties stored in node.

References [a](#), [props](#), and [GiNaC::archive::unatomize\(\)](#).

6.5.5.16 unarchive()

```
ex GiNaC::archive_node::unarchive (
    lst & sym_lst ) const
```

Convert archive node to [GiNaC](#) expression.

References [GiNaC::status_flags::dynamlocated](#), [e](#), [GiNaC::find_factory_fcn\(\)](#), [find_string\(\)](#), and [has_expression](#).

Referenced by [find_ex\(\)](#), and [find_ex_by_loc\(\)](#).

6.5.5.17 has_same_ex_as()

```
bool GiNaC::archive_node::has_same_ex_as (
    const archive\_node & other ) const
```

Check if the [archive_node](#) stores the same expression as another [archive_node](#).

Returns

"true" if expressions are the same

References [GiNaC::ex::bp](#), [e](#), and [has_expression](#).

6.5.5.18 has_ex()

```
bool GiNaC::archive_node::has_ex ( ) const [inline]
```

References [has_expression](#).

6.5.5.19 get_ex()

```
ex GiNaC::archive_node::get_ex ( ) const [inline]
```

References [e](#).

6.5.5.20 forget()

```
void GiNaC::archive_node::forget ( )
```

Delete cached unarchived expressions from node (for debugging).

References [e](#), and [has_expression](#).

Referenced by [GiNaC::archive::forget\(\)](#).

6.5.5.21 printraw()

```
void GiNaC::archive_node::printraw (
    std::ostream & os ) const
```

Output [archive_node](#) to stream in ugly raw format (for debugging).

References [a](#), [GiNaC::ex::bp](#), [e](#), [has_expression](#), [props](#), [PTYPE_BOOL](#), [PTYPE_NODE](#), [PTYPE_STRING](#), [PTYPE_UNSIGNED](#), and [GiNaC::archive::unatomize\(\)](#).

6.5.6 Friends And Related Function Documentation

6.5.6.1 operator<<

```
std::ostream & operator<< (
    std::ostream & os,
    const archive_node & ar ) [friend]
```

Write [archive_node](#) to binary data stream.

6.5.6.2 operator>>

```
std::istream & operator>> (
    std::istream & is,
    archive_node & ar ) [friend]
```

Read [archive_node](#) from binary data stream.

6.5.7 Member Data Documentation

6.5.7.1 a

```
archive& GiNaC::archive_node::a [private]
```

Reference to the archive to which this node belongs.

Referenced by [add_bool\(\)](#), [add_ex\(\)](#), [add_string\(\)](#), [add_unsigned\(\)](#), [find_bool\(\)](#), [find_ex\(\)](#), [find_ex_by_loc\(\)](#), [find_ex_node\(\)](#), [find_first\(\)](#), [find_last\(\)](#), [find_property_range\(\)](#), [find_string\(\)](#), [find_unsigned\(\)](#), [get_properties\(\)](#), and [printraw\(\)](#).

6.5.7.2 props

```
std::vector<property> GiNaC::archive_node::props [private]
```

Vector of stored properties.

Referenced by [add_bool\(\)](#), [add_ex\(\)](#), [add_string\(\)](#), [add_unsigned\(\)](#), [find_bool\(\)](#), [find_ex\(\)](#), [find_ex_node\(\)](#), [find_first\(\)](#), [find_last\(\)](#), [find_property_range\(\)](#), [find_string\(\)](#), [find_unsigned\(\)](#), [get_properties\(\)](#), [operator=\(\)](#), and [printraw\(\)](#).

6.5.7.3 has_expression

```
bool GiNaC::archive_node::has_expression [mutable], [private]
```

Flag indicating whether a cached unarchived representation of this node exists.

Referenced by [forget\(\)](#), [has_ex\(\)](#), [has_same_ex_as\(\)](#), [operator=\(\)](#), [prinraw\(\)](#), and [unarchive\(\)](#).

6.5.7.4 e

```
ex GiNaC::archive_node::e [mutable], [private]
```

The cached unarchived representation of this node (if any).

Referenced by [forget\(\)](#), [get_ex\(\)](#), [has_same_ex_as\(\)](#), [operator=\(\)](#), [prinraw\(\)](#), and [unarchive\(\)](#).

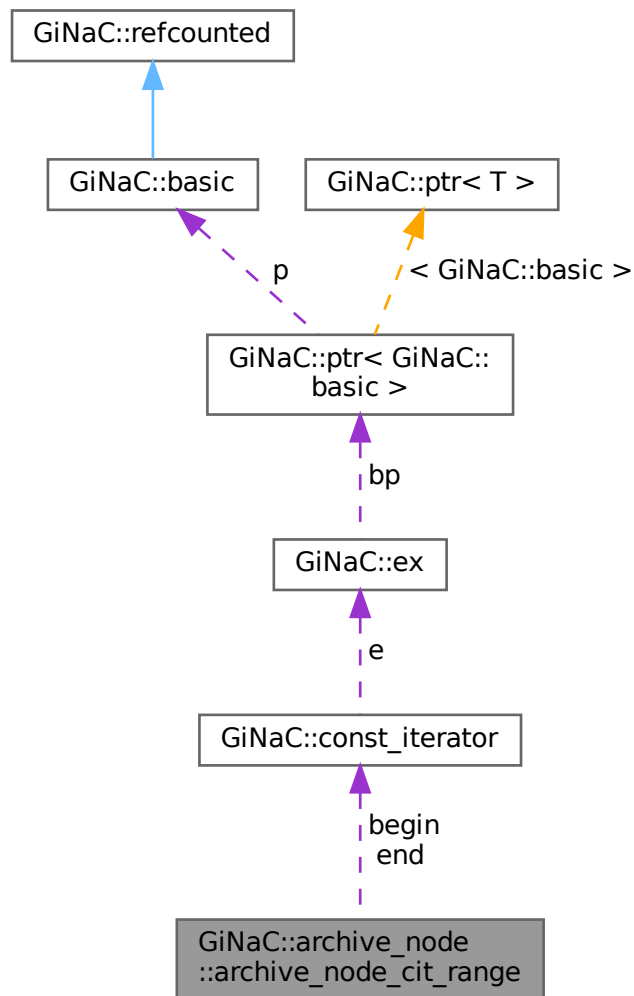
The documentation for this class was generated from the following files:

- [archive.h](#)
- [archive.cpp](#)

6.6 GiNaC::archive_node::archive_node_cit_range Struct Reference

```
#include <archive.h>
```

Collaboration diagram for GiNaC::archive_node::archive_node_cit_range:



Public Attributes

- [archive_node_cit begin](#)
- [archive_node_cit end](#)

6.6.1 Member Data Documentation

6.6.1.1 begin

[archive_node_cit](#) GiNaC::archive_node::archive_node_cit_range::begin

Referenced by [GiNaC::archive_node::find_property_range\(\)](#).

6.6.1.2 end

`archive_node_cit` `GiNaC::archive_node::archive_node_cit_range::end`

Referenced by `GiNaC::archive_node::find_property_range()`.

The documentation for this struct was generated from the following file:

- `archive.h`

6.7 GiNaC::archive::archived_ex Struct Reference

Archived expression descriptor.

Public Member Functions

- `archived_ex` ()
- `archived_ex` (`archive_atom` `n`, `archive_node_id` `node`)

Public Attributes

- `archive_atom` `name`
Name of expression.
- `archive_node_id` `root`
ID of root node.

6.7.1 Detailed Description

Archived expression descriptor.

6.7.2 Constructor & Destructor Documentation

6.7.2.1 archived_ex() [1/2]

`GiNaC::archive::archived_ex::archived_ex ()` [inline]

6.7.2.2 archived_ex() [2/2]

`GiNaC::archive::archived_ex::archived_ex (`
`archive_atom n,`
`archive_node_id node)` [inline]

6.7.3 Member Data Documentation

6.7.3.1 name

`archive_atom` GiNaC::archive::archived_ex::name

Name of expression.

6.7.3.2 root

`archive_node_id` GiNaC::archive::archived_ex::root

ID of root node.

The documentation for this struct was generated from the following file:

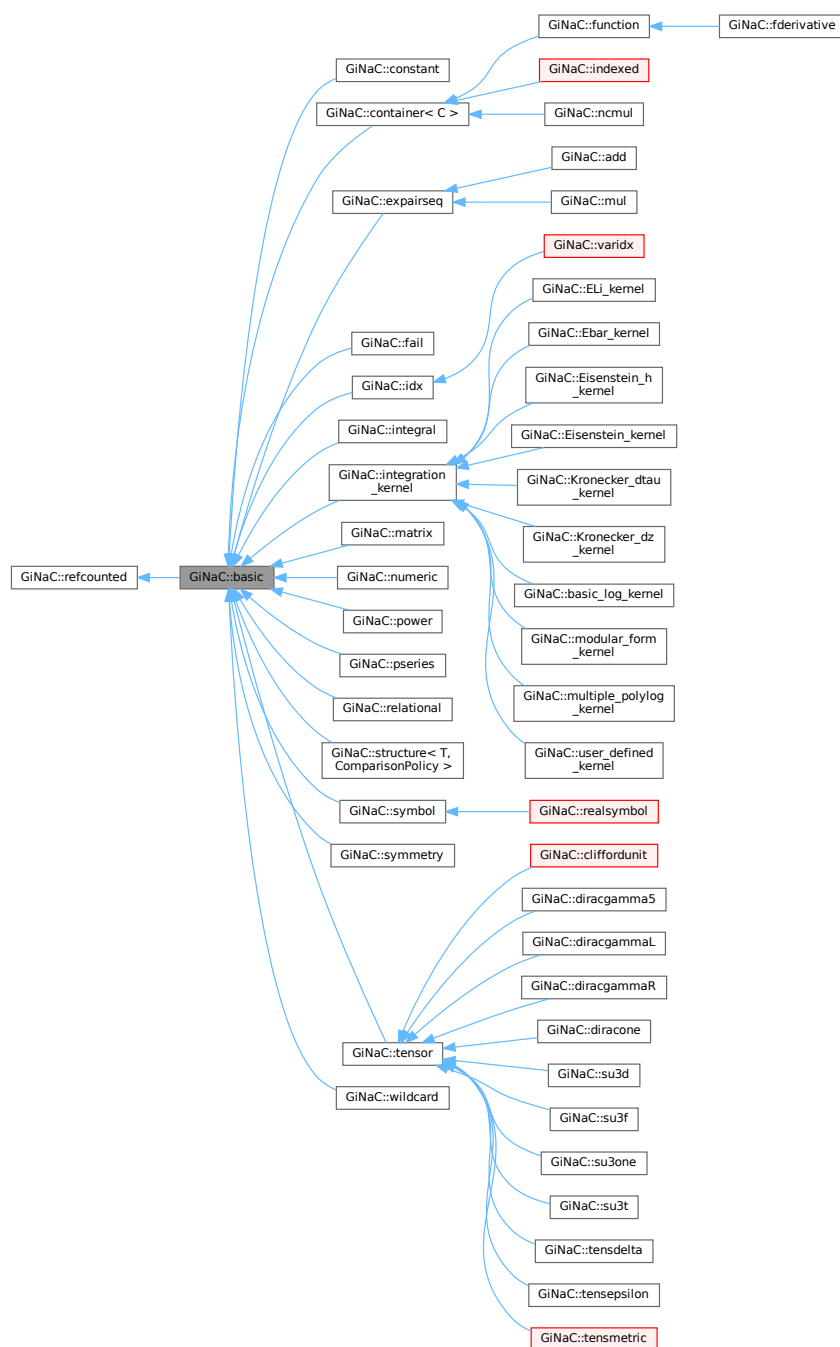
- [archive.h](#)

6.8 GiNaC::basic Class Reference

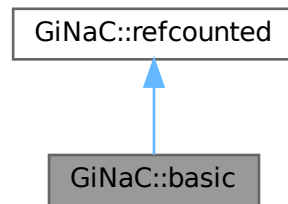
This class is the ABC (abstract base class) of [GiNaC](#)'s class hierarchy.

```
#include <basic.h>
```

Inheritance diagram for GiNaC::basic:



Collaboration diagram for GiNaC::basic:



Public Member Functions

- virtual `~basic ()`
basic destructor, virtual because class `ex` will delete objects of derived classes via a `basic`.*
- `basic (const basic &other)`
- `const basic & operator= (const basic &other)`
basic assignment operator: the other object might be of a derived class.
- virtual `basic * duplicate () const`
Create a clone of this object on the heap.
- virtual `ex eval () const`
Perform automatic non-interruptive term rewriting rules.
- virtual `ex evalf () const`
Evaluate object numerically.
- virtual `ex evalm () const`
Evaluate sums, products and integer powers of matrices.
- virtual `ex eval_integ () const`
Evaluate integrals, if result is known.
- virtual `ex eval_indexed (const basic &i) const`
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual `void print (const print_context &c, unsigned level=0) const`
Output to stream.
- virtual `void dbgprint () const`
Little wrapper around `print` to be called within a debugger.
- virtual `void dbgprinttree () const`
Little wrapper around `printtree` to be called within a debugger.
- virtual `unsigned precedence () const`
Return relative operator precedence (for parenthesizing output).
- virtual `bool info (unsigned inf) const`
Information about the object.
- virtual `size_t nops () const`
Number of operands/members.
- virtual `ex op (size_t i) const`
Return operand/member at position `i`.
- virtual `ex operator[] (const ex &index) const`
- virtual `ex operator[] (size_t i) const`

- virtual `ex & let_op (size_t i)`
Return modifiable operand/member at position i.
- virtual `ex & operator[] (const ex &index)`
- virtual `ex & operator[] (size_t i)`
- virtual `bool has (const ex &other, unsigned options=0) const`
Test for occurrence of a pattern.
- virtual `bool match (const ex &pattern, exmap &repls) const`
Check whether the expression matches a given pattern.
- virtual `ex subs (const exmap &m, unsigned options=0) const`
Substitute a set of objects by arbitrary expressions.
- virtual `ex map (map_function &f) const`
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual `void accept (GiNaC::visitor &v) const`
- virtual `bool is_polynomial (const ex &var) const`
Check whether this is a polynomial in the given variables.
- virtual `int degree (const ex &s) const`
Return degree of highest power in object s.
- virtual `int ldegree (const ex &s) const`
Return degree of lowest power in object s.
- virtual `ex coeff (const ex &s, int n=1) const`
Return coefficient of degree n in object s.
- virtual `ex expand (unsigned options=0) const`
Expand expression, i.e.
- virtual `ex collect (const ex &s, bool distributed=false) const`
Sort expanded expression in terms of powers of some object(s).
- virtual `ex series (const relational &r, int order, unsigned options=0) const`
Default implementation of `ex::series()`.
- virtual `ex normal (exmap &repl, exmap &rev_lookup, lst &modifier) const`
Default implementation of `ex::normal()`.
- virtual `ex to_rational (exmap &repl) const`
Default implementation of `ex::to_rational()`.
- virtual `ex to_polynomial (exmap &repl) const`
- virtual `numeric integer_content () const`
- virtual `ex smod (const numeric &xi) const`
Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- virtual `numeric max_coefficient () const`
Implementation `ex::max_coefficient()`.
- virtual `exvector get_free_indices () const`
Return a vector containing the free indices of an expression.
- virtual `ex add_indexed (const ex &self, const ex &other) const`
Add two indexed expressions.
- virtual `ex scalar_mul_indexed (const ex &self, const numeric &other) const`
Multiply an indexed expression with a scalar.
- virtual `bool contract_with (exvector::iterator self, exvector::iterator other, exvector &v) const`
Try to contract two indexed expressions that appear in the same product.
- virtual `unsigned return_type () const`
- virtual `return_type_t return_type_tinfo () const`
- virtual `ex conjugate () const`
- virtual `ex real_part () const`
- virtual `ex imag_part () const`

- `template<class T >`
`void print_dispatch (const print_context &c, unsigned level) const`
Like `print()`, but dispatch to the specified class.
- `void print_dispatch (const registered_class_info &ri, const print_context &c, unsigned level) const`
Like `print()`, but dispatch to the specified class.
- `virtual void archive (archive_node &n) const`
Save (serialize) the object into archive node.
- `virtual void read_archive (const archive_node &n, lst &syms)`
Load (deserialize) the object from an archive node.
- `ex subs_one_level (const exmap &m, unsigned options) const`
Helper function for `subs()`.
- `ex diff (const symbol &s, unsigned nth=1) const`
Default interface of `nth` derivative `ex::diff(s, n)`.
- `int compare (const basic &other) const`
Compare objects syntactically to establish canonical ordering.
- `bool is_equal (const basic &other) const`
Test for syntactic equality.
- `const basic & hold () const`
Stop further evaluation.
- `unsigned gethash () const`
- `const basic & setflag (unsigned f) const`
Set some `status_flags`.
- `const basic & clearflag (unsigned f) const`
Clear some `status_flags`.

Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted () noexcept`
- `unsigned int add_reference () noexcept`
- `unsigned int remove_reference () noexcept`
- `unsigned int get_refcount () const noexcept`
- `void set_refcount (unsigned int r) noexcept`

Protected Member Functions

- `basic ()`
- `virtual ex eval_ncmul (const exvector &v) const`
- `virtual bool match_same_type (const basic &other) const`
Returns true if the attributes of two objects are similar enough for a match.
- `virtual ex derivative (const symbol &s) const`
Default implementation of `ex::diff()`.
- `virtual int compare_same_type (const basic &other) const`
Returns order relation between two objects of same type.
- `virtual bool is_equal_same_type (const basic &other) const`
Returns true if two objects of same type are equal.
- `virtual unsigned calchash () const`
Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.
- `void ensure_if_modifiable () const`
Ensure the object may be modified without hurting others, throws if this is not the case.
- `void do_print (const print_context &c, unsigned level) const`
Default output to stream.
- `void do_print_tree (const print_tree &c, unsigned level) const`
Tree output to stream.
- `void do_print_python_repr (const print_python_repr &c, unsigned level) const`
Python parsable output to stream.

Protected Attributes

- unsigned [flags](#)
of type [status_flags](#)
- unsigned [hashvalue](#)
hash value

Friends

- class [ex](#)

6.8.1 Detailed Description

This class is the ABC (abstract base class) of [GiNaC](#)'s class hierarchy.

6.8.2 Constructor & Destructor Documentation

6.8.2.1 `basic()` [1/2]

```
GiNaC::basic::basic ( ) [inline], [protected]
```

Referenced by [duplicate\(\)](#).

6.8.2.2 `~basic()`

```
virtual GiNaC::basic::~~basic ( ) [inline], [virtual]
```

basic destructor, virtual because class `ex` will delete objects of derived classes via a `basic*`.

References [GiNaC::status_flags::dynallocated](#), [flags](#), [GiNaC::refcounted::get_refcount\(\)](#), and [GINAC_ASSERT](#).

6.8.2.3 `basic()` [2/2]

```
GiNaC::basic::basic (
    const basic & other )
```

6.8.3 Member Function Documentation

6.8.3.1 operator=()

```
const basic & GiNaC::basic::operator= (
    const basic & other )
```

basic assignment operator: the other object might be of a derived class.

References [flags](#), and [hashvalue](#).

6.8.3.2 duplicate()

```
virtual basic * GiNaC::basic::duplicate ( ) const [inline], [virtual]
```

Create a clone of this object on the heap.

One can think of this as simulating a virtual copy constructor which is needed for instance by the refcounted construction of an ex from a basic.

Reimplemented in [GiNaC::realsymbol](#), and [GiNaC::possymbol](#).

References [basic\(\)](#), [GiNaC::status_flags::dynallocated](#), and [setflag\(\)](#).

Referenced by [GiNaC::ex::construct_from_basic\(\)](#), [GiNaC::idx::map\(\)](#), [GiNaC::idx::replace_dim\(\)](#), [GiNaC::idx::subs\(\)](#), [GiNaC::spinidx::toggle_dot\(\)](#), [GiNaC::varidx::toggle_variance\(\)](#), and [GiNaC::spinidx::toggle_variance_dot\(\)](#).

6.8.3.3 eval()

```
ex GiNaC::basic::eval ( ) const [virtual]
```

Perform automatic non-interruptive term rewriting rules.

Reimplemented in [GiNaC::add](#), [GiNaC::expairseq](#), [GiNaC::fderivative](#), [GiNaC::function](#), [GiNaC::indexed](#), [GiNaC::integral](#), [GiNaC::mul](#), [GiNaC::ncmul](#), [GiNaC::numeric](#), [GiNaC::power](#), [GiNaC::pseries](#), [GiNaC::structure< T, ComparisonPolicy>](#), and [GiNaC::symbol](#).

Referenced by [GiNaC::ex::construct_from_basic\(\)](#).

6.8.3.4 evalf()

```
ex GiNaC::basic::evalf ( ) const [virtual]
```

Evaluate object numerically.

Reimplemented in [GiNaC::constant](#), [GiNaC::function](#), [GiNaC::idx](#), [GiNaC::integral](#), [GiNaC::mul](#), [GiNaC::numeric](#), [GiNaC::power](#), [GiNaC::pseries](#), and [GiNaC::symbol](#).

References [GiNaC::nops\(\)](#).

Referenced by [GiNaC::Kronecker_dtau_kernel::get_numerical_value\(\)](#), [GiNaC::Kronecker_dtau_kernel::series_coeff_impl\(\)](#), and [GiNaC::Kronecker_dz_kernel::series_coeff_impl\(\)](#).

6.8.3.5 evalm()

```
ex GiNaC::basic::evalm ( ) const [virtual]
```

Evaluate sums, products and integer powers of matrices.

Reimplemented in [GiNaC::add](#), [GiNaC::matrix](#), [GiNaC::mul](#), [GiNaC::ncmul](#), [GiNaC::power](#), [GiNaC::pseries](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

References [GiNaC::map_evalm](#), and [GiNaC::nops\(\)](#).

6.8.3.6 eval_integ()

```
ex GiNaC::basic::eval_integ ( ) const [virtual]
```

Evaluate integrals, if result is known.

Reimplemented in [GiNaC::integral](#), and [GiNaC::pseries](#).

References [GiNaC::map_eval_integ](#), and [GiNaC::nops\(\)](#).

6.8.3.7 eval_ncmul()

```
ex GiNaC::basic::eval_ncmul (
    const exvector & v ) const [protected], [virtual]
```

Reimplemented in [GiNaC::add](#), [GiNaC::clifford](#), [GiNaC::color](#), [GiNaC::function](#), [GiNaC::integral](#), [GiNaC::mul](#), [GiNaC::power](#), [GiNaC::relational](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

References [GiNaC::hold_ncmul\(\)](#).

6.8.3.8 eval_indexed()

```
ex GiNaC::basic::eval_indexed (
    const basic & i ) const [virtual]
```

Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.

Reimplemented in [GiNaC::su3f](#), [GiNaC::su3d](#), [GiNaC::matrix](#), [GiNaC::structure< T, ComparisonPolicy >](#), [GiNaC::tensdelta](#), [GiNaC::tensmetric](#), [GiNaC::minkmetric](#), [GiNaC::spinmetric](#), and [GiNaC::tensepsilon](#).

6.8.3.9 print()

```
void GiNaC::basic::print (
    const print\_context & c,
    unsigned level = 0 ) const [virtual]
```

Output to stream.

This performs double dispatch on the dynamic type of *this and the dynamic type of the supplied print context.

Parameters

<i>c</i>	print context object that describes the output formatting
<i>level</i>	value that is used to identify the precedence or indentation level for placing parentheses and formatting

Reimplemented in [GiNaC::fderivative](#), [GiNaC::function](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

References [c](#).

Referenced by [GiNaC::fderivative::print\(\)](#), [GiNaC::add::print_add\(\)](#), [GiNaC::mul::print_overall_coeff\(\)](#), and [GiNaC::pseries::print_series\(\)](#).

6.8.3.10 dbgprint()

```
void GiNaC::basic::dbgprint ( ) const [virtual]
```

Little wrapper around print to be called within a debugger.

This is needed because you cannot call `foo.print(cout)` from within the debugger because it might not know what `cout` is. This method can be invoked with no argument and it will simply print to `stdout`.

See also

[basic::print](#)
[basic::dbgprinttree](#)

6.8.3.11 dbgprinttree()

```
void GiNaC::basic::dbgprinttree ( ) const [virtual]
```

Little wrapper around printtree to be called within a debugger.

See also

[basic::dbgprint](#)

6.8.3.12 precedence()

```
unsigned GiNaC::basic::precedence ( ) const [virtual]
```

Return relative operator precedence (for parenthezing output).

Reimplemented in [GiNaC::add](#), [GiNaC::clifford](#), [GiNaC::container< C >](#), [GiNaC::expairseq](#), [GiNaC::function](#), [GiNaC::indexed](#), [GiNaC::integral](#), [GiNaC::mul](#), [GiNaC::ncmul](#), [GiNaC::numeric](#), [GiNaC::power](#), [GiNaC::pseries](#), [GiNaC::relational](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

6.8.3.13 info()

```
bool GiNaC::basic::info (
    unsigned int ) const [virtual]
```

Information about the object.

See also

class [info_flags](#)

Reimplemented in [GiNaC::add](#), [GiNaC::constant](#), [GiNaC::container< C >](#), [GiNaC::expairseq](#), [GiNaC::function](#), [GiNaC::idx](#), [GiNaC::indexed](#), [GiNaC::mul](#), [GiNaC::ncmul](#), [GiNaC::numeric](#), [GiNaC::power](#), [GiNaC::relational](#), [GiNaC::structure< T, ComparisonPolicy >](#), [GiNaC::symbol](#), [GiNaC::tensdelta](#), [GiNaC::tensmetric](#), [GiNaC::minkmetric](#), [GiNaC::spinmetric](#), and [GiNaC::tensepsilon](#).

Referenced by [GiNaC::matrix::gauss_elimination\(\)](#), [GiNaC::function::info\(\)](#), and [GiNaC::matrix::solve\(\)](#).

6.8.3.14 nops()

```
size_t GiNaC::basic::nops ( ) const [virtual]
```

Number of operands/members.

Reimplemented in [GiNaC::clifford](#), [GiNaC::container< C >](#), [GiNaC::expairseq](#), [GiNaC::idx](#), [GiNaC::integral](#), [GiNaC::multiple_polylog_kernel](#), [GiNaC::ELi_kernel](#), [GiNaC::Ebar_kernel](#), [GiNaC::Kronecker_dtau_kernel](#), [GiNaC::Kronecker_dz_kernel](#), [GiNaC::Eisenstein_kernel](#), [GiNaC::Eisenstein_h_kernel](#), [GiNaC::modular_form_kernel](#), [GiNaC::user_defined_kernel](#), [GiNaC::matrix](#), [GiNaC::power](#), [GiNaC::pseries](#), [GiNaC::relational](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

Referenced by [GiNaC::su3f::eval_indexed\(\)](#), [GiNaC::su3d::eval_indexed\(\)](#), [GiNaC::matrix::eval_indexed\(\)](#), [GiNaC::tensmetric::eval_indexed\(\)](#), [GiNaC::minkmetric::eval_indexed\(\)](#), [GiNaC::spinmetric::eval_indexed\(\)](#), [GiNaC::tensepsilon::eval_indexed\(\)](#), and [normal\(\)](#).

6.8.3.15 op()

```
ex GiNaC::basic::op (
    size_t i ) const [virtual]
```

Return operand/member at position i.

Reimplemented in [GiNaC::clifford](#), [GiNaC::container< C >](#), [GiNaC::expairseq](#), [GiNaC::idx](#), [GiNaC::integral](#), [GiNaC::multiple_polylog_kernel](#), [GiNaC::ELi_kernel](#), [GiNaC::Ebar_kernel](#), [GiNaC::Kronecker_dtau_kernel](#), [GiNaC::Kronecker_dz_kernel](#), [GiNaC::Eisenstein_kernel](#), [GiNaC::Eisenstein_h_kernel](#), [GiNaC::modular_form_kernel](#), [GiNaC::user_defined_kernel](#), [GiNaC::matrix](#), [GiNaC::power](#), [GiNaC::pseries](#), [GiNaC::relational](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

Referenced by [GiNaC::su3f::eval_indexed\(\)](#), [GiNaC::su3d::eval_indexed\(\)](#), [GiNaC::matrix::eval_indexed\(\)](#), [GiNaC::tensmetric::eval_indexed\(\)](#), [GiNaC::minkmetric::eval_indexed\(\)](#), [GiNaC::spinmetric::eval_indexed\(\)](#), and [GiNaC::tensepsilon::eval_indexed\(\)](#).

6.8.3.16 operator[]() [1/4]

```
ex GiNaC::basic::operator[] (
    const ex & index ) const [virtual]
```

Reimplemented in [GiNaC::structure< T, ComparisonPolicy >](#).

References [GiNaC::op\(\)](#), and [GiNaC::to_int\(\)](#).

6.8.3.17 operator[]() [2/4]

```
ex GiNaC::basic::operator[] (
    size_t i ) const [virtual]
```

Reimplemented in [GiNaC::structure< T, ComparisonPolicy >](#).

References [GiNaC::op\(\)](#).

6.8.3.18 let_op()

```
ex & GiNaC::basic::let_op (
    size_t i ) [virtual]
```

Return modifiable operand/member at position i.

Reimplemented in [GiNaC::clifford](#), [GiNaC::container< C >](#), [GiNaC::integral](#), [GiNaC::multiple_polylog_kernel](#), [GiNaC::ELi_kernel](#), [GiNaC::Ebar_kernel](#), [GiNaC::Kronecker_dtau_kernel](#), [GiNaC::Kronecker_dz_kernel](#), [GiNaC::Eisenstein_kernel](#), [GiNaC::Eisenstein_h_kernel](#), [GiNaC::modular_form_kernel](#), [GiNaC::user_defined_kernel](#), [GiNaC::matrix](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

Referenced by [map\(\)](#), and [subs\(\)](#).

6.8.3.19 operator[]() [3/4]

```
ex & GiNaC::basic::operator[] (
    const ex & index ) [virtual]
```

Reimplemented in [GiNaC::structure< T, ComparisonPolicy >](#).

References [GiNaC::to_int\(\)](#).

6.8.3.20 operator[]() [4/4]

```
ex & GiNaC::basic::operator[] (
    size_t i ) [virtual]
```

Reimplemented in [GiNaC::structure< T, ComparisonPolicy >](#).

6.8.3.21 has()

```
bool GiNaC::basic::has (
    const ex & pattern,
    unsigned options = 0 ) const [virtual]
```

Test for occurrence of a pattern.

An object 'has' a pattern if it matches the pattern itself or one of the children 'has' it. As a consequence (according to the definition of children) given $e=x+y+z$, $e.has(x)$ is true but $e.has(x+y)$ is false.

Reimplemented in [GiNaC::mul](#), [GiNaC::numeric](#), [GiNaC::power](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

References [GiNaC::ex::has\(\)](#), [GiNaC::match\(\)](#), [GiNaC::nops\(\)](#), [GiNaC::op\(\)](#), and [options](#).

Referenced by [GiNaC::mul::has\(\)](#), [GiNaC::power::has\(\)](#), and [series\(\)](#).

6.8.3.22 match()

```
bool GiNaC::basic::match (
    const ex & pattern,
    exmap & repl_lst ) const [virtual]
```

Check whether the expression matches a given pattern.

For every wildcard object in the pattern, a pair with the wildcard as a key and matching expression as a value is added to `repl_lst`.

Reimplemented in [GiNaC::expairseq](#), [GiNaC::structure< T, ComparisonPolicy >](#), and [GiNaC::wildcard](#).

References [GiNaC::ex::match\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::nops\(\)](#), [GiNaC::op\(\)](#), and [GiNaC::ex::op\(\)](#).

6.8.3.23 match_same_type()

```
bool GiNaC::basic::match_same_type (
    const basic & other ) const [protected], [virtual]
```

Returns true if the attributes of two objects are similar enough for a match.

This function must not match subexpressions (this is already done by [basic::match\(\)](#)). Only attributes not accessible by [op\(\)](#) should be compared. This is also the reason why this function doesn't take the wildcard replacement list from [match\(\)](#) as an argument: only subexpressions are subject to wildcard matches. Also, this function only needs to be implemented for container classes because [is_equal_same_type\(\)](#) is automatically used instead of [match_same_type\(\)](#) if [nops\(\)](#) == 0.

See also

[basic::match](#)

Reimplemented in [GiNaC::clifford](#), [GiNaC::color](#), [GiNaC::fderivative](#), [GiNaC::function](#), [GiNaC::idx](#), [GiNaC::varidx](#), [GiNaC::spinidx](#), [GiNaC::matrix](#), [GiNaC::relational](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

6.8.3.24 subs()

```
ex GiNaC::basic::subs (
    const exmap & m,
    unsigned options = 0 ) const [virtual]
```

Substitute a set of objects by arbitrary expressions.

The ex returned will already be evaluated.

Reimplemented in [GiNaC::clifford](#), [GiNaC::container< C >](#), [GiNaC::expairseq](#), [GiNaC::idx](#), [GiNaC::matrix](#), [GiNaC::numeric](#), [GiNaC::power](#), [GiNaC::pseries](#), [GiNaC::relational](#), [GiNaC::structure< T, ComparisonPolicy >](#), and [GiNaC::symbol](#).

References [GiNaC::are_ex_trivially_equal\(\)](#), [clearflag\(\)](#), [let_op\(\)](#), [m](#), [GiNaC::nops\(\)](#), [GiNaC::op\(\)](#), [options](#), [GiNaC::ex::subs\(\)](#), and [subs_one_level\(\)](#).

Referenced by [GiNaC::tensmetric::eval_indexed\(\)](#).

6.8.3.25 map()

```
ex GiNaC::basic::map (
    map\_function & f ) const [virtual]
```

Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).

Reimplemented in [GiNaC::expairseq](#), [GiNaC::idx](#), [GiNaC::power](#), [GiNaC::relational](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

References [GiNaC::are_ex_trivially_equal\(\)](#), [clearflag\(\)](#), [let_op\(\)](#), [n](#), [GiNaC::nops\(\)](#), and [GiNaC::op\(\)](#).

Referenced by [normal\(\)](#).

6.8.3.26 `accept()`

```
virtual void GiNaC::basic::accept (
    GiNaC::visitor & v ) const [inline], [virtual]
```

6.8.3.27 `is_polynomial()`

```
bool GiNaC::basic::is_polynomial (
    const ex & var ) const [virtual]
```

Check whether this is a polynomial in the given variables.

Reimplemented in [GiNaC::add](#), [GiNaC::constant](#), [GiNaC::mul](#), [GiNaC::numeric](#), [GiNaC::power](#), and [GiNaC::symbol](#).

References [GiNaC::has\(\)](#).

6.8.3.28 `degree()`

```
int GiNaC::basic::degree (
    const ex & s ) const [virtual]
```

Return degree of highest power in object s.

Reimplemented in [GiNaC::add](#), [GiNaC::integral](#), [GiNaC::mul](#), [GiNaC::ncmul](#), [GiNaC::numeric](#), [GiNaC::power](#), [GiNaC::pseries](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

6.8.3.29 `ldegree()`

```
int GiNaC::basic::ldegree (
    const ex & s ) const [virtual]
```

Return degree of lowest power in object s.

Reimplemented in [GiNaC::add](#), [GiNaC::integral](#), [GiNaC::mul](#), [GiNaC::ncmul](#), [GiNaC::numeric](#), [GiNaC::power](#), [GiNaC::pseries](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

6.8.3.30 coeff()

```
ex GiNaC::basic::coeff (
    const ex & s,
    int n = 1 ) const [virtual]
```

Return coefficient of degree n in object s.

Reimplemented in [GiNaC::add](#), [GiNaC::mul](#), [GiNaC::ncmul](#), [GiNaC::numeric](#), [GiNaC::power](#), [GiNaC::pseries](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

References [GiNaC::_ex0](#), [GiNaC::_ex1](#), and [n](#).

Referenced by [GiNaC::expairseq::read_archive\(\)](#), [series\(\)](#), and [GiNaC::sqrfree_parfrac\(\)](#).

6.8.3.31 expand()

```
ex GiNaC::basic::expand (
    unsigned options = 0 ) const [virtual]
```

Expand expression, i.e.

multiply it out and return the result as a new expression.

Reimplemented in [GiNaC::add](#), [GiNaC::expairseq](#), [GiNaC::function](#), [GiNaC::indexed](#), [GiNaC::integral](#), [GiNaC::mul](#), [GiNaC::ncmul](#), [GiNaC::power](#), [GiNaC::pseries](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

References [GiNaC::nops\(\)](#), and [options](#).

Referenced by [GiNaC::matrix::fraction_free_elimination\(\)](#), and [GiNaC::matrix::pivot\(\)](#).

6.8.3.32 collect()

```
ex GiNaC::basic::collect (
    const ex & s,
    bool distributed = false ) const [virtual]
```

Sort expanded expression in terms of powers of some object(s).

Parameters

<i>s</i>	object(s) to sort in
<i>distributed</i>	recursive or distributed form (only used when s is a list)

Reimplemented in [GiNaC::pseries](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

References [GiNaC::_ex0](#), [GiNaC::_ex1](#), [GiNaC::ex::coeff\(\)](#), [GiNaC::coeff\(\)](#), [GiNaC::collect\(\)](#), [GiNaC::ex::degree\(\)](#), [GiNaC::degree\(\)](#), [GiNaC::expand\(\)](#), [GiNaC::ldegree\(\)](#), [n](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), [GiNaC::pow\(\)](#), and [x](#).

6.8.3.33 derivative()

```
ex GiNaC::basic::derivative (
    const symbol & s ) const [protected], [virtual]
```

Default implementation of [ex::diff\(\)](#).

It maps the operation on the operands (or returns 0 when the object has no operands).

See also

[ex::diff](#)

Reimplemented in [GiNaC::add](#), [GiNaC::constant](#), [GiNaC::fderivative](#), [GiNaC::function](#), [GiNaC::idx](#), [GiNaC::indexed](#), [GiNaC::integral](#), [GiNaC::mul](#), [GiNaC::ncmul](#), [GiNaC::numeric](#), [GiNaC::power](#), [GiNaC::pseries](#), [GiNaC::structure< T, ComparisonPolicy>](#), and [GiNaC::symbol](#).

References [GiNaC::_ex0](#), and [GiNaC::nops\(\)](#).

6.8.3.34 series()

```
ex GiNaC::basic::series (
    const relational & r,
    int order,
    unsigned options = 0 ) const [virtual]
```

Default implementation of [ex::series\(\)](#).

This performs Taylor expansion.

See also

[ex::series](#)

Reimplemented in [GiNaC::add](#), [GiNaC::fderivative](#), [GiNaC::function](#), [GiNaC::integral](#), [GiNaC::integration_kernel](#), [GiNaC::Eisenstein_kernel](#), [GiNaC::Eisenstein_h_kernel](#), [GiNaC::modular_form_kernel](#), [GiNaC::pseries](#), [GiNaC::structure< T, ComparisonPolicy>](#), [GiNaC::mul](#), [GiNaC::power](#), and [GiNaC::symbol](#).

References [GiNaC::_ex0](#), [GiNaC::_ex1](#), [coeff\(\)](#), [GiNaC::ex::diff\(\)](#), [GiNaC::numeric::div\(\)](#), [GiNaC::ex::expand\(\)](#), [has\(\)](#), [GiNaC::ex::is_zero\(\)](#), [n](#), [GiNaC::subs_options::no_pattern](#), [order](#), [r](#), and [GiNaC::ex::subs\(\)](#).

Referenced by [GiNaC::lgamma_series\(\)](#), [GiNaC::fderivative::series\(\)](#), [GiNaC::function::series\(\)](#), and [GiNaC::power::series\(\)](#).

6.8.3.35 normal()

```
ex GiNaC::basic::normal (
    exmap & repl,
    exmap & rev_lookup,
    lst & modifier ) const [virtual]
```

Default implementation of [ex::normal\(\)](#).

It normalizes the children and replaces the object with a temporary symbol.

See also

[ex::normal](#)

Reimplemented in [GiNaC::add](#), [GiNaC::mul](#), [GiNaC::numeric](#), [GiNaC::power](#), [GiNaC::pseries](#), [GiNaC::structure< T, ComparisonPolicy >](#), and [GiNaC::symbol](#).

References [GiNaC::_ex1](#), [GiNaC::ex::info\(\)](#), [map\(\)](#), [GiNaC::info_flags::negative](#), [GiNaC::subs_options::no_pattern](#), [nops\(\)](#), [GiNaC::container< C >::nops\(\)](#), [GiNaC::ex::op\(\)](#), [GiNaC::container< C >::op\(\)](#), [GiNaC::replace_with_symbol\(\)](#), and [GiNaC::ex::subs\(\)](#).

Referenced by [GiNaC::matrix::markowitz_elimination\(\)](#), and [GiNaC::matrix::solve\(\)](#).

6.8.3.36 to_rational()

```
ex GiNaC::basic::to_rational (
    exmap & repl ) const [virtual]
```

Default implementation of [ex::to_rational\(\)](#).

This replaces the object with a temporary symbol.

Reimplemented in [GiNaC::expairseq](#), [GiNaC::numeric](#), [GiNaC::power](#), [GiNaC::structure< T, ComparisonPolicy >](#), and [GiNaC::symbol](#).

References [GiNaC::replace_with_symbol\(\)](#).

6.8.3.37 to_polynomial()

```
ex GiNaC::basic::to_polynomial (
    exmap & repl ) const [virtual]
```

Reimplemented in [GiNaC::expairseq](#), [GiNaC::numeric](#), [GiNaC::power](#), [GiNaC::structure< T, ComparisonPolicy >](#), and [GiNaC::symbol](#).

References [GiNaC::replace_with_symbol\(\)](#).

6.8.3.38 integer_content()

```
numeric GiNaC::basic::integer_content ( ) const [virtual]
```

Reimplemented in [GiNaC::add](#), [GiNaC::mul](#), [GiNaC::numeric](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

References [GiNaC::_num1_p](#).

6.8.3.39 smod()

```
ex GiNaC::basic::smod (
    const numeric & xi ) const [virtual]
```

Apply symmetric modular homomorphism to an expanded multivariate polynomial.

This function is usually used internally by [heur_gcd\(\)](#).

Parameters

xi	modulus
------	---------

Returns

mapped polynomial

See also

[heur_gcd](#)

Reimplemented in [GiNaC::add](#), [GiNaC::mul](#), [GiNaC::numeric](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

6.8.3.40 max_coefficient()

```
numeric GiNaC::basic::max_coefficient ( ) const [virtual]
```

Implementation [ex::max_coefficient\(\)](#).

See also

[heur_gcd](#)

Reimplemented in [GiNaC::add](#), [GiNaC::mul](#), [GiNaC::numeric](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

References [GiNaC::_num1_p](#).

6.8.3.41 get_free_indices()

```
exvector GiNaC::basic::get_free_indices ( ) const [virtual]
```

Return a vector containing the free indices of an expression.

Reimplemented in [GiNaC::add](#), [GiNaC::indexed](#), [GiNaC::integral](#), [GiNaC::mul](#), [GiNaC::ncmul](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

6.8.3.42 add_indexed()

```
ex GiNaC::basic::add_indexed (
    const ex & self,
    const ex & other ) const [virtual]
```

Add two indexed expressions.

They are guaranteed to be of class [indexed](#) (or a subclass) and their indices are compatible. This function is used internally by [simplify_indexed\(\)](#).

Parameters

<i>self</i>	First indexed expression; its base object is *this
<i>other</i>	Second indexed expression

Returns

sum of self and other

See also

[ex::simplify_indexed\(\)](#)

Reimplemented in [GiNaC::matrix](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

6.8.3.43 scalar_mul_indexed()

```
ex GiNaC::basic::scalar_mul_indexed (
    const ex & self,
    const numeric & other ) const [virtual]
```

Multiply an indexed expression with a scalar.

This function is used internally by [simplify_indexed\(\)](#).

Parameters

<i>self</i>	Indexed expression; its base object is <i>*this</i>
<i>other</i>	Numeric value

Returns

product of *self* and *other*

See also

[ex::simplify_indexed\(\)](#)

Reimplemented in [GiNaC::matrix](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

6.8.3.44 contract_with()

```
bool GiNaC::basic::contract_with (
    exvector::iterator self,
    exvector::iterator other,
    exvector & v ) const [virtual]
```

Try to contract two indexed expressions that appear in the same product.

If a contraction exists, the function overwrites one or both of the expressions and returns true. Otherwise it returns false. It is guaranteed that both expressions are of class indexed (or a subclass) and that at least one dummy index has been found. This functions is used internally by [simplify_indexed\(\)](#).

Parameters

<i>self</i>	Pointer to first indexed expression; its base object is <i>*this</i>
<i>other</i>	Pointer to second indexed expression
<i>v</i>	The complete vector of factors

Returns

true if the contraction was successful, false otherwise

See also

[ex::simplify_indexed\(\)](#)

Reimplemented in [GiNaC::cliffordunit](#), [GiNaC::diracgamma](#), [GiNaC::su3t](#), [GiNaC::su3f](#), [GiNaC::su3d](#), [GiNaC::matrix](#), [GiNaC::structure< T, ComparisonPolicy >](#), [GiNaC::tensdelta](#), [GiNaC::tensmetric](#), [GiNaC::spinmetric](#), and [GiNaC::tensepsilon](#).

6.8.3.45 return_type()

```
unsigned GiNaC::basic::return_type ( ) const [virtual]
```

Reimplemented in [GiNaC::add](#), [GiNaC::clifford](#), [GiNaC::color](#), [GiNaC::su3f](#), [GiNaC::su3d](#), [GiNaC::expairseq](#), [GiNaC::fail](#), [GiNaC::function](#), [GiNaC::indexed](#), [GiNaC::integral](#), [GiNaC::matrix](#), [GiNaC::mul](#), [GiNaC::ncmul](#), [GiNaC::power](#), [GiNaC::relational](#), [GiNaC::structure< T, ComparisonPolicy >](#), [GiNaC::tensor](#), [GiNaC::tensdelta](#), [GiNaC::tensmetric](#), [GiNaC::minkmetric](#), and [GiNaC::tensepsilon](#).

6.8.3.46 return_type_tinfo()

```
return_type_t GiNaC::basic::return_type_tinfo ( ) const [virtual]
```

Reimplemented in [GiNaC::add](#), [GiNaC::clifford](#), [GiNaC::color](#), [GiNaC::function](#), [GiNaC::indexed](#), [GiNaC::integral](#), [GiNaC::mul](#), [GiNaC::ncmul](#), [GiNaC::power](#), [GiNaC::relational](#), and [GiNaC::structure< T, ComparisonPolicy >](#).

References [GiNaC::return_type_t::rl](#), and [GiNaC::return_type_t::tinfo](#).

6.8.3.47 conjugate()

```
ex GiNaC::basic::conjugate ( ) const [virtual]
```

Reimplemented in [GiNaC::add](#), [GiNaC::diracgamma5](#), [GiNaC::diracgammaL](#), [GiNaC::diracgammaR](#), [GiNaC::constant](#), [GiNaC::container< C >](#), [GiNaC::expairseq](#), [GiNaC::function](#), [GiNaC::spinidx](#), [GiNaC::integral](#), [GiNaC::matrix](#), [GiNaC::mul](#), [GiNaC::ncmul](#), [GiNaC::numeric](#), [GiNaC::power](#), [GiNaC::pseries](#), [GiNaC::symbol](#), and [GiNaC::realsymbol](#).

6.8.3.48 real_part()

```
ex GiNaC::basic::real_part ( ) const [virtual]
```

Reimplemented in [GiNaC::add](#), [GiNaC::constant](#), [GiNaC::container< C >](#), [GiNaC::function](#), [GiNaC::indexed](#), [GiNaC::matrix](#), [GiNaC::mul](#), [GiNaC::ncmul](#), [GiNaC::numeric](#), [GiNaC::power](#), [GiNaC::pseries](#), [GiNaC::symbol](#), and [GiNaC::realsymbol](#).

Referenced by [GiNaC::function::real_part\(\)](#), and [GiNaC::ncmul::real_part\(\)](#).

6.8.3.49 imag_part()

```
ex GiNaC::basic::imag_part ( ) const [virtual]
```

Reimplemented in [GiNaC::add](#), [GiNaC::constant](#), [GiNaC::container< C >](#), [GiNaC::function](#), [GiNaC::indexed](#), [GiNaC::matrix](#), [GiNaC::mul](#), [GiNaC::ncmul](#), [GiNaC::numeric](#), [GiNaC::power](#), [GiNaC::pseries](#), [GiNaC::symbol](#), and [GiNaC::realsymbol](#).

Referenced by [GiNaC::function::imag_part\(\)](#), and [GiNaC::ncmul::imag_part\(\)](#).

6.8.3.50 `compare_same_type()`

```
int GiNaC::basic::compare_same_type (
    const basic & other ) const [protected], [virtual]
```

Returns order relation between two objects of same type.

This needs to be implemented by each class. It may never return anything else than 0, signalling equality, or +1 and -1 signalling inequality and determining the canonical ordering. (Perl hackers will wonder why C++ doesn't feature the spaceship operator `<=>` for denoting just this.)

References [GiNaC::compare_pointers\(\)](#).

Referenced by [GiNaC::symbol::derivative\(\)](#).

6.8.3.51 `is_equal_same_type()`

```
bool GiNaC::basic::is_equal_same_type (
    const basic & other ) const [protected], [virtual]
```

Returns true if two objects of same type are equal.

Normally needs not be reimplemented as long as it wasn't overwritten by some parent class, since it just calls [compare_same_type\(\)](#). The reason why this function exists is that sometimes it is easier to determine equality than an order relation and then it can be overridden.

Reimplemented in [GiNaC::constant](#), [GiNaC::container< C >](#), [GiNaC::expairseq](#), [GiNaC::fderivative](#), [GiNaC::function](#), [GiNaC::numeric](#), [GiNaC::structure< T, ComparisonPolicy >](#), and [GiNaC::symbol](#).

6.8.3.52 `calchash()`

```
unsigned GiNaC::basic::calchash ( ) const [protected], [virtual]
```

Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.

The method inherited from class `basic` computes a hash value based on the type and hash values of possible members. For this reason it is well suited for container classes but atomic classes should override this implementation because otherwise they would all end up with the same hashvalue.

Reimplemented in [GiNaC::constant](#), [GiNaC::expairseq](#), [GiNaC::function](#), [GiNaC::idx](#), [GiNaC::numeric](#), [GiNaC::relational](#), [GiNaC::structure< T, ComparisonPolicy >](#), [GiNaC::symbol](#), [GiNaC::symmetry](#), and [GiNaC::wildcard](#).

References [GiNaC::ex::gethash\(\)](#), [GiNaC::nops\(\)](#), [GiNaC::op\(\)](#), and [GiNaC::rotate_left\(\)](#).

Referenced by [gethash\(\)](#).

6.8.3.53 print_dispatch() [1/2]

```
template<class T >
void GiNaC::basic::print_dispatch (
    const print\_context & c,
    unsigned level ) const [inline]
```

Like [print\(\)](#), but dispatch to the specified class.

Can be used by implementations of print methods to dispatch to the method of the superclass.

See also

[basic::print](#)

References [c](#), and [print_dispatch\(\)](#).

Referenced by [print_dispatch\(\)](#).

6.8.3.54 print_dispatch() [2/2]

```
void GiNaC::basic::print_dispatch (
    const registered\_class\_info & ri,
    const print\_context & c,
    unsigned level ) const
```

Like [print\(\)](#), but dispatch to the specified class.

Can be used by implementations of print methods to dispatch to the method of the superclass.

See also

[basic::print](#)

References [c](#), [GiNaC::class_info< OPT >::get_parent\(\)](#), and [GiNaC::class_info< OPT >::options](#).

6.8.3.55 archive()

```
void GiNaC::basic::archive (
    archive\_node & n ) const [virtual]
```

Save (serialize) the object into archive node.

Archive the object.

Losely speaking, this method turns an expression into a byte stream (which can be saved and restored later on, or sent via network, etc.)

Reimplemented in [GiNaC::clifford](#), [GiNaC::color](#), [GiNaC::constant](#), [GiNaC::container< C >](#), [GiNaC::expairseq](#), [GiNaC::fderivative](#), [GiNaC::function](#), [GiNaC::idx](#), [GiNaC::varidx](#), [GiNaC::spinidx](#), [GiNaC::indexed](#), [GiNaC::integral](#), [GiNaC::matrix](#), [GiNaC::numeric](#), [GiNaC::power](#), [GiNaC::pseries](#), [GiNaC::relational](#), [GiNaC::symbol](#), [GiNaC::symmetry](#), [GiNaC::minkmetric](#), [GiNaC::tensepsilon](#), and [GiNaC::wildcard](#).

References [n](#).

6.8.3.56 read_archive()

```
void GiNaC::basic::read_archive (
    const archive_node & n,
    lst & syms ) [virtual]
```

Load (deserialize) the object from an archive node.

Construct object from [archive_node](#).

Note

This method is essentially a constructor. However, constructors can't be virtual. So, if unarchiving routines are implemented as constructors one would need to define such a constructor in every class, even if all it does is simply calling constructor of a superclass.

Reimplemented in [GiNaC::clifford](#), [GiNaC::color](#), [GiNaC::container< C >](#), [GiNaC::constant](#), [GiNaC::expairseq](#), [GiNaC::fderivative](#), [GiNaC::function](#), [GiNaC::idx](#), [GiNaC::varidx](#), [GiNaC::spinidx](#), [GiNaC::indexed](#), [GiNaC::integral](#), [GiNaC::matrix](#), [GiNaC::numeric](#), [GiNaC::power](#), [GiNaC::pseries](#), [GiNaC::relational](#), [GiNaC::symbol](#), [GiNaC::symmetry](#), [GiNaC::minkmetric](#), [GiNaC::tensepsilon](#), and [GiNaC::wildcard](#).

6.8.3.57 subs_one_level()

```
ex GiNaC::basic::subs_one_level (
    const exmap & m,
    unsigned options ) const
```

Helper function for [subs\(\)](#).

Does not recurse into subexpressions.

References [m](#), [GiNaC::match\(\)](#), [options](#), and [GiNaC::ex::subs\(\)](#).

Referenced by [GiNaC::mul::algebraic_subs_mul\(\)](#), [subs\(\)](#), [GiNaC::expairseq::subs\(\)](#), [GiNaC::matrix::subs\(\)](#), [GiNaC::numeric::subs\(\)](#), [GiNaC::power::subs\(\)](#), [GiNaC::relational::subs\(\)](#), and [GiNaC::symbol::subs\(\)](#).

6.8.3.58 diff()

```
ex GiNaC::basic::diff (
    const symbol & s,
    unsigned nth = 1 ) const
```

Default interface of nth derivative `ex::diff(s, n)`.

It should be called instead of `::derivative(s)` for first derivatives and for nth derivatives it just recurses down.

Parameters

<i>s</i>	symbol to differentiate in
<i>nth</i>	order of differentiation

See also

[ex::diff](#)

References [GiNaC::ex::diff\(\)](#), and [GiNaC::ex::is_zero\(\)](#).

Referenced by [GiNaC::mul::derivative\(\)](#).

6.8.3.59 compare()

```
int GiNaC::basic::compare (
    const basic & other ) const
```

Compare objects syntactically to establish canonical ordering.

All compare functions return: -1 for *this less than other, 0 equal, 1 greater.

References [gethash\(\)](#).

6.8.3.60 is_equal()

```
bool GiNaC::basic::is_equal (
    const basic & other ) const
```

Test for syntactic equality.

This is only a quick test, meaning objects should be in the same domain. You might have to [.expand\(\)](#), [.normal\(\)](#) objects first, depending on the domain of your computation, to get a more reliable answer.

See also

[is_equal_same_type](#)

References [gethash\(\)](#).

Referenced by [GiNaC::ncmul::coeff\(\)](#), [GiNaC::power::coeff\(\)](#), [GiNaC::ncmul::degree\(\)](#), [GiNaC::power::degree\(\)](#), [GiNaC::ncmul::ldegree\(\)](#), [GiNaC::power::ldegree\(\)](#), and [GiNaC::wildcard::match\(\)](#).

6.8.3.61 hold()

```
const basic & GiNaC::basic::hold ( ) const
```

Stop further evaluation.

See also

[basic::eval](#)

Referenced by [GiNaC::abs_conjugate\(\)](#), [GiNaC::abs_eval\(\)](#), [GiNaC::abs_evalf\(\)](#), [GiNaC::abs_expand\(\)](#), [GiNaC::abs_power\(\)](#), [GiNaC::abs_real_part\(\)](#), [GiNaC::acos_eval\(\)](#), [GiNaC::acos_evalf\(\)](#), [GiNaC::acosh_eval\(\)](#), [GiNaC::acosh_evalf\(\)](#), [GiNaC::asin_eval\(\)](#), [GiNaC::asin_evalf\(\)](#), [GiNaC::asinh_eval\(\)](#), [GiNaC::asinh_evalf\(\)](#), [GiNaC::atan2_eval\(\)](#), [GiNaC::atan_eval\(\)](#), [GiNaC::atan_evalf\(\)](#), [GiNaC::atanh_eval\(\)](#), [GiNaC::atanh_evalf\(\)](#), [GiNaC::binomial_conjugate\(\)](#), [GiNaC::binomial_eval\(\)](#), [GiNaC::binomial_evalf\(\)](#), [GiNaC::binomial_real_part\(\)](#), [GiNaC::binomial_sym\(\)](#), [GiNaC::conjugate_expl_derivative\(\)](#), [GiNaC::cos_eval\(\)](#), [GiNaC::cos_evalf\(\)](#), [GiNaC::cosh_eval\(\)](#), [GiNaC::cosh_evalf\(\)](#), [GiNaC::csgn_power\(\)](#), [GiNaC::epsilon_tensor\(\)](#), [GiNaC::eta_imag_part\(\)](#), [GiNaC::add::eval\(\)](#), [GiNaC::expairseq::eval\(\)](#), [GiNaC::fderivative::eval\(\)](#), [GiNaC::function::eval\(\)](#), [GiNaC::integral::eval\(\)](#), [GiNaC::mul::eval\(\)](#), [GiNaC::numeric::eval\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::pseries::eval\(\)](#), [GiNaC::structure< T, ComparisonPolicy >::eval\(\)](#), [GiNaC::su3f::eval_indexed\(\)](#), [GiNaC::su3d::eval_indexed\(\)](#), [GiNaC::matrix::eval_indexed\(\)](#), [GiNaC::structure< T, ComparisonPolicy >](#), [GiNaC::tensmetric::eval_indexed\(\)](#), [GiNaC::spinmetric::eval_indexed\(\)](#), [GiNaC::tensepsilon::eval_indexed\(\)](#), [GiNaC::function::evalf\(\)](#), [GiNaC::exp_eval\(\)](#), [GiNaC::exp_evalf\(\)](#), [GiNaC::exp_expand\(\)](#), [GiNaC::exp_power\(\)](#), [GiNaC::power::expand\(\)](#), [GiNaC::factorial_conjugate\(\)](#), [GiNaC::factorial_eval\(\)](#), [GiNaC::factorial_evalf\(\)](#), [GiNaC::factorial_real_part\(\)](#), [GiNaC::G2_eval\(\)](#), [GiNaC::G2_evalf\(\)](#), [GiNaC::G3_eval\(\)](#), [GiNaC::G3_evalf\(\)](#), [GiNaC::imag_part_expl_derivative\(\)](#), [GiNaC::iterated_integral2_eval\(\)](#), [GiNaC::iterated_integral3_eval\(\)](#), [GiNaC::iterated_integral_evalf_impl\(\)](#), [GiNaC::Li2_conjugate\(\)](#), [GiNaC::Li2_eval\(\)](#), [GiNaC::Li2_evalf\(\)](#), [GiNaC::log_eval\(\)](#), [GiNaC::log_evalf\(\)](#), [GiNaC::log_expand\(\)](#), [GiNaC::log_real_part\(\)](#), [GiNaC::lorentz_eps\(\)](#), [GiNaC::Order_power\(\)](#), [GiNaC::psi1_eval\(\)](#), [GiNaC::psi1_evalf\(\)](#), [GiNaC::psi2_eval\(\)](#), [GiNaC::psi2_evalf\(\)](#), [GiNaC::real_part_expl_derivative\(\)](#), [GiNaC::sin_eval\(\)](#), [GiNaC::sin_evalf\(\)](#), [GiNaC::sinh_eval\(\)](#), [GiNaC::sinh_evalf\(\)](#), [GiNaC::step_conjugate\(\)](#), [GiNaC::step_eval\(\)](#), [GiNaC::step_evalf\(\)](#), [GiNaC::step_real_part\(\)](#), [GiNaC::tan_eval\(\)](#), [GiNaC::tan_evalf\(\)](#), [GiNaC::tanh_eval\(\)](#), [GiNaC::tanh_evalf\(\)](#), [GiNaC::zeta1_eval\(\)](#), [GiNaC::zeta1_evalf\(\)](#), [GiNaC::zeta2_eval\(\)](#), [GiNaC::zeta2_evalf\(\)](#), and [GiNaC::zetaderiv_eval\(\)](#).

6.8.3.62 gethash()

```
unsigned GiNaC::basic::gethash ( ) const [inline]
```

References [calchash\(\)](#), [flags](#), [GiNaC::status_flags::hash_calculated](#), and [hashvalue](#).

Referenced by [GiNaC::remember_table::add_entry\(\)](#), [compare\(\)](#), [is_equal\(\)](#), [GiNaC::remember_table_entry::is_equal\(\)](#), and [GiNaC::remember_table::lookup_entry\(\)](#).

6.8.3.63 setflag()

```
const basic & GiNaC::basic::setflag (
    unsigned f ) const [inline]
```

Set some [status_flags](#).

References [flags](#).

Referenced by [GiNaC::constant::calchash\(\)](#), [GiNaC::expairseq::calchash\(\)](#), [GiNaC::function::calchash\(\)](#), [GiNaC::idx::calchash\(\)](#), [GiNaC::numeric::calchash\(\)](#), [GiNaC::relational::calchash\(\)](#), [GiNaC::symbol::calchash\(\)](#), [GiNaC::symmetry::calchash\(\)](#), [GiNaC::wildcard::calchash\(\)](#), [GiNaC::constant::constant\(\)](#), [GiNaC::container< C >::container\(\)](#), [duplicate\(\)](#), [GiNaC::realsymbol::duplicate\(\)](#), [GiNaC::possymbol::duplicate\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::add::expand\(\)](#), [GiNaC::expairseq::expand\(\)](#), [GiNaC::function::expand\(\)](#), [GiNaC::integral::expand\(\)](#), [GiNaC::mul::expand\(\)](#), [GiNaC::ncmul::expand\(\)](#), [GiNaC::power::expand\(\)](#), [GiNaC::power::expand_mul\(\)](#), [GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASSES::GINAC_IMPLEMENT_REGISTERED_CLASSES\(\)](#), [GiNaC::expairseq::info\(\)](#), [GiNaC::mul::info\(\)](#), [GiNaC::power::info\(\)](#), [GiNaC::log_expand\(\)](#), [GiNaC::matrix::matrix\(\)](#), [GiNaC::numeric::numeric\(\)](#), [GiNaC::container< C >::read_archive\(\)](#), [GiNaC::numeric::read_archive\(\)](#), [GiNaC::symbol::read_archive\(\)](#), [GiNaC::wildcard::read_archive\(\)](#), [GiNaC::reduced_matrix\(\)](#), [GiNaC::sub_matrix\(\)](#), [GiNaC::symbol::symbol\(\)](#), [GiNaC::symbolic_matrix\(\)](#), [GiNaC::symmetry::symmetry\(\)](#), [GiNaC::unit_matrix\(\)](#), and [GiNaC::wildcard::wildcard\(\)](#).

6.8.3.64 clearflag()

```
const basic & GiNaC::basic::clearflag (
    unsigned f ) const [inline]
```

Clear some [status_flags](#).

References [flags](#).

Referenced by [GiNaC::add::combine_ex_with_coeff_to_pair\(\)](#), [GiNaC::mul::eval\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::function::function\(\)](#), [GiNaC::expairseq::info\(\)](#), [GiNaC::power::info\(\)](#), [map\(\)](#), [GiNaC::idx::map\(\)](#), [GiNaC::idx::replace_dim\(\)](#), [GiNaC::mul::smod\(\)](#), [GiNaC::add::split_ex_to_pair\(\)](#), [subs\(\)](#), [GiNaC::idx::subs\(\)](#), [GiNaC::spinidx::toggle_dot\(\)](#), [GiNaC::varidx::toggle_variance\(\)](#), and [GiNaC::spinidx::toggle_variance_dot\(\)](#).

6.8.3.65 ensure_if_modifiable()

```
void GiNaC::basic::ensure_if_modifiable ( ) const [protected]
```

Ensure the object may be modified without hurting others, throws if this is not the case.

Referenced by [GiNaC::matrix::division_free_elimination\(\)](#), [GiNaC::matrix::fraction_free_elimination\(\)](#), [GiNaC::matrix::gauss_elimination\(\)](#), [GiNaC::clifford::let_op\(\)](#), [GiNaC::integral::let_op\(\)](#), [GiNaC::multiple_polylog_kernel::let_op\(\)](#), [GiNaC::ELi_kernel::let_op\(\)](#), [GiNaC::Ebar_kernel::let_op\(\)](#), [GiNaC::Kronecker_dtau_kernel::let_op\(\)](#), [GiNaC::Kronecker_dz_kernel::let_op\(\)](#), [GiNaC::Eisenstein_kernel::let_op\(\)](#), [GiNaC::Eisenstein_h_kernel::let_op\(\)](#), [GiNaC::modular_form_kernel::let_op\(\)](#), [GiNaC::user_defined_kernel::let_op\(\)](#), [GiNaC::matrix::let_op\(\)](#), [GiNaC::matrix::operator\(\)\(\)](#), and [GiNaC::matrix::pivot\(\)](#).

6.8.3.66 do_print()

```
void GiNaC::basic::do_print (
    const print\_context & c,
    unsigned level ) const [protected]
```

Default output to stream.

References [c](#).

6.8.3.67 do_print_tree()

```
void GiNaC::basic::do_print_tree (
    const print\_tree & c,
    unsigned level ) const [protected]
```

Tree output to stream.

References [c](#), [GiNaC::nops\(\)](#), [GiNaC::op\(\)](#), and [GiNaC::ex::print\(\)](#).

6.8.3.68 do_print_python_repr()

```
void GiNaC::basic::do_print_python_repr (
    const print\_python\_repr & c,
    unsigned level ) const [protected]
```

Python parsable output to stream.

References [c](#).

6.8.4 Friends And Related Function Documentation

6.8.4.1 ex

```
friend class ex [friend]
```

Referenced by [GiNaC::matrix::charpoly\(\)](#), [GiNaC::integral::expand\(\)](#), [GiNaC::power::expand_mul\(\)](#), and [GiNaC::structure< T, ComparisonPolicy >::scalar_mul_indexed\(\)](#).

6.8.5 Member Data Documentation

6.8.5.1 flags

`unsigned GiNaC::basic::flags [mutable], [protected]`

of type [status_flags](#)

Referenced by [GiNaC::expairseq::calchash\(\)](#), [GiNaC::function::calchash\(\)](#), [GiNaC::idx::calchash\(\)](#), [GiNaC::relational::calchash\(\)](#), [GiNaC::symmetry::calchash\(\)](#), [clearflag\(\)](#), [GiNaC::ex::construct_from_basic\(\)](#), [GiNaC::clifford::do_print_tree\(\)](#), [GiNaC::constant::do_print_tree\(\)](#), [GiNaC::expairseq::do_print_tree\(\)](#), [GiNaC::fderivative::do_print_tree\(\)](#), [GiNaC::idx::do_print_tree\(\)](#), [GiNaC::varidx::do_print_tree\(\)](#), [GiNaC::spinidx::do_print_tree\(\)](#), [GiNaC::indexed::do_print_tree\(\)](#), [GiNaC::numeric::do_print_tree\(\)](#), [GiNaC::pseries::do_print_tree\(\)](#), [GiNaC::symbol::do_print_tree\(\)](#), [GiNaC::symmetry::do_print_tree\(\)](#), [GiNaC::wildcard::do_print_tree\(\)](#), [GiNaC::add::eval\(\)](#), [GiNaC::expairseq::eval\(\)](#), [GiNaC::function::eval\(\)](#), [GiNaC::integral::eval\(\)](#), [GiNaC::mul::eval\(\)](#), [GiNaC::ncmul::eval\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::integral::eval_integ\(\)](#), [GiNaC::integral::expand\(\)](#), [gethash\(\)](#), [GiNaC::expairseq::info\(\)](#), [GiNaC::mul::info\(\)](#), [GiNaC::power::info\(\)](#), [operator=\(\)](#), [GiNaC::function::print\(\)](#), [setflag\(\)](#), and [~basic\(\)](#).

6.8.5.2 hashvalue

`unsigned GiNaC::basic::hashvalue [mutable], [protected]`

hash value

Referenced by [GiNaC::constant::calchash\(\)](#), [GiNaC::expairseq::calchash\(\)](#), [GiNaC::function::calchash\(\)](#), [GiNaC::idx::calchash\(\)](#), [GiNaC::numeric::calchash\(\)](#), [GiNaC::relational::calchash\(\)](#), [GiNaC::symbol::calchash\(\)](#), [GiNaC::symmetry::calchash\(\)](#), [GiNaC::wildcard::calchash\(\)](#), [GiNaC::clifford::do_print_tree\(\)](#), [GiNaC::constant::do_print_tree\(\)](#), [GiNaC::expairseq::do_print_tree\(\)](#), [GiNaC::fderivative::do_print_tree\(\)](#), [GiNaC::idx::do_print_tree\(\)](#), [GiNaC::varidx::do_print_tree\(\)](#), [GiNaC::spinidx::do_print_tree\(\)](#), [GiNaC::indexed::do_print_tree\(\)](#), [GiNaC::numeric::do_print_tree\(\)](#), [GiNaC::pseries::do_print_tree\(\)](#), [GiNaC::symbol::do_print_tree\(\)](#), [GiNaC::symmetry::do_print_tree\(\)](#), [GiNaC::wildcard::do_print_tree\(\)](#), [gethash\(\)](#), [operator=\(\)](#), and [GiNaC::function::print\(\)](#).

The documentation for this class was generated from the following files:

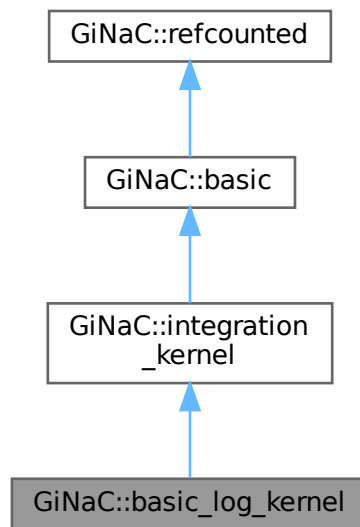
- [basic.h](#)
- [basic.cpp](#)
- [normal.cpp](#)
- [pseries.cpp](#)

6.9 GiNaC::basic_log_kernel Class Reference

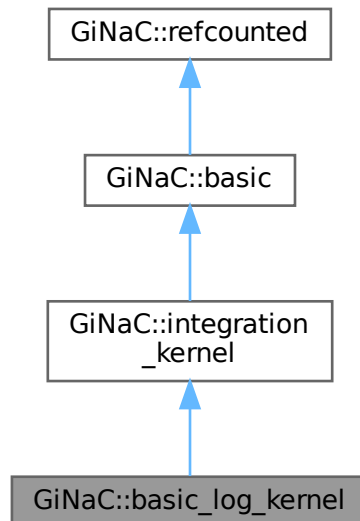
The basic integration kernel with a logarithmic singularity at the origin.

```
#include <integration_kernel.h>
```

Inheritance diagram for GiNaC::basic_log_kernel:



Collaboration diagram for GiNaC::basic_log_kernel:



Protected Member Functions

- `cln::cl_N series_coeff_impl (int i) const` override

For $\omega = d\lambda$ only the coefficient of λ^0 is non-zero.

- void `do_print` (const `print_context` &c, unsigned level) const

Protected Member Functions inherited from `GiNaC::integration_kernel`

- virtual bool `uses_Laurent_series` () const
Returns true, if the coefficients are computed from the Laurent series (in which case the method `Laurent_series` needs to be implemented).
- virtual `cln::cl_N` `series_coeff_impl` (int i) const
For $\omega = d\lambda$ only the coefficient of λ^0 is non-zero.
- `ex` `get_numerical_value_impl` (const `ex` &lambda, const `ex` &pre, int shift, int N_trunc) const
The actual implementation for computing a numerical value for the integrand.
- void `do_print` (const `print_context` &c, unsigned level) const

Protected Member Functions inherited from `GiNaC::basic`

- `basic` ()
- virtual `ex` `eval_ncmul` (const `exvector` &v) const
- virtual bool `match_same_type` (const `basic` &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual `ex` `derivative` (const `symbol` &s) const
Default implementation of `ex::diff()`.
- virtual int `compare_same_type` (const `basic` &other) const
Returns order relation between two objects of same type.
- virtual bool `is_equal_same_type` (const `basic` &other) const
Returns true if two objects of same type are equal.
- virtual unsigned `calchash` () const
Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.
- void `ensure_if_modifiable` () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void `do_print` (const `print_context` &c, unsigned level) const
Default output to stream.
- void `do_print_tree` (const `print_tree` &c, unsigned level) const
Tree output to stream.
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const
Python parsable output to stream.

Additional Inherited Members

Public Member Functions inherited from `GiNaC::integration_kernel`

- `ex` `series` (const `relational` &r, int order, unsigned options=0) const override
Default implementation of `ex::series()`.
- virtual bool `has_trailing_zero` (void) const
This routine returns true, if the integration kernel has a trailing zero.
- virtual bool `is_numeric` (void) const
This routine returns true, if the integration kernel can be evaluated numerically.
- virtual `ex` `Laurent_series` (const `ex` &x, int order) const
Returns the Laurent series, starting possibly with the pole term.

- virtual `ex get_numerical_value` (const `ex` &lambda, int N_trunc=0) const
Evaluates the integrand at lambda.
- size_t `get_cache_size` (void) const
Returns the current size of the cache.
- void `set_cache_step` (int cache_steps) const
Sets the step size by which the cache is increased.
- `ex get_series_coeff` (int i) const
Wrapper around series_coeff(i), converts cl_N to numeric.
- cln::cl_N `series_coeff` (int i) const
Subclasses have either to implement series_coeff_impl or the two methods Laurent_series and uses_Laurent_series.

Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()
basic destructor, virtual because class ex will delete objects of derived classes via a basic.*
- `basic` (const `basic` &other)
- const `basic` & `operator=` (const `basic` &other)
basic assignment operator: the other object might be of a derived class.
- virtual `basic * duplicate` () const
Create a clone of this object on the heap.
- virtual `ex eval` () const
Perform automatic non-interruptive term rewriting rules.
- virtual `ex evalf` () const
Evaluate object numerically.
- virtual `ex evalm` () const
Evaluate sums, products and integer powers of matrices.
- virtual `ex eval_integ` () const
Evaluate integrals, if result is known.
- virtual `ex eval_indexed` (const `basic` &i) const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void `print` (const `print_context` &c, unsigned level=0) const
Output to stream.
- virtual void `dbgprint` () const
Little wrapper around print to be called within a debugger.
- virtual void `dbgprinttree` () const
Little wrapper around printtree to be called within a debugger.
- virtual unsigned `precedence` () const
Return relative operator precedence (for parenthezing output).
- virtual bool `info` (unsigned inf) const
Information about the object.
- virtual size_t `nops` () const
Number of operands/members.
- virtual `ex op` (size_t i) const
Return operand/member at position i.
- virtual `ex operator[]` (const `ex` &index) const
- virtual `ex operator[]` (size_t i) const
- virtual `ex & let_op` (size_t i)
Return modifiable operand/member at position i.
- virtual `ex & operator[]` (const `ex` &index)
- virtual `ex & operator[]` (size_t i)

- virtual bool [has](#) (const [ex](#) &other, unsigned [options](#)=0) const
Test for occurrence of a pattern.
- virtual bool [match](#) (const [ex](#) &pattern, [exmap](#) &repls) const
Check whether the expression matches a given pattern.
- virtual [ex subs](#) (const [exmap](#) &m, unsigned [options](#)=0) const
Substitute a set of objects by arbitrary expressions.
- virtual [ex map](#) ([map_function](#) &f) const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void [accept](#) ([GiNaC::visitor](#) &v) const
- virtual bool [is_polynomial](#) (const [ex](#) &var) const
Check whether this is a polynomial in the given variables.
- virtual int [degree](#) (const [ex](#) &s) const
Return degree of highest power in object s.
- virtual int [ldegree](#) (const [ex](#) &s) const
Return degree of lowest power in object s.
- virtual [ex coeff](#) (const [ex](#) &s, int [n](#)=1) const
Return coefficient of degree n in object s.
- virtual [ex expand](#) (unsigned [options](#)=0) const
Expand expression, i.e.
- virtual [ex collect](#) (const [ex](#) &s, bool distributed=false) const
Sort expanded expression in terms of powers of some object(s).
- virtual [ex series](#) (const [relational](#) &r, int [order](#), unsigned [options](#)=0) const
Default implementation of [ex::series\(\)](#).
- virtual [ex normal](#) ([exmap](#) &repl, [exmap](#) &rev_lookup, [lst](#) &modifier) const
Default implementation of [ex::normal\(\)](#).
- virtual [ex to_rational](#) ([exmap](#) &repl) const
Default implementation of [ex::to_rational\(\)](#).
- virtual [ex to_polynomial](#) ([exmap](#) &repl) const
- virtual [numeric integer_content](#) () const
- virtual [ex smod](#) (const [numeric](#) &xi) const
Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- virtual [numeric max_coefficient](#) () const
Implementation [ex::max_coefficient\(\)](#).
- virtual [exvector get_free_indices](#) () const
Return a vector containing the free indices of an expression.
- virtual [ex add_indexed](#) (const [ex](#) &self, const [ex](#) &other) const
Add two indexed expressions.
- virtual [ex scalar_mul_indexed](#) (const [ex](#) &self, const [numeric](#) &other) const
Multiply an indexed expression with a scalar.
- virtual bool [contract_with](#) ([exvector::iterator](#) self, [exvector::iterator](#) other, [exvector](#) &v) const
Try to contract two indexed expressions that appear in the same product.
- virtual unsigned [return_type](#) () const
- virtual [return_type_t return_type_tinfo](#) () const
- virtual [ex conjugate](#) () const
- virtual [ex real_part](#) () const
- virtual [ex imag_part](#) () const
- template<class T >
void [print_dispatch](#) (const [print_context](#) &c, unsigned level) const
Like [print\(\)](#), but dispatch to the specified class.
- void [print_dispatch](#) (const [registered_class_info](#) &ri, const [print_context](#) &c, unsigned level) const
Like [print\(\)](#), but dispatch to the specified class.

- virtual void `archive (archive_node &n)` const
Save (serialize) the object into archive node.
- virtual void `read_archive (const archive_node &n, lst &syms)`
Load (deserialize) the object from an archive node.
- `ex subs_one_level (const exmap &m, unsigned options)` const
Helper function for subs().
- `ex diff (const symbol &s, unsigned nth=1)` const
Default interface of nth derivative ex::diff(s, n).
- int `compare (const basic &other)` const
Compare objects syntactically to establish canonical ordering.
- bool `is_equal (const basic &other)` const
Test for syntactic equality.
- const `basic & hold ()` const
Stop further evaluation.
- unsigned `gethash ()` const
- const `basic & setflag (unsigned f)` const
Set some status_flags.
- const `basic & clearflag (unsigned f)` const
Clear some status_flags.

Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted ()` noexcept
- unsigned int `add_reference ()` noexcept
- unsigned int `remove_reference ()` noexcept
- unsigned int `get_refcount ()` const noexcept
- void `set_refcount (unsigned int r)` noexcept

Protected Attributes inherited from `GiNaC::integration_kernel`

- int `cache_step_size`
- `std::vector< cln::cl_N >` `series_vec`

Protected Attributes inherited from `GiNaC::basic`

- unsigned `flags`
of type status_flags
- unsigned `hashvalue`
hash value

6.9.1 Detailed Description

The basic integration kernel with a logarithmic singularity at the origin.

This class represents the differential one-form

$$L_0 = \frac{d\lambda}{\lambda}$$

6.9.2 Member Function Documentation

6.9.2.1 series_coeff_impl()

```
cln::cl_N GiNaC::basic_log_kernel::series_coeff_impl (
    int i ) const [override], [protected], [virtual]
```

For $\omega = d\lambda$ only the coefficient of λ^0 is non-zero.

The i -th coefficient corresponds to the power λ^{i-1} .

Reimplemented from [GiNaC::integration_kernel](#).

6.9.2.2 do_print()

```
void GiNaC::basic_log_kernel::do_print (
    const print_context & c,
    unsigned level ) const [protected]
```

References [c](#).

The documentation for this class was generated from the following files:

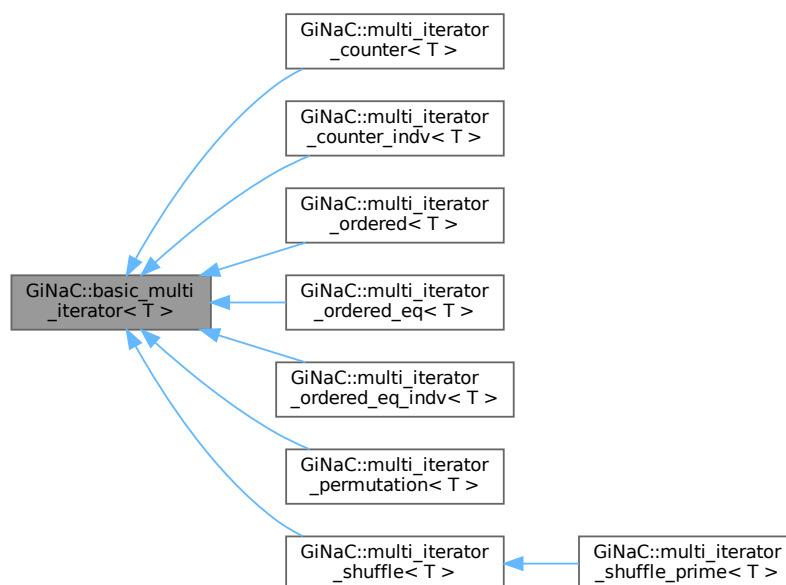
- [integration_kernel.h](#)
- [integration_kernel.cpp](#)

6.10 GiNaC::basic_multi_iterator< T > Class Template Reference

[basic_multi_iterator](#) is a base class.

```
#include <utils_multi_iterator.h>
```

Inheritance diagram for GiNaC::basic_multi_iterator< T >:



Public Member Functions

- [basic_multi_iterator](#) (void)
Default constructor.
- [basic_multi_iterator](#) (T [B](#), T [N](#), size_t [k](#))
Construct a multi_iterator with upper limit N, lower limit B and size k.
- [basic_multi_iterator](#) (T [B](#), T [N](#), const std::vector< T > &vv)
Construct from a vector.
- virtual [~basic_multi_iterator](#) ()
Destructor.
- size_t [size](#) (void) const
Returns the size of a multi_iterator.
- bool [overflow](#) (void) const
Return the overflow flag.
- const std::vector< T > &[get_vector](#) (void) const
Returns a reference to the vector v.
- T [operator\[\]](#) (size_t i) const
Subscription via [].
- T & [operator\[\]](#) (size_t i)
Subscription via [].
- T [operator\(\)](#) (size_t i) const
Subscription via ().
- T & [operator\(\)](#) (size_t i)
Subscription via ().
- virtual [basic_multi_iterator](#)< T > & [init](#) (void)
Initialize the multi-index to.
- virtual [basic_multi_iterator](#)< T > & [operator++](#) (int)
No effect for basic_multi_iterator.

Protected Attributes

- T [N](#)
- T [B](#)
- std::vector< T > [v](#)
- bool [flag_overflow](#)

Friends

- template<class TT >
std::ostream & [operator<<](#) (std::ostream &os, const [basic_multi_iterator](#)< TT > &v)

6.10.1 Detailed Description

```
template<class T>
class GiNaC::basic_multi_iterator< T >
```

[basic_multi_iterator](#) is a base class.

The base class itself does not do anything useful. A typical use of a class derived from [basic_multi_iterator](#) is

```
multi_iterator_ordered<int> k(0,4,2);
```

```
for( k.init(); !k.overflow(); k++) { std::cout << k << std::endl; }
```

which prints out

```
multi_iterator_ordered(0,1) multi_iterator_ordered(0,2) multi_iterator_ordered(0,3) multi_iterator_ordered(1,2)
multi_iterator_ordered(1,3) multi_iterator_ordered(2,3)
```

Individual components of k can be accessed with `k[i]` or `k(i)`.

All classes derived from [basic_multi_iterator](#) follow the same syntax.

6.10.2 Constructor & Destructor Documentation

6.10.2.1 basic_multi_iterator() [1/3]

```
template<class T >
GiNaC::basic_multi_iterator< T >::basic_multi_iterator (
    void ) [inline]
```

Default constructor.

6.10.2.2 basic_multi_iterator() [2/3]

```
template<class T >
GiNaC::basic_multi_iterator< T >::basic_multi_iterator (
    T B,
    T N,
    size_t k ) [inline], [explicit]
```

Construct a multi_iterator with upper limit N, lower limit B and size k .

6.10.2.3 `basic_multi_iterator()` [3/3]

```
template<class T >
GiNaC::basic_multi_iterator< T >::basic_multi_iterator (
    T B,
    T N,
    const std::vector< T > & vv ) [inline], [explicit]
```

Construct from a vector.

6.10.2.4 `~basic_multi_iterator()`

```
template<class T >
GiNaC::basic_multi_iterator< T >::~~basic_multi_iterator [inline], [virtual]
```

Destructor.

6.10.3 Member Function Documentation

6.10.3.1 `size()`

```
template<class T >
size_t GiNaC::basic_multi_iterator< T >::size (
    void ) const [inline]
```

Returns the size of a multi_iterator.

Referenced by [GiNaC::operator<<\(\)](#).

6.10.3.2 `overflow()`

```
template<class T >
bool GiNaC::basic_multi_iterator< T >::overflow (
    void ) const [inline]
```

Return the overflow flag.

6.10.3.3 get_vector()

```
template<class T >
const std::vector< T > & GiNaC::basic_multi_iterator< T >::get_vector (
    void ) const [inline]
```

Returns a reference to the vector v.

6.10.3.4 operator[]() [1/2]

```
template<class T >
T GiNaC::basic_multi_iterator< T >::operator[] (
    size_t i ) const [inline]
```

Subscription via [].

6.10.3.5 operator[]() [2/2]

```
template<class T >
T & GiNaC::basic_multi_iterator< T >::operator[] (
    size_t i ) [inline]
```

Subscription via [].

6.10.3.6 operator()() [1/2]

```
template<class T >
T GiNaC::basic_multi_iterator< T >::operator() (
    size_t i ) const [inline]
```

Subscription via ()

6.10.3.7 operator()() [2/2]

```
template<class T >
T & GiNaC::basic_multi_iterator< T >::operator() (
    size_t i ) [inline]
```

Subscription via ()

6.10.3.8 init()

```
template<class T >
basic_multi_iterator< T > & GiNaC::basic_multi_iterator< T >::init (
    void ) [inline], [virtual]
```

Initialize the multi-index to.

$$(n_1, n_2, n_3, \dots, n_k) = (B, B, \dots, B)$$

Reimplemented in [GiNaC::multi_iterator_ordered< T >](#), [GiNaC::multi_iterator_ordered_eq< T >](#), [GiNaC::multi_iterator_ordered_eq< T >](#), [GiNaC::multi_iterator_counter< T >](#), [GiNaC::multi_iterator_counter_indv< T >](#), [GiNaC::multi_iterator_permutation< T >](#), [GiNaC::multi_iterator_shuffle< T >](#), and [GiNaC::multi_iterator_shuffle_prime< T >](#).

6.10.3.9 operator++()

```
template<class T >
basic_multi_iterator< T > & GiNaC::basic_multi_iterator< T >::operator++ (
    int ) [inline], [virtual]
```

No effect for [basic_multi_iterator](#).

Reimplemented in [GiNaC::multi_iterator_ordered< T >](#), [GiNaC::multi_iterator_ordered_eq< T >](#), [GiNaC::multi_iterator_ordered_eq< T >](#), [GiNaC::multi_iterator_counter< T >](#), [GiNaC::multi_iterator_counter_indv< T >](#), [GiNaC::multi_iterator_permutation< T >](#), and [GiNaC::multi_iterator_shuffle< T >](#).

6.10.4 Friends And Related Function Documentation

6.10.4.1 operator<<

```
template<class T >
template<class TT >
std::ostream & operator<< (
    std::ostream & os,
    const basic_multi_iterator< TT > & v ) [friend]
```

6.10.5 Member Data Documentation

6.10.5.1 N

```
template<class T >
T GiNaC::basic_multi_iterator< T >::N [protected]
```

6.10.5.2 B

```
template<class T >
T GiNaC::basic_multi_iterator< T >::B [protected]
```

Referenced by [GiNaC::multi_iterator_shuffle< T >::multi_iterator_shuffle\(\)](#), and [GiNaC::operator<<\(\)](#).

6.10.5.3 v

```
template<class T >
std::vector<T> GiNaC::basic_multi_iterator< T >::v [protected]
```

Referenced by [GiNaC::multi_iterator_shuffle< T >::multi_iterator_shuffle\(\)](#).

6.10.5.4 flag_overflow

```
template<class T >
bool GiNaC::basic_multi_iterator< T >::flag_overflow [protected]
```

The documentation for this class was generated from the following file:

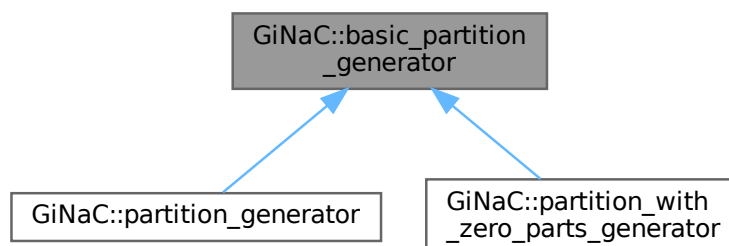
- [utils_multi_iterator.h](#)

6.11 GiNaC::basic_partition_generator Class Reference

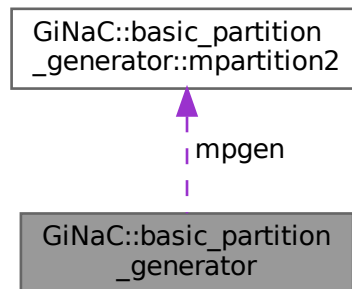
Base class for generating all bounded combinatorial partitions of an integer n with exactly m parts in non-decreasing order.

```
#include <utils.h>
```

Inheritance diagram for GiNaC::basic_partition_generator:



Collaboration diagram for GiNaC::basic_partition_generator:



Classes

- struct [mpartition2](#)

Protected Member Functions

- [basic_partition_generator](#) (unsigned *n_*, unsigned *m_*)

Protected Attributes

- [mpartition2](#) [mpgen](#)

6.11.1 Detailed Description

Base class for generating all bounded combinatorial partitions of an integer *n* with exactly *m* parts in non-decreasing order.

6.11.2 Constructor & Destructor Documentation

6.11.2.1 basic_partition_generator()

```

GiNaC::basic_partition_generator::basic_partition_generator (
    unsigned n_,
    unsigned m_ ) [inline], [protected]
  
```


6.11.3 Member Data Documentation

6.11.3.1 mpgen

`mpartition2` GiNaC::basic_partition_generator::mpgen [protected]

Referenced by [GiNaC::partition_with_zero_parts_generator::get\(\)](#), [GiNaC::partition_generator::get\(\)](#), [GiNaC::partition_with_zero_parts_generator::next\(\)](#) and [GiNaC::partition_generator::next\(\)](#).

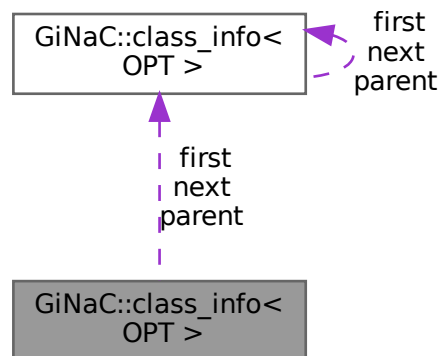
The documentation for this class was generated from the following file:

- [utils.h](#)

6.12 GiNaC::class_info< OPT > Class Template Reference

```
#include <class_info.h>
```

Collaboration diagram for GiNaC::class_info< OPT >:



Classes

- struct [tree_node](#)

Public Member Functions

- [class_info](#) (const OPT &o)
- [class_info](#) * [get_parent](#) () const

Get pointer to [class_info](#) of parent class (or nullptr).

Static Public Member Functions

- static const [class_info](#) * [find](#) (const std::string &class_name)
Find [class_info](#) by name.
- static void [dump_hierarchy](#) (bool verbose=false)
Dump class hierarchy to std::cout.

Public Attributes

- OPT [options](#)

Static Private Member Functions

- static void [dump_tree](#) ([tree_node](#) *n, const std::string &prefix, bool verbose)
- static void [identify_parents](#) ()

Private Attributes

- [class_info](#) * [next](#)
- [class_info](#) * [parent](#)

Static Private Attributes

- static [class_info](#) * [first](#) = nullptr
- static bool [parents_identified](#) = false

6.12.1 Constructor & Destructor Documentation

6.12.1.1 [class_info](#)()

```
template<class OPT >
GiNaC::class_info< OPT >::class_info (
    const OPT & o ) [inline]
```

References [GiNaC::class_info< OPT >::first](#), and [GiNaC::class_info< OPT >::parents_identified](#).

6.12.2 Member Function Documentation

6.12.2.1 get_parent()

```
template<class OPT >
class_info * GiNaC::class_info< OPT >::get_parent ( ) const [inline]
```

Get pointer to [class_info](#) of parent class (or nullptr).

References [GiNaC::class_info< OPT >::identify_parents\(\)](#), and [GiNaC::class_info< OPT >::parent](#).

Referenced by [GiNaC::class_info< OPT >::dump_hierarchy\(\)](#), [GiNaC::function::print\(\)](#), and [GiNaC::basic::print_dispatch\(\)](#).

6.12.2.2 find()

```
template<class OPT >
const class_info< OPT > * GiNaC::class_info< OPT >::find (
    const std::string & class_name ) [static]
```

Find [class_info](#) by name.

References [GiNaC::class_info< OPT >::find\(\)](#), [GiNaC::class_info< OPT >::next](#), and [GiNaC::class_info< OPT >::options](#).

Referenced by [GiNaC::class_info< OPT >::find\(\)](#).

6.12.2.3 dump_hierarchy()

```
template<class OPT >
void GiNaC::class_info< OPT >::dump_hierarchy (
    bool verbose = false ) [static]
```

Dump class hierarchy to `std::cout`.

References [GiNaC::class_info< OPT >::get_parent\(\)](#), [GiNaC::class_info< OPT >::next](#), and [GiNaC::tree\(\)](#).

6.12.2.4 dump_tree()

```
template<class OPT >
void GiNaC::class_info< OPT >::dump_tree (
    tree_node * n,
    const std::string & prefix,
    bool verbose ) [static], [private]
```

References [n](#).

6.12.2.5 identify_parents()

```
template<class OPT >
void GiNaC::class_info< OPT >::identify_parents [static], [private]
```

References [GiNaC::class_info< OPT >::next](#).

Referenced by [GiNaC::class_info< OPT >::get_parent\(\)](#).

6.12.3 Member Data Documentation

6.12.3.1 options

```
template<class OPT >
OPT GiNaC::class_info< OPT >::options
```

Referenced by [GiNaC::class_info< OPT >::find\(\)](#), [GiNaC::function::print\(\)](#), and [GiNaC::basic::print_dispatch\(\)](#).

6.12.3.2 first

```
template<class OPT >
class_info< OPT > * GiNaC::class_info< OPT >::first = nullptr [static], [private]
```

Referenced by [GiNaC::class_info< OPT >::class_info\(\)](#).

6.12.3.3 next

```
template<class OPT >
class_info* GiNaC::class_info< OPT >::next [private]
```

Referenced by [GiNaC::class_info< OPT >::dump_hierarchy\(\)](#), [GiNaC::class_info< OPT >::find\(\)](#), and [GiNaC::class_info< OPT >::i](#)

6.12.3.4 parent

```
template<class OPT >
class_info* GiNaC::class_info< OPT >::parent [mutable], [private]
```

Referenced by [GiNaC::class_info< OPT >::get_parent\(\)](#).

6.12.3.5 parents_identified

```
template<class OPT >
bool GiNaC::class_info< OPT >::parents_identified = false [static], [private]
```

Referenced by [GiNaC::class_info< OPT >::class_info\(\)](#).

The documentation for this class was generated from the following file:

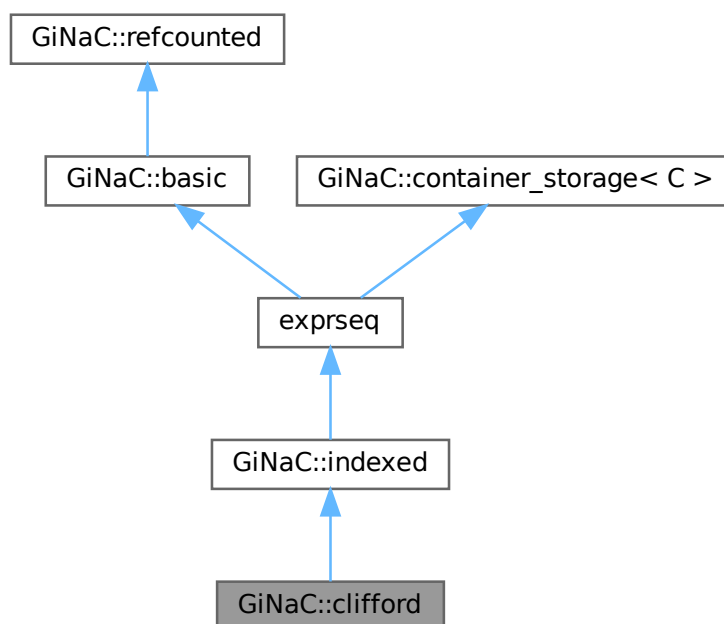
- [class_info.h](#)

6.13 GiNaC::clifford Class Reference

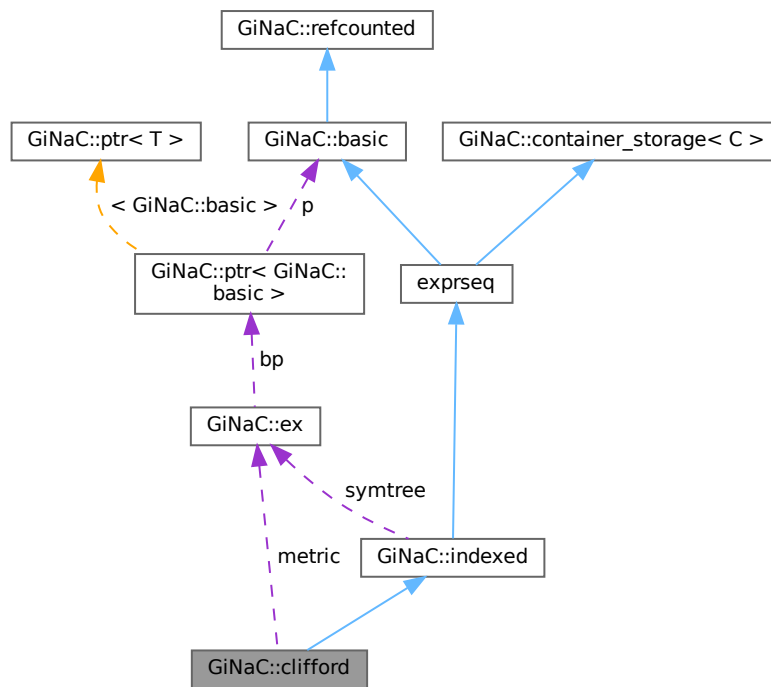
This class holds an object representing an element of the Clifford algebra (the Dirac gamma matrices).

```
#include <clifford.h>
```

Inheritance diagram for GiNaC::clifford:



Collaboration diagram for `GiNaC::clifford`:



Public Member Functions

- `clifford` (const `ex` &b, unsigned char rl=0)
Construct object without any indices.
- `clifford` (const `ex` &b, const `ex` &mu, const `ex` &metr, unsigned char rl=0, int comm_sign=-1)
Construct object with one Lorentz index.
- `clifford` (unsigned char rl, const `ex` &metr, int comm_sign, const `exvector` &v)
- `clifford` (unsigned char rl, const `ex` &metr, int comm_sign, `exvector` &&v)
- unsigned `precedence` () const override
Return relative operator precedence (for parenthezing output).
- void `archive` (`archive_node` &n) const override
Save (serialize) the object into archive node.
- void `read_archive` (const `archive_node` &n, `lst` &sym_lst) override
Load (deserialize) the object from an archive node.
- unsigned char `get_representation_label` () const
- `ex` `get_metric` () const
- virtual `ex` `get_metric` (const `ex` &i, const `ex` &j, bool symmetrised=false) const
- bool `same_metric` (const `ex` &other) const
- int `get_commutator_sign` () const
- size_t `nops` () const override
Number of operands/members.
- `ex` `op` (size_t i) const override
Return operand/member at position i.
- `ex` & `let_op` (size_t i) override

Return modifiable operand/member at position i .

- `ex subs` (const `exmap` &`m`, unsigned `options`=0) const override
Substitute a set of objects by arbitrary expressions.

Public Member Functions inherited from `GiNaC::indexed`

- `indexed` (const `ex` &`b`)
Construct indexed object with no index.
- `indexed` (const `ex` &`b`, const `ex` &`i1`)
Construct indexed object with one index.
- `indexed` (const `ex` &`b`, const `ex` &`i1`, const `ex` &`i2`)
Construct indexed object with two indices.
- `indexed` (const `ex` &`b`, const `ex` &`i1`, const `ex` &`i2`, const `ex` &`i3`)
Construct indexed object with three indices.
- `indexed` (const `ex` &`b`, const `ex` &`i1`, const `ex` &`i2`, const `ex` &`i3`, const `ex` &`i4`)
Construct indexed object with four indices.
- `indexed` (const `ex` &`b`, const `symmetry` &`symm`, const `ex` &`i1`, const `ex` &`i2`)
Construct indexed object with two indices and a specified symmetry.
- `indexed` (const `ex` &`b`, const `symmetry` &`symm`, const `ex` &`i1`, const `ex` &`i2`, const `ex` &`i3`)
Construct indexed object with three indices and a specified symmetry.
- `indexed` (const `ex` &`b`, const `symmetry` &`symm`, const `ex` &`i1`, const `ex` &`i2`, const `ex` &`i3`, const `ex` &`i4`)
Construct indexed object with four indices and a specified symmetry.
- `indexed` (const `ex` &`b`, const `exvector` &`iv`)
Construct indexed object with a specified vector of indices.
- `indexed` (const `ex` &`b`, const `symmetry` &`symm`, const `exvector` &`iv`)
Construct indexed object with a specified vector of indices and symmetry.
- `indexed` (const `symmetry` &`symm`, const `exprseq` &`es`)
- `indexed` (const `symmetry` &`symm`, const `exvector` &`v`)
- `indexed` (const `symmetry` &`symm`, `exvector` &&`v`)
- unsigned `precedence` () const override
Return relative operator precedence (for parenthezing output).
- bool `info` (unsigned `inf`) const override
Information about the object.
- `ex eval` () const override
Perform automatic non-interruptive term rewriting rules.
- `ex real_part` () const override
- `ex imag_part` () const override
- `exvector get_free_indices` () const override
Return a vector containing the free indices of an expression.
- void `archive` (`archive_node` &`n`) const override
Save (a.k.a.
- void `read_archive` (const `archive_node` &`n`, `lst` &`syms`) override
Read (a.k.a.
- bool `all_index_values_are` (unsigned `inf`) const
Check whether all index values have a certain property.
- `exvector get_indices` () const
Return a vector containing the object's indices.
- `exvector get_dummy_indices` () const
Return a vector containing the dummy indices of the object, if any.
- `exvector get_dummy_indices` (const `indexed` &`other`) const

Return a vector containing the dummy indices in the contraction with another indexed object.

- `bool has_dummy_index_for (const ex &i) const`

Check whether the object has an index that forms a dummy index pair with a given index.

- `ex get_symmetry () const`

Return symmetry properties.

Public Member Functions inherited from [GiNaC::container< C >](#)

- `container (STLT const &s)`
- `container (STLT &&v)`
- `container (exvector::const_iterator b, exvector::const_iterator e)`
- `container (std::initializer_list< ex > il)`
- `bool info (unsigned inf) const override`
Information about the object.
- `unsigned precedence () const override`
Return relative operator precedence (for parenthezing output).
- `size_t nops () const override`
Number of operands/members.
- `ex op (size_t i) const override`
Return operand/member at position i.
- `ex & let_op (size_t i) override`
Return modifiable operand/member at position i.
- `ex subs (const exmap &m, unsigned options=0) const override`
Substitute a set of objects by arbitrary expressions.
- `void read_archive (const archive_node &n, lst &sym_lst) override`
Load (deserialize) the object from an archive node.
- `void archive (archive_node &n) const override`
Archive the object.
- `container & prepend (const ex &b)`
Add element at front.
- `container & append (const ex &b)`
Add element at back.
- `container & remove_first ()`
Remove first element.
- `container & remove_last ()`
Remove last element.
- `container & remove_all ()`
Remove all elements.
- `container & sort ()`
Sort elements.
- `container & unique ()`
Remove adjacent duplicate elements.
- `const_iterator begin () const`
- `const_iterator end () const`
- `const_reverse_iterator rbegin () const`
- `const_reverse_iterator rend () const`

Public Member Functions inherited from [GiNaC::basic](#)

- virtual [~basic](#) ()
basic destructor, virtual because class ex will delete objects of derived classes via a basic.*
- [basic](#) (const [basic](#) &other)
- const [basic](#) & [operator=](#) (const [basic](#) &other)
basic assignment operator: the other object might be of a derived class.
- virtual [basic](#) * [duplicate](#) () const
Create a clone of this object on the heap.
- virtual [ex eval](#) () const
Perform automatic non-interruptive term rewriting rules.
- virtual [ex evalf](#) () const
Evaluate object numerically.
- virtual [ex evalm](#) () const
Evaluate sums, products and integer powers of matrices.
- virtual [ex eval_integ](#) () const
Evaluate integrals, if result is known.
- virtual [ex eval_indexed](#) (const [basic](#) &i) const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void [print](#) (const [print_context](#) &c, unsigned level=0) const
Output to stream.
- virtual void [dbgprint](#) () const
Little wrapper around print to be called within a debugger.
- virtual void [dbgprinttree](#) () const
Little wrapper around printtree to be called within a debugger.
- virtual unsigned [precedence](#) () const
Return relative operator precedence (for parenthezing output).
- virtual bool [info](#) (unsigned inf) const
Information about the object.
- virtual size_t [nops](#) () const
Number of operands/members.
- virtual [ex op](#) (size_t i) const
Return operand/member at position i.
- virtual [ex operator\[\]](#) (const [ex](#) &index) const
- virtual [ex operator\[\]](#) (size_t i) const
- virtual [ex](#) & [let_op](#) (size_t i)
Return modifiable operand/member at position i.
- virtual [ex](#) & [operator\[\]](#) (const [ex](#) &index)
- virtual [ex](#) & [operator\[\]](#) (size_t i)
- virtual bool [has](#) (const [ex](#) &other, unsigned [options](#)=0) const
Test for occurrence of a pattern.
- virtual bool [match](#) (const [ex](#) &pattern, [exmap](#) &repls) const
Check whether the expression matches a given pattern.
- virtual [ex subs](#) (const [exmap](#) &m, unsigned [options](#)=0) const
Substitute a set of objects by arbitrary expressions.
- virtual [ex map](#) ([map_function](#) &f) const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void [accept](#) ([GiNaC::visitor](#) &v) const
- virtual bool [is_polynomial](#) (const [ex](#) &var) const
Check whether this is a polynomial in the given variables.
- virtual int [degree](#) (const [ex](#) &s) const

- Return degree of highest power in object s.*

 - virtual int `ldegree` (const `ex` &s) const
- Return degree of lowest power in object s.*

 - virtual `ex coeff` (const `ex` &s, int `n`=1) const
- Return coefficient of degree n in object s.*

 - virtual `ex expand` (unsigned `options`=0) const
- Expand expression, i.e.*

 - virtual `ex collect` (const `ex` &s, bool `distributed`=false) const
- Sort expanded expression in terms of powers of some object(s).*

 - virtual `ex series` (const `relational` &r, int `order`, unsigned `options`=0) const
- Default implementation of `ex::series()`.*

 - virtual `ex normal` (`exmap` &repl, `exmap` &rev_lookup, `lst` &modifier) const
- Default implementation of `ex::normal()`.*

 - virtual `ex to_rational` (`exmap` &repl) const
- Default implementation of `ex::to_rational()`.*

 - virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const
- Apply symmetric modular homomorphism to an expanded multivariate polynomial.*

 - virtual `numeric max_coefficient` () const
- Implementation `ex::max_coefficient()`.*

 - virtual `exvector get_free_indices` () const
- Return a vector containing the free indices of an expression.*

 - virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
- Add two indexed expressions.*

 - virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
- Multiply an indexed expression with a scalar.*

 - virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const
- Try to contract two indexed expressions that appear in the same product.*

 - virtual unsigned `return_type` () const
 - virtual `return_type_t return_type_tinfo` () const
 - virtual `ex conjugate` () const
 - virtual `ex real_part` () const
 - virtual `ex imag_part` () const
- template<class T >

 - void `print_dispatch` (const `print_context` &c, unsigned `level`) const
- Like `print()`, but dispatch to the specified class.*

 - void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned `level`) const
- Like `print()`, but dispatch to the specified class.*

 - virtual void `archive` (`archive_node` &n) const
- Save (serialize) the object into archive node.*

 - virtual void `read_archive` (const `archive_node` &n, `lst` &syms)
- Load (deserialize) the object from an archive node.*

 - `ex subs_one_level` (const `exmap` &m, unsigned `options`) const
- Helper function for `subs()`.*

 - `ex diff` (const `symbol` &s, unsigned `nth`=1) const
- Default interface of nth derivative `ex::diff(s, n)`.*

 - int `compare` (const `basic` &other) const
- Compare objects syntactically to establish canonical ordering.*

 - bool `is_equal` (const `basic` &other) const
- Test for syntactic equality.*

- const [basic](#) & [hold](#) () const
Stop further evaluation.
- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const
Set some [status_flags](#).
- const [basic](#) & [clearflag](#) (unsigned f) const
Clear some [status_flags](#).

Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add_reference](#) () noexcept
- unsigned int [remove_reference](#) () noexcept
- unsigned int [get_refcount](#) () const noexcept
- void [set_refcount](#) (unsigned int r) noexcept

Protected Member Functions

- [ex eval_ncmul](#) (const [exvector](#) &v) const override
Perform automatic simplification on noncommutative product of clifford objects.
- bool [match_same_type](#) (const [basic](#) &other) const override
Returns true if the attributes of two objects are similar enough for a match.
- [ex thiscontainer](#) (const [exvector](#) &v) const override
- [ex thiscontainer](#) ([exvector](#) &&v) const override
- unsigned [return_type](#) () const override
- [return_type_t](#) [return_type_tinfo](#) () const override
- void [do_print_dflt](#) (const [print_dflt](#) &c, unsigned level) const
- void [do_print_latex](#) (const [print_latex](#) &c, unsigned level) const
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const

Protected Member Functions inherited from [GiNaC::indexed](#)

- [ex derivative](#) (const [symbol](#) &s) const override
Implementation of [ex::diff\(\)](#) for an indexed object always returns 0.
- [ex thiscontainer](#) (const [exvector](#) &v) const override
- [ex thiscontainer](#) ([exvector](#) &&v) const override
- unsigned [return_type](#) () const override
- [return_type_t](#) [return_type_tinfo](#) () const override
- [ex expand](#) (unsigned [options](#)=0) const override
Expand expression, i.e.
- void [printindices](#) (const [print_context](#) &c, unsigned level) const
- void [print_indexed](#) (const [print_context](#) &c, const char *openbrace, const char *closebrace, unsigned level) const
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
- void [do_print_latex](#) (const [print_latex](#) &c, unsigned level) const
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
- void [validate](#) () const
Check whether all indices are of class [idx](#) and validate the symmetry tree.

Protected Member Functions inherited from [GiNaC::container< C >](#)

- [ex conjugate](#) () const override
- [ex real_part](#) () const override
- [ex imag_part](#) () const override
- bool [is_equal_same_type](#) (const [basic](#) &other) const override
Returns true if two objects of same type are equal.
- virtual [ex thiscontainer](#) (const [STLT](#) &v) const
Similar to [duplicate\(\)](#), but with a preset sequence.
- virtual [ex thiscontainer](#) ([STLT](#) &&v) const
Similar to [duplicate\(\)](#), but with a preset sequence (which gets pilfered).
- virtual void [printseq](#) (const [print_context](#) &c, char openbracket, char delim, char closebracket, unsigned this↔_precedence, unsigned upper_precedence=0) const
Print sequence of contained elements.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
- void [do_print_python](#) (const [print_python](#) &c, unsigned level) const
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
- [STLT](#) [subchildren](#) (const [exmap](#) &m, unsigned [options](#)=0) const

Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match_same_type](#) (const [basic](#) &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual [ex derivative](#) (const [symbol](#) &s) const
Default implementation of [ex::diff\(\)](#).
- virtual int [compare_same_type](#) (const [basic](#) &other) const
Returns order relation between two objects of same type.
- virtual bool [is_equal_same_type](#) (const [basic](#) &other) const
Returns true if two objects of same type are equal.
- virtual unsigned [calchash](#) () const
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- void [ensure_if_modifiable](#) () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
Default output to stream.
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
Tree output to stream.
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
Python parsable output to stream.

Protected Member Functions inherited from [GiNaC::container_storage< C >](#)

- [container_storage](#) ()
- [container_storage](#) (size_t n, const [ex](#) &e)
- [container_storage](#) (std::initializer_list< [ex](#) > il)
- template<class In >
 [container_storage](#) (In b, In e)
- void [reserve](#) (size_t)
- [~container_storage](#) ()
- void [reserve](#) (size_t n)
- void [reserve](#) (std::vector< [ex](#) > &v, size_t n)

Protected Attributes

- unsigned char [representation_label](#)
Representation label to distinguish independent spin lines.
- [ex metric](#)
Metric of the space, all constructors make it an indexed object.
- int [commutator_sign](#)
It is the sign in the definition $e \sim i \ e \sim j \ +/- \ e \sim j \ e \sim i = B(i, j) + B(j, i)$

Protected Attributes inherited from [GiNaC::indexed](#)

- [ex symtree](#)
Index symmetry (tree of symmetry objects)

Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)
of type [status_flags](#)
- unsigned [hashvalue](#)
hash value

Protected Attributes inherited from [GiNaC::container_storage< C >](#)

- [STLT seq](#)

Additional Inherited Members

Public Types inherited from [GiNaC::container< C >](#)

- typedef [STLT::const_iterator](#) [const_iterator](#)
- typedef [STLT::const_reverse_iterator](#) [const_reverse_iterator](#)

Protected Types inherited from [GiNaC::container< C >](#)

- typedef [container_storage< C >::STLT](#) [STLT](#)

Protected Types inherited from [GiNaC::container_storage< C >](#)

- typedef [C< ex >](#) [STLT](#)

Static Protected Member Functions inherited from [GiNaC::container< C >](#)

- static unsigned [get_default_flags](#) ()
Specialization of [container::get_default_flags\(\)](#) for [lst](#).
- static char [get_open_delim](#) ()
Specialization of [container::get_open_delim\(\)](#) for [lst](#).
- static char [get_close_delim](#) ()
Specialization of [container::get_close_delim\(\)](#) for [lst](#).

Static Protected Member Functions inherited from [GiNaC::container_storage< C >](#)

- static void [reserve](#) (STLT &, size_t)

6.13.1 Detailed Description

This class holds an object representing an element of the Clifford algebra (the Dirac gamma matrices).

These objects only carry Lorentz indices. Spinor indices are hidden. A representation label (an unsigned 8-bit integer) is used to distinguish elements from different Clifford algebras (objects with different labels commute).

6.13.2 Constructor & Destructor Documentation

6.13.2.1 [clifford\(\)](#) [1/4]

```
GiNaC::clifford::clifford (
    const ex & b,
    unsigned char rl = 0 )
```

Construct object without any indices.

This constructor is for internal use only. Use the [dirac_ONE\(\)](#) function instead.

See also

[dirac_ONE](#)

6.13.2.2 [clifford\(\)](#) [2/4]

```
GiNaC::clifford::clifford (
    const ex & b,
    const ex & mu,
    const ex & metr,
    unsigned char rl = 0,
    int comm_sign = -1 )
```

Construct object with one Lorentz index.

This constructor is for internal use only. Use the [clifford_unit\(\)](#) or [dirac_gamma\(\)](#) functions instead.

See also

[clifford_unit](#)

[dirac_gamma](#)

References [GINAC_ASSERT](#).

6.13.2.3 clifford() [3/4]

```
GiNaC::clifford::clifford (
    unsigned char rl,
    const ex & metr,
    int comm_sign,
    const exvector & v )
```

6.13.2.4 clifford() [4/4]

```
GiNaC::clifford::clifford (
    unsigned char rl,
    const ex & metr,
    int comm_sign,
    exvector && v )
```

6.13.3 Member Function Documentation**6.13.3.1 precedence()**

```
unsigned GiNaC::clifford::precedence ( ) const [inline], [override], [virtual]
```

Return relative operator precedence (for parenthezing output).

Reimplemented from [GiNaC::basic](#).

Referenced by [do_print_dflt\(\)](#), and [do_print_latex\(\)](#).

6.13.3.2 archive()

```
void GiNaC::clifford::archive (
    archive_node & n ) const [override], [virtual]
```

Save (serialize) the object into archive node.

Archive the object.

Losely speaking, this method turns an expression into a byte stream (which can be saved and restored later on, or sent via network, etc.)

Reimplemented from [GiNaC::basic](#).

References [commutator_sign](#), [metric](#), [n](#), and [representation_label](#).

6.13.3.3 read_archive()

```
void GiNaC::clifford::read_archive (
    const archive_node & n,
    lst & syms ) [override], [virtual]
```

Load (deserialize) the object from an archive node.

Construct object from [archive_node](#).

Note

This method is essentially a constructor. However, constructors can't be virtual. So, if unarchiving routines are implemented as constructors one would need to define such a constructor in every class, even if all it does is simply calling constructor of a superclass.

Reimplemented from [GiNaC::basic](#).

References [commutator_sign](#), [metric](#), [n](#), and [representation_label](#).

6.13.3.4 eval_ncmul()

```
ex GiNaC::clifford::eval_ncmul (
    const exvector & v ) const [override], [protected], [virtual]
```

Perform automatic simplification on noncommutative product of clifford objects.

This removes superfluous ONEs, permutes gamma5/L/R's to the front and removes squares of gamma objects.

Reimplemented from [GiNaC::basic](#).

6.13.3.5 match_same_type()

```
bool GiNaC::clifford::match_same_type (
    const basic & other ) const [override], [protected], [virtual]
```

Returns true if the attributes of two objects are similar enough for a match.

This function must not match subexpressions (this is already done by [basic::match\(\)](#)). Only attributes not accessible by [op\(\)](#) should be compared. This is also the reason why this function doesn't take the wildcard replacement list from [match\(\)](#) as an argument: only subexpressions are subject to wildcard matches. Also, this function only needs to be implemented for container classes because [is_equal_same_type\(\)](#) is automatically used instead of [match_same_type\(\)](#) if [nops\(\)](#) == 0.

See also

[basic::match](#)

Reimplemented from [GiNaC::basic](#).

References [commutator_sign](#), [get_commutator_sign\(\)](#), [GINAC_ASSERT](#), [representation_label](#), and [same_metric\(\)](#).

6.13.3.6 thiscontainer() [1/2]

```
ex GiNaC::clifford::thiscontainer (
    const exvector & v ) const [override], [protected]
```

6.13.3.7 thiscontainer() [2/2]

```
ex GiNaC::clifford::thiscontainer (
    exvector && v ) const [override], [protected]
```

6.13.3.8 return_type()

```
unsigned GiNaC::clifford::return_type ( ) const [inline], [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::return_types::noncommutative](#).

6.13.3.9 return_type_tinfo()

```
return\_type\_t GiNaC::clifford::return_type_tinfo ( ) const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [representation_label](#).

6.13.3.10 get_representation_label()

```
unsigned char GiNaC::clifford::get_representation_label ( ) const [inline]
```

References [representation_label](#).

6.13.3.11 get_metric() [1/2]

```
ex GiNaC::clifford::get_metric ( ) const [inline]
```

References [metric](#).

Referenced by [same_metric\(\)](#).

6.13.3.12 get_metric() [2/2]

```
ex GiNaC::clifford::get_metric (
    const ex & i,
    const ex & j,
    bool symmetrised = false ) const [virtual]
```

References [GiNaC::_ex1_2](#), [GiNaC::ex::get_free_indices\(\)](#), [GiNaC::indexed::get_symmetry\(\)](#), [metric](#), [GiNaC::subs_options::no_pattern](#), [GiNaC::ex::op\(\)](#), [GiNaC::indexed::simplify_indexed](#), [GiNaC::ex::subs\(\)](#), and [GiNaC::symmetric2\(\)](#).

6.13.3.13 same_metric()

```
bool GiNaC::clifford::same_metric (
    const ex & other ) const
```

References [GiNaC::ex::get_free_indices\(\)](#), [get_metric\(\)](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::ex::is_zero\(\)](#), [GiNaC::ex::op\(\)](#), [op\(\)](#), and [GiNaC::indexed::simplify_indexed](#).

Referenced by [match_same_type\(\)](#).

6.13.3.14 get_commutator_sign()

```
int GiNaC::clifford::get_commutator_sign ( ) const [inline]
```

References [commutator_sign](#).

Referenced by [match_same_type\(\)](#).

6.13.3.15 nops()

```
size_t GiNaC::clifford::nops ( ) const [inline], [override], [virtual]
```

Number of operands/members.

Reimplemented from [GiNaC::basic](#).

Referenced by [let_op\(\)](#), and [op\(\)](#).

6.13.3.16 op()

```
ex GiNaC::clifford::op (
    size_t i ) const [override], [virtual]
```

Return operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [GINAC_ASSERT](#), [nops\(\)](#), and [representation_label](#).

Referenced by [same_metric\(\)](#).

6.13.3.17 let_op()

```
ex & GiNaC::clifford::let_op (
    size_t i ) [override], [virtual]
```

Return modifiable operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ensure_if_modifiable\(\)](#), [GINAC_ASSERT](#), [nops\(\)](#), and [representation_label](#).

6.13.3.18 subs()

```
ex GiNaC::clifford::subs (
    const exmap & m,
    unsigned options = 0 ) const [override], [virtual]
```

Substitute a set of objects by arbitrary expressions.

The ex returned will already be evaluated.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::are_ex_trivially_equal\(\)](#), [c](#), [m](#), [options](#), and [GiNaC::ex::subs\(\)](#).

6.13.3.19 do_print_dflt()

```
void GiNaC::clifford::do_print_dflt (
    const print_dflt & c,
    unsigned level ) const [protected]
```

References [c](#), [GiNaC::is_dirac_slash\(\)](#), [precedence\(\)](#), [GiNaC::indexed::printindices\(\)](#), [representation_label](#), and [GiNaC::container_storage< C >::seq](#).

6.13.3.20 do_print_latex()

```
void GiNaC::clifford::do_print_latex (
    const print\_latex & c,
    unsigned level ) const [protected]
```

References [c](#), [GiNaC::is_dirac_slash\(\)](#), [precedence\(\)](#), [representation_label](#), and [GiNaC::container_storage< C >::seq](#).

6.13.3.21 do_print_tree()

```
void GiNaC::clifford::do_print_tree (
    const print\_tree & c,
    unsigned level ) const [protected]
```

References [c](#), [GiNaC::basic::flags](#), [GiNaC::basic::hashvalue](#), [metric](#), [GiNaC::ex::print\(\)](#), [GiNaC::indexed::printindices\(\)](#), [GiNaC::container_storage< C >::seq](#), and [GiNaC::indexed::symtree](#).

6.13.4 Member Data Documentation

6.13.4.1 representation_label

```
unsigned char GiNaC::clifford::representation_label [protected]
```

Representation label to distinguish independent spin lines.

Referenced by [archive\(\)](#), [do_print_dflt\(\)](#), [do_print_latex\(\)](#), [get_representation_label\(\)](#), [let_op\(\)](#), [match_same_type\(\)](#), [op\(\)](#), [read_archive\(\)](#), and [return_type_tinfo\(\)](#).

6.13.4.2 metric

```
ex GiNaC::clifford::metric [protected]
```

Metric of the space, all constructors make it an indexed object.

Referenced by [archive\(\)](#), [do_print_tree\(\)](#), [get_metric\(\)](#), and [read_archive\(\)](#).

6.13.4.3 commutator_sign

```
int GiNaC::clifford::commutator_sign [protected]
```

It is the sign in the definition $e_i e_j \pm e_j e_i = B(i, j) + B(j, i)$

Referenced by [archive\(\)](#), [get_commutator_sign\(\)](#), [match_same_type\(\)](#), and [read_archive\(\)](#).

The documentation for this class was generated from the following files:

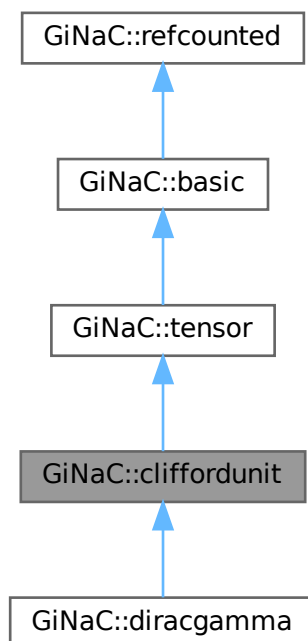
- [clifford.h](#)
- [clifford.cpp](#)

6.14 GiNaC::cliffordunit Class Reference

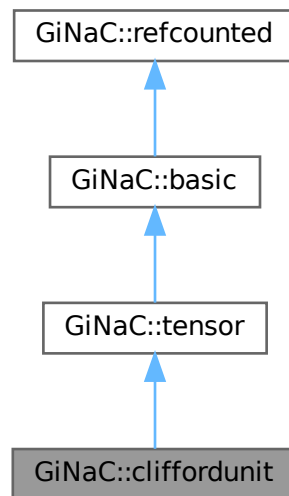
This class represents the Clifford algebra generators (units).

```
#include <clifford.h>
```

Inheritance diagram for GiNaC::cliffordunit:



Collaboration diagram for `GiNaC::cliffordunit`:



Public Member Functions

- bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const override
Contraction of a Clifford unit with something else.

Public Member Functions inherited from `GiNaC::tensor`

- bool `replace_contr_index` (exvector::iterator self, exvector::iterator other) const
Replace dummy index in contracted-with object by the contracting object's second index (used internally for delta and metric tensor contractions).

Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()
basic destructor, virtual because class ex will delete objects of derived classes via a basic.*
- `basic` (const `basic` &other)
- const `basic` & `operator=` (const `basic` &other)
basic assignment operator: the other object might be of a derived class.
- virtual `basic` * `duplicate` () const
Create a clone of this object on the heap.
- virtual `ex eval` () const
Perform automatic non-interruptive term rewriting rules.
- virtual `ex evalf` () const
Evaluate object numerically.
- virtual `ex evalm` () const
Evaluate sums, products and integer powers of matrices.

- virtual `ex eval_integ ()` const
Evaluate integrals, if result is known.
- virtual `ex eval_indexed (const basic &i)` const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void `print (const print_context &c, unsigned level=0)` const
Output to stream.
- virtual void `dbgprint ()` const
Little wrapper around print to be called within a debugger.
- virtual void `dbgprinttree ()` const
Little wrapper around printtree to be called within a debugger.
- virtual unsigned `precedence ()` const
Return relative operator precedence (for parenthezing output).
- virtual bool `info (unsigned inf)` const
Information about the object.
- virtual size_t `nops ()` const
Number of operands/members.
- virtual `ex op (size_t i)` const
Return operand/member at position i.
- virtual `ex operator[] (const ex &index)` const
- virtual `ex operator[] (size_t i)` const
- virtual `ex &let_op (size_t i)`
Return modifiable operand/member at position i.
- virtual `ex &operator[] (const ex &index)`
- virtual `ex &operator[] (size_t i)`
- virtual bool `has (const ex &other, unsigned options=0)` const
Test for occurrence of a pattern.
- virtual bool `match (const ex &pattern, exmap &repls)` const
Check whether the expression matches a given pattern.
- virtual `ex subs (const exmap &m, unsigned options=0)` const
Substitute a set of objects by arbitrary expressions.
- virtual `ex map (map_function &f)` const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void `accept (GiNaC::visitor &v)` const
- virtual bool `is_polynomial (const ex &var)` const
Check whether this is a polynomial in the given variables.
- virtual int `degree (const ex &s)` const
Return degree of highest power in object s.
- virtual int `ldegree (const ex &s)` const
Return degree of lowest power in object s.
- virtual `ex coeff (const ex &s, int n=1)` const
Return coefficient of degree n in object s.
- virtual `ex expand (unsigned options=0)` const
Expand expression, i.e.
- virtual `ex collect (const ex &s, bool distributed=false)` const
Sort expanded expression in terms of powers of some object(s).
- virtual `ex series (const relational &r, int order, unsigned options=0)` const
Default implementation of `ex::series()`.
- virtual `ex normal (exmap &repl, exmap &rev_lookup, lst &modifier)` const
Default implementation of `ex::normal()`.
- virtual `ex to_rational (exmap &repl)` const
Default implementation of `ex::to_rational()`.

- virtual [ex to_polynomial](#) ([exmap](#) &repl) const
- virtual [numeric integer_content](#) () const
- virtual [ex smod](#) (const [numeric](#) &xi) const
Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- virtual [numeric max_coefficient](#) () const
Implementation [ex::max_coefficient\(\)](#).
- virtual [exvector get_free_indices](#) () const
Return a vector containing the free indices of an expression.
- virtual [ex add_indexed](#) (const [ex](#) &self, const [ex](#) &other) const
Add two indexed expressions.
- virtual [ex scalar_mul_indexed](#) (const [ex](#) &self, const [numeric](#) &other) const
Multiply an indexed expression with a scalar.
- virtual bool [contract_with](#) (exvector::iterator self, exvector::iterator other, [exvector](#) &v) const
Try to contract two indexed expressions that appear in the same product.
- virtual unsigned [return_type](#) () const
- virtual [return_type_t](#) [return_type_tinfo](#) () const
- virtual [ex conjugate](#) () const
- virtual [ex real_part](#) () const
- virtual [ex imag_part](#) () const
- template<class T >
void [print_dispatch](#) (const [print_context](#) &c, unsigned level) const
Like [print\(\)](#), but dispatch to the specified class.
- void [print_dispatch](#) (const [registered_class_info](#) &ri, const [print_context](#) &c, unsigned level) const
Like [print\(\)](#), but dispatch to the specified class.
- virtual void [archive](#) ([archive_node](#) &n) const
Save (serialize) the object into archive node.
- virtual void [read_archive](#) (const [archive_node](#) &n, [lst](#) &syms)
Load (deserialize) the object from an archive node.
- [ex subs_one_level](#) (const [exmap](#) &m, unsigned [options](#)) const
Helper function for [subs\(\)](#).
- [ex diff](#) (const [symbol](#) &s, unsigned nth=1) const
Default interface of nth derivative [ex::diff\(s, n\)](#).
- int [compare](#) (const [basic](#) &other) const
Compare objects syntactically to establish canonical ordering.
- bool [is_equal](#) (const [basic](#) &other) const
Test for syntactic equality.
- const [basic](#) & [hold](#) () const
Stop further evaluation.
- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const
Set some [status_flags](#).
- const [basic](#) & [clearflag](#) (unsigned f) const
Clear some [status_flags](#).

Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add_reference](#) () noexcept
- unsigned int [remove_reference](#) () noexcept
- unsigned int [get_refcount](#) () const noexcept
- void [set_refcount](#) (unsigned int r) noexcept

Protected Member Functions

- void `do_print` (const `print_context` &c, unsigned level) const
- void `do_print_latex` (const `print_latex` &c, unsigned level) const

Protected Member Functions inherited from `GiNaC::tensor`

- unsigned `return_type` () const override

Protected Member Functions inherited from `GiNaC::basic`

- `basic` ()
- virtual `ex eval_ncmul` (const `exvector` &v) const
- virtual bool `match_same_type` (const `basic` &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual `ex derivative` (const `symbol` &s) const
Default implementation of `ex::diff()`.
- virtual int `compare_same_type` (const `basic` &other) const
Returns order relation between two objects of same type.
- virtual bool `is_equal_same_type` (const `basic` &other) const
Returns true if two objects of same type are equal.
- virtual unsigned `calchash` () const
Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.
- void `ensure_if_modifiable` () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void `do_print` (const `print_context` &c, unsigned level) const
Default output to stream.
- void `do_print_tree` (const `print_tree` &c, unsigned level) const
Tree output to stream.
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const
Python parsable output to stream.

Additional Inherited Members

Protected Attributes inherited from `GiNaC::basic`

- unsigned `flags`
of type `status_flags`
- unsigned `hashvalue`
hash value

6.14.1 Detailed Description

This class represents the Clifford algebra generators (units).

6.14.2 Member Function Documentation

6.14.2.1 `contract_with()`

```
bool GiNaC::cliffordunit::contract_with (
    exvector::iterator self,
    exvector::iterator other,
    exvector & v ) const [override], [virtual]
```

Contraction of a Clifford unit with something else.

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::diracgamma](#).

6.14.2.2 `do_print()`

```
void GiNaC::cliffordunit::do_print (
    const print_context & c,
    unsigned level ) const [protected]
```

6.14.2.3 `do_print_latex()`

```
void GiNaC::cliffordunit::do_print_latex (
    const print_latex & c,
    unsigned level ) const [protected]
```

The documentation for this class was generated from the following files:

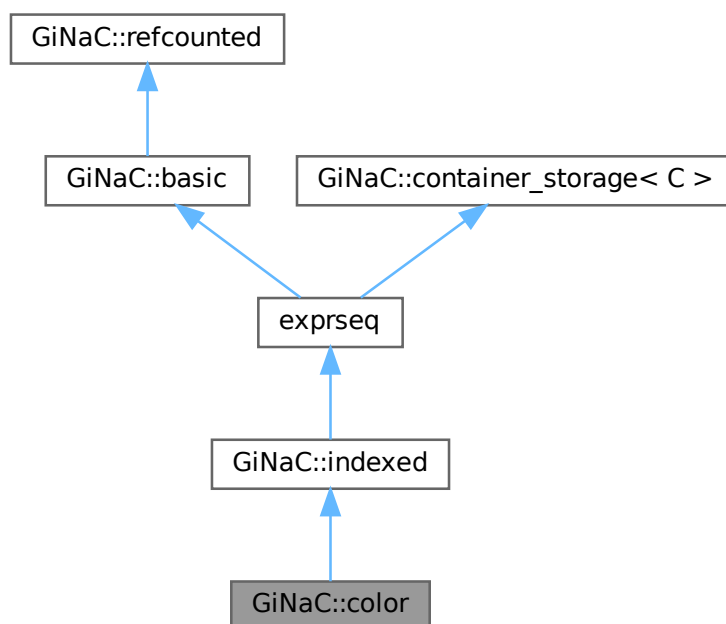
- [clifford.h](#)
- [clifford.cpp](#)

6.15 `GiNaC::color` Class Reference

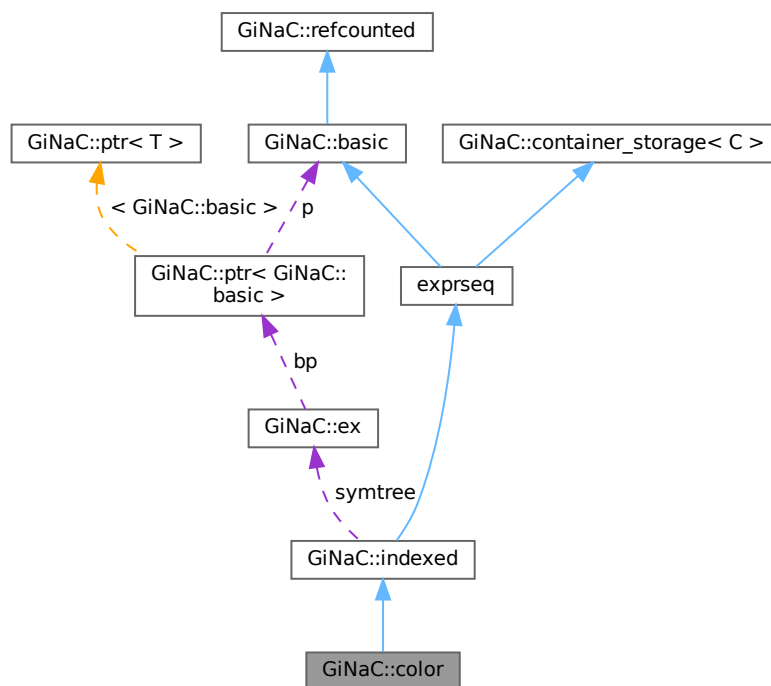
This class holds a generator `T_a` or the unity element of the Lie algebra of $SU(3)$, as used for calculations in quantum chromodynamics.

```
#include <color.h>
```

Inheritance diagram for GiNaC::color:



Collaboration diagram for `GiNaC::color`:



Public Member Functions

- `color` (const `ex` &b, unsigned char rl=0)
Construct object without any color index.
- `color` (const `ex` &b, const `ex` &i1, unsigned char rl=0)
Construct object with one color index.
- `color` (unsigned char rl, const `exvector` &v)
- `color` (unsigned char rl, `exvector` &&v)
- void `archive` (`archive_node` &n) const override
Save (serialize) the object into archive node.
- void `read_archive` (const `archive_node` &n, `lst` &sym_lst) override
Load (deserialize) the object from an archive node.
- unsigned char `get_representation_label` () const

Public Member Functions inherited from `GiNaC::indexed`

- `indexed` (const `ex` &b)
Construct indexed object with no index.
- `indexed` (const `ex` &b, const `ex` &i1)
Construct indexed object with one index.
- `indexed` (const `ex` &b, const `ex` &i1, const `ex` &i2)
Construct indexed object with two indices.
- `indexed` (const `ex` &b, const `ex` &i1, const `ex` &i2, const `ex` &i3)

- Construct indexed object with three indices.
 - `indexed` (const `ex` &b, const `ex` &i1, const `ex` &i2, const `ex` &i3, const `ex` &i4)
 - Construct indexed object with four indices.
 - `indexed` (const `ex` &b, const `symmetry` &symm, const `ex` &i1, const `ex` &i2)
 - Construct indexed object with two indices and a specified symmetry.
 - `indexed` (const `ex` &b, const `symmetry` &symm, const `ex` &i1, const `ex` &i2, const `ex` &i3)
 - Construct indexed object with three indices and a specified symmetry.
 - `indexed` (const `ex` &b, const `symmetry` &symm, const `ex` &i1, const `ex` &i2, const `ex` &i3, const `ex` &i4)
 - Construct indexed object with four indices and a specified symmetry.
 - `indexed` (const `ex` &b, const `exvector` &iv)
 - Construct indexed object with a specified vector of indices.
 - `indexed` (const `ex` &b, const `symmetry` &symm, const `exvector` &iv)
 - Construct indexed object with a specified vector of indices and symmetry.
 - `indexed` (const `symmetry` &symm, const `exprseq` &es)
 - `indexed` (const `symmetry` &symm, const `exvector` &v)
 - `indexed` (const `symmetry` &symm, `exvector` &&v)
 - unsigned `precedence` () const override
 - Return relative operator precedence (for parenthezing output).
 - bool `info` (unsigned inf) const override
 - Information about the object.
 - `ex eval` () const override
 - Perform automatic non-interruptive term rewriting rules.
 - `ex real_part` () const override
 - `ex imag_part` () const override
 - `exvector get_free_indices` () const override
 - Return a vector containing the free indices of an expression.
 - void `archive` (`archive_node` &n) const override
 - Save (a.k.a.
 - void `read_archive` (const `archive_node` &n, `lst` &syms) override
 - Read (a.k.a.
 - bool `all_index_values_are` (unsigned inf) const
 - Check whether all index values have a certain property.
 - `exvector get_indices` () const
 - Return a vector containing the object's indices.
 - `exvector get_dummy_indices` () const
 - Return a vector containing the dummy indices of the object, if any.
 - `exvector get_dummy_indices` (const `indexed` &other) const
 - Return a vector containing the dummy indices in the contraction with another indexed object.
 - bool `has_dummy_index_for` (const `ex` &i) const
 - Check whether the object has an index that forms a dummy index pair with a given index.
 - `ex get_symmetry` () const
 - Return symmetry properties.

Public Member Functions inherited from `GiNaC::container< C >`

- `container` (STLT const &s)
- `container` (STLT &&v)
- `container` (`exvector::const_iterator` b, `exvector::const_iterator` e)
- `container` (std::initializer_list< `ex` > il)
- bool `info` (unsigned inf) const override
- Information about the object.

- unsigned `precedence` () const override
Return relative operator precedence (for parenthesizing output).
- size_t `nops` () const override
Number of operands/members.
- `ex op` (size_t i) const override
Return operand/member at position i.
- `ex & let_op` (size_t i) override
Return modifiable operand/member at position i.
- `ex subs` (const `exmap` &m, unsigned `options`=0) const override
Substitute a set of objects by arbitrary expressions.
- void `read_archive` (const `archive_node` &n, `lst` &sym_lst) override
Load (deserialize) the object from an archive node.
- void `archive` (`archive_node` &n) const override
Archive the object.
- `container & prepend` (const `ex` &b)
Add element at front.
- `container & append` (const `ex` &b)
Add element at back.
- `container & remove_first` ()
Remove first element.
- `container & remove_last` ()
Remove last element.
- `container & remove_all` ()
Remove all elements.
- `container & sort` ()
Sort elements.
- `container & unique` ()
Remove adjacent duplicate elements.
- `const_iterator begin` () const
- `const_iterator end` () const
- `const_reverse_iterator rbegin` () const
- `const_reverse_iterator rend` () const

Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()
basic destructor, virtual because class `ex` will delete objects of derived classes via a `basic`.*
- `basic` (const `basic` &other)
- const `basic & operator=` (const `basic` &other)
basic assignment operator: the other object might be of a derived class.
- virtual `basic * duplicate` () const
Create a clone of this object on the heap.
- virtual `ex eval` () const
Perform automatic non-interruptive term rewriting rules.
- virtual `ex evalf` () const
Evaluate object numerically.
- virtual `ex evalm` () const
Evaluate sums, products and integer powers of matrices.
- virtual `ex eval_integ` () const
Evaluate integrals, if result is known.

- virtual `ex eval_indexed` (const `basic` &i) const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void `print` (const `print_context` &c, unsigned level=0) const
Output to stream.
- virtual void `dbgprint` () const
Little wrapper around print to be called within a debugger.
- virtual void `dbgprinttree` () const
Little wrapper around printtree to be called within a debugger.
- virtual unsigned `precedence` () const
Return relative operator precedence (for parenthezing output).
- virtual bool `info` (unsigned inf) const
Information about the object.
- virtual size_t `nops` () const
Number of operands/members.
- virtual `ex op` (size_t i) const
Return operand/member at position i.
- virtual `ex operator[]` (const `ex` &index) const
- virtual `ex operator[]` (size_t i) const
- virtual `ex & let_op` (size_t i)
Return modifiable operand/member at position i.
- virtual `ex & operator[]` (const `ex` &index)
- virtual `ex & operator[]` (size_t i)
- virtual bool `has` (const `ex` &other, unsigned `options`=0) const
Test for occurrence of a pattern.
- virtual bool `match` (const `ex` &pattern, `exmap` &repls) const
Check whether the expression matches a given pattern.
- virtual `ex subs` (const `exmap` &m, unsigned `options`=0) const
Substitute a set of objects by arbitrary expressions.
- virtual `ex map` (`map_function` &f) const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void `accept` (GiNaC::visitor &v) const
- virtual bool `is_polynomial` (const `ex` &var) const
Check whether this is a polynomial in the given variables.
- virtual int `degree` (const `ex` &s) const
Return degree of highest power in object s.
- virtual int `ldegree` (const `ex` &s) const
Return degree of lowest power in object s.
- virtual `ex coeff` (const `ex` &s, int n=1) const
Return coefficient of degree n in object s.
- virtual `ex expand` (unsigned `options`=0) const
Expand expression, i.e.
- virtual `ex collect` (const `ex` &s, bool distributed=false) const
Sort expanded expression in terms of powers of some object(s).
- virtual `ex series` (const `relational` &r, int `order`, unsigned `options`=0) const
Default implementation of `ex::series()`.
- virtual `ex normal` (`exmap` &repl, `exmap` &rev_lookup, `lst` &modifier) const
Default implementation of `ex::normal()`.
- virtual `ex to_rational` (`exmap` &repl) const
Default implementation of `ex::to_rational()`.
- virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const

- virtual `ex smod` (const `numeric` &xi) const
Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- virtual `numeric max_coefficient` () const
Implementation `ex::max_coefficient()`.
- virtual `exvector get_free_indices` () const
Return a vector containing the free indices of an expression.
- virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
Add two indexed expressions.
- virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
Multiply an indexed expression with a scalar.
- virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const
Try to contract two indexed expressions that appear in the same product.
- virtual unsigned `return_type` () const
- virtual `return_type_t return_type_tinfo` () const
- virtual `ex conjugate` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const
- template<class T >
void `print_dispatch` (const `print_context` &c, unsigned level) const
Like `print()`, but dispatch to the specified class.
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const
Like `print()`, but dispatch to the specified class.
- virtual void `archive` (`archive_node` &n) const
Save (serialize) the object into archive node.
- virtual void `read_archive` (const `archive_node` &n, lst &syms)
Load (deserialize) the object from an archive node.
- `ex subs_one_level` (const `exmap` &m, unsigned options) const
Helper function for `subs()`.
- `ex diff` (const `symbol` &s, unsigned nth=1) const
Default interface of nth derivative `ex::diff(s, n)`.
- int `compare` (const `basic` &other) const
Compare objects syntactically to establish canonical ordering.
- bool `is_equal` (const `basic` &other) const
Test for syntactic equality.
- const `basic` & `hold` () const
Stop further evaluation.
- unsigned `gethash` () const
- const `basic` & `setflag` (unsigned f) const
Set some `status_flags`.
- const `basic` & `clearflag` (unsigned f) const
Clear some `status_flags`.

Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- unsigned int `add_reference` () noexcept
- unsigned int `remove_reference` () noexcept
- unsigned int `get_refcount` () const noexcept
- void `set_refcount` (unsigned int r) noexcept

Protected Member Functions

- `ex eval_ncmul` (const `exvector` &`v`) const override
Perform automatic simplification on noncommutative product of color objects.
- `bool match_same_type` (const `basic` &`other`) const override
Returns true if the attributes of two objects are similar enough for a match.
- `ex thiscontainer` (const `exvector` &`v`) const override
- `ex thiscontainer` (`exvector` &&`v`) const override
- unsigned `return_type` () const override
- `return_type_t return_type_tinfo` () const override

Protected Member Functions inherited from `GiNaC::indexed`

- `ex derivative` (const `symbol` &`s`) const override
Implementation of `ex::diff()` for an indexed object always returns 0.
- `ex thiscontainer` (const `exvector` &`v`) const override
- `ex thiscontainer` (`exvector` &&`v`) const override
- unsigned `return_type` () const override
- `return_type_t return_type_tinfo` () const override
- `ex expand` (unsigned `options`=0) const override
Expand expression, i.e.
- void `printindices` (const `print_context` &`c`, unsigned level) const
- void `print_indexed` (const `print_context` &`c`, const char *`openbrace`, const char *`closebrace`, unsigned level) const
- void `do_print` (const `print_context` &`c`, unsigned level) const
- void `do_print_latex` (const `print_latex` &`c`, unsigned level) const
- void `do_print_tree` (const `print_tree` &`c`, unsigned level) const
- void `validate` () const
Check whether all indices are of class `idx` and validate the symmetry tree.

Protected Member Functions inherited from `GiNaC::container< C >`

- `ex conjugate` () const override
- `ex real_part` () const override
- `ex imag_part` () const override
- `bool is_equal_same_type` (const `basic` &`other`) const override
Returns true if two objects of same type are equal.
- virtual `ex thiscontainer` (const `STLT` &`v`) const
Similar to `duplicate()`, but with a preset sequence.
- virtual `ex thiscontainer` (`STLT` &&`v`) const
Similar to `duplicate()`, but with a preset sequence (which gets pilfered).
- virtual void `printseq` (const `print_context` &`c`, char `openbracket`, char `delim`, char `closebracket`, unsigned `this↔_precedence`, unsigned `upper_precedence`=0) const
Print sequence of contained elements.
- void `do_print` (const `print_context` &`c`, unsigned level) const
- void `do_print_tree` (const `print_tree` &`c`, unsigned level) const
- void `do_print_python` (const `print_python` &`c`, unsigned level) const
- void `do_print_python_repr` (const `print_python_repr` &`c`, unsigned level) const
- `STLT subchildren` (const `exmap` &`m`, unsigned `options`=0) const

Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match_same_type](#) (const [basic](#) &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual [ex derivative](#) (const [symbol](#) &s) const
Default implementation of [ex::diff\(\)](#).
- virtual int [compare_same_type](#) (const [basic](#) &other) const
Returns order relation between two objects of same type.
- virtual bool [is_equal_same_type](#) (const [basic](#) &other) const
Returns true if two objects of same type are equal.
- virtual unsigned [calchash](#) () const
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- void [ensure_if_modifiable](#) () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
Default output to stream.
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
Tree output to stream.
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
Python parsable output to stream.

Protected Member Functions inherited from [GiNaC::container_storage< C >](#)

- [container_storage](#) ()
- [container_storage](#) (size_t n, const [ex](#) &e)
- [container_storage](#) (std::initializer_list< [ex](#) > il)
- template<class In >
 [container_storage](#) (In b, In e)
- void [reserve](#) (size_t)
- [~container_storage](#) ()
- void [reserve](#) (size_t n)
- void [reserve](#) (std::vector< [ex](#) > &v, size_t n)

Private Attributes

- unsigned char [representation_label](#)
Representation label to distinguish independent color matrices coming from separated fermion lines.

Additional Inherited Members

Public Types inherited from [GiNaC::container< C >](#)

- typedef STLT::const_iterator [const_iterator](#)
- typedef STLT::const_reverse_iterator [const_reverse_iterator](#)

Protected Types inherited from [GiNaC::container< C >](#)

- typedef [container_storage< C >::STLT](#) [STLT](#)

Protected Types inherited from [GiNaC::container_storage< C >](#)

- typedef C< [ex](#) > [STLT](#)

Static Protected Member Functions inherited from [GiNaC::container< C >](#)

- static unsigned [get_default_flags](#) ()
Specialization of [container::get_default_flags\(\)](#) for [lst](#).
- static char [get_open_delim](#) ()
Specialization of [container::get_open_delim\(\)](#) for [lst](#).
- static char [get_close_delim](#) ()
Specialization of [container::get_close_delim\(\)](#) for [lst](#).

Static Protected Member Functions inherited from [GiNaC::container_storage< C >](#)

- static void [reserve](#) ([STLT](#) &, size_t)

Protected Attributes inherited from [GiNaC::indexed](#)

- [ex symtree](#)
Index symmetry (tree of symmetry objects)

Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)
of type [status_flags](#)
- unsigned [hashvalue](#)
hash value

Protected Attributes inherited from [GiNaC::container_storage< C >](#)

- [STLT seq](#)

6.15.1 Detailed Description

This class holds a generator `T_a` or the unity element of the Lie algebra of $SU(3)$, as used for calculations in quantum chromodynamics.

A representation label (an unsigned 8-bit integer) is used to distinguish elements from different Lie algebras (objects with different labels commute). These objects implement an abstract representation of the group, not a specific matrix representation. The indices used for color objects should not have a variance.

6.15.2 Constructor & Destructor Documentation

6.15.2.1 `color()` [1/4]

```
GiNaC::color::color (
    const ex & b,
    unsigned char rl = 0 )
```

Construct object without any color index.

This constructor is for internal use only. Use the [color_ONE\(\)](#) function instead.

See also

[color_ONE](#)

6.15.2.2 `color()` [2/4]

```
GiNaC::color::color (
    const ex & b,
    const ex & il,
    unsigned char rl = 0 )
```

Construct object with one color index.

This constructor is for internal use only. Use the [color_T\(\)](#) function instead.

See also

[color_T](#)

6.15.2.3 `color()` [3/4]

```
GiNaC::color::color (
    unsigned char rl,
    const exvector & v )
```

6.15.2.4 `color()` [4/4]

```
GiNaC::color::color (
    unsigned char rl,
    exvector && v )
```

6.15.3 Member Function Documentation

6.15.3.1 archive()

```
void GiNaC::color::archive (
    archive_node & n ) const [override], [virtual]
```

Save (serialize) the object into archive node.

Archive the object.

Loosely speaking, this method turns an expression into a byte stream (which can be saved and restored later on, or sent via network, etc.)

Reimplemented from [GiNaC::basic](#).

References [n](#), and [representation_label](#).

6.15.3.2 read_archive()

```
void GiNaC::color::read_archive (
    const archive_node & n,
    lst & syms ) [override], [virtual]
```

Load (deserialize) the object from an archive node.

Construct object from [archive_node](#).

Note

This method is essentially a constructor. However, constructors can't be virtual. So, if unarchiving routines are implemented as constructors one would need to define such a constructor in every class, even if all it does is simply calling constructor of a superclass.

Reimplemented from [GiNaC::basic](#).

References [n](#), and [representation_label](#).

6.15.3.3 eval_ncmul()

```
ex GiNaC::color::eval_ncmul (
    const exvector & v ) const [override], [protected], [virtual]
```

Perform automatic simplification on noncommutative product of color objects.

This removes superfluous ONEs.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::hold_ncmul\(\)](#), and [GiNaC::container_storage< C >::reserve\(\)](#).

6.15.3.4 `match_same_type()`

```
bool GiNaC::color::match_same_type (
    const basic & other ) const [override], [protected], [virtual]
```

Returns true if the attributes of two objects are similar enough for a match.

This function must not match subexpressions (this is already done by [basic::match\(\)](#)). Only attributes not accessible by [op\(\)](#) should be compared. This is also the reason why this function doesn't take the wildcard replacement list from [match\(\)](#) as an argument: only subexpressions are subject to wildcard matches. Also, this function only needs to be implemented for container classes because [is_equal_same_type\(\)](#) is automatically used instead of [match_same_type\(\)](#) if [nops\(\)](#) == 0.

See also

[basic::match](#)

Reimplemented from [GiNaC::basic](#).

References [GINAC_ASSERT](#), and [representation_label](#).

6.15.3.5 `thiscontainer()` [1/2]

```
ex GiNaC::color::thiscontainer (
    const exvector & v ) const [override], [protected]
```

References [representation_label](#).

6.15.3.6 `thiscontainer()` [2/2]

```
ex GiNaC::color::thiscontainer (
    exvector && v ) const [override], [protected]
```

References [representation_label](#).

6.15.3.7 `return_type()`

```
unsigned GiNaC::color::return_type ( ) const [inline], [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::return_types::noncommutative](#).

6.15.3.8 return_type_tinfo()

```
return_type_t GiNaC::color::return_type_tinfo ( ) const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [representation_label](#).

6.15.3.9 get_representation_label()

```
unsigned char GiNaC::color::get_representation_label ( ) const [inline]
```

References [representation_label](#).

6.15.4 Member Data Documentation

6.15.4.1 representation_label

```
unsigned char GiNaC::color::representation_label [private]
```

Representation label to distinguish independent color matrices coming from separated fermion lines.

Referenced by [archive\(\)](#), [get_representation_label\(\)](#), [match_same_type\(\)](#), [read_archive\(\)](#), [return_type_tinfo\(\)](#), and [thiscontainer\(\)](#).

The documentation for this class was generated from the following files:

- [color.h](#)
- [color.cpp](#)

6.16 GiNaC::compare_all_equal< T > Class Template Reference

Comparison policy: all structures of one type are equal.

```
#include <structure.h>
```

Protected Member Functions

- [~compare_all_equal\(\)](#)

Static Protected Member Functions

- static bool [struct_is_equal](#) (const T *t1, const T *t2)
- static int [struct_compare](#) (const T *t1, const T *t2)

6.16.1 Detailed Description

```
template<class T>
class GiNaC::compare_all_equal< T >
```

Comparison policy: all structures of one type are equal.

6.16.2 Constructor & Destructor Documentation

6.16.2.1 ~compare_all_equal()

```
template<class T >
GiNaC::compare_all_equal< T >::~~compare_all_equal ( ) [inline], [protected]
```

6.16.3 Member Function Documentation

6.16.3.1 struct_is_equal()

```
template<class T >
static bool GiNaC::compare_all_equal< T >::struct_is_equal (
    const T * t1,
    const T * t2 ) [inline], [static], [protected]
```

6.16.3.2 struct_compare()

```
template<class T >
static int GiNaC::compare_all_equal< T >::struct_compare (
    const T * t1,
    const T * t2 ) [inline], [static], [protected]
```

The documentation for this class was generated from the following file:

- [structure.h](#)

6.17 GiNaC::compare_bitwise< T > Class Template Reference

Comparison policy: use bit-wise comparison to compare structures.

```
#include <structure.h>
```

Protected Member Functions

- [~compare_bitwise](#) ()

Static Protected Member Functions

- static bool [struct_is_equal](#) (const T *t1, const T *t2)
- static int [struct_compare](#) (const T *t1, const T *t2)

6.17.1 Detailed Description

```
template<class T>  
class GiNaC::compare_bitwise< T >
```

Comparison policy: use bit-wise comparison to compare structures.

6.17.2 Constructor & Destructor Documentation

6.17.2.1 ~compare_bitwise()

```
template<class T >  
GiNaC::compare\_bitwise< T >::~~compare\_bitwise ( ) [inline], [protected]
```

6.17.3 Member Function Documentation

6.17.3.1 struct_is_equal()

```
template<class T >  
static bool GiNaC::compare\_bitwise< T >::struct_is_equal (   
    const T * t1,  
    const T * t2 ) [inline], [static], [protected]
```

6.17.3.2 struct_compare()

```
template<class T >
static int GiNaC::compare_bitwise< T >::struct_compare (
    const T * t1,
    const T * t2 ) [inline], [static], [protected]
```

The documentation for this class was generated from the following file:

- [structure.h](#)

6.18 GiNaC::compare_std_less< T > Class Template Reference

Comparison policy: use std::equal_to/std::less (defaults to operators == and <) to compare structures.

```
#include <structure.h>
```

Protected Member Functions

- [~compare_std_less\(\)](#)

Static Protected Member Functions

- static bool [struct_is_equal](#) (const T *t1, const T *t2)
- static int [struct_compare](#) (const T *t1, const T *t2)

6.18.1 Detailed Description

```
template<class T>
class GiNaC::compare_std_less< T >
```

Comparison policy: use std::equal_to/std::less (defaults to operators == and <) to compare structures.

6.18.2 Constructor & Destructor Documentation

6.18.2.1 ~compare_std_less()

```
template<class T >
GiNaC::compare_std_less< T >::~~compare_std_less ( ) [inline], [protected]
```

6.18.3 Member Function Documentation

6.18.3.1 struct_is_equal()

```
template<class T >
static bool GiNaC::compare_std_less< T >::struct_is_equal (
    const T * t1,
    const T * t2 ) [inline], [static], [protected]
```

6.18.3.2 struct_compare()

```
template<class T >
static int GiNaC::compare_std_less< T >::struct_compare (
    const T * t1,
    const T * t2 ) [inline], [static], [protected]
```

The documentation for this class was generated from the following file:

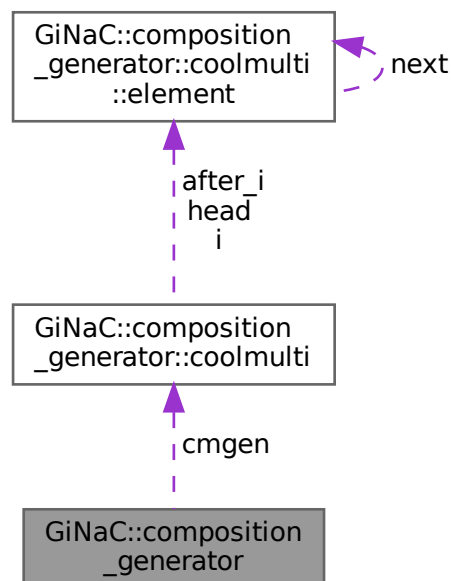
- [structure.h](#)

6.19 GiNaC::composition_generator Class Reference

Generate all compositions of a partition of an integer n, starting with the compositions which has non-decreasing order.

```
#include <utils.h>
```

Collaboration diagram for GiNaC::composition_generator:



Classes

- struct [coolmulti](#)

Public Member Functions

- [composition_generator](#) (const std::vector< unsigned > &partition)
- const std::vector< unsigned > & [get](#) () const
- bool [next](#) ()

Private Attributes

- struct [GiNaC::composition_generator::coolmulti](#) cmgen
- bool [atend](#)
- bool [trivial](#)
- std::vector< unsigned > [composition](#)
- bool [current_updated](#)

6.19.1 Detailed Description

Generate all compositions of a partition of an integer n, starting with the compositions which has non-decreasing order.

6.19.2 Constructor & Destructor Documentation

6.19.2.1 composition_generator()

```
GiNaC::composition_generator::composition_generator (
    const std::vector< unsigned > & partition ) [inline], [explicit]
```

References [trivial](#).

6.19.3 Member Function Documentation

6.19.3.1 get()

```
const std::vector< unsigned > & GiNaC::composition_generator::get ( ) const [inline]
```

References [cmgen](#), [composition](#), [current_updated](#), [GiNaC::composition_generator::coolmulti::head](#), [GiNaC::composition_generator::coolmulti::element::value](#), and [GiNaC::composition_generator::coolmulti::element::value](#).

Referenced by [GiNaC::power::expand_add\(\)](#).

6.19.3.2 next()

```
bool GiNaC::composition_generator::next ( ) [inline]
```

References [attend](#), [cmgen](#), [current_updated](#), [GiNaC::composition_generator::coolmulti::finished\(\)](#), [GiNaC::composition_generator::coolmulti::next\(\)](#) and [trivial](#).

Referenced by [GiNaC::power::expand_add\(\)](#).

6.19.4 Member Data Documentation

6.19.4.1 cmgen

```
struct GiNaC::composition_generator::coolmulti GiNaC::composition_generator::cmgen [private]
```

Referenced by [get\(\)](#), and [next\(\)](#).

6.19.4.2 attend

```
bool GiNaC::composition_generator::attend [private]
```

Referenced by [next\(\)](#).

6.19.4.3 trivial

```
bool GiNaC::composition_generator::trivial [private]
```

Referenced by [composition_generator\(\)](#), and [next\(\)](#).

6.19.4.4 composition

```
std::vector<unsigned> GiNaC::composition_generator::composition [mutable], [private]
```

Referenced by [get\(\)](#).

6.19.4.5 current_updated

```
bool GiNaC::composition_generator::current_updated [mutable], [private]
```

Referenced by [get\(\)](#), and [next\(\)](#).

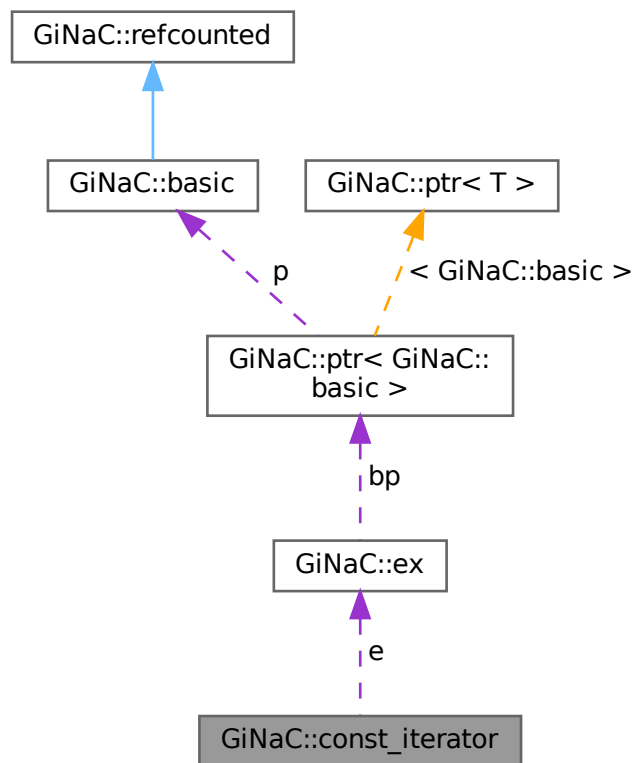
The documentation for this class was generated from the following file:

- [utils.h](#)

6.20 GiNaC::const_iterator Class Reference

```
#include <ex.h>
```

Collaboration diagram for GiNaC::const_iterator:



Public Types

- using `iterator_category` = `std::random_access_iterator_tag`
- using `value_type` = `ex`
- using `difference_type` = `ptrdiff_t`
- using `pointer` = `const ex *`
- using `reference` = `const ex &`

Public Member Functions

- [const_iterator](#) () noexcept
- [ex operator*](#) () const
- [std::unique_ptr< ex > operator->](#) () const
- [ex operator\[\]](#) (difference_type n) const
- [const_iterator & operator++](#) () noexcept
- [const_iterator operator++](#) (int) noexcept
- [const_iterator & operator+=](#) (difference_type n) noexcept
- [const_iterator operator+](#) (difference_type n) const noexcept
- [const_iterator & operator--](#) () noexcept
- [const_iterator operator--](#) (int) noexcept
- [const_iterator & operator-=](#) (difference_type n) noexcept
- [const_iterator operator-](#) (difference_type n) const noexcept
- [bool operator==](#) (const [const_iterator](#) &other) const noexcept
- [bool operator!=](#) (const [const_iterator](#) &other) const noexcept
- [bool operator<](#) (const [const_iterator](#) &other) const noexcept
- [bool operator>](#) (const [const_iterator](#) &other) const noexcept
- [bool operator<=](#) (const [const_iterator](#) &other) const noexcept
- [bool operator>=](#) (const [const_iterator](#) &other) const noexcept

Protected Attributes

- [ex e](#)
- [size_t i](#)

Private Member Functions

- [const_iterator](#) (const [ex](#) &e_, size_t i_) noexcept

Friends

- class [ex](#)
- class [const_preorder_iterator](#)
- class [const_postorder_iterator](#)
- [const_iterator operator+](#) (difference_type n, const [const_iterator](#) &it) noexcept
- [difference_type operator-](#) (const [const_iterator](#) &lhs, const [const_iterator](#) &rhs) noexcept

6.20.1 Member Typedef Documentation

6.20.1.1 iterator_category

```
using GiNaC::const_iterator::iterator_category = std::random_access_iterator_tag
```

6.20.1.2 value_type

```
using GiNaC::const_iterator::value_type = ex
```

6.20.1.3 difference_type

```
using GiNaC::const_iterator::difference_type = ptrdiff_t
```

6.20.1.4 pointer

```
using GiNaC::const_iterator::pointer = const ex *
```

6.20.1.5 reference

```
using GiNaC::const_iterator::reference = const ex &
```

6.20.2 Constructor & Destructor Documentation

6.20.2.1 const_iterator() [1/2]

```
GiNaC::const_iterator::const_iterator ( ) [inline], [noexcept]
```

Referenced by [operator+\(\)](#), and [operator-\(\)](#).

6.20.2.2 const_iterator() [2/2]

```
GiNaC::const_iterator::const_iterator (
    const ex & e_,
    size_t i_ ) [inline], [private], [noexcept]
```

6.20.3 Member Function Documentation

6.20.3.1 operator*()

```
ex GiNaC::const_iterator::operator* ( ) const [inline]
```

References [e](#), [i](#), and [GiNaC::ex::op\(\)](#).

6.20.3.2 operator->()

```
std::unique_ptr< ex > GiNaC::const_iterator::operator-> ( ) const [inline]
```

References [ex](#).

6.20.3.3 operator[]()

```
ex GiNaC::const_iterator::operator[] (
    difference_type n ) const [inline]
```

References [e](#), [i](#), [n](#), and [GiNaC::ex::op\(\)](#).

6.20.3.4 operator++() [1/2]

```
const_iterator & GiNaC::const_iterator::operator++ ( ) [inline], [noexcept]
```

References [i](#).

6.20.3.5 operator++() [2/2]

```
const_iterator GiNaC::const_iterator::operator++ (
    int ) [inline], [noexcept]
```

References [i](#).

6.20.3.6 operator+=()

```
const_iterator & GiNaC::const_iterator::operator+= (
    difference_type n ) [inline], [noexcept]
```

References [i](#), and [n](#).

6.20.3.7 operator+()

```
const_iterator GiNaC::const_iterator::operator+ (
    difference_type n ) const [inline], [noexcept]
```

References [const_iterator\(\)](#), [e](#), [i](#), and [n](#).

6.20.3.8 operator--() [1/2]

```
const_iterator & GiNaC::const_iterator::operator-- ( ) [inline], [noexcept]
```

References [i](#).

6.20.3.9 operator--() [2/2]

```
const_iterator GiNaC::const_iterator::operator-- (
    int ) [inline], [noexcept]
```

References [i](#).

6.20.3.10 operator-=()

```
const_iterator & GiNaC::const_iterator::operator-= (
    difference_type n ) [inline], [noexcept]
```

References [i](#), and [n](#).

6.20.3.11 operator-()

```
const_iterator GiNaC::const_iterator::operator- (
    difference_type n ) const [inline], [noexcept]
```

References [const_iterator\(\)](#), [e](#), [i](#), and [n](#).

6.20.3.12 operator==()

```
bool GiNaC::const_iterator::operator== (
    const const_iterator & other ) const [inline], [noexcept]
```

References [GiNaC::are_ex_trivially_equal\(\)](#), [e](#), and [i](#).

6.20.3.13 operator"!=()

```
bool GiNaC::const_iterator::operator!= (
    const const\_iterator & other ) const    [inline], [noexcept]
```

6.20.3.14 operator<()

```
bool GiNaC::const_iterator::operator< (
    const const\_iterator & other ) const    [inline], [noexcept]
```

References [i](#).

6.20.3.15 operator>()

```
bool GiNaC::const_iterator::operator> (
    const const\_iterator & other ) const    [inline], [noexcept]
```

6.20.3.16 operator<=()

```
bool GiNaC::const_iterator::operator<= (
    const const\_iterator & other ) const    [inline], [noexcept]
```

6.20.3.17 operator>=()

```
bool GiNaC::const_iterator::operator>= (
    const const\_iterator & other ) const    [inline], [noexcept]
```

6.20.4 Friends And Related Function Documentation

6.20.4.1 ex

```
friend class ex    [friend]
```

Referenced by [operator->\(\)](#).

6.20.4.2 `const_preorder_iterator`

```
friend class const_preorder_iterator [friend]
```

6.20.4.3 `const_postorder_iterator`

```
friend class const_postorder_iterator [friend]
```

6.20.4.4 `operator+`

```
const_iterator operator+ (  
    difference_type n,  
    const const_iterator & it ) [friend]
```

6.20.4.5 `operator-`

```
difference_type operator- (  
    const const_iterator & lhs,  
    const const_iterator & rhs ) [friend]
```

6.20.5 Member Data Documentation

6.20.5.1 `e`

```
ex GiNaC::const_iterator::e [protected]
```

Referenced by [operator*\(\)](#), [operator+\(\)](#), [operator-\(\)](#), [operator==\(\)](#), and [operator\[\]\(\)](#).

6.20.5.2 `i`

```
size_t GiNaC::const_iterator::i [protected]
```

Referenced by [operator*\(\)](#), [operator+\(\)](#), [operator++\(\)](#), [operator+=\(\)](#), [operator-\(\)](#), [operator--\(\)](#), [operator-=\(\)](#), [operator<\(\)](#), [operator==\(\)](#), and [operator\[\]\(\)](#).

The documentation for this class was generated from the following file:

- [ex.h](#)

6.21 GiNaC::const_postorder_iterator Class Reference

```
#include <ex.h>
```

Public Types

- using `iterator_category` = `std::forward_iterator_tag`
- using `value_type` = `ex`
- using `difference_type` = `ptrdiff_t`
- using `pointer` = `const ex *`
- using `reference` = `const ex &`

Public Member Functions

- `const_postorder_iterator` () noexcept
- `const_postorder_iterator` (const `ex` &`e`, `size_t` `n`)
- `reference operator*` () const
- `pointer operator->` () const
- `const_postorder_iterator & operator++` ()
- `const_postorder_iterator operator++` (int)
- bool `operator==` (const `const_postorder_iterator` &`other`) const noexcept
- bool `operator!=` (const `const_postorder_iterator` &`other`) const noexcept

Private Member Functions

- void `descend` ()
- void `increment` ()

Private Attributes

- `std::stack< internal::_iter_rep, std::vector< internal::_iter_rep > >` `s`

6.21.1 Member Typedef Documentation

6.21.1.1 iterator_category

```
using GiNaC::const_postorder_iterator::iterator_category = std::forward_iterator_tag
```

6.21.1.2 value_type

```
using GiNaC::const_postorder_iterator::value_type = ex
```

6.21.1.3 difference_type

```
using GiNaC::const_postorder_iterator::difference_type = ptrdiff_t
```

6.21.1.4 pointer

```
using GiNaC::const_postorder_iterator::pointer = const ex *
```

6.21.1.5 reference

```
using GiNaC::const_postorder_iterator::reference = const ex &
```

6.21.2 Constructor & Destructor Documentation

6.21.2.1 const_postorder_iterator() [1/2]

```
GiNaC::const_postorder_iterator::const_postorder_iterator ( ) [inline], [noexcept]
```

6.21.2.2 const_postorder_iterator() [2/2]

```
GiNaC::const_postorder_iterator::const_postorder_iterator (
    const ex & e,
    size_t n ) [inline]
```

References [descend\(\)](#), [n](#), and [s](#).

6.21.3 Member Function Documentation

6.21.3.1 operator*()

```
reference GiNaC::const_postorder_iterator::operator* ( ) const [inline]
```

References [s](#).

6.21.3.2 operator->()

```
pointer GiNaC::const_postorder_iterator::operator-> ( ) const [inline]
```

References [s](#).

6.21.3.3 operator++() [1/2]

```
const_postorder_iterator & GiNaC::const_postorder_iterator::operator++ ( ) [inline]
```

References [increment\(\)](#).

6.21.3.4 operator++() [2/2]

```
const_postorder_iterator GiNaC::const_postorder_iterator::operator++ (
    int ) [inline]
```

References [increment\(\)](#).

6.21.3.5 operator==()

```
bool GiNaC::const_postorder_iterator::operator== (
    const const_postorder_iterator & other ) const [inline], [noexcept]
```

References [s](#).

6.21.3.6 operator!=(=)

```
bool GiNaC::const_postorder_iterator::operator!= (
    const const_postorder_iterator & other ) const [inline], [noexcept]
```

6.21.3.7 descend()

```
void GiNaC::const_postorder_iterator::descend ( ) [inline], [private]
```

References [GiNaC::internal::_iter_rep::e](#), [GiNaC::internal::_iter_rep::i](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), and [s](#).

Referenced by [const_postorder_iterator\(\)](#), and [increment\(\)](#).

6.21.3.8 increment()

```
void GiNaC::const_postorder_iterator::increment ( ) [inline], [private]
```

References [descend\(\)](#), and [s](#).

Referenced by [operator++\(\)](#).

6.21.4 Member Data Documentation

6.21.4.1 s

```
std::stack<internal::_iter_rep, std::vector<internal::_iter_rep> > GiNaC::const_postorder_iterator::s [private]
```

Referenced by [const_postorder_iterator\(\)](#), [descend\(\)](#), [increment\(\)](#), [operator*\(\)](#), [operator->\(\)](#), and [operator==\(\)](#).

The documentation for this class was generated from the following file:

- [ex.h](#)

6.22 GiNaC::const_preorder_iterator Class Reference

```
#include <ex.h>
```

Public Types

- using [iterator_category](#) = std::forward_iterator_tag
- using [value_type](#) = ex
- using [difference_type](#) = ptrdiff_t
- using [pointer](#) = const ex *
- using [reference](#) = const ex &

Public Member Functions

- [const_preorder_iterator](#) () noexcept
- [const_preorder_iterator](#) (const ex &e, size_t n)
- [reference operator*](#) () const
- [pointer operator->](#) () const
- [const_preorder_iterator](#) & [operator++](#) ()
- [const_preorder_iterator](#) [operator++](#) (int)
- bool [operator==](#) (const [const_preorder_iterator](#) &other) const noexcept
- bool [operator!=](#) (const [const_preorder_iterator](#) &other) const noexcept

Private Member Functions

- void [increment](#) ()

Private Attributes

- std::stack< [internal::_iter_rep](#), std::vector< [internal::_iter_rep](#) > > s

6.22.1 Member Typedef Documentation

6.22.1.1 iterator_category

```
using GiNaC::const_preorder_iterator::iterator_category = std::forward_iterator_tag
```

6.22.1.2 value_type

```
using GiNaC::const_preorder_iterator::value_type = ex
```

6.22.1.3 difference_type

```
using GiNaC::const_preorder_iterator::difference_type = ptrdiff_t
```

6.22.1.4 pointer

```
using GiNaC::const_preorder_iterator::pointer = const ex *
```

6.22.1.5 reference

```
using GiNaC::const_preorder_iterator::reference = const ex &
```

6.22.2 Constructor & Destructor Documentation

6.22.2.1 `const_preorder_iterator()` [1/2]

```
GiNaC::const_preorder_iterator::const_preorder_iterator ( ) [inline], [noexcept]
```

6.22.2.2 `const_preorder_iterator()` [2/2]

```
GiNaC::const_preorder_iterator::const_preorder_iterator (
    const ex & e,
    size_t n ) [inline]
```

References [n](#), and [s](#).

6.22.3 Member Function Documentation

6.22.3.1 `operator*()`

```
reference GiNaC::const_preorder_iterator::operator* ( ) const [inline]
```

References [s](#).

6.22.3.2 `operator->()`

```
pointer GiNaC::const_preorder_iterator::operator-> ( ) const [inline]
```

References [s](#).

6.22.3.3 `operator++()` [1/2]

```
const\_preorder\_iterator & GiNaC::const_preorder_iterator::operator++ ( ) [inline]
```

References [increment\(\)](#).

6.22.3.4 `operator++()` [2/2]

```
const\_preorder\_iterator GiNaC::const_preorder_iterator::operator++ (
    int ) [inline]
```

References [increment\(\)](#).

6.22.3.5 operator==()

```
bool GiNaC::const_preorder_iterator::operator== (
    const const\_preorder\_iterator & other ) const [inline], [noexcept]
```

References [s](#).

6.22.3.6 operator!=(())

```
bool GiNaC::const_preorder_iterator::operator!= (
    const const\_preorder\_iterator & other ) const [inline], [noexcept]
```

6.22.3.7 increment()

```
void GiNaC::const_preorder_iterator::increment ( ) [inline], [private]
```

References [GiNaC::internal::_iter_rep::e](#), [GiNaC::internal::_iter_rep::i](#), [GiNaC::internal::_iter_rep::i_end](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), and [s](#).

Referenced by [operator++\(\)](#).

6.22.4 Member Data Documentation

6.22.4.1 s

```
std::stack<internal::\_iter\_rep, std::vector<internal::\_iter\_rep> > GiNaC::const_preorder_↵
iterator::s [private]
```

Referenced by [const_preorder_iterator\(\)](#), [increment\(\)](#), [operator*\(\)](#), [operator->\(\)](#), and [operator==\(\)](#).

The documentation for this class was generated from the following file:

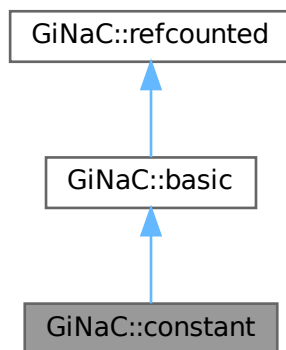
- [ex.h](#)

6.23 GiNaC::constant Class Reference

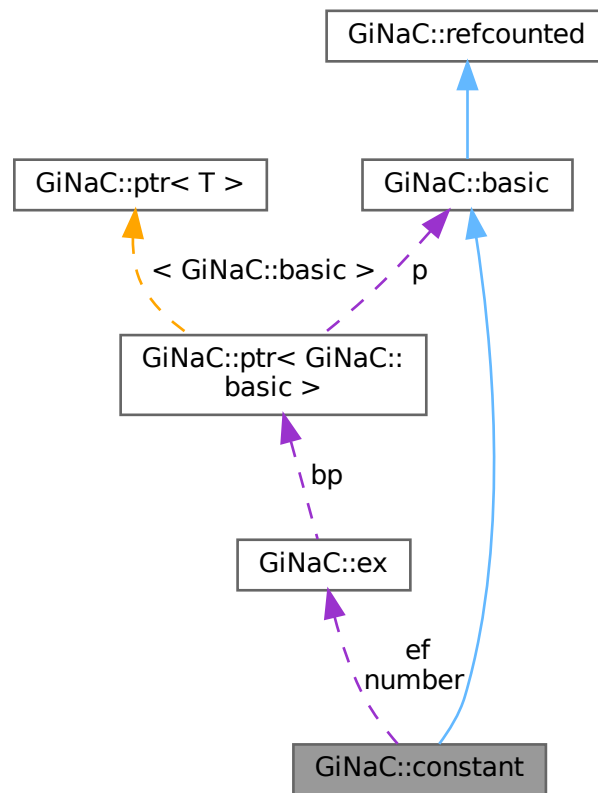
This class holds constants, symbols with specific numerical value.

```
#include <constant.h>
```

Inheritance diagram for GiNaC::constant:



Collaboration diagram for GiNaC::constant:



Public Member Functions

- `constant` (const std::string &initname, evalffunctype efun=nullptr, const std::string &texname=std::string(), unsigned domain=domain::complex)
- `constant` (const std::string &initname, const numeric &initnumber, const std::string &texname=std::string(), unsigned domain=domain::complex)
- bool `info` (unsigned inf) const override
Information about the object.
- `ex evalf` () const override
Evaluate object numerically.
- bool `is_polynomial` (const `ex` &var) const override
Check whether this is a polynomial in the given variables.
- `ex conjugate` () const override
- `ex real_part` () const override
- `ex imag_part` () const override
- void `archive` (archive_node &n) const override
Save (serialize) the object into archive node.
- void `read_archive` (const archive_node &n, lst &syms) override
Load (deserialize) the object from an archive node.

Public Member Functions inherited from [GiNaC::basic](#)

- virtual [~basic](#) ()
basic destructor, virtual because class ex will delete objects of derived classes via a basic.*
- [basic](#) (const [basic](#) &other)
- const [basic](#) & [operator=](#) (const [basic](#) &other)
basic assignment operator: the other object might be of a derived class.
- virtual [basic](#) * [duplicate](#) () const
Create a clone of this object on the heap.
- virtual [ex eval](#) () const
Perform automatic non-interruptive term rewriting rules.
- virtual [ex evalf](#) () const
Evaluate object numerically.
- virtual [ex evalm](#) () const
Evaluate sums, products and integer powers of matrices.
- virtual [ex eval_integ](#) () const
Evaluate integrals, if result is known.
- virtual [ex eval_indexed](#) (const [basic](#) &i) const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void [print](#) (const [print_context](#) &c, unsigned level=0) const
Output to stream.
- virtual void [dbgprint](#) () const
Little wrapper around print to be called within a debugger.
- virtual void [dbgprinttree](#) () const
Little wrapper around printtree to be called within a debugger.
- virtual unsigned [precedence](#) () const
Return relative operator precedence (for parenthezing output).
- virtual bool [info](#) (unsigned inf) const
Information about the object.
- virtual size_t [nops](#) () const
Number of operands/members.
- virtual [ex op](#) (size_t i) const
Return operand/member at position i.
- virtual [ex operator\[\]](#) (const [ex](#) &index) const
- virtual [ex operator\[\]](#) (size_t i) const
- virtual [ex](#) & [let_op](#) (size_t i)
Return modifiable operand/member at position i.
- virtual [ex](#) & [operator\[\]](#) (const [ex](#) &index)
- virtual [ex](#) & [operator\[\]](#) (size_t i)
- virtual bool [has](#) (const [ex](#) &other, unsigned [options](#)=0) const
Test for occurrence of a pattern.
- virtual bool [match](#) (const [ex](#) &pattern, [exmap](#) &repls) const
Check whether the expression matches a given pattern.
- virtual [ex subs](#) (const [exmap](#) &m, unsigned [options](#)=0) const
Substitute a set of objects by arbitrary expressions.
- virtual [ex map](#) ([map_function](#) &f) const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void [accept](#) ([GiNaC::visitor](#) &v) const
- virtual bool [is_polynomial](#) (const [ex](#) &var) const
Check whether this is a polynomial in the given variables.
- virtual int [degree](#) (const [ex](#) &s) const

- Return degree of highest power in object s.*

 - virtual int `ldegree` (const `ex` &s) const
- Return degree of lowest power in object s.*

 - virtual `ex coeff` (const `ex` &s, int `n`=1) const
- Return coefficient of degree n in object s.*

 - virtual `ex expand` (unsigned `options`=0) const
- Expand expression, i.e.*

 - virtual `ex collect` (const `ex` &s, bool `distributed`=false) const
- Sort expanded expression in terms of powers of some object(s).*

 - virtual `ex series` (const `relational` &r, int `order`, unsigned `options`=0) const
- Default implementation of `ex::series()`.*

 - virtual `ex normal` (`exmap` &repl, `exmap` &rev_lookup, `lst` &modifier) const
- Default implementation of `ex::normal()`.*

 - virtual `ex to_rational` (`exmap` &repl) const
- Default implementation of `ex::to_rational()`.*

 - virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const
- Apply symmetric modular homomorphism to an expanded multivariate polynomial.*

 - virtual `numeric max_coefficient` () const
- Implementation `ex::max_coefficient()`.*

 - virtual `exvector get_free_indices` () const
- Return a vector containing the free indices of an expression.*

 - virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
- Add two indexed expressions.*

 - virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
- Multiply an indexed expression with a scalar.*

 - virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const
- Try to contract two indexed expressions that appear in the same product.*

 - virtual unsigned `return_type` () const
 - virtual `return_type_t return_type_tinfo` () const
 - virtual `ex conjugate` () const
 - virtual `ex real_part` () const
 - virtual `ex imag_part` () const
- template<class T >

 - void `print_dispatch` (const `print_context` &c, unsigned `level`) const

Like `print()`, but dispatch to the specified class.

 - void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned `level`) const

Like `print()`, but dispatch to the specified class.

 - virtual void `archive` (`archive_node` &n) const

Save (serialize) the object into archive node.

 - virtual void `read_archive` (const `archive_node` &n, `lst` &syms)

Load (deserialize) the object from an archive node.

 - `ex subs_one_level` (const `exmap` &m, unsigned `options`) const

Helper function for `subs()`.

 - `ex diff` (const `symbol` &s, unsigned `nth`=1) const

Default interface of nth derivative `ex::diff(s, n)`.

 - int `compare` (const `basic` &other) const

Compare objects syntactically to establish canonical ordering.

 - bool `is_equal` (const `basic` &other) const

Test for syntactic equality.

- const [basic](#) & [hold](#) () const
Stop further evaluation.
- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const
Set some [status_flags](#).
- const [basic](#) & [clearflag](#) (unsigned f) const
Clear some [status_flags](#).

Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add_reference](#) () noexcept
- unsigned int [remove_reference](#) () noexcept
- unsigned int [get_refcount](#) () const noexcept
- void [set_refcount](#) (unsigned int r) noexcept

Protected Member Functions

- [ex_derivative](#) (const [symbol](#) &s) const override
Implementation of [ex::diff\(\)](#) for a constant always returns 0.
- bool [is_equal_same_type](#) (const [basic](#) &other) const override
Returns true if two objects of same type are equal.
- unsigned [calchash](#) () const override
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
- void [do_print_latex](#) (const [print_latex](#) &c, unsigned level) const
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const

Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match_same_type](#) (const [basic](#) &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual [ex_derivative](#) (const [symbol](#) &s) const
Default implementation of [ex::diff\(\)](#).
- virtual int [compare_same_type](#) (const [basic](#) &other) const
Returns order relation between two objects of same type.
- virtual bool [is_equal_same_type](#) (const [basic](#) &other) const
Returns true if two objects of same type are equal.
- virtual unsigned [calchash](#) () const
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- void [ensure_if_modifiable](#) () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
Default output to stream.
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
Tree output to stream.
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
Python parsable output to stream.

Private Attributes

- `std::string name`
printrname of this constant
- `std::string TeX_name`
LaTeX name.
- `evalfunctype ef`
- `ex number`
numerical value this constant `evalf()`s to
- `unsigned serial`
unique serial number for comparison
- `unsigned domain`
numerical value this constant `evalf()`s to

Static Private Attributes

- `static unsigned next_serial = 0`

Additional Inherited Members

Protected Attributes inherited from [GiNaC::basic](#)

- `unsigned flags`
of type `status_flags`
- `unsigned hashvalue`
hash value

6.23.1 Detailed Description

This class holds constants, symbols with specific numerical value.

Each object of this class must either provide their own function to evaluate it to class numeric or provide the constant as a numeric (if it's an exact number).

6.23.2 Constructor & Destructor Documentation

6.23.2.1 `constant()` [1/2]

```
GiNaC::constant::constant (
    const std::string & initname,
    evalfunctype efun = nullptr,
    const std::string & texname = std::string(),
    unsigned domain = domain::complex )
```

References [GiNaC::status_flags::evaluated](#), [GiNaC::status_flags::expanded](#), [name](#), [GiNaC::basic::setflag\(\)](#), and [TeX_name](#).

6.23.2.2 `constant()` [2/2]

```
GiNaC::constant::constant (
    const std::string & initname,
    const numeric & initnumber,
    const std::string & texname = std::string(),
    unsigned domain = domain::complex )
```

References [GiNaC::status_flags::evaluated](#), [GiNaC::status_flags::expanded](#), [name](#), [GiNaC::basic::setflag\(\)](#), and [TeX_name](#).

6.23.3 Member Function Documentation

6.23.3.1 `info()`

```
bool GiNaC::constant::info (
    unsigned inf ) const [override], [virtual]
```

Information about the object.

See also

class [info_flags](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::info_flags::nonnegative](#), [GiNaC::info_flags::polynomial](#), [GiNaC::domain::positive](#), [GiNaC::info_flags::positive](#), [GiNaC::domain::real](#), and [GiNaC::info_flags::real](#).

6.23.3.2 `evalf()`

```
ex GiNaC::constant::evalf ( ) const [override], [virtual]
```

Evaluate object numerically.

Reimplemented from [GiNaC::basic](#).

References [ef](#), [GiNaC::ex::evalf\(\)](#), and [number](#).

Referenced by [GiNaC::EllipticE_eval\(\)](#), and [GiNaC::EllipticK_eval\(\)](#).

6.23.3.3 is_polynomial()

```
bool GiNaC::constant::is_polynomial (
    const ex & var ) const [override], [virtual]
```

Check whether this is a polynomial in the given variables.

Reimplemented from [GiNaC::basic](#).

6.23.3.4 conjugate()

```
ex GiNaC::constant::conjugate ( ) const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::domain::positive](#), and [GiNaC::domain::real](#).

6.23.3.5 real_part()

```
ex GiNaC::constant::real_part ( ) const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::domain::positive](#), and [GiNaC::domain::real](#).

6.23.3.6 imag_part()

```
ex GiNaC::constant::imag_part ( ) const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::domain::positive](#), and [GiNaC::domain::real](#).

6.23.3.7 archive()

```
void GiNaC::constant::archive (
    archive\_node & n ) const [override], [virtual]
```

Save (serialize) the object into archive node.

Archive the object.

Losely speaking, this method turns an expression into a byte stream (which can be saved and restored later on, or sent via network, etc.)

Reimplemented from [GiNaC::basic](#).

References [n](#), and [name](#).

6.23.3.8 read_archive()

```
void GiNaC::constant::read_archive (
    const archive_node & n,
    lst & syms ) [override], [virtual]
```

Load (deserialize) the object from an archive node.

Construct object from [archive_node](#).

Note

This method is essentially a constructor. However, constructors can't be virtual. So, if unarchiving routines are implemented as constructors one would need to define such a constructor in every class, even if all it does is simply calling constructor of a superclass.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::Catalan](#), [GiNaC::Euler](#), [n](#), [name](#), and [GiNaC::Pi](#).

6.23.3.9 derivative()

```
ex GiNaC::constant::derivative (
    const symbol & s ) const [override], [protected], [virtual]
```

Implementation of [ex::diff\(\)](#) for a constant always returns 0.

See also

[ex::diff](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex0](#).

6.23.3.10 is_equal_same_type()

```
bool GiNaC::constant::is_equal_same_type (
    const basic & other ) const [override], [protected], [virtual]
```

Returns true if two objects of same type are equal.

Normally needs not be reimplemented as long as it wasn't overwritten by some parent class, since it just calls [compare_same_type\(\)](#). The reason why this function exists is that sometimes it is easier to determine equality than an order relation and then it can be overridden.

Reimplemented from [GiNaC::basic](#).

References [GINAC_ASSERT](#), and [serial](#).

6.23.3.11 calchash()

```
unsigned GiNaC::constant::calchash ( ) const [override], [protected], [virtual]
```

Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.

The method inherited from class `basic` computes a hash value based on the type and hash values of possible members. For this reason it is well suited for container classes but atomic classes should override this implementation because otherwise they would all end up with the same hashvalue.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::golden_ratio_hash\(\)](#), [GiNaC::status_flags::hash_calculated](#), [GiNaC::basic::hashvalue](#), [serial](#), and [GiNaC::basic::setflag\(\)](#).

6.23.3.12 do_print()

```
void GiNaC::constant::do_print (
    const print\_context & c,
    unsigned level ) const [protected]
```

References [c](#), and [name](#).

6.23.3.13 do_print_tree()

```
void GiNaC::constant::do_print_tree (
    const print\_tree & c,
    unsigned level ) const [protected]
```

References [c](#), [GiNaC::basic::flags](#), [GiNaC::basic::hashvalue](#), and [name](#).

6.23.3.14 do_print_latex()

```
void GiNaC::constant::do_print_latex (
    const print\_latex & c,
    unsigned level ) const [protected]
```

References [c](#), and [TeX_name](#).

6.23.3.15 do_print_python_repr()

```
void GiNaC::constant::do_print_python_repr (
    const print\_python\_repr & c,
    unsigned level ) const [protected]
```

References [c](#), [name](#), and [TeX_name](#).

6.23.4 Member Data Documentation

6.23.4.1 name

`std::string GiNaC::constant::name [private]`

printname of this constant

Referenced by [archive\(\)](#), [constant\(\)](#), [do_print\(\)](#), [do_print_python_repr\(\)](#), [do_print_tree\(\)](#), and [read_archive\(\)](#).

6.23.4.2 TeX_name

`std::string GiNaC::constant::TeX_name [private]`

LaTeX name.

Referenced by [constant\(\)](#), [do_print_latex\(\)](#), and [do_print_python_repr\(\)](#).

6.23.4.3 ef

`evalffunctype GiNaC::constant::ef [private]`

Referenced by [evalf\(\)](#).

6.23.4.4 number

`ex GiNaC::constant::number [private]`

numerical value this constant [evalf\(\)](#)s to

Referenced by [evalf\(\)](#).

6.23.4.5 serial

`unsigned GiNaC::constant::serial [private]`

unique serial number for comparison

Referenced by [calchash\(\)](#), and [is_equal_same_type\(\)](#).

6.23.4.6 next_serial

```
unsigned GiNaC::constant::next_serial = 0 [static], [private]
```

6.23.4.7 domain

```
unsigned GiNaC::constant::domain [private]
```

numerical value this constant [evalf\(\)](#)s to

The documentation for this class was generated from the following files:

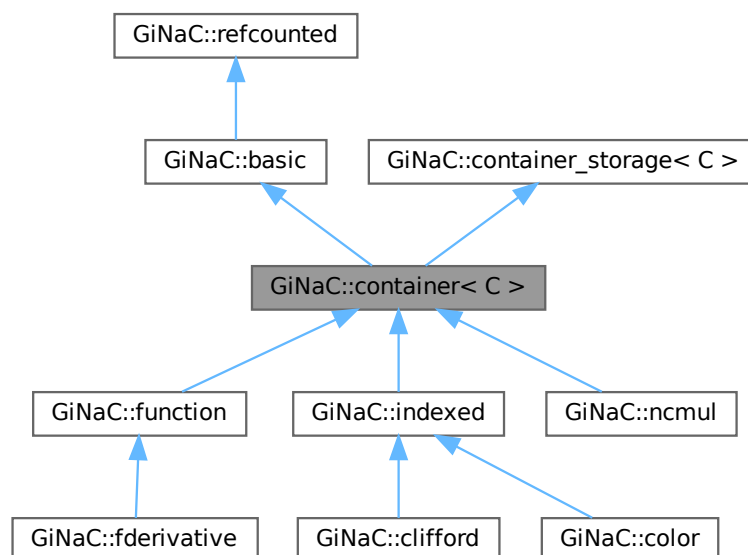
- [constant.h](#)
- [constant.cpp](#)

6.24 GiNaC::container< C > Class Template Reference

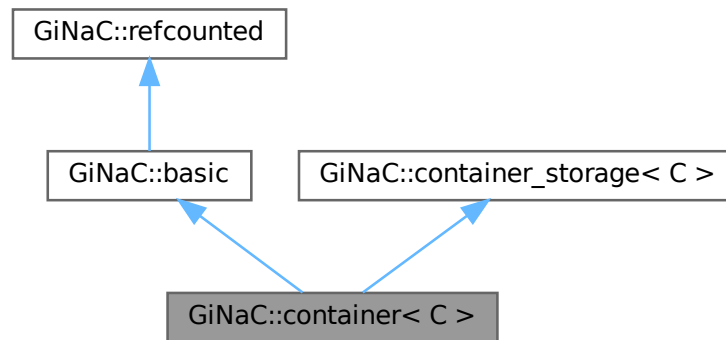
Wrapper template for making [GiNaC](#) classes out of STL containers.

```
#include <container.h>
```

Inheritance diagram for GiNaC::container< C >:



Collaboration diagram for `GiNaC::container< C >`:



Public Types

- typedef `STLT::const_iterator` `const_iterator`
- typedef `STLT::const_reverse_iterator` `const_reverse_iterator`

Public Member Functions

- `container` (`STLT const &s`)
- `container` (`STLT &&v`)
- `container` (`exvector::const_iterator b`, `exvector::const_iterator e`)
- `container` (`std::initializer_list< ex > il`)
- `bool info` (`unsigned inf`) `const` override
Information about the object.
- `unsigned precedence` () `const` override
Return relative operator precedence (for parenthezing output).
- `size_t nops` () `const` override
Number of operands/members.
- `ex op` (`size_t i`) `const` override
Return operand/member at position i.
- `ex & let_op` (`size_t i`) `override`
Return modifiable operand/member at position i.
- `ex subs` (`const exmap &m`, `unsigned options=0`) `const` override
Substitute a set of objects by arbitrary expressions.
- `void read_archive` (`const archive_node &n`, `lst &sym_lst`) `override`
Load (deserialize) the object from an archive node.
- `void archive` (`archive_node &n`) `const` override
Archive the object.
- `container & prepend` (`const ex &b`)
Add element at front.
- `container & append` (`const ex &b`)
Add element at back.

- `container & remove_first ()`
Remove first element.
- `container & remove_last ()`
Remove last element.
- `container & remove_all ()`
Remove all elements.
- `container & sort ()`
Sort elements.
- `container & unique ()`
Remove adjacent duplicate elements.
- `const_iterator begin () const`
- `const_iterator end () const`
- `const_reverse_iterator rbegin () const`
- `const_reverse_iterator rend () const`

Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic ()`
basic destructor, virtual because class ex will delete objects of derived classes via a basic.*
- `basic (const basic &other)`
- `const basic & operator= (const basic &other)`
basic assignment operator: the other object might be of a derived class.
- virtual `basic * duplicate () const`
Create a clone of this object on the heap.
- virtual `ex eval () const`
Perform automatic non-interruptive term rewriting rules.
- virtual `ex evalf () const`
Evaluate object numerically.
- virtual `ex evalm () const`
Evaluate sums, products and integer powers of matrices.
- virtual `ex eval_integ () const`
Evaluate integrals, if result is known.
- virtual `ex eval_indexed (const basic &i) const`
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void `print (const print_context &c, unsigned level=0) const`
Output to stream.
- virtual void `dbgprint () const`
Little wrapper around print to be called within a debugger.
- virtual void `dbgprinttree () const`
Little wrapper around printtree to be called within a debugger.
- virtual unsigned `precedence () const`
Return relative operator precedence (for parenthesizing output).
- virtual bool `info (unsigned inf) const`
Information about the object.
- virtual size_t `nops () const`
Number of operands/members.
- virtual `ex op (size_t i) const`
Return operand/member at position i.
- virtual `ex operator[] (const ex &index) const`
- virtual `ex operator[] (size_t i) const`
- virtual `ex & let_op (size_t i)`

- Return modifiable operand/member at position i.*
- virtual `ex & operator[]` (const `ex` &index)
- virtual `ex & operator[]` (size_t i)
- virtual bool `has` (const `ex` &other, unsigned `options`=0) const
- Test for occurrence of a pattern.*
- virtual bool `match` (const `ex` &pattern, `exmap` &repls) const
- Check whether the expression matches a given pattern.*
- virtual `ex subs` (const `exmap` &m, unsigned `options`=0) const
- Substitute a set of objects by arbitrary expressions.*
- virtual `ex map` (`map_function` &f) const
- Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual void `accept` (`GiNaC::visitor` &v) const
- virtual bool `is_polynomial` (const `ex` &var) const
- Check whether this is a polynomial in the given variables.*
- virtual int `degree` (const `ex` &s) const
- Return degree of highest power in object s.*
- virtual int `ldegree` (const `ex` &s) const
- Return degree of lowest power in object s.*
- virtual `ex coeff` (const `ex` &s, int `n`=1) const
- Return coefficient of degree n in object s.*
- virtual `ex expand` (unsigned `options`=0) const
- Expand expression, i.e.*
- virtual `ex collect` (const `ex` &s, bool `distributed`=false) const
- Sort expanded expression in terms of powers of some object(s).*
- virtual `ex series` (const `relational` &r, int `order`, unsigned `options`=0) const
- Default implementation of `ex::series()`.*
- virtual `ex normal` (`exmap` &repl, `exmap` &rev_lookup, `lst` &modifier) const
- Default implementation of `ex::normal()`.*
- virtual `ex to_rational` (`exmap` &repl) const
- Default implementation of `ex::to_rational()`.*
- virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const
- Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- virtual `numeric max_coefficient` () const
- Implementation `ex::max_coefficient()`.*
- virtual `exvector get_free_indices` () const
- Return a vector containing the free indices of an expression.*
- virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
- Add two indexed expressions.*
- virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
- Multiply an indexed expression with a scalar.*
- virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const
- Try to contract two indexed expressions that appear in the same product.*
- virtual unsigned `return_type` () const
- virtual `return_type_t return_type_tinfo` () const
- virtual `ex conjugate` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const
- template<class T >
- void `print_dispatch` (const `print_context` &c, unsigned level) const

- Like `print()`, but dispatch to the specified class.
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const
- Like `print()`, but dispatch to the specified class.
- virtual void `archive` (`archive_node` &n) const
- Save (serialize) the object into archive node.
- virtual void `read_archive` (const `archive_node` &n, `lst` &syms)
- Load (deserialize) the object from an archive node.
- `ex subs_one_level` (const `exmap` &m, unsigned `options`) const
- Helper function for `subs()`.
- `ex diff` (const `symbol` &s, unsigned nth=1) const
- Default interface of nth derivative `ex::diff(s, n)`.
- int `compare` (const `basic` &other) const
- Compare objects syntactically to establish canonical ordering.
- bool `is_equal` (const `basic` &other) const
- Test for syntactic equality.
- const `basic` & `hold` () const
- Stop further evaluation.
- unsigned `gethash` () const
- const `basic` & `setflag` (unsigned f) const
- Set some `status_flags`.
- const `basic` & `clearflag` (unsigned f) const
- Clear some `status_flags`.

Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- unsigned int `add_reference` () noexcept
- unsigned int `remove_reference` () noexcept
- unsigned int `get_refcount` () const noexcept
- void `set_refcount` (unsigned int r) noexcept

Protected Types

- typedef `container_storage`< C >::STLT `STLT`

Protected Types inherited from `GiNaC::container_storage< C >`

- typedef C< `ex` > `STLT`

Protected Member Functions

- `ex conjugate ()` const override
- `ex real_part ()` const override
- `ex imag_part ()` const override
- `bool is_equal_same_type` (const `basic` &other) const override
Returns true if two objects of same type are equal.
- virtual `ex thiscontainer` (const `STLT` &v) const
Similar to `duplicate()`, but with a preset sequence.
- virtual `ex thiscontainer` (`STLT` &&v) const
Similar to `duplicate()`, but with a preset sequence (which gets pilfered).
- virtual void `printseq` (const `print_context` &c, char openbracket, char delim, char closebracket, unsigned this←_precedence, unsigned upper_precedence=0) const
Print sequence of contained elements.
- void `do_print` (const `print_context` &c, unsigned level) const
- void `do_print_tree` (const `print_tree` &c, unsigned level) const
- void `do_print_python` (const `print_python` &c, unsigned level) const
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const
- `STLT` `subchildren` (const `exmap` &m, unsigned `options`=0) const

Protected Member Functions inherited from `GiNaC::basic`

- `basic ()`
- virtual `ex eval_ncmul` (const `exvector` &v) const
- virtual `bool match_same_type` (const `basic` &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual `ex derivative` (const `symbol` &s) const
Default implementation of `ex::diff()`.
- virtual int `compare_same_type` (const `basic` &other) const
Returns order relation between two objects of same type.
- virtual `bool is_equal_same_type` (const `basic` &other) const
Returns true if two objects of same type are equal.
- virtual unsigned `calchash` () const
Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.
- void `ensure_if_modifiable` () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void `do_print` (const `print_context` &c, unsigned level) const
Default output to stream.
- void `do_print_tree` (const `print_tree` &c, unsigned level) const
Tree output to stream.
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const
Python parsable output to stream.

Protected Member Functions inherited from `GiNaC::container_storage< C >`

- `container_storage ()`
- `container_storage` (size_t n, const `ex` &e)
- `container_storage` (std::initializer_list< `ex` > il)
- template<class In >
 `container_storage` (In b, In e)
- void `reserve` (size_t)
- `~container_storage ()`
- void `reserve` (size_t n)
- void `reserve` (std::vector< `ex` > &v, size_t n)

Static Protected Member Functions

- static unsigned [get_default_flags](#) ()
Specialization of [container::get_default_flags\(\)](#) for [lst](#).
- static char [get_open_delim](#) ()
Specialization of [container::get_open_delim\(\)](#) for [lst](#).
- static char [get_close_delim](#) ()
Specialization of [container::get_close_delim\(\)](#) for [lst](#).

Static Protected Member Functions inherited from [GiNaC::container_storage< C >](#)

- static void [reserve](#) (STLT &, size_t)

Private Member Functions

- void [sort_](#) (std::random_access_iterator_tag)
- void [sort_](#) (std::input_iterator_tag)
- void [unique_](#) ()
- void [unique_](#) ()
Specialization of [container::unique_\(\)](#) for [std::list](#).

Additional Inherited Members

Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)
of type [status_flags](#)
- unsigned [hashvalue](#)
hash value

Protected Attributes inherited from [GiNaC::container_storage< C >](#)

- [STLT seq](#)

6.24.1 Detailed Description

```
template<template< class T, class=std::allocator< T > > class C>
class GiNaC::container< C >
```

Wrapper template for making [GiNaC](#) classes out of STL containers.

6.24.2 Member Typedef Documentation

6.24.2.1 STL

```
template<template< class T, class=std::allocator< T > > class C>
typedef container\_storage<C>::STLT GiNaC::container< C >::STLT [protected]
```

6.24.2.2 const_iterator

```
template<template< class T, class=std::allocator< T > > class C>
typedef STLT::const_iterator GiNaC::container< C >::const_iterator
```

6.24.2.3 const_reverse_iterator

```
template<template< class T, class=std::allocator< T > > class C>
typedef STLT::const_reverse_iterator GiNaC::container< C >::const_reverse_iterator
```

6.24.3 Constructor & Destructor Documentation

6.24.3.1 container() [1/4]

```
template<template< class T, class=std::allocator< T > > class C>
GiNaC::container< C >::container (
    STLT const & s ) [inline]
```

References [GiNaC::container< C >::get_default_flags\(\)](#), [GiNaC::container_storage< C >::seq](#), and [GiNaC::basic::setflag\(\)](#).

6.24.3.2 container() [2/4]

```
template<template< class T, class=std::allocator< T > > class C>
GiNaC::container< C >::container (
    STLT && v ) [inline], [explicit]
```

References [GiNaC::container< C >::get_default_flags\(\)](#), [GiNaC::container_storage< C >::seq](#), and [GiNaC::basic::setflag\(\)](#).

6.24.3.3 container() [3/4]

```
template<template< class T, class=std::allocator< T > > class C>
GiNaC::container< C >::container (
    exvector::const_iterator b,
    exvector::const_iterator e ) [inline]
```

References [GiNaC::container< C >::get_default_flags\(\)](#), and [GiNaC::basic::setflag\(\)](#).

6.24.3.4 container() [4/4]

```
template<template< class T, class=std::allocator< T > > class C>
GiNaC::container< C >::container (
    std::initializer_list< ex > il ) [inline]
```

References [GiNaC::container< C >::get_default_flags\(\)](#), and [GiNaC::basic::setflag\(\)](#).

6.24.4 Member Function Documentation**6.24.4.1 get_default_flags()**

```
unsigned GiNaC::lst::get_default_flags [inline], [static], [protected]
```

Specialization of [container::get_default_flags\(\)](#) for `lst`.

Referenced by [GiNaC::container< C >::container\(\)](#), and [GiNaC::container< C >::read_archive\(\)](#).

6.24.4.2 get_open_delim()

```
char GiNaC::lst::get_open_delim [inline], [static], [protected]
```

Specialization of [container::get_open_delim\(\)](#) for `lst`.

6.24.4.3 get_close_delim()

```
char GiNaC::lst::get_close_delim [inline], [static], [protected]
```

Specialization of [container::get_close_delim\(\)](#) for `lst`.

6.24.4.4 info()

```
template bool GiNaC::container< C >::info (
    unsigned inf ) const [inline], [override], [virtual]
```

Information about the object.

See also

class [info_flags](#)

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::function](#), [GiNaC::indexed](#), and [GiNaC::ncmul](#).

6.24.4.5 precedence()

```
template<template< class T, class=std::allocator< T > > class C>
unsigned GiNaC::container< C >::precedence ( ) const [inline], [override], [virtual]
```

Return relative operator precedence (for parenthezing output).

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::function](#), [GiNaC::indexed](#), and [GiNaC::ncmul](#).

Referenced by [GiNaC::fderivative::do_print\(\)](#), [GiNaC::fderivative::do_print_csrc\(\)](#), [GiNaC::fderivative::do_print_latex\(\)](#), and [GiNaC::function::print\(\)](#).

6.24.4.6 nops()

```
template<template< class T, class=std::allocator< T > > class C>
size_t GiNaC::container< C >::nops ( ) const [inline], [override], [virtual]
```

Number of operands/members.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::container_storage< C >::seq](#).

Referenced by [GiNaC::function::calchash\(\)](#), [GiNaC::ncmul::conjugate\(\)](#), [GiNaC::ex::denom\(\)](#), [GiNaC::diag_matrix\(\)](#), [GiNaC::fderivative::do_print_tree\(\)](#), [GiNaC::G3_eval\(\)](#), [GiNaC::G3_evalf\(\)](#), [GiNaC::ncmul::get_free_indices\(\)](#), [GiNaC::H_evalf\(\)](#), [GiNaC::container< C >::imag_part\(\)](#), [GiNaC::is_discriminant_of_quadratic_number_field\(\)](#), [GiNaC::iterated_integral_evalf_impl\(\)](#), [GiNaC::lst_to_matrix\(\)](#), [GiNaC::ex::normal\(\)](#), [GiNaC::basic::normal\(\)](#), [GiNaC::add::normal\(\)](#), [GiNaC::mul::normal\(\)](#), [GiNaC::power::normal\(\)](#), [GiNaC::ex::numer\(\)](#), [GiNaC::ex::numer_denom\(\)](#), [GiNaC::function::print\(\)](#), [GiNaC::container< C >::real_part\(\)](#), [GiNaC::sqrfree\(\)](#), and [GiNaC::ex::subs\(\)](#).

6.24.4.7 op()

```
template<template< class T, class=std::allocator< T > > class C>
ex GiNaC::container< C >::op (
    size_t i ) const [override], [virtual]
```

Return operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [GINAC_ASSERT](#), and [GiNaC::nops\(\)](#).

Referenced by [GiNaC::function::calchash\(\)](#), [GiNaC::ex::denom\(\)](#), [GiNaC::mul::expand\(\)](#), [GiNaC::ncmul::expand\(\)](#), [GiNaC::ncmul::get_free_indices\(\)](#), [GiNaC::H_evalf\(\)](#), [GiNaC::indexed::imag_part\(\)](#), [GiNaC::is_discriminant_of_quadratic_number_field\(\)](#), [GiNaC::kronecker_symbol\(\)](#), [GiNaC::ex::normal\(\)](#), [GiNaC::basic::normal\(\)](#), [GiNaC::add::normal\(\)](#), [GiNaC::mul::normal\(\)](#), [GiNaC::power::normal\(\)](#), [GiNaC::ex::numer\(\)](#), [GiNaC::ex::numer_denom\(\)](#), [GiNaC::indexed::real_part\(\)](#), [GiNaC::rename_dummy_indices\(\)](#), [GiNaC::indexed::return_type\(\)](#), [GiNaC::indexed::return_type_tinfo\(\)](#), [GiNaC::sqrfree\(\)](#), [GiNaC::symm\(\)](#), and [GiNaC::symmetrize_cyclic\(\)](#).

6.24.4.8 let_op()

```
template<template< class T, class=std::allocator< T > > class C>
ex & GiNaC::container< C >::let_op (
    size_t i ) [override], [virtual]
```

Return modifiable operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [GINAC_ASSERT](#), and [GiNaC::nops\(\)](#).

6.24.4.9 subs()

```
template<template< class T, class=std::allocator< T > > class C>
ex GiNaC::container< C >::subs (
    const exmap & m,
    unsigned options = 0 ) const [override], [virtual]
```

Substitute a set of objects by arbitrary expressions.

The ex returned will already be evaluated.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::is_a\(\)](#), [m](#), and [options](#).

6.24.4.10 read_archive()

```
template<template< class T, class=std::allocator< T > > class C>
void GiNaC::container< C >::read_archive (
    const archive_node & n,
    lst & syms ) [inline], [override], [virtual]
```

Load (deserialize) the object from an archive node.

Construct object from [archive_node](#).

Note

This method is essentially a constructor. However, constructors can't be virtual. So, if unarchiving routines are implemented as constructors one would need to define such a constructor in every class, even if all it does is simply calling constructor of a superclass.

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::fderivative](#), [GiNaC::function](#), and [GiNaC::indexed](#).

References [GiNaC::container< C >::get_default_flags\(\)](#), [n](#), [GiNaC::container_storage< C >::reserve\(\)](#), [GiNaC::container_storage< C >::seq](#), and [GiNaC::basic::setflag\(\)](#).

6.24.4.11 archive()

```
template<template< class T, class=std::allocator< T > > class C>
void GiNaC::container< C >::archive (
    archive_node & n ) const [inline], [override], [virtual]
```

Archive the object.

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::fderivative](#), [GiNaC::function](#), and [GiNaC::indexed](#).

References [GiNaC::archive_node::add_ex\(\)](#), [n](#), and [GiNaC::container_storage< C >::seq](#).

6.24.4.12 conjugate()

```
template<template< class T, class=std::allocator< T > > class C>
ex GiNaC::container< C >::conjugate ( ) const [inline], [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::function](#), and [GiNaC::ncmul](#).

References [GiNaC::are_ex_trivially_equal\(\)](#), [GiNaC::container_storage< C >::reserve\(\)](#), [GiNaC::container_storage< C >::seq](#), [GiNaC::container< C >::thiscontainer\(\)](#), and [x](#).

Referenced by [GiNaC::ncmul::conjugate\(\)](#).

6.24.4.13 real_part()

```
template<template< class T, class=std::allocator< T > > class C>
ex GiNaC::container< C >::real_part ( ) const [inline], [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::function](#), [GiNaC::indexed](#), and [GiNaC::ncmul](#).

References [GiNaC::container< C >::begin\(\)](#), [cont](#), [GiNaC::container< C >::end\(\)](#), [GiNaC::container< C >::nops\(\)](#), [GiNaC::container_storage< C >::reserve\(\)](#), and [GiNaC::container< C >::thiscontainer\(\)](#).

6.24.4.14 imag_part()

```
template<template< class T, class=std::allocator< T > > class C>
ex GiNaC::container< C >::imag_part ( ) const [inline], [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::function](#), [GiNaC::indexed](#), and [GiNaC::ncmul](#).

References [GiNaC::container< C >::begin\(\)](#), [cont](#), [GiNaC::container< C >::end\(\)](#), [GiNaC::container< C >::nops\(\)](#), [GiNaC::container_storage< C >::reserve\(\)](#), and [GiNaC::container< C >::thiscontainer\(\)](#).

6.24.4.15 is_equal_same_type()

```
template<template< class T, class=std::allocator< T > > class C>
bool GiNaC::container< C >::is_equal_same_type (
    const basic & other ) const [override], [protected], [virtual]
```

Returns true if two objects of same type are equal.

Normally needs not be reimplemented as long as it wasn't overwritten by some parent class, since it just calls [compare_same_type\(\)](#). The reason why this function exists is that sometimes it is easier to determine equality than an order relation and then it can be overridden.

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::fderivative](#), and [GiNaC::function](#).

References [GINAC_ASSERT](#), and [GiNaC::container_storage< C >::seq](#).

Referenced by [GiNaC::function::is_equal_same_type\(\)](#).

6.24.4.16 thiscontainer() [1/2]

```
template<template< class T, class=std::allocator< T > > class C>
virtual ex GiNaC::container< C >::thiscontainer (
    const STLT & v ) const [inline], [protected], [virtual]
```

Similar to [duplicate\(\)](#), but with a preset sequence.

Must be overridden by derived classes.

Referenced by [GiNaC::container< C >::conjugate\(\)](#), [GiNaC::container< C >::imag_part\(\)](#), and [GiNaC::container< C >::real_part\(\)](#).

6.24.4.17 thiscontainer() [2/2]

```
template<template< class T, class=std::allocator< T > > class C>
virtual ex GiNaC::container< C >::thiscontainer (
    STLT && v ) const [inline], [protected], [virtual]
```

Similar to [duplicate\(\)](#), but with a preset sequence (which gets pilfered).

Must be overridden by derived classes.

6.24.4.18 printseq()

```
template<template< class T, class=std::allocator< T > > class C>
void GiNaC::container< C >::printseq (
    const print\_context & c,
    char openbracket,
    char delim,
    char closebracket,
    unsigned this_precedence,
    unsigned upper_precedence = 0 ) const [protected], [virtual]
```

Print sequence of contained elements.

References [c](#).

Referenced by [GiNaC::fderivative::do_print\(\)](#), [GiNaC::ncmul::do_print\(\)](#), [GiNaC::ncmul::do_print_src\(\)](#), [GiNaC::fderivative::do_print_latex\(\)](#), and [GiNaC::function::print\(\)](#).

6.24.4.19 sort_() [1/2]

```
template<template< class T, class=std::allocator< T > > class C>
void GiNaC::container< C >::sort_ (
    std::random_access_iterator_tag ) [inline], [private]
```

References [GiNaC::container_storage< C >::seq](#).

6.24.4.20 sort_() [2/2]

```
template<template< class T, class=std::allocator< T > > class C>
void GiNaC::container< C >::sort_ (
    std::input_iterator_tag ) [inline], [private]
```

References [GiNaC::container_storage< C >::seq](#).

6.24.4.21 unique_() [1/2]

```
template<template< class T, class=std::allocator< T > > class C>
void GiNaC::container< C >::unique_ ( ) [inline], [private]
```

References [GiNaC::container_storage< C >::seq](#).

6.24.4.22 prepend()

```
template<template< class T, class=std::allocator< T > > class C>
container< C > & GiNaC::container< C >::prepend (
    const ex & b )
```

Add element at front.

6.24.4.23 append()

```
template<template< class T, class=std::allocator< T > > class C>
container< C > & GiNaC::container< C >::append (
    const ex & b )
```

Add element at back.

Referenced by [GiNaC::ifactor\(\)](#), [GiNaC::Li_eval\(\)](#), [GiNaC::lsolve\(\)](#), [GiNaC::symbol::read_archive\(\)](#), [GiNaC::replace_with_symbol\(\)](#), [GiNaC::sqrfree\(\)](#), [GiNaC::symm\(\)](#), and [GiNaC::symmetrize_cyclic\(\)](#).

6.24.4.24 remove_first()

```
template<template< class T, class=std::allocator< T > > class C>
container< C > & GiNaC::container< C >::remove_first
```

Remove first element.

Referenced by [GiNaC::sqrfree\(\)](#), and [GiNaC::symmetrize_cyclic\(\)](#).

6.24.4.25 remove_last()

```
template<template< class T, class=std::allocator< T > > class C>
container< C > & GiNaC::container< C >::remove_last
```

Remove last element.

6.24.4.26 remove_all()

```
template<template< class T, class=std::allocator< T > > class C>
container< C > & GiNaC::container< C >::remove_all
```

Remove all elements.

6.24.4.27 sort()

```
template<template< class T, class=std::allocator< T > > class C>
container< C > & GiNaC::container< C >::sort
```

Sort elements.

6.24.4.28 unique()

```
template<template< class T, class=std::allocator< T > > class C>
container< C > & GiNaC::container< C >::unique
```

Remove adjacent duplicate elements.

6.24.4.29 begin()

```
template<template< class T, class=std::allocator< T > > class C>
const_iterator GiNaC::container< C >::begin ( ) const [inline]
```

References [GiNaC::container_storage< C >::seq](#).

Referenced by [GiNaC::ex::antisymmetrize\(\)](#), [GiNaC::ncmul::conjugate\(\)](#), [GiNaC::G3_eval\(\)](#), [GiNaC::G3_evalf\(\)](#), [GiNaC::H_evalf\(\)](#), [GiNaC::container< C >::imag_part\(\)](#), [GiNaC::kronecker_symbol\(\)](#), [GiNaC::container< C >::real_part\(\)](#), [GiNaC::ex::subs\(\)](#), [GiNaC::ex::symmetrize\(\)](#), [GiNaC::ex::symmetrize_cyclic\(\)](#), [GiNaC::zeta1_evalf\(\)](#), [GiNaC::zeta2_evalf\(\)](#), and [GiNaC::zeta2_print_latex\(\)](#).

6.24.4.30 end()

```
template<template< class T, class=std::allocator< T > > class C>
const_iterator GiNaC::container< C >::end ( ) const [inline]
```

References [GiNaC::container_storage< C >::seq](#).

Referenced by [GiNaC::ex::antisymmetrize\(\)](#), [GiNaC::fderivative::archive\(\)](#), [GiNaC::ncmul::conjugate\(\)](#), [GiNaC::fderivative::do_print\(\)](#), [GiNaC::fderivative::do_print_csrc\(\)](#), [GiNaC::fderivative::do_print_latex\(\)](#), [GiNaC::fderivative::do_print_tree\(\)](#), [GiNaC::ncmul::expandchildren\(\)](#), [GiNaC::H_evalf\(\)](#), [GiNaC::container< C >::imag_part\(\)](#), [GiNaC::kronecker_symbol\(\)](#), [GiNaC::container< C >::real_part\(\)](#), [GiNaC::ncmul::return_type\(\)](#), [GiNaC::ex::subs\(\)](#), [GiNaC::ex::symmetrize\(\)](#), and [GiNaC::ex::symmetrize_cyclic\(\)](#).

6.24.4.31 rbegin()

```
template<template< class T, class=std::allocator< T > > class C>
const_reverse_iterator GiNaC::container< C >::rbegin ( ) const [inline]
```

References [GiNaC::container_storage< C >::seq](#).

6.24.4.32 rend()

```
template<template< class T, class=std::allocator< T > > class C>
const_reverse_iterator GiNaC::container< C >::rend ( ) const [inline]
```

References [GiNaC::container_storage< C >::seq](#).

6.24.4.33 do_print()

```
template<template< class T, class=std::allocator< T > > class C>
void GiNaC::container< C >::do_print (
    const print_context & c,
    unsigned level ) const [protected]
```

References [c](#).

6.24.4.34 do_print_tree()

```
template<template< class T, class=std::allocator< T > > class C>
void GiNaC::container< C >::do_print_tree (
    const print_tree & c,
    unsigned level ) const [protected]
```

References [c](#), and [GiNaC::nops\(\)](#).

6.24.4.35 do_print_python()

```
template<template< class T, class=std::allocator< T > > class C>
void GiNaC::container< C >::do_print_python (
    const print_python & c,
    unsigned level ) const [protected]
```

References [c](#).

6.24.4.36 do_print_python_repr()

```
template<template< class T, class=std::allocator< T > > class C>
void GiNaC::container< C >::do_print_python_repr (
    const print_python_repr & c,
    unsigned level ) const [protected]
```

References [c](#).

6.24.4.37 subschildren()

```
template<template< class T, class=std::allocator< T > > class C>
container< C >::STLT GiNaC::container< C >::subschildren (
    const exmap & m,
    unsigned options = 0 ) const [protected]
```

References [GiNaC::are_ex_trivially_equal\(\)](#), [m](#), [options](#), and [GiNaC::ex::subs\(\)](#).

6.24.4.38 unique_() [2/2]

```
void GiNaC::container< std::list >::unique_ ( ) [inline], [private]
```

Specialization of [container::unique_\(\)](#) for `std::list`.

The documentation for this class was generated from the following files:

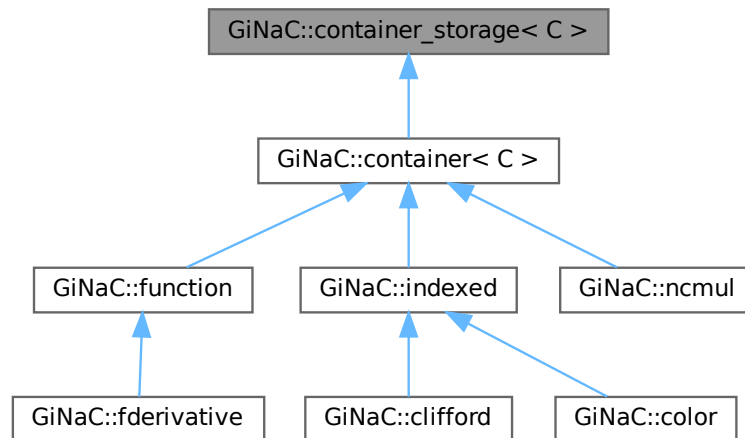
- [container.h](#)
- [exprseq.h](#)
- [lst.h](#)

6.25 GiNaC::container_storage< C > Class Template Reference

Helper template for encapsulating the [reserve\(\)](#) mechanics of STL containers.

```
#include <container.h>
```

Inheritance diagram for GiNaC::container_storage< C >:



Protected Types

- typedef C< [ex](#) > [STLT](#)

Protected Member Functions

- [container_storage](#) ()
- [container_storage](#) (size_t n, const [ex](#) &e)
- [container_storage](#) (std::initializer_list< [ex](#) > il)
- template<class In >
 [container_storage](#) (In b, In e)
- void [reserve](#) (size_t)
- ~[container_storage](#) ()
- void [reserve](#) (size_t n)
- void [reserve](#) (std::vector< [ex](#) > &v, size_t n)

Static Protected Member Functions

- static void [reserve](#) ([STLT](#) &, size_t)

Protected Attributes

- [STLT](#) seq

6.25.1 Detailed Description

```
template<template< class T, class=std::allocator< T > > class C>
class GiNaC::container_storage< C >
```

Helper template for encapsulating the [reserve\(\)](#) mechanics of STL containers.

6.25.2 Member Typedef Documentation

6.25.2.1 STLT

```
template<template< class T, class=std::allocator< T > > class C>
typedef C<ex> GiNaC::container_storage< C >::STLT [protected]
```

6.25.3 Constructor & Destructor Documentation

6.25.3.1 container_storage() [1/4]

```
template<template< class T, class=std::allocator< T > > class C>
GiNaC::container_storage< C >::container_storage ( ) [inline], [protected]
```

6.25.3.2 container_storage() [2/4]

```
template<template< class T, class=std::allocator< T > > class C>
GiNaC::container_storage< C >::container_storage (
    size_t n,
    const ex & e ) [inline], [protected]
```

6.25.3.3 container_storage() [3/4]

```
template<template< class T, class=std::allocator< T > > class C>
GiNaC::container_storage< C >::container_storage (
    std::initializer_list< ex > il ) [inline], [protected]
```

6.25.3.4 container_storage() [4/4]

```
template<template< class T, class=std::allocator< T > > class C>
template<class In >
GiNaC::container_storage< C >::container_storage (
    In b,
    In e ) [inline], [protected]
```

6.25.3.5 ~container_storage()

```
template<template< class T, class=std::allocator< T > > class C>
GiNaC::container_storage< C >::~~container_storage ( ) [inline], [protected]
```

6.25.4 Member Function Documentation**6.25.4.1 reserve() [1/4]**

```
template<template< class T, class=std::allocator< T > > class C>
void GiNaC::container_storage< C >::reserve (
    size_t ) [inline], [protected]
```

Referenced by [GiNaC::container< C >::conjugate\(\)](#), [GiNaC::ncmul::eval\(\)](#), [GiNaC::color::eval_ncmul\(\)](#), [GiNaC::container< C >::imag](#), [GiNaC::container< C >::read_archive\(\)](#), [GiNaC::container< C >::real_part\(\)](#), and [GiNaC::rename_dummy_indices_uniquely\(\)](#).

6.25.4.2 reserve() [2/4]

```
template<template< class T, class=std::allocator< T > > class C>
static void GiNaC::container_storage< C >::reserve (
    STLT & ,
    size_t ) [inline], [static], [protected]
```

6.25.4.3 reserve() [3/4]

```
void GiNaC::container_storage< std::vector >::reserve (
    size_t n ) [inline], [protected]
```

References [n](#).

6.25.4.4 `reserve()` [4/4]

```
void GiNaC::container_storage< std::vector >::reserve (
    std::vector< ex > & v,
    size_t n ) [inline], [protected]
```

References [n](#).

6.25.5 Member Data Documentation

6.25.5.1 `seq`

```
template<template< class T, class=std::allocator< T > > class C>
STLT GiNaC::container_storage< C >::seq [protected]
```

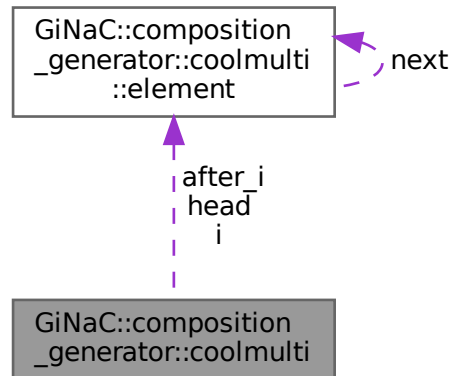
Referenced by [GiNaC::indexed::all_index_values_are\(\)](#), [GiNaC::container< C >::archive\(\)](#), [GiNaC::container< C >::begin\(\)](#), [GiNaC::ncmul::coeff\(\)](#), [GiNaC::container< C >::conjugate\(\)](#), [GiNaC::function::conjugate\(\)](#), [GiNaC::container< C >::container\(\)](#), [GiNaC::ncmul::degree\(\)](#), [GiNaC::fderivative::derivative\(\)](#), [GiNaC::function::derivative\(\)](#), [GiNaC::ncmul::derivative\(\)](#), [GiNaC::clifford::do_print_dflt\(\)](#), [GiNaC::clifford::do_print_latex\(\)](#), [GiNaC::clifford::do_print_tree\(\)](#), [GiNaC::fderivative::do_print_tree\(\)](#), [GiNaC::indexed::do_print_tree\(\)](#), [GiNaC::container< C >::end\(\)](#), [GiNaC::fderivative::eval\(\)](#), [GiNaC::function::eval\(\)](#), [GiNaC::indexed::eval\(\)](#), [GiNaC::ncmul::eval\(\)](#), [GiNaC::function::eval_ncmul\(\)](#), [GiNaC::function::evalf\(\)](#), [GiNaC::ncmul::evalm\(\)](#), [GiNaC::function::expand\(\)](#), [GiNaC::indexed::expand\(\)](#), [GiNaC::ncmul::expand\(\)](#), [GiNaC::ncmul::expandchildren\(\)](#), [GiNaC::indexed::get_dummy_indices\(\)](#), [GiNaC::ncmul::get_factors\(\)](#), [GiNaC::indexed::get_free_indices\(\)](#), [GiNaC::indexed::get_indices\(\)](#), [GiNaC::indexed::has_dummy_index_for\(\)](#), [GiNaC::function::imag_part\(\)](#), [GiNaC::indexed::indexed\(\)](#), [GiNaC::function::info\(\)](#), [GiNaC::indexed::info\(\)](#), [GiNaC::remember_table_entry::is_equal\(\)](#), [GiNaC::container< C >::is_equal_same_type\(\)](#), [GiNaC::ncmul::ldegree\(\)](#), [GiNaC::container< C >::nops\(\)](#), [GiNaC::function::print\(\)](#), [GiNaC::indexed::print_indexed\(\)](#), [GiNaC::indexed::printindices\(\)](#), [GiNaC::container< C >::rbegin\(\)](#), [GiNaC::container< C >::read_archive\(\)](#), [GiNaC::function::read_archive\(\)](#), [GiNaC::indexed::read_archive\(\)](#), [GiNaC::function::real_part\(\)](#), [GiNaC::container< C >::rend\(\)](#), [GiNaC::function::return_type\(\)](#), [GiNaC::ncmul::return_type\(\)](#), [GiNaC::function::return_type_tinfo\(\)](#), [GiNaC::ncmul::return_type_tinfo\(\)](#), [GiNaC::function::series\(\)](#), [GiNaC::container< C >::sort_\(\)](#), [GiNaC::container< C >::unique_\(\)](#), and [GiNaC::indexed::validate\(\)](#).

The documentation for this class was generated from the following file:

- [container.h](#)

6.26 GiNaC::composition_generator::coolmulti Struct Reference

Collaboration diagram for GiNaC::composition_generator::coolmulti:



Classes

- struct [element](#)

Public Member Functions

- [coolmulti](#) (const std::vector< unsigned > &partition)
- [~coolmulti](#) ()
- void [next_permutation](#) ()
- bool [finished](#) () const

Public Attributes

- [element](#) * [head](#)
- [element](#) * [i](#)
- [element](#) * [after_i](#)

6.26.1 Constructor & Destructor Documentation

6.26.1.1 coolmulti()

```

GiNaC::composition_generator::coolmulti::coolmulti (
    const std::vector< unsigned > & partition ) [inline], [explicit]

```

References [after_i](#), [head](#), [i](#), [n](#), and [GiNaC::composition_generator::coolmulti::element::next](#).

6.26.1.2 ~coolmulti()

`GiNaC::composition_generator::coolmulti::~~coolmulti () [inline]`

References [head](#).

6.26.2 Member Function Documentation

6.26.2.1 next_permutation()

`void GiNaC::composition_generator::coolmulti::next_permutation () [inline]`

References [after_i](#), [head](#), [i](#), [k](#), [GiNaC::composition_generator::coolmulti::element::next](#), and [GiNaC::composition_generator::coolmulti::next_permutation](#).

Referenced by [GiNaC::composition_generator::next\(\)](#).

6.26.2.2 finished()

`bool GiNaC::composition_generator::coolmulti::finished () const [inline]`

References [after_i](#), [head](#), [GiNaC::composition_generator::coolmulti::element::next](#), and [GiNaC::composition_generator::coolmulti::element::finished](#).

Referenced by [GiNaC::composition_generator::next\(\)](#).

6.26.3 Member Data Documentation

6.26.3.1 head

`element* GiNaC::composition_generator::coolmulti::head`

Referenced by [coolmulti\(\)](#), [finished\(\)](#), [GiNaC::composition_generator::get\(\)](#), [next_permutation\(\)](#), and [~coolmulti\(\)](#).

6.26.3.2 i

`element * GiNaC::composition_generator::coolmulti::i`

Referenced by [coolmulti\(\)](#), and [next_permutation\(\)](#).

6.26.3.3 after_i

`element` * `GiNaC::composition_generator::coolmulti::after_i`

Referenced by `coolmulti()`, `finished()`, and `next_permutation()`.

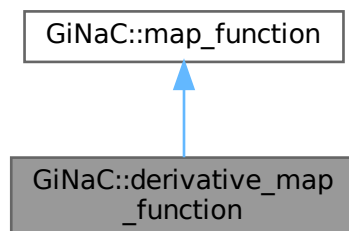
The documentation for this struct was generated from the following file:

- [utils.h](#)

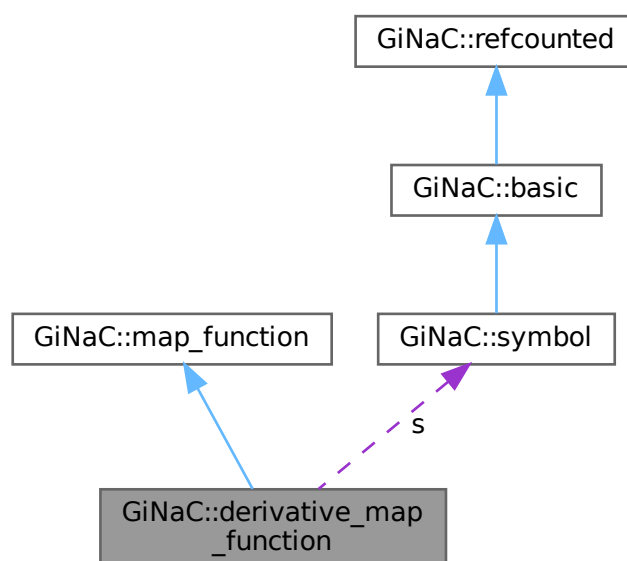
6.27 GiNaC::derivative_map_function Struct Reference

Function object to be applied by `basic::derivative()`.

Inheritance diagram for `GiNaC::derivative_map_function`:



Collaboration diagram for `GiNaC::derivative_map_function`:



Public Member Functions

- [derivative_map_function](#) (const [symbol](#) &sym)
- [ex operator\(\)](#) (const [ex](#) &e) override

Public Member Functions inherited from [GiNaC::map_function](#)

- virtual [~map_function](#) ()
- virtual [ex operator\(\)](#) (const [ex](#) &e)=0

Public Attributes

- const [symbol](#) & s

Additional Inherited Members

Public Types inherited from [GiNaC::map_function](#)

- typedef const [ex](#) & [argument_type](#)
- typedef [ex](#) [result_type](#)

6.27.1 Detailed Description

Function object to be applied by [basic::derivative\(\)](#).

6.27.2 Constructor & Destructor Documentation

6.27.2.1 [derivative_map_function\(\)](#)

```
GiNaC::derivative_map_function::derivative_map_function (
    const symbol & sym ) [inline]
```

6.27.3 Member Function Documentation

6.27.3.1 [operator\(\)](#)

```
ex GiNaC::derivative_map_function::operator() (
    const ex & e ) [inline], [override], [virtual]
```

Implements [GiNaC::map_function](#).

References [GiNaC::diff\(\)](#).

6.27.4 Member Data Documentation

6.27.4.1 s

```
const symbol& GiNaC::derivative_map_function::s
```

The documentation for this struct was generated from the following file:

- [basic.cpp](#)

6.28 GiNaC::determinant_algo Class Reference

Switch to control algorithm for determinant computation.

```
#include <flags.h>
```

Public Types

- enum {
 [automatic](#) , [gauss](#) , [divfree](#) , [laplace](#) ,
 [bareiss](#) }

6.28.1 Detailed Description

Switch to control algorithm for determinant computation.

6.28.2 Member Enumeration Documentation

Enumerator

6.28.2.1 anonymous enum

anonymous enum

Enumerator

automatic	Let the system choose. A heuristics is applied for automatic determination of a suitable algorithm.
gauss	<p>Gauss elimination. If $m_{i,j}^{(0)}$ are the entries of the original matrix, then the matrix is transformed into triangular form by applying the rules</p> $m_{i,j}^{(k+1)} = m_{i,j}^{(k)} - m_{i,k}^{(k)} m_{k,j}^{(k)} / m_{k,k}^{(k)}$ <p>The determinant is then just the product of diagonal elements. Choose this algorithm only for purely numerical matrices.</p>
divfree	<p>Division-free elimination. This is a modification of Gauss elimination where the division by the pivot element is not carried out. If $m_{i,j}^{(0)}$ are the entries of the original matrix, then the matrix is transformed into triangular form by applying the rules</p> $m_{i,j}^{(k+1)} = m_{i,j}^{(k)} m_{k,k}^{(k)} - m_{i,k}^{(k)} m_{k,j}^{(k)}$ <p>The determinant can later be computed by inspecting the diagonal elements only. This algorithm is only there for the purpose of cross-checks. It is never fast.</p>
laplace	Laplace elimination. This is plain recursive elimination along minors although multiple minors are avoided by the algorithm. Although the algorithm is exponential in complexity it is frequently the fastest one when the matrix is populated by complicated symbolic expressions.
bareiss	<p>Bareiss fraction-free elimination. This is a modification of Gauss elimination where the division by the pivot element is <i>delayed</i> until it can be carried out without computing GCDs. If $m_{i,j}^{(0)}$ are the entries of the original matrix, then the matrix is transformed into triangular form by applying the rules</p> $m_{i,j}^{(k+1)} = (m_{i,j}^{(k)} m_{k,k}^{(k)} - m_{i,k}^{(k)} m_{k,j}^{(k)}) / m_{k-1,k-1}^{(k-1)}$ <p>(We have set $m_{-1,-1}^{(-1)} = 1$ in order to avoid a case distinction in above formula.) It can be shown that nothing more than polynomial long division is needed for carrying out the division. The determinant can then be read of from the lower right entry. This algorithm is rarely fast for computing determinants.</p>

The documentation for this class was generated from the following file:

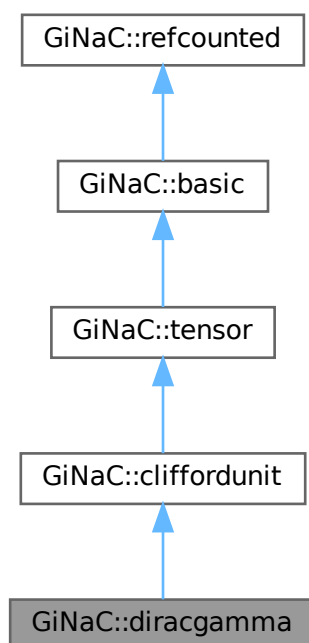
- [flags.h](#)

6.29 GiNaC::diracgamma Class Reference

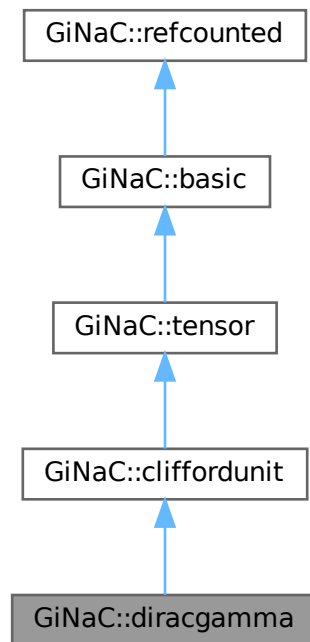
This class represents the Dirac gamma Lorentz vector.

```
#include <clifford.h>
```

Inheritance diagram for GiNaC::diracgamma:



Collaboration diagram for `GiNaC::diracgamma`:



Public Member Functions

- `bool contract_with (exvector::iterator self, exvector::iterator other, exvector &v) const` override
Contraction of a gamma matrix with something else.
- `bool contract_with (exvector::iterator self, exvector::iterator other, exvector &v) const` override
Contraction of a Clifford unit with something else.

Public Member Functions inherited from [GiNaC::tensor](#)

- `bool replace_contr_index (exvector::iterator self, exvector::iterator other) const`
Replace dummy index in contracted-with object by the contracting object's second index (used internally for delta and metric tensor contractions).

Public Member Functions inherited from [GiNaC::basic](#)

- `virtual ~basic ()`
basic destructor, virtual because class `ex` will delete objects of derived classes via a `basic`.*
- `basic (const basic &other)`
- `const basic & operator= (const basic &other)`
basic assignment operator: the other object might be of a derived class.
- `virtual basic * duplicate () const`

- Create a clone of this object on the heap.*

 - virtual `ex eval` () const
- Perform automatic non-interruptive term rewriting rules.*

 - virtual `ex evalf` () const
- Evaluate object numerically.*

 - virtual `ex evalm` () const
- Evaluate sums, products and integer powers of matrices.*

 - virtual `ex eval_integ` () const
- Evaluate integrals, if result is known.*

 - virtual `ex eval_indexed` (const `basic` &i) const
- Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*

 - virtual void `print` (const `print_context` &c, unsigned level=0) const
- Output to stream.*

 - virtual void `dbgprint` () const
- Little wrapper around print to be called within a debugger.*

 - virtual void `dbgprinttree` () const
- Little wrapper around printtree to be called within a debugger.*

 - virtual unsigned `precedence` () const
- Return relative operator precedence (for parenthezing output).*

 - virtual bool `info` (unsigned inf) const
- Information about the object.*

 - virtual size_t `nops` () const
- Number of operands/members.*

 - virtual `ex op` (size_t i) const
- Return operand/member at position i.*

 - virtual `ex operator[]` (const `ex` &index) const
 - virtual `ex operator[]` (size_t i) const
 - virtual `ex & let_op` (size_t i)
- Return modifiable operand/member at position i.*

 - virtual `ex & operator[]` (const `ex` &index)
 - virtual `ex & operator[]` (size_t i)
- Test for occurrence of a pattern.*

 - virtual bool `has` (const `ex` &other, unsigned `options`=0) const
- Check whether the expression matches a given pattern.*

 - virtual bool `match` (const `ex` &pattern, `exmap` &repls) const
- Substitute a set of objects by arbitrary expressions.*

 - virtual `ex subs` (const `exmap` &m, unsigned `options`=0) const
- Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*

 - virtual `ex map` (`map_function` &f) const
- Check whether this is a polynomial in the given variables.*

 - virtual void `accept` (GiNaC::visitor &v) const
 - virtual bool `is_polynomial` (const `ex` &var) const
- Return degree of highest power in object s.*

 - virtual int `degree` (const `ex` &s) const
- Return degree of lowest power in object s.*

 - virtual int `ldegree` (const `ex` &s) const
- Return coefficient of degree n in object s.*

 - virtual `ex coeff` (const `ex` &s, int n=1) const
- Expand expression, i.e.*

 - virtual `ex expand` (unsigned `options`=0) const
- Expand expression, i.e.*

 - virtual `ex collect` (const `ex` &s, bool distributed=false) const

- Sort expanded expression in terms of powers of some object(s).*

 - virtual `ex series` (const `relational` &r, int `order`, unsigned `options`=0) const

Default implementation of `ex::series()`.
- virtual `ex normal` (`exmap` &repl, `exmap` &rev_lookup, `lst` &modifier) const

Default implementation of `ex::normal()`.
- virtual `ex to_rational` (`exmap` &repl) const

Default implementation of `ex::to_rational()`.
- virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const

Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- virtual `numeric max_coefficient` () const

Implementation `ex::max_coefficient()`.
- virtual `exvector get_free_indices` () const

Return a vector containing the free indices of an expression.
- virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const

Add two indexed expressions.
- virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const

Multiply an indexed expression with a scalar.
- virtual bool `contract_with` (`exvector::iterator` self, `exvector::iterator` other, `exvector` &v) const

Try to contract two indexed expressions that appear in the same product.
- virtual unsigned `return_type` () const
- virtual `return_type_t return_type_tinfo` () const
- virtual `ex conjugate` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const
- template<class T >
 - void `print_dispatch` (const `print_context` &c, unsigned level) const

Like `print()`, but dispatch to the specified class.
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const

Like `print()`, but dispatch to the specified class.
- virtual void `archive` (`archive_node` &n) const

Save (serialize) the object into archive node.
- virtual void `read_archive` (const `archive_node` &n, `lst` &syms)

Load (deserialize) the object from an archive node.
- `ex subs_one_level` (const `exmap` &m, unsigned `options`) const

Helper function for `subs()`.
- `ex diff` (const `symbol` &s, unsigned nth=1) const

Default interface of nth derivative `ex::diff(s, n)`.
- int `compare` (const `basic` &other) const

Compare objects syntactically to establish canonical ordering.
- bool `is_equal` (const `basic` &other) const

Test for syntactic equality.
- const `basic` & `hold` () const

Stop further evaluation.
- unsigned `gethash` () const
- const `basic` & `setflag` (unsigned f) const

Set some `status_flags`.
- const `basic` & `clearflag` (unsigned f) const

Clear some `status_flags`.

Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add_reference](#) () noexcept
- unsigned int [remove_reference](#) () noexcept
- unsigned int [get_refcount](#) () const noexcept
- void [set_refcount](#) (unsigned int r) noexcept

Protected Member Functions

- void [do_print](#) (const [print_context](#) &c, unsigned level) const
- void [do_print_latex](#) (const [print_latex](#) &c, unsigned level) const

Protected Member Functions inherited from [GiNaC::cliffordunit](#)

- void [do_print](#) (const [print_context](#) &c, unsigned level) const
- void [do_print_latex](#) (const [print_latex](#) &c, unsigned level) const

Protected Member Functions inherited from [GiNaC::tensor](#)

- unsigned [return_type](#) () const override

Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match_same_type](#) (const [basic](#) &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual [ex derivative](#) (const [symbol](#) &s) const
Default implementation of [ex::diff\(\)](#).
- virtual int [compare_same_type](#) (const [basic](#) &other) const
Returns order relation between two objects of same type.
- virtual bool [is_equal_same_type](#) (const [basic](#) &other) const
Returns true if two objects of same type are equal.
- virtual unsigned [calchash](#) () const
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- void [ensure_if_modifiable](#) () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
Default output to stream.
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
Tree output to stream.
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
Python parsable output to stream.

Additional Inherited Members

Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)
of type [status_flags](#)
- unsigned [hashvalue](#)
hash value

6.29.1 Detailed Description

This class represents the Dirac gamma Lorentz vector.

6.29.2 Member Function Documentation

6.29.2.1 `contract_with()`

```
bool GiNaC::diracgamma::contract_with (
    exvector::iterator self,
    exvector::iterator other,
    exvector & v ) const [override], [virtual]
```

Contraction of a gamma matrix with something else.

Reimplemented from [GiNaC::cliffordunit](#).

6.29.2.2 `do_print()`

```
void GiNaC::diracgamma::do_print (
    const print\_context & c,
    unsigned level ) const [protected]
```

6.29.2.3 `do_print_latex()`

```
void GiNaC::diracgamma::do_print_latex (
    const print\_latex & c,
    unsigned level ) const [protected]
```

The documentation for this class was generated from the following files:

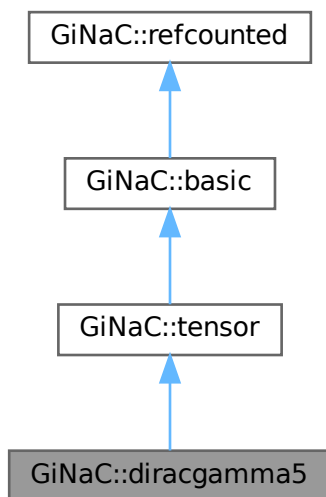
- [clifford.h](#)
- [clifford.cpp](#)

6.30 GiNaC::diracgamma5 Class Reference

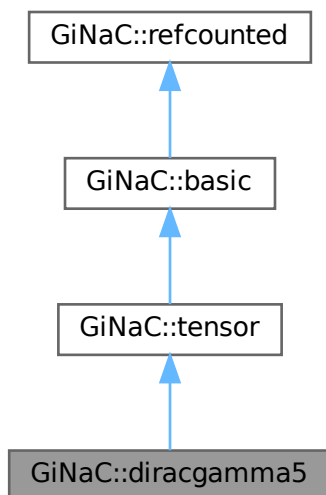
This class represents the Dirac gamma5 object which anticommutes with all other gammas.

```
#include <clifford.h>
```

Inheritance diagram for GiNaC::diracgamma5:



Collaboration diagram for GiNaC::diracgamma5:



Protected Member Functions

- void `do_print` (const `print_context` &c, unsigned level) const
- void `do_print_latex` (const `print_latex` &c, unsigned level) const

Protected Member Functions inherited from `GiNaC::tensor`

- unsigned `return_type` () const override

Protected Member Functions inherited from `GiNaC::basic`

- `basic` ()
- virtual `ex eval_ncmul` (const `exvector` &v) const
- virtual bool `match_same_type` (const `basic` &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual `ex derivative` (const `symbol` &s) const
Default implementation of `ex::diff()`.
- virtual int `compare_same_type` (const `basic` &other) const
Returns order relation between two objects of same type.
- virtual bool `is_equal_same_type` (const `basic` &other) const
Returns true if two objects of same type are equal.
- virtual unsigned `calchash` () const
Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.
- void `ensure_if_modifiable` () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void `do_print` (const `print_context` &c, unsigned level) const
Default output to stream.
- void `do_print_tree` (const `print_tree` &c, unsigned level) const
Tree output to stream.
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const
Python parsable output to stream.

Private Member Functions

- `ex conjugate` () const override

Additional Inherited Members

Public Member Functions inherited from `GiNaC::tensor`

- bool `replace_contr_index` (`exvector::iterator` self, `exvector::iterator` other) const
Replace dummy index in contracted-with object by the contracting object's second index (used internally for delta and metric tensor contractions).

Public Member Functions inherited from [GiNaC::basic](#)

- virtual [~basic](#) ()
basic destructor, virtual because class ex will delete objects of derived classes via a basic.*
- [basic](#) (const [basic](#) &other)
- const [basic](#) & [operator=](#) (const [basic](#) &other)
basic assignment operator: the other object might be of a derived class.
- virtual [basic](#) * [duplicate](#) () const
Create a clone of this object on the heap.
- virtual [ex eval](#) () const
Perform automatic non-interruptive term rewriting rules.
- virtual [ex evalf](#) () const
Evaluate object numerically.
- virtual [ex evalm](#) () const
Evaluate sums, products and integer powers of matrices.
- virtual [ex eval_integ](#) () const
Evaluate integrals, if result is known.
- virtual [ex eval_indexed](#) (const [basic](#) &i) const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void [print](#) (const [print_context](#) &c, unsigned level=0) const
Output to stream.
- virtual void [dbgprint](#) () const
Little wrapper around print to be called within a debugger.
- virtual void [dbgprinttree](#) () const
Little wrapper around printtree to be called within a debugger.
- virtual unsigned [precedence](#) () const
Return relative operator precedence (for parenthezing output).
- virtual bool [info](#) (unsigned inf) const
Information about the object.
- virtual size_t [nops](#) () const
Number of operands/members.
- virtual [ex op](#) (size_t i) const
Return operand/member at position i.
- virtual [ex operator\[\]](#) (const [ex](#) &index) const
- virtual [ex operator\[\]](#) (size_t i) const
- virtual [ex](#) & [let_op](#) (size_t i)
Return modifiable operand/member at position i.
- virtual [ex](#) & [operator\[\]](#) (const [ex](#) &index)
- virtual [ex](#) & [operator\[\]](#) (size_t i)
- virtual bool [has](#) (const [ex](#) &other, unsigned [options](#)=0) const
Test for occurrence of a pattern.
- virtual bool [match](#) (const [ex](#) &pattern, [exmap](#) &repls) const
Check whether the expression matches a given pattern.
- virtual [ex subs](#) (const [exmap](#) &m, unsigned [options](#)=0) const
Substitute a set of objects by arbitrary expressions.
- virtual [ex map](#) ([map_function](#) &f) const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void [accept](#) ([GiNaC::visitor](#) &v) const
- virtual bool [is_polynomial](#) (const [ex](#) &var) const
Check whether this is a polynomial in the given variables.
- virtual int [degree](#) (const [ex](#) &s) const

- Return degree of highest power in object s.*

 - virtual int `ldegree` (const `ex` &s) const
- Return degree of lowest power in object s.*

 - virtual `ex coeff` (const `ex` &s, int `n`=1) const
- Return coefficient of degree n in object s.*

 - virtual `ex expand` (unsigned `options`=0) const
- Expand expression, i.e.*

 - virtual `ex collect` (const `ex` &s, bool `distributed`=false) const
- Sort expanded expression in terms of powers of some object(s).*

 - virtual `ex series` (const `relational` &r, int `order`, unsigned `options`=0) const
- Default implementation of `ex::series()`.*

 - virtual `ex normal` (`exmap` &repl, `exmap` &rev_lookup, `lst` &modifier) const
- Default implementation of `ex::normal()`.*

 - virtual `ex to_rational` (`exmap` &repl) const
- Default implementation of `ex::to_rational()`.*

 - virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const
- Apply symmetric modular homomorphism to an expanded multivariate polynomial.*

 - virtual `numeric max_coefficient` () const
- Implementation `ex::max_coefficient()`.*

 - virtual `exvector get_free_indices` () const
- Return a vector containing the free indices of an expression.*

 - virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
- Add two indexed expressions.*

 - virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
- Multiply an indexed expression with a scalar.*

 - virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const
- Try to contract two indexed expressions that appear in the same product.*

 - virtual unsigned `return_type` () const
 - virtual `return_type_t return_type_tinfo` () const
 - virtual `ex conjugate` () const
 - virtual `ex real_part` () const
 - virtual `ex imag_part` () const
- template<class T >

 - void `print_dispatch` (const `print_context` &c, unsigned `level`) const
- Like `print()`, but dispatch to the specified class.*

 - void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned `level`) const
- Like `print()`, but dispatch to the specified class.*

 - virtual void `archive` (`archive_node` &n) const
- Save (serialize) the object into archive node.*

 - virtual void `read_archive` (const `archive_node` &n, `lst` &syms)
- Load (deserialize) the object from an archive node.*

 - `ex subs_one_level` (const `exmap` &m, unsigned `options`) const
- Helper function for `subs()`.*

 - `ex diff` (const `symbol` &s, unsigned `nth`=1) const
- Default interface of nth derivative `ex::diff(s, n)`.*

 - int `compare` (const `basic` &other) const
- Compare objects syntactically to establish canonical ordering.*

 - bool `is_equal` (const `basic` &other) const
- Test for syntactic equality.*

- const [basic](#) & [hold](#) () const
Stop further evaluation.
- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const
Set some [status_flags](#).
- const [basic](#) & [clearflag](#) (unsigned f) const
Clear some [status_flags](#).

Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add_reference](#) () noexcept
- unsigned int [remove_reference](#) () noexcept
- unsigned int [get_refcount](#) () const noexcept
- void [set_refcount](#) (unsigned int r) noexcept

Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)
of type [status_flags](#)
- unsigned [hashvalue](#)
hash value

6.30.1 Detailed Description

This class represents the Dirac gamma5 object which anticommutes with all other gammas.

6.30.2 Member Function Documentation

6.30.2.1 conjugate()

```
ex GiNaC::diracgamma5::conjugate ( ) const [override], [private], [virtual]
```

Reimplemented from [GiNaC::basic](#).

6.30.2.2 do_print()

```
void GiNaC::diracgamma5::do_print (
    const print\_context & c,
    unsigned level ) const [protected]
```

6.30.2.3 do_print_latex()

```
void GiNaC::diracgamma5::do_print_latex (
    const print\_latex & c,
    unsigned level ) const [protected]
```

The documentation for this class was generated from the following files:

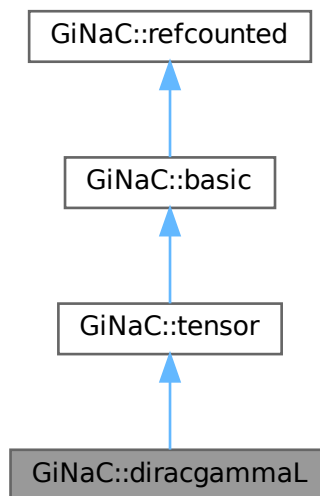
- [clifford.h](#)
- [clifford.cpp](#)

6.31 GiNaC::diracgammaL Class Reference

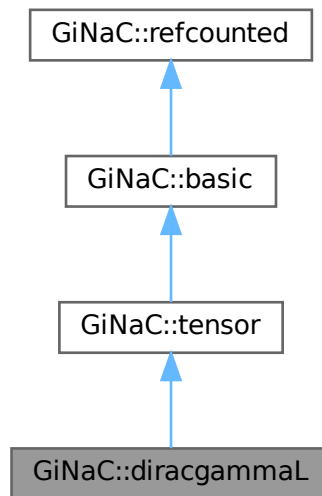
This class represents the Dirac gammaL object which behaves like $1/2 (1-\gamma_5)$.

```
#include <clifford.h>
```

Inheritance diagram for GiNaC::diracgammaL:



Collaboration diagram for GiNaC::diracgammaL:



Protected Member Functions

- void `do_print` (const `print_context` &c, unsigned level) const
- void `do_print_latex` (const `print_latex` &c, unsigned level) const

Protected Member Functions inherited from `GiNaC::tensor`

- unsigned `return_type` () const override

Protected Member Functions inherited from `GiNaC::basic`

- `basic` ()
- virtual `ex eval_ncmul` (const `exvector` &v) const
- virtual bool `match_same_type` (const `basic` &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual `ex derivative` (const `symbol` &s) const
Default implementation of `ex::diff()`.
- virtual int `compare_same_type` (const `basic` &other) const
Returns order relation between two objects of same type.
- virtual bool `is_equal_same_type` (const `basic` &other) const
Returns true if two objects of same type are equal.
- virtual unsigned `calchash` () const
Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.
- void `ensure_if_modifiable` () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void `do_print` (const `print_context` &c, unsigned level) const
Default output to stream.
- void `do_print_tree` (const `print_tree` &c, unsigned level) const
Tree output to stream.
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const
Python parsable output to stream.

Private Member Functions

- `ex conjugate ()` const override

Additional Inherited Members

Public Member Functions inherited from `GiNaC::tensor`

- bool `replace_contr_index` (exvector::iterator self, exvector::iterator other) const
Replace dummy index in contracted-with object by the contracting object's second index (used internally for delta and metric tensor contractions).

Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic ()`
basic destructor, virtual because class ex will delete objects of derived classes via a basic.*
- `basic` (const `basic` &other)
- const `basic & operator=` (const `basic` &other)
basic assignment operator: the other object might be of a derived class.
- virtual `basic * duplicate ()` const
Create a clone of this object on the heap.
- virtual `ex eval ()` const
Perform automatic non-interruptive term rewriting rules.
- virtual `ex evalf ()` const
Evaluate object numerically.
- virtual `ex evalm ()` const
Evaluate sums, products and integer powers of matrices.
- virtual `ex eval_integ ()` const
Evaluate integrals, if result is known.
- virtual `ex eval_indexed` (const `basic` &i) const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void `print` (const `print_context` &c, unsigned level=0) const
Output to stream.
- virtual void `dbgprint ()` const
Little wrapper around print to be called within a debugger.
- virtual void `dbgprinttree ()` const
Little wrapper around printtree to be called within a debugger.
- virtual unsigned `precedence ()` const
Return relative operator precedence (for parenthezing output).
- virtual bool `info` (unsigned inf) const
Information about the object.
- virtual size_t `nops ()` const
Number of operands/members.
- virtual `ex op` (size_t i) const
Return operand/member at position i.
- virtual `ex operator[]` (const `ex` &index) const
- virtual `ex operator[]` (size_t i) const
- virtual `ex & let_op` (size_t i)
Return modifiable operand/member at position i.
- virtual `ex & operator[]` (const `ex` &index)

- virtual `ex & operator[]` (size_t i)
- virtual bool `has` (const `ex` &other, unsigned `options`=0) const
Test for occurrence of a pattern.
- virtual bool `match` (const `ex` &pattern, `exmap` &repls) const
Check whether the expression matches a given pattern.
- virtual `ex subs` (const `exmap` &m, unsigned `options`=0) const
Substitute a set of objects by arbitrary expressions.
- virtual `ex map` (`map_function` &f) const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void `accept` (GiNaC::visitor &v) const
- virtual bool `is_polynomial` (const `ex` &var) const
Check whether this is a polynomial in the given variables.
- virtual int `degree` (const `ex` &s) const
Return degree of highest power in object s.
- virtual int `ldegree` (const `ex` &s) const
Return degree of lowest power in object s.
- virtual `ex coeff` (const `ex` &s, int `n`=1) const
Return coefficient of degree n in object s.
- virtual `ex expand` (unsigned `options`=0) const
Expand expression, i.e.
- virtual `ex collect` (const `ex` &s, bool `distributed`=false) const
Sort expanded expression in terms of powers of some object(s).
- virtual `ex series` (const `relational` &r, int `order`, unsigned `options`=0) const
Default implementation of `ex::series()`.
- virtual `ex normal` (`exmap` &repl, `exmap` &rev_lookup, `lst` &modifier) const
Default implementation of `ex::normal()`.
- virtual `ex to_rational` (`exmap` &repl) const
Default implementation of `ex::to_rational()`.
- virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const
Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- virtual `numeric max_coefficient` () const
Implementation `ex::max_coefficient()`.
- virtual `exvector get_free_indices` () const
Return a vector containing the free indices of an expression.
- virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
Add two indexed expressions.
- virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
Multiply an indexed expression with a scalar.
- virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const
Try to contract two indexed expressions that appear in the same product.
- virtual unsigned `return_type` () const
- virtual `return_type_t return_type_info` () const
- virtual `ex conjugate` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const
- template<class T >
void `print_dispatch` (const `print_context` &c, unsigned level) const
Like `print()`, but dispatch to the specified class.
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const

- Like `print()`, but dispatch to the specified class.
- virtual void `archive (archive_node &n)` const
Save (serialize) the object into archive node.
- virtual void `read_archive (const archive_node &n, lst &syms)`
Load (deserialize) the object from an archive node.
- `ex subs_one_level (const exmap &m, unsigned options)` const
Helper function for `subs()`.
- `ex diff (const symbol &s, unsigned nth=1)` const
Default interface of `nth` derivative `ex::diff(s, n)`.
- int `compare (const basic &other)` const
Compare objects syntactically to establish canonical ordering.
- bool `is_equal (const basic &other)` const
Test for syntactic equality.
- const `basic & hold ()` const
Stop further evaluation.
- unsigned `gethash ()` const
- const `basic & setflag (unsigned f)` const
Set some `status_flags`.
- const `basic & clearflag (unsigned f)` const
Clear some `status_flags`.

Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted ()` noexcept
- unsigned int `add_reference ()` noexcept
- unsigned int `remove_reference ()` noexcept
- unsigned int `get_refcount ()` const noexcept
- void `set_refcount (unsigned int r)` noexcept

Protected Attributes inherited from `GiNaC::basic`

- unsigned `flags`
of type `status_flags`
- unsigned `hashvalue`
hash value

6.31.1 Detailed Description

This class represents the Dirac gammaL object which behaves like $1/2 (1-\gamma_5)$.

6.31.2 Member Function Documentation

6.31.2.1 conjugate()

```
ex GiNaC::diracgammaL::conjugate ( ) const [override], [private], [virtual]
```

Reimplemented from [GiNaC::basic](#).

6.31.2.2 do_print()

```
void GiNaC::diracgammaL::do_print (
    const print\_context & c,
    unsigned level ) const [protected]
```

6.31.2.3 do_print_latex()

```
void GiNaC::diracgammaL::do_print_latex (
    const print\_latex & c,
    unsigned level ) const [protected]
```

The documentation for this class was generated from the following files:

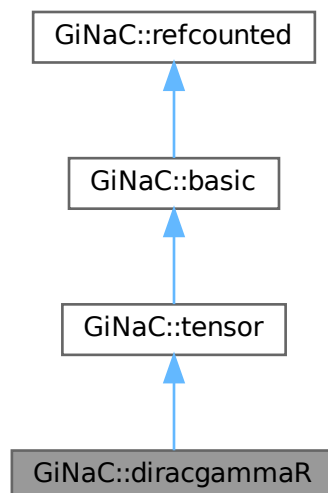
- [clifford.h](#)
- [clifford.cpp](#)

6.32 GiNaC::diracgammaR Class Reference

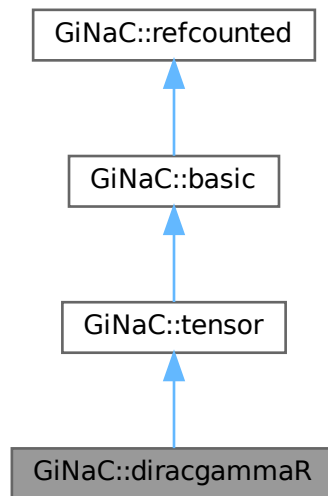
This class represents the Dirac gammaL object which behaves like $\frac{1}{2}(1+\gamma_5)$.

```
#include <clifford.h>
```

Inheritance diagram for GiNaC::diracgammaR:



Collaboration diagram for `GiNaC::diracgammaR`:



Protected Member Functions

- void `do_print` (const `print_context` &c, unsigned level) const
- void `do_print_latex` (const `print_latex` &c, unsigned level) const

Protected Member Functions inherited from `GiNaC::tensor`

- unsigned `return_type` () const override

Protected Member Functions inherited from `GiNaC::basic`

- `basic` ()
- virtual `ex eval_ncmul` (const `exvector` &v) const
- virtual bool `match_same_type` (const `basic` &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual `ex derivative` (const `symbol` &s) const
Default implementation of `ex::diff()`.
- virtual int `compare_same_type` (const `basic` &other) const
Returns order relation between two objects of same type.
- virtual bool `is_equal_same_type` (const `basic` &other) const
Returns true if two objects of same type are equal.
- virtual unsigned `calchash` () const
Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.
- void `ensure_if_modifiable` () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void `do_print` (const `print_context` &c, unsigned level) const
Default output to stream.
- void `do_print_tree` (const `print_tree` &c, unsigned level) const
Tree output to stream.
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const
Python parsable output to stream.

Private Member Functions

- `ex conjugate ()` const override

Additional Inherited Members

Public Member Functions inherited from `GiNaC::tensor`

- `bool replace_contr_index (exvector::iterator self, exvector::iterator other) const`
Replace dummy index in contracted-with object by the contracting object's second index (used internally for delta and metric tensor contractions).

Public Member Functions inherited from `GiNaC::basic`

- `virtual ~basic ()`
basic destructor, virtual because class ex will delete objects of derived classes via a basic.*
- `basic (const basic &other)`
- `const basic & operator= (const basic &other)`
basic assignment operator: the other object might be of a derived class.
- `virtual basic * duplicate () const`
Create a clone of this object on the heap.
- `virtual ex eval () const`
Perform automatic non-interruptive term rewriting rules.
- `virtual ex evalf () const`
Evaluate object numerically.
- `virtual ex evalm () const`
Evaluate sums, products and integer powers of matrices.
- `virtual ex eval_integ () const`
Evaluate integrals, if result is known.
- `virtual ex eval_indexed (const basic &i) const`
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- `virtual void print (const print_context &c, unsigned level=0) const`
Output to stream.
- `virtual void dbgprint () const`
Little wrapper around print to be called within a debugger.
- `virtual void dbgprinttree () const`
Little wrapper around printtree to be called within a debugger.
- `virtual unsigned precedence () const`
Return relative operator precedence (for parenthezing output).
- `virtual bool info (unsigned inf) const`
Information about the object.
- `virtual size_t nops () const`
Number of operands/members.
- `virtual ex op (size_t i) const`
Return operand/member at position i.
- `virtual ex operator[] (const ex &index) const`
- `virtual ex operator[] (size_t i) const`
- `virtual ex & let_op (size_t i)`
Return modifiable operand/member at position i.
- `virtual ex & operator[] (const ex &index)`

- virtual `ex & operator[]` (size_t i)
- virtual bool `has` (const `ex` &other, unsigned `options`=0) const
Test for occurrence of a pattern.
- virtual bool `match` (const `ex` &pattern, `exmap` &repls) const
Check whether the expression matches a given pattern.
- virtual `ex subs` (const `exmap` &m, unsigned `options`=0) const
Substitute a set of objects by arbitrary expressions.
- virtual `ex map` (`map_function` &f) const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void `accept` (`GiNaC::visitor` &v) const
- virtual bool `is_polynomial` (const `ex` &var) const
Check whether this is a polynomial in the given variables.
- virtual int `degree` (const `ex` &s) const
Return degree of highest power in object s.
- virtual int `ldegree` (const `ex` &s) const
Return degree of lowest power in object s.
- virtual `ex coeff` (const `ex` &s, int `n`=1) const
Return coefficient of degree n in object s.
- virtual `ex expand` (unsigned `options`=0) const
Expand expression, i.e.
- virtual `ex collect` (const `ex` &s, bool `distributed`=false) const
Sort expanded expression in terms of powers of some object(s).
- virtual `ex series` (const `relational` &r, int `order`, unsigned `options`=0) const
Default implementation of `ex::series()`.
- virtual `ex normal` (`exmap` &repl, `exmap` &rev_lookup, `lst` &modifier) const
Default implementation of `ex::normal()`.
- virtual `ex to_rational` (`exmap` &repl) const
Default implementation of `ex::to_rational()`.
- virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const
Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- virtual `numeric max_coefficient` () const
Implementation `ex::max_coefficient()`.
- virtual `exvector get_free_indices` () const
Return a vector containing the free indices of an expression.
- virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
Add two indexed expressions.
- virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
Multiply an indexed expression with a scalar.
- virtual bool `contract_with` (`exvector::iterator` self, `exvector::iterator` other, `exvector` &v) const
Try to contract two indexed expressions that appear in the same product.
- virtual unsigned `return_type` () const
- virtual `return_type_t return_type_info` () const
- virtual `ex conjugate` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const
- template<class T >
void `print_dispatch` (const `print_context` &c, unsigned level) const
Like `print()`, but dispatch to the specified class.
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const

- Like `print()`, but dispatch to the specified class.
- virtual void `archive (archive_node &n)` const
Save (serialize) the object into archive node.
- virtual void `read_archive (const archive_node &n, lst &syms)`
Load (deserialize) the object from an archive node.
- `ex subs_one_level (const exmap &m, unsigned options)` const
Helper function for `subs()`.
- `ex diff (const symbol &s, unsigned nth=1)` const
Default interface of `nth` derivative `ex::diff(s, n)`.
- int `compare (const basic &other)` const
Compare objects syntactically to establish canonical ordering.
- bool `is_equal (const basic &other)` const
Test for syntactic equality.
- const `basic & hold ()` const
Stop further evaluation.
- unsigned `gethash ()` const
- const `basic & setflag (unsigned f)` const
Set some `status_flags`.
- const `basic & clearflag (unsigned f)` const
Clear some `status_flags`.

Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted ()` noexcept
- unsigned int `add_reference ()` noexcept
- unsigned int `remove_reference ()` noexcept
- unsigned int `get_refcount ()` const noexcept
- void `set_refcount (unsigned int r)` noexcept

Protected Attributes inherited from `GiNaC::basic`

- unsigned `flags`
of type `status_flags`
- unsigned `hashvalue`
hash value

6.32.1 Detailed Description

This class represents the Dirac gammaL object which behaves like $\frac{1}{2} (1+\gamma_5)$.

6.32.2 Member Function Documentation

6.32.2.1 conjugate()

```
ex GiNaC::diracgammaR::conjugate ( ) const [override], [private], [virtual]
```

Reimplemented from [GiNaC::basic](#).

6.32.2.2 do_print()

```
void GiNaC::diracgammaR::do_print (
    const print\_context & c,
    unsigned level ) const [protected]
```

6.32.2.3 do_print_latex()

```
void GiNaC::diracgammaR::do_print_latex (
    const print\_latex & c,
    unsigned level ) const [protected]
```

The documentation for this class was generated from the following files:

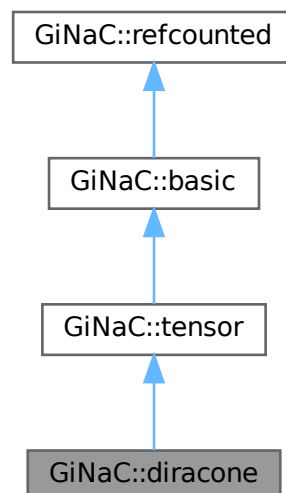
- [clifford.h](#)
- [clifford.cpp](#)

6.33 GiNaC::diracone Class Reference

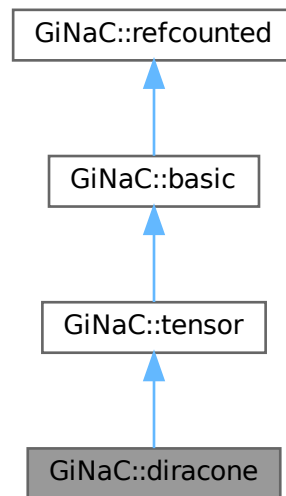
This class represents the Clifford algebra unity element.

```
#include <clifford.h>
```

Inheritance diagram for GiNaC::diracone:



Collaboration diagram for GiNaC::diracone:



Protected Member Functions

- void `do_print` (const `print_context` &c, unsigned level) const
- void `do_print_latex` (const `print_latex` &c, unsigned level) const

Protected Member Functions inherited from `GiNaC::tensor`

- unsigned `return_type` () const override

Protected Member Functions inherited from `GiNaC::basic`

- `basic` ()
- virtual `ex eval_ncmul` (const `exvector` &v) const
- virtual bool `match_same_type` (const `basic` &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual `ex derivative` (const `symbol` &s) const
Default implementation of `ex::diff()`.
- virtual int `compare_same_type` (const `basic` &other) const
Returns order relation between two objects of same type.
- virtual bool `is_equal_same_type` (const `basic` &other) const
Returns true if two objects of same type are equal.
- virtual unsigned `calchash` () const
Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.
- void `ensure_if_modifiable` () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void `do_print` (const `print_context` &c, unsigned level) const
Default output to stream.
- void `do_print_tree` (const `print_tree` &c, unsigned level) const
Tree output to stream.
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const
Python parsable output to stream.

Additional Inherited Members

Public Member Functions inherited from [GiNaC::tensor](#)

- bool [replace_contr_index](#) (exvector::iterator self, exvector::iterator other) const
Replace dummy index in contracted-with object by the contracting object's second index (used internally for delta and metric tensor contractions).

Public Member Functions inherited from [GiNaC::basic](#)

- virtual [~basic](#) ()
basic destructor, virtual because class ex will delete objects of derived classes via a basic.*
- [basic](#) (const [basic](#) &other)
- const [basic](#) & [operator=](#) (const [basic](#) &other)
basic assignment operator: the other object might be of a derived class.
- virtual [basic](#) * [duplicate](#) () const
Create a clone of this object on the heap.
- virtual [ex eval](#) () const
Perform automatic non-interruptive term rewriting rules.
- virtual [ex evalf](#) () const
Evaluate object numerically.
- virtual [ex evalm](#) () const
Evaluate sums, products and integer powers of matrices.
- virtual [ex eval_integ](#) () const
Evaluate integrals, if result is known.
- virtual [ex eval_indexed](#) (const [basic](#) &i) const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void [print](#) (const [print_context](#) &c, unsigned level=0) const
Output to stream.
- virtual void [dbgprint](#) () const
Little wrapper around print to be called within a debugger.
- virtual void [dbgprinttree](#) () const
Little wrapper around printtree to be called within a debugger.
- virtual unsigned [precedence](#) () const
Return relative operator precedence (for parenthesizing output).
- virtual bool [info](#) (unsigned inf) const
Information about the object.
- virtual size_t [nops](#) () const
Number of operands/members.
- virtual [ex op](#) (size_t i) const
Return operand/member at position i.
- virtual [ex operator\[\]](#) (const [ex](#) &index) const
- virtual [ex operator\[\]](#) (size_t i) const
- virtual [ex](#) & [let_op](#) (size_t i)
Return modifiable operand/member at position i.
- virtual [ex](#) & [operator\[\]](#) (const [ex](#) &index)
- virtual [ex](#) & [operator\[\]](#) (size_t i)
- virtual bool [has](#) (const [ex](#) &other, unsigned [options](#)=0) const
Test for occurrence of a pattern.
- virtual bool [match](#) (const [ex](#) &pattern, [exmap](#) &repls) const
Check whether the expression matches a given pattern.

- virtual `ex subs` (const `exmap` &m, unsigned `options`=0) const
Substitute a set of objects by arbitrary expressions.
- virtual `ex map` (`map_function` &f) const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void `accept` (GiNaC::visitor &v) const
- virtual bool `is_polynomial` (const `ex` &var) const
Check whether this is a polynomial in the given variables.
- virtual int `degree` (const `ex` &s) const
Return degree of highest power in object s.
- virtual int `ldegree` (const `ex` &s) const
Return degree of lowest power in object s.
- virtual `ex coeff` (const `ex` &s, int `n`=1) const
Return coefficient of degree n in object s.
- virtual `ex expand` (unsigned `options`=0) const
Expand expression, i.e.
- virtual `ex collect` (const `ex` &s, bool `distributed`=false) const
Sort expanded expression in terms of powers of some object(s).
- virtual `ex series` (const `relational` &r, int `order`, unsigned `options`=0) const
Default implementation of `ex::series()`.
- virtual `ex normal` (`exmap` &repl, `exmap` &rev_lookup, `lst` &modifier) const
Default implementation of `ex::normal()`.
- virtual `ex to_rational` (`exmap` &repl) const
Default implementation of `ex::to_rational()`.
- virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const
Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- virtual `numeric max_coefficient` () const
Implementation `ex::max_coefficient()`.
- virtual `exvector get_free_indices` () const
Return a vector containing the free indices of an expression.
- virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
Add two indexed expressions.
- virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
Multiply an indexed expression with a scalar.
- virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const
Try to contract two indexed expressions that appear in the same product.
- virtual unsigned `return_type` () const
- virtual `return_type_t return_type_tinfo` () const
- virtual `ex conjugate` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const
- template<class T >
void `print_dispatch` (const `print_context` &c, unsigned level) const
Like `print()`, but dispatch to the specified class.
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const
Like `print()`, but dispatch to the specified class.
- virtual void `archive` (`archive_node` &n) const
Save (serialize) the object into archive node.
- virtual void `read_archive` (const `archive_node` &n, `lst` &syms)
Load (deserialize) the object from an archive node.

- `ex subs_one_level` (const `exmap` &`m`, unsigned `options`) const
Helper function for `subs()`.
- `ex diff` (const `symbol` &`s`, unsigned `nth=1`) const
Default interface of `nth` derivative `ex::diff(s, n)`.
- `int compare` (const `basic` &`other`) const
Compare objects syntactically to establish canonical ordering.
- `bool is_equal` (const `basic` &`other`) const
Test for syntactic equality.
- `const basic & hold` () const
Stop further evaluation.
- `unsigned gethash` () const
- `const basic & setflag` (unsigned `f`) const
Set some `status_flags`.
- `const basic & clearflag` (unsigned `f`) const
Clear some `status_flags`.

Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- `unsigned int add_reference` () noexcept
- `unsigned int remove_reference` () noexcept
- `unsigned int get_refcount` () const noexcept
- `void set_refcount` (unsigned int `r`) noexcept

Protected Attributes inherited from `GiNaC::basic`

- `unsigned flags`
of type `status_flags`
- `unsigned hashvalue`
hash value

6.33.1 Detailed Description

This class represents the Clifford algebra unity element.

6.33.2 Member Function Documentation

6.33.2.1 `do_print()`

```
void GiNaC::diracone::do_print (
    const print_context & c,
    unsigned level ) const [protected]
```

6.33.2.2 do_print_latex()

```
void GiNaC::diracone::do_print_latex (
    const print\_latex & c,
    unsigned level ) const [protected]
```

The documentation for this class was generated from the following file:

- [clifford.h](#)

6.34 GiNaC::do_taylor Class Reference

Exception class thrown by classes which provide their own series expansion to signal that ordinary Taylor expansion is safe.

```
#include <function.h>
```

6.34.1 Detailed Description

Exception class thrown by classes which provide their own series expansion to signal that ordinary Taylor expansion is safe.

The documentation for this class was generated from the following file:

- [function.h](#)

6.35 GiNaC::domain Class Reference

Domain of an object.

```
#include <flags.h>
```

Public Types

- enum { [complex](#) , [real](#) , [positive](#) }

6.35.1 Detailed Description

Domain of an object.

6.35.2 Member Enumeration Documentation

6.35.2.1 anonymous enum

```
anonymous enum
```

Enumerator

complex	
real	
positive	

The documentation for this class was generated from the following file:

- [flags.h](#)

6.36 GiNaC::dunno Class Reference

Exception class thrown by functions to signal unimplemented functionality so the expression may just be .hold()

```
#include <utils.h>
```

6.36.1 Detailed Description

Exception class thrown by functions to signal unimplemented functionality so the expression may just be .hold()

The documentation for this class was generated from the following file:

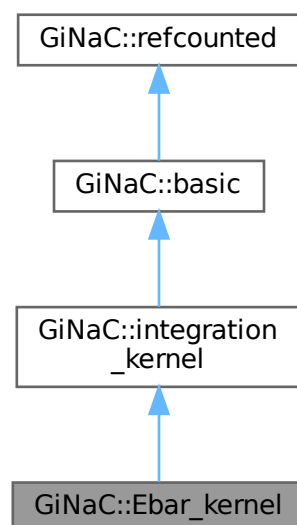
- [utils.h](#)

6.37 GiNaC::Ebar_kernel Class Reference

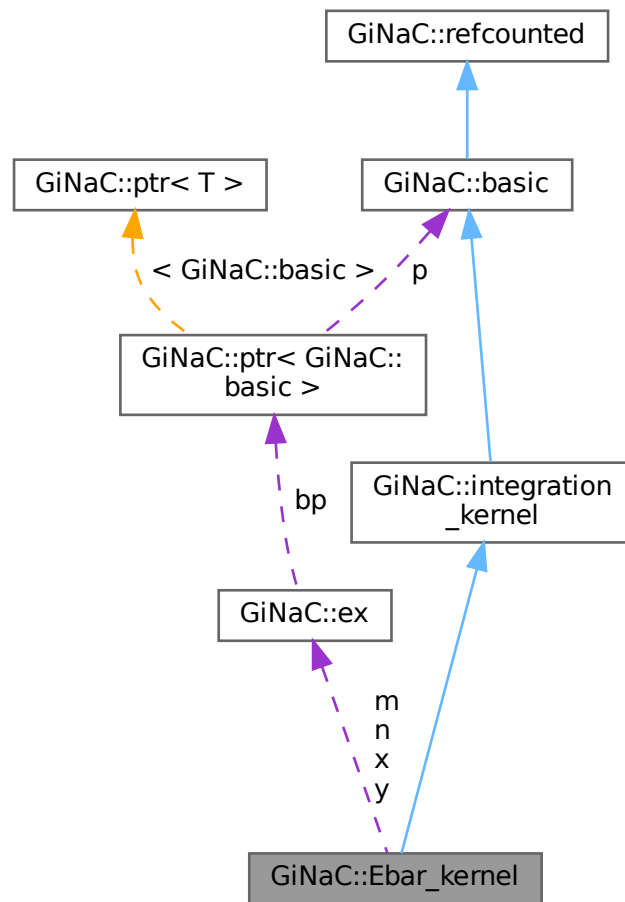
The Ebar-kernel.

```
#include <integration_kernel.h>
```

Inheritance diagram for GiNaC::Ebar_kernel:



Collaboration diagram for GiNaC::Ebar_kernel:



Public Member Functions

- `Ebar_kernel` (const `ex` &`n`, const `ex` &`m`, const `ex` &`x`, const `ex` &`y`)
- `size_t nops ()` const override
Number of operands/members.
- `ex op (size_t i)` const override
Return operand/member at position i.
- `ex & let_op (size_t i)` override
Return modifiable operand/member at position i.
- `bool is_numeric (void)` const override
This routine returns true, if the integration kernel can be evaluated numerically.
- `ex get_numerical_value (const ex &qbar, int N_trunc=0)` const override
Returns the value of $Ebar_{\{n,m\}}(x,y,qbar)$

Public Member Functions inherited from [GiNaC::integration_kernel](#)

- [ex series](#) (const [relational](#) &r, int [order](#), unsigned [options](#)=0) const override
Default implementation of [ex::series\(\)](#).
- virtual bool [has_trailing_zero](#) (void) const
This routine returns true, if the integration kernel has a trailing zero.
- virtual bool [is_numeric](#) (void) const
This routine returns true, if the integration kernel can be evaluated numerically.
- virtual [ex Laurent_series](#) (const [ex](#) &x, int [order](#)) const
Returns the Laurent series, starting possibly with the pole term.
- virtual [ex get_numerical_value](#) (const [ex](#) &lambda, int N_trunc=0) const
Evaluates the integrand at lambda.
- size_t [get_cache_size](#) (void) const
Returns the current size of the cache.
- void [set_cache_step](#) (int cache_steps) const
Sets the step size by which the cache is increased.
- [ex get_series_coeff](#) (int i) const
Wrapper around [series_coeff\(i\)](#), converts [cl_N](#) to numeric.
- [cln::cl_N series_coeff](#) (int i) const
Subclasses have either to implement [series_coeff_impl](#) or the two methods [Laurent_series](#) and [uses_Laurent_series](#).

Public Member Functions inherited from [GiNaC::basic](#)

- virtual [~basic](#) ()
basic destructor, virtual because class [ex](#) will delete objects of derived classes via a [basic](#).*
- [basic](#) (const [basic](#) &other)
- const [basic](#) & [operator=](#) (const [basic](#) &other)
basic assignment operator: the other object might be of a derived class.
- virtual [basic * duplicate](#) () const
Create a clone of this object on the heap.
- virtual [ex eval](#) () const
Perform automatic non-interruptive term rewriting rules.
- virtual [ex evalf](#) () const
Evaluate object numerically.
- virtual [ex evalm](#) () const
Evaluate sums, products and integer powers of matrices.
- virtual [ex eval_integ](#) () const
Evaluate integrals, if result is known.
- virtual [ex eval_indexed](#) (const [basic](#) &i) const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void [print](#) (const [print_context](#) &c, unsigned level=0) const
Output to stream.
- virtual void [dbgprint](#) () const
Little wrapper around [print](#) to be called within a debugger.
- virtual void [dbgprinttree](#) () const
Little wrapper around [printtree](#) to be called within a debugger.
- virtual unsigned [precedence](#) () const
Return relative operator precedence (for parenthesizing output).
- virtual bool [info](#) (unsigned inf) const
Information about the object.

- virtual `size_t nops ()` const
Number of operands/members.
- virtual `ex op (size_t i)` const
Return operand/member at position i.
- virtual `ex operator[] (const ex &index)` const
- virtual `ex operator[] (size_t i)` const
- virtual `ex & let_op (size_t i)`
Return modifiable operand/member at position i.
- virtual `ex & operator[] (const ex &index)`
- virtual `ex & operator[] (size_t i)`
- virtual `bool has (const ex &other, unsigned options=0)` const
Test for occurrence of a pattern.
- virtual `bool match (const ex &pattern, exmap &repls)` const
Check whether the expression matches a given pattern.
- virtual `ex subs (const exmap &m, unsigned options=0)` const
Substitute a set of objects by arbitrary expressions.
- virtual `ex map (map_function &f)` const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual `void accept (GiNaC::visitor &v)` const
- virtual `bool is_polynomial (const ex &var)` const
Check whether this is a polynomial in the given variables.
- virtual `int degree (const ex &s)` const
Return degree of highest power in object s.
- virtual `int ldegree (const ex &s)` const
Return degree of lowest power in object s.
- virtual `ex coeff (const ex &s, int n=1)` const
Return coefficient of degree n in object s.
- virtual `ex expand (unsigned options=0)` const
Expand expression, i.e.
- virtual `ex collect (const ex &s, bool distributed=false)` const
Sort expanded expression in terms of powers of some object(s).
- virtual `ex series (const relational &r, int order, unsigned options=0)` const
Default implementation of `ex::series()`.
- virtual `ex normal (exmap &repl, exmap &rev_lookup, lst &modifier)` const
Default implementation of `ex::normal()`.
- virtual `ex to_rational (exmap &repl)` const
Default implementation of `ex::to_rational()`.
- virtual `ex to_polynomial (exmap &repl)` const
- virtual `numeric integer_content ()` const
- virtual `ex smod (const numeric &xi)` const
Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- virtual `numeric max_coefficient ()` const
Implementation `ex::max_coefficient()`.
- virtual `exvector get_free_indices ()` const
Return a vector containing the free indices of an expression.
- virtual `ex add_indexed (const ex &self, const ex &other)` const
Add two indexed expressions.
- virtual `ex scalar_mul_indexed (const ex &self, const numeric &other)` const
Multiply an indexed expression with a scalar.
- virtual `bool contract_with (exvector::iterator self, exvector::iterator other, exvector &v)` const
Try to contract two indexed expressions that appear in the same product.

- virtual unsigned `return_type` () const
- virtual `return_type_t return_type_tinfo` () const
- virtual `ex conjugate` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const
- template<class T >
void `print_dispatch` (const `print_context` &c, unsigned level) const
Like `print()`, but dispatch to the specified class.
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const
Like `print()`, but dispatch to the specified class.
- virtual void `archive` (`archive_node` &n) const
Save (serialize) the object into archive node.
- virtual void `read_archive` (const `archive_node` &n, `lst` &syms)
Load (deserialize) the object from an archive node.
- `ex subs_one_level` (const `exmap` &m, unsigned `options`) const
Helper function for `subs()`.
- `ex diff` (const `symbol` &s, unsigned nth=1) const
Default interface of nth derivative `ex::diff(s, n)`.
- int `compare` (const `basic` &other) const
Compare objects syntactically to establish canonical ordering.
- bool `is_equal` (const `basic` &other) const
Test for syntactic equality.
- const `basic` & `hold` () const
Stop further evaluation.
- unsigned `gethash` () const
- const `basic` & `setflag` (unsigned f) const
Set some `status_flags`.
- const `basic` & `clearflag` (unsigned f) const
Clear some `status_flags`.

Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- unsigned int `add_reference` () noexcept
- unsigned int `remove_reference` () noexcept
- unsigned int `get_refcount` () const noexcept
- void `set_refcount` (unsigned int r) noexcept

Protected Member Functions

- `cln::cl_N series_coeff_impl` (int i) const override
For $\omega = d\lambda$ only the coefficient of λ^0 is non-zero.
- void `do_print` (const `print_context` &c, unsigned level) const

Protected Member Functions inherited from `GiNaC::integration_kernel`

- virtual bool `uses_Laurent_series` () const
Returns true, if the coefficients are computed from the Laurent series (in which case the method `Laurent_series` needs to be implemented).
- virtual `cln::cl_N series_coeff_impl` (int i) const
For $\omega = d\lambda$ only the coefficient of λ^0 is non-zero.
- `ex get_numerical_value_impl` (const `ex` &lambda, const `ex` &pre, int shift, int N_trunc) const
The actual implementation for computing a numerical value for the integrand.
- void `do_print` (const `print_context` &c, unsigned level) const

Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match_same_type](#) (const [basic](#) &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual [ex derivative](#) (const [symbol](#) &s) const
Default implementation of [ex::diff\(\)](#).
- virtual int [compare_same_type](#) (const [basic](#) &other) const
Returns order relation between two objects of same type.
- virtual bool [is_equal_same_type](#) (const [basic](#) &other) const
Returns true if two objects of same type are equal.
- virtual unsigned [calchash](#) () const
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- void [ensure_if_modifiable](#) () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
Default output to stream.
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
Tree output to stream.
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
Python parsable output to stream.

Protected Attributes

- [ex n](#)
- [ex m](#)
- [ex x](#)
- [ex y](#)

Protected Attributes inherited from [GiNaC::integration_kernel](#)

- int [cache_step_size](#)
- std::vector< [cln::cl_N](#) > [series_vec](#)

Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)
of type [status_flags](#)
- unsigned [hashvalue](#)
hash value

6.37.1 Detailed Description

The Ebar-kernel.

This class represents the differential one-form

$$\omega_{n;m}^{\bar{E}}(x; y) = \bar{E}_{n;m}(x; y; \bar{q}) \frac{d\bar{q}}{\bar{q}}$$

6.37.2 Constructor & Destructor Documentation

6.37.2.1 Ebar_kernel()

```
GiNaC::Ebar_kernel::Ebar_kernel (
    const ex & n,
    const ex & m,
    const ex & x,
    const ex & y )
```

6.37.3 Member Function Documentation

6.37.3.1 nops()

```
size_t GiNaC::Ebar_kernel::nops ( ) const [override], [virtual]
```

Number of operands/members.

Reimplemented from [GiNaC::basic](#).

6.37.3.2 op()

```
ex GiNaC::Ebar_kernel::op (
    size_t i ) const [override], [virtual]
```

Return operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [m](#), [n](#), [x](#), and [y](#).

6.37.3.3 let_op()

```
ex & GiNaC::Ebar_kernel::let_op (
    size_t i ) [override], [virtual]
```

Return modifiable operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ensure_if_modifiable\(\)](#), [m](#), [n](#), [x](#), and [y](#).

6.37.3.4 is_numeric()

```
bool GiNaC::Ebar_kernel::is_numeric (
    void ) const [override], [virtual]
```

This routine returns true, if the integration kernel can be evaluated numerically.

Reimplemented from [GiNaC::integration_kernel](#).

References [GiNaC::ex::evalf\(\)](#), [GiNaC::ex::info\(\)](#), [m](#), [n](#), [GiNaC::info_flags::nonnegint](#), [GiNaC::info_flags::numeric](#), [x](#), and [y](#).

6.37.3.5 get_numerical_value()

```
ex GiNaC::Ebar_kernel::get_numerical_value (
    const ex & qbar,
    int N_trunc = 0 ) const [override], [virtual]
```

Returns the value of $Ebar_{\{n,m\}}(x,y,qbar)$

Reimplemented from [GiNaC::integration_kernel](#).

References [GiNaC::integration_kernel::get_numerical_value_impl\(\)](#), and [qbar](#).

Referenced by [GiNaC::Kronecker_dtau_kernel::get_numerical_value\(\)](#), and [GiNaC::Kronecker_dz_kernel::series_coeff_impl\(\)](#).

6.37.3.6 series_coeff_impl()

```
cln::cl_N GiNaC::Ebar_kernel::series_coeff_impl (
    int i ) const [override], [protected], [virtual]
```

For $\omega = d\lambda$ only the coefficient of λ^0 is non-zero.

The i -th coefficient corresponds to the power λ^{i-1} .

Reimplemented from [GiNaC::integration_kernel](#).

References [GiNaC::ex::evalf\(\)](#), [k](#), [m](#), [n](#), [x](#), and [y](#).

6.37.3.7 do_print()

```
void GiNaC::Ebar_kernel::do_print (
    const print_context & c,
    unsigned level ) const [protected]
```

References [c](#), [m](#), [n](#), [GiNaC::ex::print\(\)](#), [x](#), and [y](#).

6.37.4 Member Data Documentation

6.37.4.1 `n`

`ex GiNaC::Ebar_kernel::n` [protected]

Referenced by [do_print\(\)](#), [is_numeric\(\)](#), [let_op\(\)](#), [op\(\)](#), and [series_coeff_impl\(\)](#).

6.37.4.2 `m`

`ex GiNaC::Ebar_kernel::m` [protected]

Referenced by [do_print\(\)](#), [is_numeric\(\)](#), [let_op\(\)](#), [op\(\)](#), and [series_coeff_impl\(\)](#).

6.37.4.3 `x`

`ex GiNaC::Ebar_kernel::x` [protected]

Referenced by [do_print\(\)](#), [is_numeric\(\)](#), [let_op\(\)](#), [op\(\)](#), and [series_coeff_impl\(\)](#).

6.37.4.4 `y`

`ex GiNaC::Ebar_kernel::y` [protected]

Referenced by [do_print\(\)](#), [is_numeric\(\)](#), [let_op\(\)](#), [op\(\)](#), and [series_coeff_impl\(\)](#).

The documentation for this class was generated from the following files:

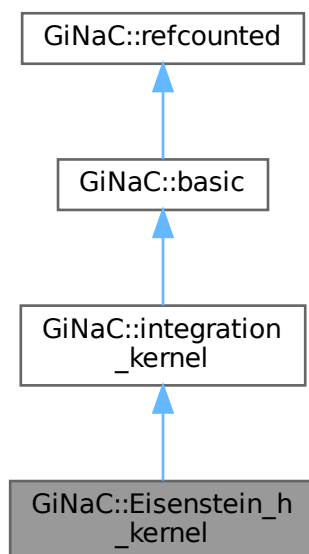
- [integration_kernel.h](#)
- [integration_kernel.cpp](#)

6.38 GiNaC::Eisenstein_h_kernel Class Reference

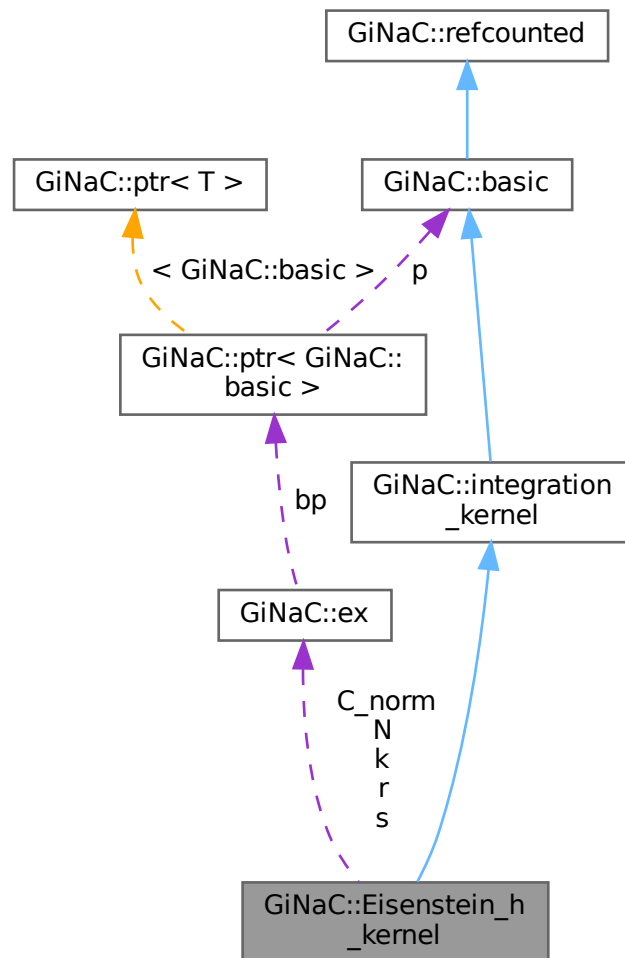
The kernel corresponding to the Eisenstein series $h_{k,N,r,s}(\tau)$.

```
#include <integration_kernel.h>
```

Inheritance diagram for GiNaC::Eisenstein_h_kernel:



Collaboration diagram for `GiNaC::Eisenstein_h_kernel`:



Public Member Functions

- `Eisenstein_h_kernel` (const `ex` &`k`, const `ex` &`N`, const `ex` &`r`, const `ex` &`s`, const `ex` &`C_norm`=`numeric`(1))
- `ex series` (const `relational` &`r`, int `order`, unsigned `options`=0) const override
The series method for this class returns the qbar-expansion of the modular form, without an additional factor of C_norm/qbar.
- `size_t nops` () const override
Number of operands/members.
- `ex op` (size_t `i`) const override
Return operand/member at position i.
- `ex &let_op` (size_t `i`) override
Return modifiable operand/member at position i.
- `bool is_numeric` (void) const override
This routine returns true, if the integration kernel can be evaluated numerically.
- `ex Laurent_series` (const `ex` &`x`, int `order`) const override

- Returns the Laurent series, starting possibly with the pole term.*
- `ex get_numerical_value` (const `ex` &`qbar`, int `N_trunc`=0) const override
Returns the value of the modular form.
- `ex coefficient_a0` (const `numeric` &`k`, const `numeric` &`r`, const `numeric` &`s`, const `numeric` &`N`) const
The constant coefficient in the Fourier expansion.
- `ex coefficient_an` (const `numeric` &`n`, const `numeric` &`k`, const `numeric` &`r`, const `numeric` &`s`, const `numeric` &`N`) const
The higher coefficients in the Fourier expansion.
- `ex q_expansion_modular_form` (const `ex` &`q`, int `order`) const

Public Member Functions inherited from `GiNaC::integration_kernel`

- `ex series` (const `relational` &`r`, int `order`, unsigned `options`=0) const override
Default implementation of `ex::series()`.
- virtual bool `has_trailing_zero` (void) const
This routine returns true, if the integration kernel has a trailing zero.
- virtual bool `is_numeric` (void) const
This routine returns true, if the integration kernel can be evaluated numerically.
- virtual `ex Laurent_series` (const `ex` &`x`, int `order`) const
Returns the Laurent series, starting possibly with the pole term.
- virtual `ex get_numerical_value` (const `ex` &`lambda`, int `N_trunc`=0) const
Evaluates the integrand at `lambda`.
- size_t `get_cache_size` (void) const
Returns the current size of the cache.
- void `set_cache_step` (int `cache_steps`) const
Sets the step size by which the cache is increased.
- `ex get_series_coeff` (int `i`) const
Wrapper around `series_coeff(i)`, converts `cl_N` to numeric.
- `cln::cl_N series_coeff` (int `i`) const
Subclasses have either to implement `series_coeff_impl` or the two methods `Laurent_series` and `uses_Laurent_series`.

Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()
basic destructor, virtual because class `ex` will delete objects of derived classes via a `basic`.*
- `basic` (const `basic` &`other`)
- const `basic` & `operator=` (const `basic` &`other`)
basic assignment operator: the other object might be of a derived class.
- virtual `basic * duplicate` () const
Create a clone of this object on the heap.
- virtual `ex eval` () const
Perform automatic non-interruptive term rewriting rules.
- virtual `ex evalf` () const
Evaluate object numerically.
- virtual `ex evalm` () const
Evaluate sums, products and integer powers of matrices.
- virtual `ex eval_integ` () const
Evaluate integrals, if result is known.
- virtual `ex eval_indexed` (const `basic` &`i`) const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.

- virtual void `print` (const `print_context` &c, unsigned level=0) const
Output to stream.
- virtual void `dbgprint` () const
Little wrapper around print to be called within a debugger.
- virtual void `dbgprintree` () const
Little wrapper around printree to be called within a debugger.
- virtual unsigned `precedence` () const
Return relative operator precedence (for parenthezing output).
- virtual bool `info` (unsigned inf) const
Information about the object.
- virtual size_t `nops` () const
Number of operands/members.
- virtual `ex op` (size_t i) const
Return operand/member at position i.
- virtual `ex operator[]` (const `ex` &index) const
- virtual `ex operator[]` (size_t i) const
- virtual `ex & let_op` (size_t i)
Return modifiable operand/member at position i.
- virtual `ex & operator[]` (const `ex` &index)
- virtual `ex & operator[]` (size_t i)
- virtual bool `has` (const `ex` &other, unsigned `options`=0) const
Test for occurrence of a pattern.
- virtual bool `match` (const `ex` &pattern, `exmap` &repls) const
Check whether the expression matches a given pattern.
- virtual `ex subs` (const `exmap` &m, unsigned `options`=0) const
Substitute a set of objects by arbitrary expressions.
- virtual `ex map` (`map_function` &f) const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void `accept` (`GiNaC::visitor` &v) const
- virtual bool `is_polynomial` (const `ex` &var) const
Check whether this is a polynomial in the given variables.
- virtual int `degree` (const `ex` &s) const
Return degree of highest power in object s.
- virtual int `ldegree` (const `ex` &s) const
Return degree of lowest power in object s.
- virtual `ex coeff` (const `ex` &s, int n=1) const
Return coefficient of degree n in object s.
- virtual `ex expand` (unsigned `options`=0) const
Expand expression, i.e.
- virtual `ex collect` (const `ex` &s, bool distributed=false) const
Sort expanded expression in terms of powers of some object(s).
- virtual `ex series` (const `relational` &r, int `order`, unsigned `options`=0) const
Default implementation of `ex::series()`.
- virtual `ex normal` (`exmap` &repl, `exmap` &rev_lookup, `lst` &modifier) const
Default implementation of `ex::normal()`.
- virtual `ex to_rational` (`exmap` &repl) const
Default implementation of `ex::to_rational()`.
- virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const
Apply symmetric modular homomorphism to an expanded multivariate polynomial.

- virtual [numeric max_coefficient](#) () const
Implementation [ex::max_coefficient\(\)](#).
- virtual [exvector get_free_indices](#) () const
Return a vector containing the free indices of an expression.
- virtual [ex add_indexed](#) (const [ex](#) &self, const [ex](#) &other) const
Add two indexed expressions.
- virtual [ex scalar_mul_indexed](#) (const [ex](#) &self, const [numeric](#) &other) const
Multiply an indexed expression with a scalar.
- virtual bool [contract_with](#) (exvector::iterator self, exvector::iterator other, [exvector](#) &v) const
Try to contract two indexed expressions that appear in the same product.
- virtual unsigned [return_type](#) () const
- virtual [return_type_t](#) [return_type_tinfo](#) () const
- virtual [ex conjugate](#) () const
- virtual [ex real_part](#) () const
- virtual [ex imag_part](#) () const
- template<class T >
void [print_dispatch](#) (const [print_context](#) &c, unsigned level) const
Like [print\(\)](#), but dispatch to the specified class.
- void [print_dispatch](#) (const [registered_class_info](#) &ri, const [print_context](#) &c, unsigned level) const
Like [print\(\)](#), but dispatch to the specified class.
- virtual void [archive](#) ([archive_node](#) &n) const
Save (serialize) the object into archive node.
- virtual void [read_archive](#) (const [archive_node](#) &n, [lst](#) &syms)
Load (deserialize) the object from an archive node.
- [ex subs_one_level](#) (const [exmap](#) &m, unsigned [options](#)) const
Helper function for [subs\(\)](#).
- [ex diff](#) (const [symbol](#) &s, unsigned nth=1) const
Default interface of nth derivative [ex::diff\(s, n\)](#).
- int [compare](#) (const [basic](#) &other) const
Compare objects syntactically to establish canonical ordering.
- bool [is_equal](#) (const [basic](#) &other) const
Test for syntactic equality.
- const [basic](#) & [hold](#) () const
Stop further evaluation.
- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const
Set some [status_flags](#).
- const [basic](#) & [clearflag](#) (unsigned f) const
Clear some [status_flags](#).

Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add_reference](#) () noexcept
- unsigned int [remove_reference](#) () noexcept
- unsigned int [get_refcount](#) () const noexcept
- void [set_refcount](#) (unsigned int r) noexcept

Protected Member Functions

- bool [uses_Laurent_series](#) () const override
Returns true, if the coefficients are computed from the Laurent series (in which case the method `Laurent_series` needs to be implemented).
- void [do_print](#) (const [print_context](#) &c, unsigned level) const

Protected Member Functions inherited from [GiNaC::integration_kernel](#)

- virtual bool [uses_Laurent_series](#) () const
Returns true, if the coefficients are computed from the Laurent series (in which case the method `Laurent_series` needs to be implemented).
- virtual `cln::cl_N` [series_coeff_impl](#) (int i) const
For $\omega = d\lambda$ only the coefficient of λ^0 is non-zero.
- `ex` [get_numerical_value_impl](#) (const `ex` &lambda, const `ex` &pre, int shift, int N_trunc) const
The actual implementation for computing a numerical value for the integrand.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const

Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual `ex` [eval_ncmul](#) (const `exvector` &v) const
- virtual bool [match_same_type](#) (const [basic](#) &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual `ex` [derivative](#) (const `symbol` &s) const
Default implementation of `ex::diff()`.
- virtual int [compare_same_type](#) (const [basic](#) &other) const
Returns order relation between two objects of same type.
- virtual bool [is_equal_same_type](#) (const [basic](#) &other) const
Returns true if two objects of same type are equal.
- virtual unsigned [calchash](#) () const
Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.
- void [ensure_if_modifiable](#) () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
Default output to stream.
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
Tree output to stream.
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
Python parsable output to stream.

Protected Attributes

- `ex` k
- `ex` N
- `ex` r
- `ex` s
- `ex` C_norm

Protected Attributes inherited from [GiNaC::integration_kernel](#)

- int [cache_step_size](#)
- std::vector< cln::cl_N > [series_vec](#)

Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)
of type [status_flags](#)
- unsigned [hashvalue](#)
hash value

6.38.1 Detailed Description

The kernel corresponding to the Eisenstein series $h_{k,N,r,s}(\tau)$.

This class represents the differential one-form

$$\omega_{k,N,r,s}^{\text{Eisenstein,h}} = C_k h_{k,N,r,s}(\tau) \frac{d\bar{q}_N}{\bar{q}_N}$$

6.38.2 Constructor & Destructor Documentation**6.38.2.1 Eisenstein_h_kernel()**

```
GiNaC::Eisenstein_h_kernel::Eisenstein_h_kernel (
    const ex & k,
    const ex & N,
    const ex & r,
    const ex & s,
    const ex & C_norm = numeric(1) )
```

6.38.3 Member Function Documentation**6.38.3.1 series()**

```
ex GiNaC::Eisenstein_h_kernel::series (
    const relational & r,
    int order,
    unsigned options = 0 ) const [override], [virtual]
```

The series method for this class returns the qbar-expansion of the modular form, without an additional factor of C_norm/qbar.

This allows for easy use in the class [modular_form_kernel](#).

Reimplemented from [GiNaC::integration_kernel](#).

References [GiNaC::ex::lhs\(\)](#), [order](#), [q_expansion_modular_form\(\)](#), [qbar](#), [r](#), [GiNaC::ex::rhs\(\)](#), and [GiNaC::ex::series\(\)](#).

6.38.3.2 nops()

```
size_t GiNaC::Eisenstein_h_kernel::nops ( ) const [override], [virtual]
```

Number of operands/members.

Reimplemented from [GiNaC::basic](#).

6.38.3.3 op()

```
ex GiNaC::Eisenstein_h_kernel::op (
    size_t i ) const [override], [virtual]
```

Return operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [C_norm](#), [k](#), [N](#), [r](#), and [s](#).

6.38.3.4 let_op()

```
ex & GiNaC::Eisenstein_h_kernel::let_op (
    size_t i ) [override], [virtual]
```

Return modifiable operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [C_norm](#), [GiNaC::basic::ensure_if_modifiable\(\)](#), [k](#), [N](#), [r](#), and [s](#).

6.38.3.5 is_numeric()

```
bool GiNaC::Eisenstein_h_kernel::is_numeric (
    void ) const [override], [virtual]
```

This routine returns true, if the integration kernel can be evaluated numerically.

Reimplemented from [GiNaC::integration_kernel](#).

References [C_norm](#), [GiNaC::ex::evalf\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::integer](#), [k](#), [N](#), [GiNaC::info_flags::nonnegint](#), [GiNaC::info_flags::numeric](#), [GiNaC::info_flags::posint](#), [r](#), and [s](#).

6.38.3.6 Laurent_series()

```
ex GiNaC::Eisenstein_h_kernel::Laurent_series (
    const ex & x,
    int order ) const [override], [virtual]
```

Returns the Laurent series, starting possibly with the pole term.

Neglected terms are of order $O(x^{order})$.

Reimplemented from [GiNaC::integration_kernel](#).

References [C_norm](#), [order](#), [q_expansion_modular_form\(\)](#), [GiNaC::ex::series\(\)](#), and [x](#).

6.38.3.7 get_numerical_value()

```
ex GiNaC::Eisenstein_h_kernel::get_numerical_value (
    const ex & qbar,
    int N_trunc = 0 ) const [override], [virtual]
```

Returns the value of the modular form.

Reimplemented from [GiNaC::integration_kernel](#).

References [C_norm](#), [GiNaC::integration_kernel::get_numerical_value_impl\(\)](#), and [qbar](#).

6.38.3.8 uses_Laurent_series()

```
bool GiNaC::Eisenstein_h_kernel::uses_Laurent_series ( ) const [override], [protected], [virtual]
```

Returns true, if the coefficients are computed from the Laurent series (in which case the method `Laurent_series` needs to be implemented).

Returns false if this is not the case (and the class has an implementation of `series_coeff_impl`).

Reimplemented from [GiNaC::integration_kernel](#).

6.38.3.9 coefficient_a0()

```
ex GiNaC::Eisenstein_h_kernel::coefficient_a0 (
    const numeric & k,
    const numeric & r,
    const numeric & s,
    const numeric & N ) const
```

The constant coefficient in the Fourier expansion.

References [GiNaC::Bernoulli_polynomial\(\)](#), [GiNaC::cos\(\)](#), [GiNaC::I](#), [GiNaC::irem\(\)](#), [k](#), [GiNaC::mod\(\)](#), [N](#), [GiNaC::Pi](#), [r](#), [s](#), and [GiNaC::sin\(\)](#).

Referenced by [q_expansion_modular_form\(\)](#).

6.38.3.10 coefficient_an()

```
ex GiNaC::Eisenstein_h_kernel::coefficient_an (
    const numeric & n,
    const numeric & k,
    const numeric & r,
    const numeric & s,
    const numeric & N ) const
```

The higher coefficients in the Fourier expansion.

References [GiNaC::exp\(\)](#), [GiNaC::l](#), [GiNaC::irem\(\)](#), [k](#), [m](#), [GiNaC::mod\(\)](#), [n](#), [N](#), [GiNaC::Pi](#), [GiNaC::pow\(\)](#), [r](#), and [s](#).

Referenced by [q_expansion_modular_form\(\)](#).

6.38.3.11 q_expansion_modular_form()

```
ex GiNaC::Eisenstein_h_kernel::q_expansion_modular_form (
    const ex & q,
    int order ) const
```

References [coefficient_a0\(\)](#), [coefficient_an\(\)](#), [k](#), [N](#), [GiNaC::pow\(\)](#), [r](#), [s](#), and [GiNaC::ex::series\(\)](#).

Referenced by [Laurent_series\(\)](#), and [series\(\)](#).

6.38.3.12 do_print()

```
void GiNaC::Eisenstein_h_kernel::do_print (
    const print_context & c,
    unsigned level ) const [protected]
```

References [c](#), [C_norm](#), [k](#), [N](#), [GiNaC::ex::print\(\)](#), [r](#), and [s](#).

6.38.4 Member Data Documentation

6.38.4.1 k

```
ex GiNaC::Eisenstein_h_kernel::k [protected]
```

Referenced by [coefficient_a0\(\)](#), [coefficient_an\(\)](#), [do_print\(\)](#), [is_numeric\(\)](#), [let_op\(\)](#), [op\(\)](#), and [q_expansion_modular_form\(\)](#).

6.38.4.2 N

`ex` GiNaC::Eisenstein_h_kernel::N [protected]

Referenced by [coefficient_a0\(\)](#), [coefficient_an\(\)](#), [do_print\(\)](#), [is_numeric\(\)](#), [let_op\(\)](#), [op\(\)](#), and [q_expansion_modular_form\(\)](#).

6.38.4.3 r

`ex` GiNaC::Eisenstein_h_kernel::r [protected]

Referenced by [coefficient_a0\(\)](#), [coefficient_an\(\)](#), [do_print\(\)](#), [is_numeric\(\)](#), [let_op\(\)](#), [op\(\)](#), [q_expansion_modular_form\(\)](#), and [series\(\)](#).

6.38.4.4 s

`ex` GiNaC::Eisenstein_h_kernel::s [protected]

Referenced by [coefficient_a0\(\)](#), [coefficient_an\(\)](#), [do_print\(\)](#), [is_numeric\(\)](#), [let_op\(\)](#), [op\(\)](#), and [q_expansion_modular_form\(\)](#).

6.38.4.5 C_norm

`ex` GiNaC::Eisenstein_h_kernel::C_norm [protected]

Referenced by [do_print\(\)](#), [get_numerical_value\(\)](#), [is_numeric\(\)](#), [Laurent_series\(\)](#), [let_op\(\)](#), and [op\(\)](#).

The documentation for this class was generated from the following files:

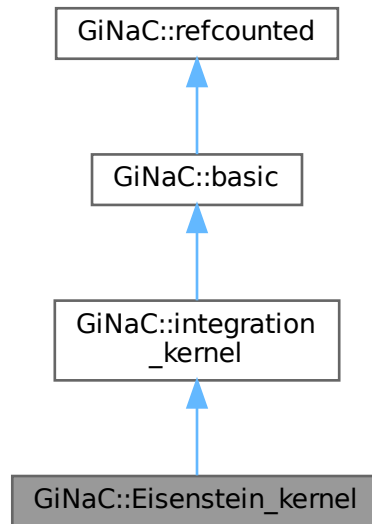
- [integration_kernel.h](#)
- [integration_kernel.cpp](#)

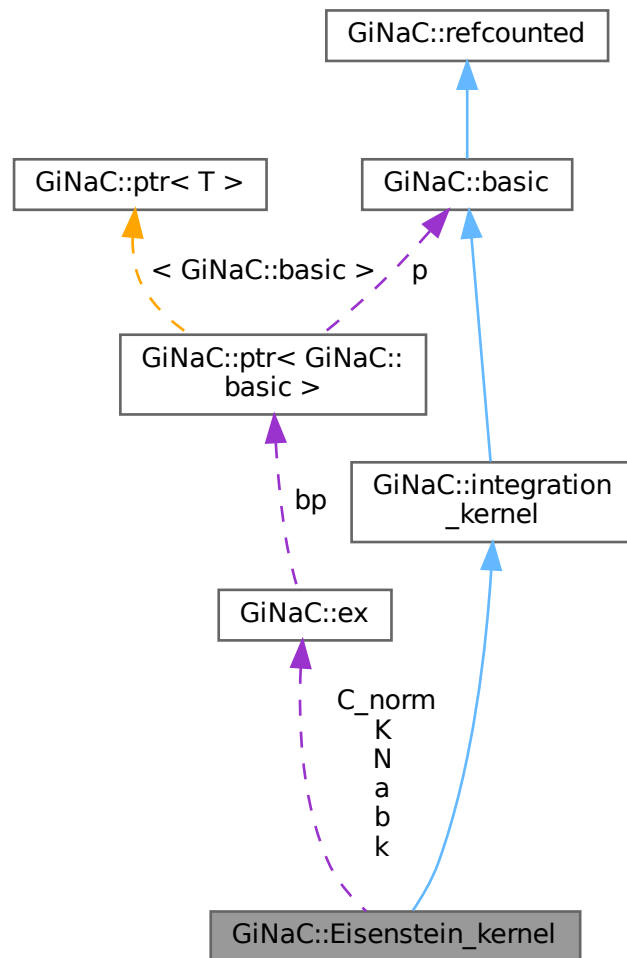
6.39 GiNaC::Eisenstein_kernel Class Reference

The kernel corresponding to the Eisenstein series $E_{k,N,a,b,K}(\tau)$.

```
#include <integration_kernel.h>
```

Inheritance diagram for GiNaC::Eisenstein_kernel:





- Eisenstein kernel (const

- `Eisenstein_kernel` (const `ex` &k, const `ex` &N, const `ex` &a, const `ex` &b, const `ex` &K, const `ex` &C_norm=numeric(1))
- `ex series` (const `relational` &r, int `order`, unsigned `options`=0) const override

The series method for this class returns the qbar-expansion of the modular form, without an additional factor of C_norm/qbar.
- `size_t nops` () const override

Number of operands/members.
- `ex op` (size_t i) const override

Return operand/member at position i.
- `ex & let_op` (size_t i) override

Return modifiable operand/member at position i.
- `bool is_numeric` (void) const override

This routine returns true, if the integration kernel can be evaluated numerically.

- `ex Laurent_series` (const `ex` &`x`, int `order`) const override
Returns the Laurent series, starting possibly with the pole term.
- `ex get_numerical_value` (const `ex` &`qbar`, int `N_trunc`=0) const override
Returns the value of the modular form.
- `ex q_expansion_modular_form` (const `ex` &`q`, int `order`) const

Public Member Functions inherited from `GiNaC::integration_kernel`

- `ex series` (const `relational` &`r`, int `order`, unsigned `options`=0) const override
Default implementation of `ex::series()`.
- virtual bool `has_trailing_zero` (void) const
This routine returns true, if the integration kernel has a trailing zero.
- virtual bool `is_numeric` (void) const
This routine returns true, if the integration kernel can be evaluated numerically.
- virtual `ex Laurent_series` (const `ex` &`x`, int `order`) const
Returns the Laurent series, starting possibly with the pole term.
- virtual `ex get_numerical_value` (const `ex` &`lambda`, int `N_trunc`=0) const
Evaluates the integrand at `lambda`.
- size_t `get_cache_size` (void) const
Returns the current size of the cache.
- void `set_cache_step` (int `cache_steps`) const
Sets the step size by which the cache is increased.
- `ex get_series_coeff` (int `i`) const
Wrapper around `series_coeff(i)`, converts `cl_N` to numeric.
- `cln::cl_N series_coeff` (int `i`) const
Subclasses have either to implement `series_coeff_impl` or the two methods `Laurent_series` and `uses_Laurent_series`.

Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()
basic destructor, virtual because class `ex` will delete objects of derived classes via a `basic`.*
- `basic` (const `basic` &`other`)
- const `basic` & `operator=` (const `basic` &`other`)
basic assignment operator: the other object might be of a derived class.
- virtual `basic * duplicate` () const
Create a clone of this object on the heap.
- virtual `ex eval` () const
Perform automatic non-interruptive term rewriting rules.
- virtual `ex evalf` () const
Evaluate object numerically.
- virtual `ex evalm` () const
Evaluate sums, products and integer powers of matrices.
- virtual `ex eval_integ` () const
Evaluate integrals, if result is known.
- virtual `ex eval_indexed` (const `basic` &`i`) const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void `print` (const `print_context` &`c`, unsigned `level`=0) const
Output to stream.
- virtual void `dbgprint` () const
Little wrapper around `print` to be called within a debugger.

- virtual void `dbgprinttree` () const
Little wrapper around printtree to be called within a debugger.
- virtual unsigned `precedence` () const
Return relative operator precedence (for parenthezing output).
- virtual bool `info` (unsigned inf) const
Information about the object.
- virtual size_t `nops` () const
Number of operands/members.
- virtual `ex op` (size_t i) const
Return operand/member at position i.
- virtual `ex operator[]` (const `ex` &index) const
- virtual `ex operator[]` (size_t i) const
- virtual `ex & let_op` (size_t i)
Return modifiable operand/member at position i.
- virtual `ex & operator[]` (const `ex` &index)
- virtual `ex & operator[]` (size_t i)
- virtual bool `has` (const `ex` &other, unsigned `options`=0) const
Test for occurrence of a pattern.
- virtual bool `match` (const `ex` &pattern, `exmap` &repls) const
Check whether the expression matches a given pattern.
- virtual `ex subs` (const `exmap` &m, unsigned `options`=0) const
Substitute a set of objects by arbitrary expressions.
- virtual `ex map` (`map_function` &f) const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void `accept` (GiNaC::visitor &v) const
- virtual bool `is_polynomial` (const `ex` &var) const
Check whether this is a polynomial in the given variables.
- virtual int `degree` (const `ex` &s) const
Return degree of highest power in object s.
- virtual int `ldegree` (const `ex` &s) const
Return degree of lowest power in object s.
- virtual `ex coeff` (const `ex` &s, int n=1) const
Return coefficient of degree n in object s.
- virtual `ex expand` (unsigned `options`=0) const
Expand expression, i.e.
- virtual `ex collect` (const `ex` &s, bool distributed=false) const
Sort expanded expression in terms of powers of some object(s).
- virtual `ex series` (const `relational` &r, int `order`, unsigned `options`=0) const
Default implementation of `ex::series()`.
- virtual `ex normal` (`exmap` &repl, `exmap` &rev_lookup, `lst` &modifier) const
Default implementation of `ex::normal()`.
- virtual `ex to_rational` (`exmap` &repl) const
Default implementation of `ex::to_rational()`.
- virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const
Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- virtual `numeric max_coefficient` () const
Implementation `ex::max_coefficient()`.
- virtual `exvector get_free_indices` () const
Return a vector containing the free indices of an expression.

- virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
Add two indexed expressions.
- virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
Multiply an indexed expression with a scalar.
- virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const
Try to contract two indexed expressions that appear in the same product.
- virtual unsigned `return_type` () const
- virtual `return_type_t` `return_type_tinfo` () const
- virtual `ex conjugate` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const
- template<class T >
void `print_dispatch` (const `print_context` &c, unsigned level) const
Like `print()`, but dispatch to the specified class.
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const
Like `print()`, but dispatch to the specified class.
- virtual void `archive` (`archive_node` &n) const
Save (serialize) the object into archive node.
- virtual void `read_archive` (const `archive_node` &n, `lst` &syms)
Load (deserialize) the object from an archive node.
- `ex subs_one_level` (const `exmap` &m, unsigned `options`) const
Helper function for `subs()`.
- `ex diff` (const `symbol` &s, unsigned nth=1) const
Default interface of nth derivative `ex::diff(s, n)`.
- int `compare` (const `basic` &other) const
Compare objects syntactically to establish canonical ordering.
- bool `is_equal` (const `basic` &other) const
Test for syntactic equality.
- const `basic` & `hold` () const
Stop further evaluation.
- unsigned `gethash` () const
- const `basic` & `setflag` (unsigned f) const
Set some `status_flags`.
- const `basic` & `clearflag` (unsigned f) const
Clear some `status_flags`.

Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- unsigned int `add_reference` () noexcept
- unsigned int `remove_reference` () noexcept
- unsigned int `get_refcount` () const noexcept
- void `set_refcount` (unsigned int r) noexcept

Protected Member Functions

- bool `uses_Laurent_series` () const override
Returns true, if the coefficients are computed from the Laurent series (in which case the method `Laurent_series` needs to be implemented).
- void `do_print` (const `print_context` &c, unsigned level) const

Protected Member Functions inherited from [GiNaC::integration_kernel](#)

- virtual bool [uses_Laurent_series](#) () const
Returns true, if the coefficients are computed from the Laurent series (in which case the method [Laurent_series](#) needs to be implemented).
- virtual [cln::cl_N](#) [series_coeff_impl](#) (int i) const
For $\omega = d\lambda$ only the coefficient of λ^0 is non-zero.
- [ex](#) [get_numerical_value_impl](#) (const [ex](#) &lambda, const [ex](#) &pre, int shift, int N_trunc) const
The actual implementation for computing a numerical value for the integrand.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const

Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex](#) [eval_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match_same_type](#) (const [basic](#) &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual [ex](#) [derivative](#) (const [symbol](#) &s) const
Default implementation of [ex::diff\(\)](#).
- virtual int [compare_same_type](#) (const [basic](#) &other) const
Returns order relation between two objects of same type.
- virtual bool [is_equal_same_type](#) (const [basic](#) &other) const
Returns true if two objects of same type are equal.
- virtual unsigned [calchash](#) () const
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- void [ensure_if_modifiable](#) () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
Default output to stream.
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
Tree output to stream.
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
Python parsable output to stream.

Protected Attributes

- [ex](#) k
- [ex](#) N
- [ex](#) a
- [ex](#) b
- [ex](#) K
- [ex](#) C_norm

Protected Attributes inherited from [GiNaC::integration_kernel](#)

- int [cache_step_size](#)
- [std::vector](#)< [cln::cl_N](#) > [series_vec](#)

Protected Attributes inherited from `GiNaC::basic`

- unsigned `flags`
of type `status_flags`
- unsigned `hashvalue`
hash value

6.39.1 Detailed Description

The kernel corresponding to the Eisenstein series $E_{k,N,a,b,K}(\tau)$.

This class represents the differential one-form

$$\omega_{k,N,a,b,K}^{\text{Eisenstein}} = C_k E_{k,N,a,b,K}(\tau) \frac{d\bar{q}_N}{\bar{q}_N}$$

The integers a and b are either one or the discriminant of a quadratic number field. This class represents Eisenstein series, which can be defined by primitive Dirichlet characters from the Kronecker symbol. This implies that the characters take the values -1,0,1, i.e. no higher roots of unity occur. The

$$\bar{q}$$

-expansion has then rational coefficients.

Ref.: W. Stein, Modular Forms: A Computational Approach, Chapter 5

6.39.2 Constructor & Destructor Documentation

6.39.2.1 `Eisenstein_kernel()`

```
GiNaC::Eisenstein_kernel::Eisenstein_kernel (
    const ex & k,
    const ex & N,
    const ex & a,
    const ex & b,
    const ex & K,
    const ex & C_norm = numeric(1) )
```

6.39.3 Member Function Documentation

6.39.3.1 series()

```
ex GiNaC::Eisenstein_kernel::series (
    const relational & r,
    int order,
    unsigned options = 0 ) const [override], [virtual]
```

The series method for this class returns the qbar-expansion of the modular form, without an additional factor of $C_norm/qbar$.

This allows for easy use in the class [modular_form_kernel](#).

Reimplemented from [GiNaC::integration_kernel](#).

References [order](#), [q_expansion_modular_form\(\)](#), [qbar](#), [r](#), and [GiNaC::ex::series\(\)](#).

6.39.3.2 nops()

```
size_t GiNaC::Eisenstein_kernel::nops ( ) const [override], [virtual]
```

Number of operands/members.

Reimplemented from [GiNaC::basic](#).

6.39.3.3 op()

```
ex GiNaC::Eisenstein_kernel::op (
    size_t i ) const [override], [virtual]
```

Return operand/member at position i .

Reimplemented from [GiNaC::basic](#).

References [a](#), [b](#), [C_norm](#), [k](#), [K](#), and [N](#).

6.39.3.4 let_op()

```
ex & GiNaC::Eisenstein_kernel::let_op (
    size_t i ) [override], [virtual]
```

Return modifiable operand/member at position i .

Reimplemented from [GiNaC::basic](#).

References [a](#), [b](#), [C_norm](#), [GiNaC::basic::ensure_if_modifiable\(\)](#), [k](#), [K](#), and [N](#).

6.39.3.5 is_numeric()

```
bool GiNaC::Eisenstein_kernel::is_numeric (
    void ) const [override], [virtual]
```

This routine returns true, if the integration kernel can be evaluated numerically.

Reimplemented from [GiNaC::integration_kernel](#).

References [a](#), [b](#), [C_norm](#), [GiNaC::ex::evalf\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::integer](#), [k](#), [K](#), [N](#), [GiNaC::info_flags::nonnegint](#), [GiNaC::info_flags::numeric](#), and [GiNaC::info_flags::posint](#).

6.39.3.6 Laurent_series()

```
ex GiNaC::Eisenstein_kernel::Laurent_series (
    const ex & x,
    int order ) const [override], [virtual]
```

Returns the Laurent series, starting possibly with the pole term.

Neglected terms are of order $O(x^{order})$.

Reimplemented from [GiNaC::integration_kernel](#).

References [C_norm](#), [order](#), [q_expansion_modular_form\(\)](#), [GiNaC::ex::series\(\)](#), and [x](#).

6.39.3.7 get_numerical_value()

```
ex GiNaC::Eisenstein_kernel::get_numerical_value (
    const ex & qbar,
    int N_trunc = 0 ) const [override], [virtual]
```

Returns the value of the modular form.

Reimplemented from [GiNaC::integration_kernel](#).

References [C_norm](#), [GiNaC::integration_kernel::get_numerical_value_impl\(\)](#), and [qbar](#).

6.39.3.8 uses_Laurent_series()

```
bool GiNaC::Eisenstein_kernel::uses_Laurent_series ( ) const [override], [protected], [virtual]
```

Returns true, if the coefficients are computed from the Laurent series (in which case the method `Laurent_series` needs to be implemented).

Returns false if this is not the case (and the class has an implementation of `series_coeff_impl`).

Reimplemented from [GiNaC::integration_kernel](#).

6.39.3.9 q_expansion_modular_form()

```
ex GiNaC::Eisenstein_kernel::q_expansion_modular_form (
    const ex & q,
    int order ) const
```

References [a](#), [b](#), [k](#), [K](#), [N](#), and [order](#).

Referenced by [Laurent_series\(\)](#), and [series\(\)](#).

6.39.3.10 do_print()

```
void GiNaC::Eisenstein_kernel::do_print (
    const print_context & c,
    unsigned level ) const [protected]
```

References [a](#), [b](#), [c](#), [C_norm](#), [k](#), [K](#), [N](#), and [GiNaC::ex::print\(\)](#).

6.39.4 Member Data Documentation

6.39.4.1 k

```
ex GiNaC::Eisenstein_kernel::k [protected]
```

Referenced by [do_print\(\)](#), [is_numeric\(\)](#), [let_op\(\)](#), [op\(\)](#), and [q_expansion_modular_form\(\)](#).

6.39.4.2 N

```
ex GiNaC::Eisenstein_kernel::N [protected]
```

Referenced by [do_print\(\)](#), [is_numeric\(\)](#), [let_op\(\)](#), [op\(\)](#), and [q_expansion_modular_form\(\)](#).

6.39.4.3 a

```
ex GiNaC::Eisenstein_kernel::a [protected]
```

Referenced by [do_print\(\)](#), [is_numeric\(\)](#), [let_op\(\)](#), [op\(\)](#), and [q_expansion_modular_form\(\)](#).

6.39.4.4 b

`ex GiNaC::Eisenstein_kernel::b [protected]`

Referenced by [do_print\(\)](#), [is_numeric\(\)](#), [let_op\(\)](#), [op\(\)](#), and [q_expansion_modular_form\(\)](#).

6.39.4.5 K

`ex GiNaC::Eisenstein_kernel::K [protected]`

Referenced by [do_print\(\)](#), [is_numeric\(\)](#), [let_op\(\)](#), [op\(\)](#), and [q_expansion_modular_form\(\)](#).

6.39.4.6 C_norm

`ex GiNaC::Eisenstein_kernel::C_norm [protected]`

Referenced by [do_print\(\)](#), [get_numerical_value\(\)](#), [is_numeric\(\)](#), [Laurent_series\(\)](#), [let_op\(\)](#), and [op\(\)](#).

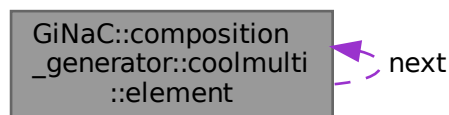
The documentation for this class was generated from the following files:

- [integration_kernel.h](#)
- [integration_kernel.cpp](#)

6.40 GiNaC::composition_generator::coolmulti::element Struct Reference

```
#include <utils.h>
```

Collaboration diagram for GiNaC::composition_generator::coolmulti::element:

**Public Member Functions**

- [element](#) (unsigned val, [element](#) *n)
- [~element](#) ()

Public Attributes

- unsigned [value](#)
- [element](#) * [next](#)

6.40.1 Constructor & Destructor Documentation

6.40.1.1 element()

```
GiNaC::composition_generator::coolmulti::element::element (
    unsigned val,
    element * n ) [inline]
```

6.40.1.2 ~element()

```
GiNaC::composition_generator::coolmulti::element::~~element ( ) [inline]
```

References [next](#).

6.40.2 Member Data Documentation

6.40.2.1 value

```
unsigned GiNaC::composition_generator::coolmulti::element::value
```

Referenced by [GiNaC::composition_generator::coolmulti::finished\(\)](#), [GiNaC::composition_generator::get\(\)](#), and [GiNaC::composition_generator::coolmulti::next_permutation\(\)](#).

6.40.2.2 next

```
element* GiNaC::composition_generator::coolmulti::element::next
```

Referenced by [GiNaC::composition_generator::coolmulti::coolmulti\(\)](#), [GiNaC::composition_generator::coolmulti::finished\(\)](#), [GiNaC::composition_generator::get\(\)](#), [GiNaC::composition_generator::coolmulti::next_permutation\(\)](#), and [~element\(\)](#).

The documentation for this struct was generated from the following file:

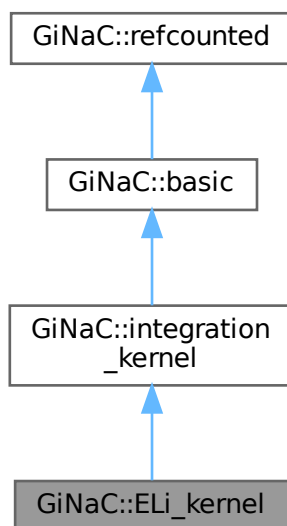
- [utils.h](#)

6.41 GiNaC::ELi_kernel Class Reference

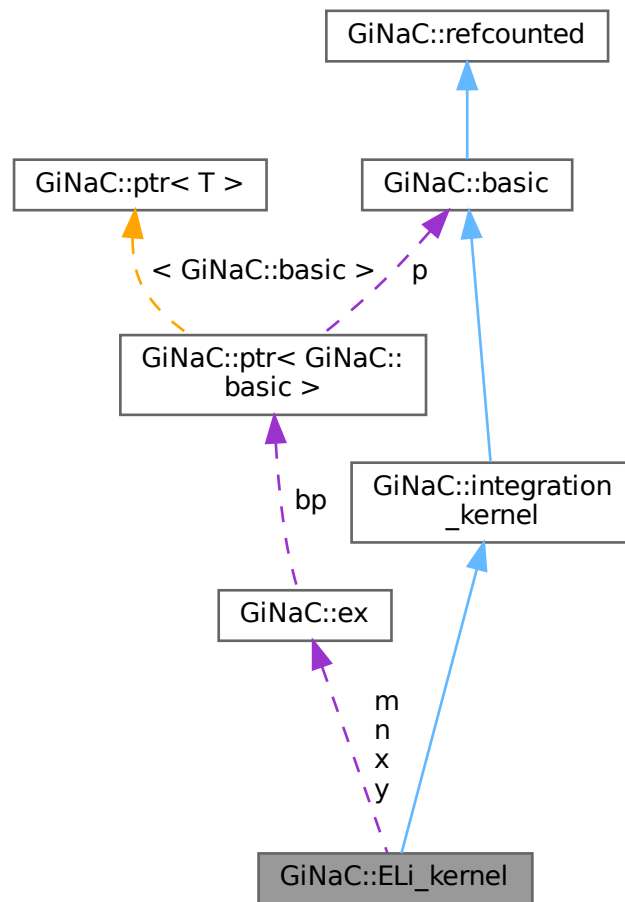
The ELi-kernel.

```
#include <integration_kernel.h>
```

Inheritance diagram for GiNaC::ELi_kernel:



Collaboration diagram for GiNaC::ELi_kernel:



Public Member Functions

- `ELi_kernel` (const `ex` &`n`, const `ex` &`m`, const `ex` &`x`, const `ex` &`y`)
- `size_t nops ()` const override
Number of operands/members.
- `ex op (size_t i)` const override
Return operand/member at position i.
- `ex & let_op (size_t i)` override
Return modifiable operand/member at position i.
- `bool is_numeric (void)` const override
This routine returns true, if the integration kernel can be evaluated numerically.
- `ex get_numerical_value (const ex &qbar, int N_trunc=0)` const override
Returns the value of $ELi_{\{n,m\}}(x,y,qbar)$

Public Member Functions inherited from [GiNaC::integration_kernel](#)

- [ex series](#) (const [relational](#) &r, int [order](#), unsigned [options](#)=0) const override
Default implementation of [ex::series\(\)](#).
- virtual bool [has_trailing_zero](#) (void) const
This routine returns true, if the integration kernel has a trailing zero.
- virtual bool [is_numeric](#) (void) const
This routine returns true, if the integration kernel can be evaluated numerically.
- virtual [ex Laurent_series](#) (const [ex](#) &x, int [order](#)) const
Returns the Laurent series, starting possibly with the pole term.
- virtual [ex get_numerical_value](#) (const [ex](#) &lambda, int N_trunc=0) const
Evaluates the integrand at lambda.
- size_t [get_cache_size](#) (void) const
Returns the current size of the cache.
- void [set_cache_step](#) (int cache_steps) const
Sets the step size by which the cache is increased.
- [ex get_series_coeff](#) (int i) const
Wrapper around [series_coeff\(i\)](#), converts [cl_N](#) to numeric.
- [cln::cl_N series_coeff](#) (int i) const
Subclasses have either to implement [series_coeff_impl](#) or the two methods [Laurent_series](#) and [uses_Laurent_series](#).

Public Member Functions inherited from [GiNaC::basic](#)

- virtual [~basic](#) ()
basic destructor, virtual because class [ex](#) will delete objects of derived classes via a [basic](#).*
- [basic](#) (const [basic](#) &other)
- const [basic](#) & [operator=](#) (const [basic](#) &other)
basic assignment operator: the other object might be of a derived class.
- virtual [basic * duplicate](#) () const
Create a clone of this object on the heap.
- virtual [ex eval](#) () const
Perform automatic non-interruptive term rewriting rules.
- virtual [ex evalf](#) () const
Evaluate object numerically.
- virtual [ex evalm](#) () const
Evaluate sums, products and integer powers of matrices.
- virtual [ex eval_integ](#) () const
Evaluate integrals, if result is known.
- virtual [ex eval_indexed](#) (const [basic](#) &i) const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void [print](#) (const [print_context](#) &c, unsigned level=0) const
Output to stream.
- virtual void [dbgprint](#) () const
Little wrapper around [print](#) to be called within a debugger.
- virtual void [dbgprinttree](#) () const
Little wrapper around [printtree](#) to be called within a debugger.
- virtual unsigned [precedence](#) () const
Return relative operator precedence (for parenthezing output).
- virtual bool [info](#) (unsigned inf) const
Information about the object.

- virtual `size_t nops ()` const
Number of operands/members.
- virtual `ex op (size_t i)` const
Return operand/member at position i.
- virtual `ex operator[] (const ex &index)` const
- virtual `ex operator[] (size_t i)` const
- virtual `ex & let_op (size_t i)`
Return modifiable operand/member at position i.
- virtual `ex & operator[] (const ex &index)`
- virtual `ex & operator[] (size_t i)`
- virtual `bool has (const ex &other, unsigned options=0)` const
Test for occurrence of a pattern.
- virtual `bool match (const ex &pattern, exmap &repls)` const
Check whether the expression matches a given pattern.
- virtual `ex subs (const exmap &m, unsigned options=0)` const
Substitute a set of objects by arbitrary expressions.
- virtual `ex map (map_function &f)` const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual `void accept (GiNaC::visitor &v)` const
- virtual `bool is_polynomial (const ex &var)` const
Check whether this is a polynomial in the given variables.
- virtual `int degree (const ex &s)` const
Return degree of highest power in object s.
- virtual `int ldegree (const ex &s)` const
Return degree of lowest power in object s.
- virtual `ex coeff (const ex &s, int n=1)` const
Return coefficient of degree n in object s.
- virtual `ex expand (unsigned options=0)` const
Expand expression, i.e.
- virtual `ex collect (const ex &s, bool distributed=false)` const
Sort expanded expression in terms of powers of some object(s).
- virtual `ex series (const relational &r, int order, unsigned options=0)` const
Default implementation of `ex::series()`.
- virtual `ex normal (exmap &repl, exmap &rev_lookup, lst &modifier)` const
Default implementation of `ex::normal()`.
- virtual `ex to_rational (exmap &repl)` const
Default implementation of `ex::to_rational()`.
- virtual `ex to_polynomial (exmap &repl)` const
- virtual `numeric integer_content ()` const
- virtual `ex smod (const numeric &xi)` const
Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- virtual `numeric max_coefficient ()` const
Implementation `ex::max_coefficient()`.
- virtual `exvector get_free_indices ()` const
Return a vector containing the free indices of an expression.
- virtual `ex add_indexed (const ex &self, const ex &other)` const
Add two indexed expressions.
- virtual `ex scalar_mul_indexed (const ex &self, const numeric &other)` const
Multiply an indexed expression with a scalar.
- virtual `bool contract_with (exvector::iterator self, exvector::iterator other, exvector &v)` const
Try to contract two indexed expressions that appear in the same product.

- virtual unsigned `return_type` () const
- virtual `return_type_t return_type_tinfo` () const
- virtual `ex conjugate` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const
- template<class T >
void `print_dispatch` (const `print_context` &c, unsigned level) const
Like `print()`, but dispatch to the specified class.
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const
Like `print()`, but dispatch to the specified class.
- virtual void `archive` (`archive_node` &n) const
Save (serialize) the object into archive node.
- virtual void `read_archive` (const `archive_node` &n, `lst` &syms)
Load (deserialize) the object from an archive node.
- `ex subs_one_level` (const `exmap` &m, unsigned `options`) const
Helper function for `subs()`.
- `ex diff` (const `symbol` &s, unsigned nth=1) const
Default interface of nth derivative `ex::diff(s, n)`.
- int `compare` (const `basic` &other) const
Compare objects syntactically to establish canonical ordering.
- bool `is_equal` (const `basic` &other) const
Test for syntactic equality.
- const `basic` & `hold` () const
Stop further evaluation.
- unsigned `gethash` () const
- const `basic` & `setflag` (unsigned f) const
Set some `status_flags`.
- const `basic` & `clearflag` (unsigned f) const
Clear some `status_flags`.

Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- unsigned int `add_reference` () noexcept
- unsigned int `remove_reference` () noexcept
- unsigned int `get_refcount` () const noexcept
- void `set_refcount` (unsigned int r) noexcept

Protected Member Functions

- `cln::cl_N series_coeff_impl` (int i) const override
For $\omega = d\lambda$ only the coefficient of λ^0 is non-zero.
- void `do_print` (const `print_context` &c, unsigned level) const

Protected Member Functions inherited from `GiNaC::integration_kernel`

- virtual bool `uses_Laurent_series` () const
Returns true, if the coefficients are computed from the Laurent series (in which case the method `Laurent_series` needs to be implemented).
- virtual `cln::cl_N series_coeff_impl` (int i) const
For $\omega = d\lambda$ only the coefficient of λ^0 is non-zero.
- `ex get_numerical_value_impl` (const `ex` &lambda, const `ex` &pre, int shift, int N_trunc) const
The actual implementation for computing a numerical value for the integrand.
- void `do_print` (const `print_context` &c, unsigned level) const

Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match_same_type](#) (const [basic](#) &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual [ex derivative](#) (const [symbol](#) &s) const
Default implementation of [ex::diff\(\)](#).
- virtual int [compare_same_type](#) (const [basic](#) &other) const
Returns order relation between two objects of same type.
- virtual bool [is_equal_same_type](#) (const [basic](#) &other) const
Returns true if two objects of same type are equal.
- virtual unsigned [calchash](#) () const
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- void [ensure_if_modifiable](#) () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
Default output to stream.
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
Tree output to stream.
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
Python parsable output to stream.

Protected Attributes

- [ex n](#)
- [ex m](#)
- [ex x](#)
- [ex y](#)

Protected Attributes inherited from [GiNaC::integration_kernel](#)

- int [cache_step_size](#)
- std::vector< [cln::cl_N](#) > [series_vec](#)

Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)
of type [status_flags](#)
- unsigned [hashvalue](#)
hash value

6.41.1 Detailed Description

The ELi-kernel.

This class represents the differential one-form

$$\omega_{n;m}^{\text{ELi}}(x; y) = \text{ELi}_{n;m}(x; y; \bar{q}) \frac{d\bar{q}}{\bar{q}}$$

6.41.2 Constructor & Destructor Documentation

6.41.2.1 ELi_kernel()

```
GiNaC::ELi_kernel::ELi_kernel (
    const ex & n,
    const ex & m,
    const ex & x,
    const ex & y )
```

6.41.3 Member Function Documentation

6.41.3.1 nops()

```
size_t GiNaC::ELi_kernel::nops ( ) const [override], [virtual]
```

Number of operands/members.

Reimplemented from [GiNaC::basic](#).

6.41.3.2 op()

```
ex GiNaC::ELi_kernel::op (
    size_t i ) const [override], [virtual]
```

Return operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [m](#), [n](#), [x](#), and [y](#).

6.41.3.3 let_op()

```
ex & GiNaC::ELi_kernel::let_op (
    size_t i ) [override], [virtual]
```

Return modifiable operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ensure_if_modifiable\(\)](#), [m](#), [n](#), [x](#), and [y](#).

6.41.3.4 is_numeric()

```
bool GiNaC::ELi_kernel::is_numeric (
    void ) const [override], [virtual]
```

This routine returns true, if the integration kernel can be evaluated numerically.

Reimplemented from [GiNaC::integration_kernel](#).

References [GiNaC::ex::evalf\(\)](#), [GiNaC::ex::info\(\)](#), [m](#), [n](#), [GiNaC::info_flags::nonnegint](#), [GiNaC::info_flags::numeric](#), [x](#), and [y](#).

6.41.3.5 get_numerical_value()

```
ex GiNaC::ELi_kernel::get_numerical_value (
    const ex & qbar,
    int N_trunc = 0 ) const [override], [virtual]
```

Returns the value of $\text{ELi}_{\{n,m\}}(x,y,qbar)$

Reimplemented from [GiNaC::integration_kernel](#).

References [GiNaC::integration_kernel::get_numerical_value_impl\(\)](#), and [qbar](#).

6.41.3.6 series_coeff_impl()

```
cln::cl_N GiNaC::ELi_kernel::series_coeff_impl (
    int i ) const [override], [protected], [virtual]
```

For $\omega = d\lambda$ only the coefficient of λ^0 is non-zero.

The i -th coefficient corresponds to the power λ^{i-1} .

Reimplemented from [GiNaC::integration_kernel](#).

References [GiNaC::ex::evalf\(\)](#), [k](#), [m](#), [n](#), [x](#), and [y](#).

6.41.3.7 do_print()

```
void GiNaC::ELi_kernel::do_print (
    const print_context & c,
    unsigned level ) const [protected]
```

References [c](#), [m](#), [n](#), [GiNaC::ex::print\(\)](#), [x](#), and [y](#).

6.41.4 Member Data Documentation

6.41.4.1 n

`ex GiNaC::ELi_kernel::n` [protected]

Referenced by [do_print\(\)](#), [is_numeric\(\)](#), [let_op\(\)](#), [op\(\)](#), and [series_coeff_impl\(\)](#).

6.41.4.2 m

`ex GiNaC::ELi_kernel::m` [protected]

Referenced by [do_print\(\)](#), [is_numeric\(\)](#), [let_op\(\)](#), [op\(\)](#), and [series_coeff_impl\(\)](#).

6.41.4.3 x

`ex GiNaC::ELi_kernel::x` [protected]

Referenced by [do_print\(\)](#), [is_numeric\(\)](#), [let_op\(\)](#), [op\(\)](#), and [series_coeff_impl\(\)](#).

6.41.4.4 y

`ex GiNaC::ELi_kernel::y` [protected]

Referenced by [do_print\(\)](#), [is_numeric\(\)](#), [let_op\(\)](#), [op\(\)](#), and [series_coeff_impl\(\)](#).

The documentation for this class was generated from the following files:

- [integration_kernel.h](#)
- [integration_kernel.cpp](#)

6.42 std::equal_to< GiNaC::ex > Struct Reference

Specialization of `std::equal_to()` for `ex` objects.

```
#include <ex.h>
```

Public Member Functions

- bool [operator\(\)](#) (const [GiNaC::ex](#) &e1, const [GiNaC::ex](#) &e2) const noexcept

6.42.1 Detailed Description

Specialization of std::equal_to() for ex objects.

6.42.2 Member Function Documentation

6.42.2.1 operator()

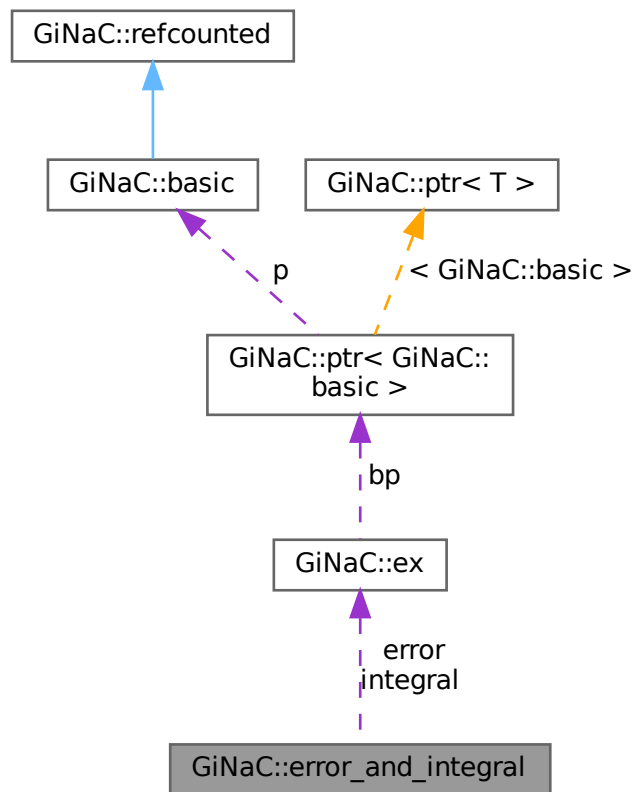
```
bool std::equal_to< GiNaC::ex >::operator() (
    const GiNaC::ex & e1,
    const GiNaC::ex & e2 ) const [inline], [noexcept]
```

The documentation for this struct was generated from the following file:

- [ex.h](#)

6.43 GiNaC::error_and_integral Struct Reference

Collaboration diagram for GiNaC::error_and_integral:



Public Member Functions

- [error_and_integral](#) (const [ex](#) &err, const [ex](#) &integ)

Public Attributes

- [ex error](#)
- [ex integral](#)

6.43.1 Constructor & Destructor Documentation

6.43.1.1 error_and_integral()

```
GiNaC::error_and_integral::error_and_integral (
    const ex & err,
    const ex & integ ) [inline]
```

6.43.2 Member Data Documentation

6.43.2.1 error

[ex](#) [GiNaC::error_and_integral::error](#)

Referenced by [GiNaC::error_and_integral_is_less::operator\(\)](#)).

6.43.2.2 integral

[ex](#) [GiNaC::error_and_integral::integral](#)

Referenced by [GiNaC::error_and_integral_is_less::operator\(\)](#)).

The documentation for this struct was generated from the following file:

- [integral.cpp](#)

6.44 GiNaC::error_and_integral_is_less Struct Reference

Public Member Functions

- [bool operator\(\)](#) (const [error_and_integral](#) &e1, const [error_and_integral](#) &e2) const

6.44.1 Member Function Documentation

6.44.1.1 operator()

```
bool GiNaC::error_and_integral_is_less::operator() (
    const error\_and\_integral & e1,
    const error\_and\_integral & e2 ) const [inline]
```

References [c](#), [GiNaC::ex::compare\(\)](#), [GiNaC::error_and_integral::error](#), and [GiNaC::error_and_integral::integral](#).

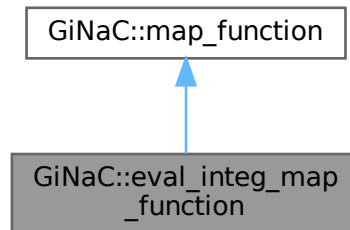
The documentation for this struct was generated from the following file:

- [integral.cpp](#)

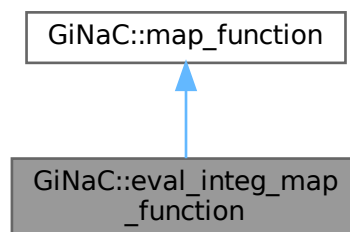
6.45 GiNaC::eval_integ_map_function Struct Reference

Function object to be applied by [basic::eval_integ\(\)](#).

Inheritance diagram for GiNaC::eval_integ_map_function:



Collaboration diagram for GiNaC::eval_integ_map_function:



Public Member Functions

- [ex operator\(\)](#) (const [ex](#) &e) override

Public Member Functions inherited from [GiNaC::map_function](#)

- virtual [~map_function](#) ()
- virtual [ex operator\(\)](#) (const [ex](#) &e)=0

Additional Inherited Members

Public Types inherited from [GiNaC::map_function](#)

- typedef const [ex](#) & [argument_type](#)
- typedef [ex](#) [result_type](#)

6.45.1 Detailed Description

Function object to be applied by [basic::eval_integ\(\)](#).

6.45.2 Member Function Documentation

6.45.2.1 operator()

```
ex GiNaC::eval_integ_map_function::operator() (
    const ex & e ) [inline], [override], [virtual]
```

Implements [GiNaC::map_function](#).

References [GiNaC::eval_integ\(\)](#).

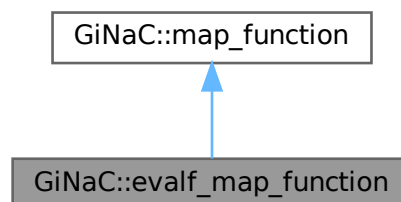
The documentation for this struct was generated from the following file:

- [basic.cpp](#)

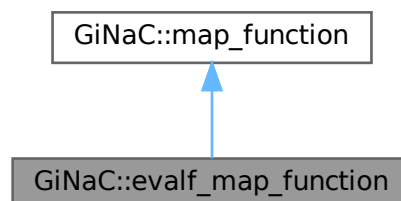
6.46 GiNaC::evalf_map_function Struct Reference

Function object to be applied by [basic::evalf\(\)](#).

Inheritance diagram for GiNaC::evalf_map_function:



Collaboration diagram for GiNaC::evalf_map_function:



Public Member Functions

- [ex operator\(\)](#) (const [ex](#) &e) override

Public Member Functions inherited from [GiNaC::map_function](#)

- virtual [~map_function](#) ()
- virtual [ex operator\(\)](#) (const [ex](#) &e)=0

Additional Inherited Members

Public Types inherited from [GiNaC::map_function](#)

- typedef const [ex](#) & [argument_type](#)
- typedef [ex](#) [result_type](#)

6.46.1 Detailed Description

Function object to be applied by [basic::evalf\(\)](#).

6.46.2 Member Function Documentation

6.46.2.1 [operator\(\)](#)()

```
ex GiNaC::evalf_map_function::operator() (  
    const ex & e ) [inline], [override], [virtual]
```

Implements [GiNaC::map_function](#).

References [GiNaC::evalf\(\)](#).

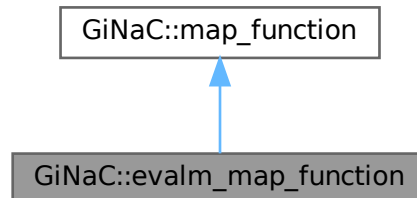
The documentation for this struct was generated from the following file:

- [basic.cpp](#)

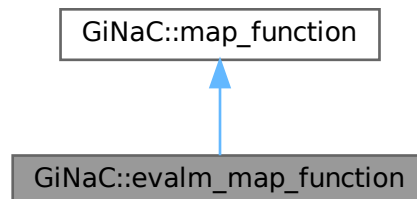
6.47 GiNaC::evalm_map_function Struct Reference

Function object to be applied by [basic::evalm\(\)](#).

Inheritance diagram for GiNaC::evalm_map_function:



Collaboration diagram for GiNaC::evalm_map_function:



Public Member Functions

- [ex operator\(\)](#) (const [ex](#) &*e*) override

Public Member Functions inherited from [GiNaC::map_function](#)

- virtual [~map_function](#) ()
- virtual [ex operator\(\)](#) (const [ex](#) &*e*)=0

Additional Inherited Members

Public Types inherited from [GiNaC::map_function](#)

- typedef const [ex](#) & [argument_type](#)
- typedef [ex](#) [result_type](#)

6.47.1 Detailed Description

Function object to be applied by [basic::evalm\(\)](#).

6.47.2 Member Function Documentation

6.47.2.1 operator()

```
ex GiNaC::evalm_map_function::operator() (
    const ex & e ) [inline], [override], [virtual]
```

Implements [GiNaC::map_function](#).

References [GiNaC::evalm\(\)](#).

The documentation for this struct was generated from the following file:

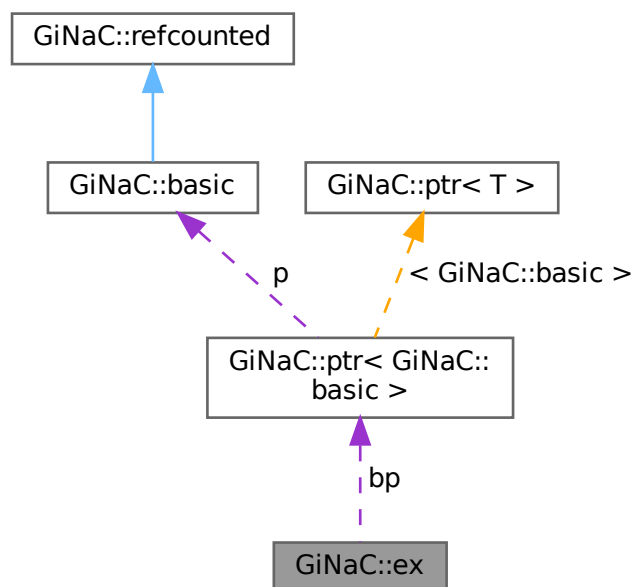
- [basic.cpp](#)

6.48 GiNaC::ex Class Reference

Lightweight wrapper for [GiNaC](#)'s symbolic objects.

```
#include <ex.h>
```

Collaboration diagram for [GiNaC::ex](#):



Public Member Functions

- `ex ()` noexcept
- `ex (const basic &other)`
- `ex (int i)`
- `ex (unsigned int i)`
- `ex (long i)`
- `ex (unsigned long i)`
- `ex (long long i)`
- `ex (unsigned long long i)`
- `ex (double const d)`
- `ex (const std::string &s, const ex &l)`
Construct ex from string and a list of symbols.
- `void swap (ex &other)` noexcept
Efficiently swap the contents of two expressions.
- `const_iterator begin ()` const noexcept
- `const_iterator end ()` const noexcept
- `const_preorder_iterator preorder_begin ()` const
- `const_preorder_iterator preorder_end ()` const noexcept
- `const_postorder_iterator postorder_begin ()` const
- `const_postorder_iterator postorder_end ()` const noexcept
- `ex eval ()` const
- `ex evalf ()` const
- `ex evalm ()` const
- `ex eval_ncmul (const exvector &v)` const
- `ex eval_integ ()` const
- `void print (const print_context &c, unsigned level=0)` const
Print expression to stream.
- `void dbgprint ()` const
Little wrapper around print to be called within a debugger.
- `void dbgprinttree ()` const
Little wrapper around printtree to be called within a debugger.
- `bool info (unsigned inf)` const
- `size_t nops ()` const
- `ex op (size_t i)` const
- `ex operator[] (const ex &index)` const
- `ex operator[] (size_t i)` const
- `ex &let_op (size_t i)`
Return modifiable operand/member at position i.
- `ex &operator[] (const ex &index)`
- `ex &operator[] (size_t i)`
- `ex lhs ()` const
Left hand side of relational expression.
- `ex rhs ()` const
Right hand side of relational expression.
- `ex conjugate ()` const
- `ex real_part ()` const
- `ex imag_part ()` const
- `bool has (const ex &pattern, unsigned options=0)` const
- `bool find (const ex &pattern, exset &found)` const
Find all occurrences of a pattern.
- `bool match (const ex &pattern)` const
Check whether expression matches a specified pattern.

- `bool match` (const `ex` &pattern, `exmap` &repls) const
- `ex subs` (const `exmap` &m, unsigned `options`=0) const
- `ex subs` (const `lst` &ls, const `lst` &lr, unsigned `options`=0) const
Substitute objects in an expression (syntactic substitution) and return the result as a new expression.
- `ex subs` (const `ex` &e, unsigned `options`=0) const
Substitute objects in an expression (syntactic substitution) and return the result as a new expression.
- `ex map` (`map_function` &f) const
- `ex map` (`ex`(*f)(const `ex` &e)) const
- `void accept` (`visitor` &v) const
- `void traverse_preorder` (`visitor` &v) const
Traverse expression tree with given visitor, preorder traversal.
- `void traverse_postorder` (`visitor` &v) const
Traverse expression tree with given visitor, postorder traversal.
- `void traverse` (`visitor` &v) const
- `bool is_polynomial` (const `ex` &vars) const
Check whether expression is a polynomial.
- `int degree` (const `ex` &s) const
- `int ldegree` (const `ex` &s) const
- `ex coeff` (const `ex` &s, int `n`=1) const
- `ex lcoeff` (const `ex` &s) const
- `ex tcoeff` (const `ex` &s) const
- `ex expand` (unsigned `options`=0) const
Expand an expression.
- `ex collect` (const `ex` &s, bool `distributed`=false) const
- `ex diff` (const `symbol` &s, unsigned `nth`=1) const
Compute partial derivative of an expression.
- `ex series` (const `ex` &r, int `order`, unsigned `options`=0) const
Compute the truncated series expansion of an expression.
- `ex normal` () const
Normalization of rational functions.
- `ex to_rational` (`exmap` &repl) const
Rationalization of non-rational functions.
- `ex to_polynomial` (`exmap` &repl) const
- `ex numer` () const
Get numerator of an expression.
- `ex denom` () const
Get denominator of an expression.
- `ex numer_denom` () const
Get numerator and denominator of an expression.
- `ex unit` (const `ex` &x) const
Compute unit part (= sign of leading coefficient) of a multivariate polynomial in $Q[x]$.
- `ex content` (const `ex` &x) const
Compute content part (= unit normal GCD of all coefficients) of a multivariate polynomial in $Q[x]$.
- `numeric_integer_content` () const
Compute the integer content (= GCD of all numeric coefficients) of an expanded polynomial.
- `ex primpart` (const `ex` &x) const
Compute primitive part of a multivariate polynomial in $Q[x]$.
- `ex primpart` (const `ex` &x, const `ex` &cont) const
Compute primitive part of a multivariate polynomial in $Q[x]$ when the content part is already known.
- `void unitcontprim` (const `ex` &x, `ex` &u, `ex` &c, `ex` &p) const
Compute unit part, content part, and primitive part of a multivariate polynomial in $Q[x]$.
- `ex smod` (const `numeric` &xi) const

- `numeric max_coefficient () const`
Return maximum (absolute value) coefficient of a polynomial.
- `exvector get_free_indices () const`
- `ex simplify_indexed (unsigned options=0) const`
Simplify/canonicalize expression containing indexed objects.
- `ex simplify_indexed (const scalar_products &sp, unsigned options=0) const`
Simplify/canonicalize expression containing indexed objects.
- `int compare (const ex &other) const`
- `bool is_equal (const ex &other) const`
- `bool is_zero () const`
- `bool is_zero_matrix () const`
Check whether expression is zero or zero matrix.
- `ex symmetrize () const`
Symmetrize expression over its free indices.
- `ex symmetrize (const lst &l) const`
Symmetrize expression over a list of objects (symbols, indices).
- `ex antisymmetrize () const`
Antisymmetrize expression over its free indices.
- `ex antisymmetrize (const lst &l) const`
Antisymmetrize expression over a list of objects (symbols, indices).
- `ex symmetrize_cyclic () const`
Symmetrize expression by cyclic permutation over its free indices.
- `ex symmetrize_cyclic (const lst &l) const`
Symmetrize expression by cyclic permutation over a list of objects (symbols, indices).
- `unsigned return_type () const`
- `return_type_t return_type_tinfo () const`
- `unsigned gethash () const`

Private Member Functions

- `void makewritableable ()`
Make this ex writable (if more than one ex handle the same basic) by unlinking the object and creating an unshared copy of it.
- `void share (const ex &other) const`
Share equal objects between expressions.

Static Private Member Functions

- `static ptr< basic > construct_from_basic (const basic &other)`
Helper function for the ex-from-basic constructor.
- `static basic & construct_from_int (int i)`
- `static basic & construct_from_uint (unsigned int i)`
- `static basic & construct_from_long (long i)`
- `static basic & construct_from_ulong (unsigned long i)`
- `static basic & construct_from_longlong (long long i)`
- `static basic & construct_from_ulonglong (unsigned long long i)`
- `static basic & construct_from_double (double d)`
- `static ptr< basic > construct_from_string_and_lst (const std::string &s, const ex &l)`

Private Attributes

- `ptr< basic > bp`
pointer to basic object managed by this

Friends

- class `archive_node`
- bool `are_ex_trivially_equal` (const `ex` &, const `ex` &)
Compare two objects of class quickly without doing a deep tree traversal.
- template<class T >
const T & `ex_to` (const `ex` &)
Return a reference to the basic-derived class T object embedded in an expression.
- template<class T >
bool `is_a` (const `ex` &)
Check if ex is a handle to a T, including base classes.
- template<class T >
bool `is_exactly_a` (const `ex` &)
Check if ex is a handle to a T, not including base classes.

6.48.1 Detailed Description

Lightweight wrapper for `GiNaC`'s symbolic objects.

It holds a pointer to the other object in order to do garbage collection by the method of reference counting. I.e., it is a smart pointer. Also, the constructor `ex::ex(const basic & other)` calls the methods that do automatic evaluation. E.g., `x-x` turns automatically into 0.

6.48.2 Constructor & Destructor Documentation

6.48.2.1 `ex()` [1/10]

```
GiNaC::ex::ex ( ) [inline], [noexcept]
```

References `bp`, `GiNaC::status_flags::dynallocated`, and `GINAC_ASSERT`.

6.48.2.2 `ex()` [2/10]

```
GiNaC::ex::ex (
    const basic & other ) [inline]
```

References `bp`, `GiNaC::status_flags::dynallocated`, and `GINAC_ASSERT`.

6.48.2.3 ex() [3/10]

```
GiNaC::ex::ex (
    int i ) [inline]
```

References [bp](#), [GiNaC::status_flags::dynallocated](#), and [GINAC_ASSERT](#).

6.48.2.4 ex() [4/10]

```
GiNaC::ex::ex (
    unsigned int i ) [inline]
```

References [bp](#), [GiNaC::status_flags::dynallocated](#), and [GINAC_ASSERT](#).

6.48.2.5 ex() [5/10]

```
GiNaC::ex::ex (
    long i ) [inline]
```

References [bp](#), [GiNaC::status_flags::dynallocated](#), and [GINAC_ASSERT](#).

6.48.2.6 ex() [6/10]

```
GiNaC::ex::ex (
    unsigned long i ) [inline]
```

References [bp](#), [GiNaC::status_flags::dynallocated](#), and [GINAC_ASSERT](#).

6.48.2.7 ex() [7/10]

```
GiNaC::ex::ex (
    long long i ) [inline]
```

References [bp](#), [GiNaC::status_flags::dynallocated](#), and [GINAC_ASSERT](#).

6.48.2.8 ex() [8/10]

```
GiNaC::ex::ex (
    unsigned long long i ) [inline]
```

References [bp](#), [GiNaC::status_flags::dynallocated](#), and [GINAC_ASSERT](#).

6.48.2.9 `ex()` [9/10]

```
GiNaC::ex::ex (
    double const d ) [inline]
```

References [bp](#), [GiNaC::status_flags::dynallocated](#), and [GINAC_ASSERT](#).

6.48.2.10 `ex()` [10/10]

```
GiNaC::ex::ex (
    const std::string & s,
    const ex & l ) [inline]
```

Construct `ex` from string and a list of symbols.

The input grammar is similar to the [GiNaC](#) output format. All symbols and indices to be used in the expression must be specified in a list in the second argument. Undefined symbols and other parser errors will throw an exception.

References [bp](#), [GiNaC::status_flags::dynallocated](#), and [GINAC_ASSERT](#).

6.48.3 Member Function Documentation

6.48.3.1 `swap()`

```
void GiNaC::ex::swap (
    ex & other ) [inline], [noexcept]
```

Efficiently swap the contents of two expressions.

References [bp](#), [GiNaC::status_flags::dynallocated](#), and [GINAC_ASSERT](#).

Referenced by [GiNaC::ncmul::derivative\(\)](#), [GiNaC::ex_swap::operator\(\)\(\)](#), [GiNaC::swap\(\)](#), [GiNaC::expair::swap\(\)](#), and [std::swap\(\)](#).

6.48.3.2 `begin()`

```
const\_iterator GiNaC::ex::begin ( ) const [inline], [noexcept]
```

Referenced by [GiNaC::abs_expand\(\)](#), [GiNaC::antisymmetrize\(\)](#), [GiNaC::divide_in_z\(\)](#), [GiNaC::ncmul::evalm\(\)](#), [GiNaC::exp_expand\(\)](#), [GiNaC::G3_eval\(\)](#), [GiNaC::G3_evalf\(\)](#), [GiNaC::Li_eval\(\)](#), [GiNaC::Li_evalf\(\)](#), [GiNaC::Li_print_latex\(\)](#), [GiNaC::log_expand\(\)](#), [GiNaC::expairseq::match\(\)](#), [GiNaC::rename_dummy_indices\(\)](#), [GiNaC::rename_dummy_indices_uniquely\(\)](#), [GiNaC::symmetrize\(\)](#), and [GiNaC::symmetrize_cyclic\(\)](#).

6.48.3.3 end()

```
const_iterator GiNaC::ex::end ( ) const [inline], [noexcept]
```

References [nops\(\)](#).

Referenced by [GiNaC::abs_expand\(\)](#), [GiNaC::mul::evalm\(\)](#), [GiNaC::exp_expand\(\)](#), [GiNaC::G3_eval\(\)](#), [GiNaC::G3_evalf\(\)](#), [GiNaC::Li_print_latex\(\)](#), [GiNaC::log_expand\(\)](#), and [GiNaC::rename_dummy_indices_uniquely\(\)](#).

6.48.3.4 preorder_begin()

```
const_preorder_iterator GiNaC::ex::preorder_begin ( ) const [inline]
```

References [nops\(\)](#).

6.48.3.5 preorder_end()

```
const_preorder_iterator GiNaC::ex::preorder_end ( ) const [inline], [noexcept]
```

6.48.3.6 postorder_begin()

```
const_postorder_iterator GiNaC::ex::postorder_begin ( ) const [inline]
```

References [nops\(\)](#).

6.48.3.7 postorder_end()

```
const_postorder_iterator GiNaC::ex::postorder_end ( ) const [inline], [noexcept]
```

6.48.3.8 eval()

```
ex GiNaC::ex::eval ( ) const [inline]
```

References [bp](#).

Referenced by [GiNaC::eval\(\)](#).

6.48.3.9 evalf()

```
ex GiNaC::ex::evalf ( ) const [inline]
```

References [bp](#).

Referenced by [GiNaC::adaptivesimpson\(\)](#), [GiNaC::EllipticE_evalf\(\)](#), [GiNaC::EllipticK_evalf\(\)](#), [GiNaC::constant::evalf\(\)](#), [GiNaC::integral::evalf\(\)](#), [GiNaC::mul::evalf\(\)](#), [GiNaC::power::evalf\(\)](#), [GiNaC::evalf\(\)](#), [GiNaC::fsolve\(\)](#), [GiNaC::Kronecker_dtau_kernel::get_numerical_value_impl\(\)](#), [GiNaC::H_eval\(\)](#), [GiNaC::H_evalf\(\)](#), [GiNaC::multiple_polylog_kernel::is_numeric\(\)](#), [GiNaC::ELi_kernel::is_numeric\(\)](#), [GiNaC::Ebar_kernel::is_numeric\(\)](#), [GiNaC::Kronecker_dtau_kernel::is_numeric\(\)](#), [GiNaC::Kronecker_dz_kernel::is_numeric\(\)](#), [GiNaC::Eisenstein_kernel::is_numeric\(\)](#), [GiNaC::Eisenstein_h_kernel::is_numeric\(\)](#), [GiNaC::modular_form_kernel::is_numeric\(\)](#), [GiNaC::user_defined_kernel::is_numeric\(\)](#), [GiNaC::iterated_integral_evalf_impl\(\)](#), [GiNaC::Li_evalf\(\)](#), [GiNaC::S_evalf\(\)](#), [GiNaC::integration_kernel::series_coeff\(\)](#), [GiNaC::multiple_polylog_kernel::series_coeff_impl\(\)](#), [GiNaC::ELi_kernel::series_coeff_impl\(\)](#), [GiNaC::Ebar_kernel::series_coeff_impl\(\)](#), [GiNaC::Kronecker_dtau_kernel::series_coeff_impl\(\)](#), [GiNaC::Kronecker_dz_kernel::series_coeff_impl\(\)](#), and [GiNaC::subsvalue\(\)](#).

6.48.3.10 evalm()

```
ex GiNaC::ex::evalm ( ) const [inline]
```

References [bp](#).

Referenced by [GiNaC::add::evalm\(\)](#), [GiNaC::mul::evalm\(\)](#), [GiNaC::power::evalm\(\)](#), [GiNaC::pseries::evalm\(\)](#), [GiNaC::evalm\(\)](#), and [is_zero_matrix\(\)](#).

6.48.3.11 eval_ncmul()

```
ex GiNaC::ex::eval_ncmul (
    const exvector & v ) const [inline]
```

References [bp](#).

Referenced by [GiNaC::integral::eval_ncmul\(\)](#), and [GiNaC::relational::eval_ncmul\(\)](#).

6.48.3.12 eval_integ()

```
ex GiNaC::ex::eval_integ ( ) const [inline]
```

References [bp](#).

Referenced by [GiNaC::integral::eval_integ\(\)](#), [GiNaC::pseries::eval_integ\(\)](#), and [GiNaC::eval_integ\(\)](#).

6.48.3.13 print()

```
void GiNaC::ex::print (
    const print\_context & c,
    unsigned level = 0 ) const
```

Print expression to stream.

The formatting of the output is determined by the kind of [print_context](#) object that is passed. Possible formattings include ginsh-parsable output (the default), tree-like output for debugging, and C++ source.

See also

[print_context](#)

References [bp](#), and [c](#).

Referenced by [GiNaC::abs_print_csrc_float\(\)](#), [GiNaC::abs_print_latex\(\)](#), [GiNaC::conjugate_print_latex\(\)](#), [GiNaC::integral::do_print\(\)](#), [GiNaC::multiple_polylog_kernel::do_print\(\)](#), [GiNaC::ELi_kernel::do_print\(\)](#), [GiNaC::Ebar_kernel::do_print\(\)](#), [GiNaC::Kronecker_dtau_kernel::do_print\(\)](#), [GiNaC::Kronecker_dz_kernel::do_print\(\)](#), [GiNaC::Eisenstein_kernel::do_print\(\)](#), [GiNaC::Eisenstein_h_kernel::do_print\(\)](#), [GiNaC::modular_form_kernel::do_print\(\)](#), [GiNaC::user_defined_kernel::do_print\(\)](#), [GiNaC::mul::do_print\(\)](#), [GiNaC::relational::do_print\(\)](#), [GiNaC::add::do_print_csrc\(\)](#), [GiNaC::idx::do_print_csrc\(\)](#), [GiNaC::mul::do_print_csrc\(\)](#), [GiNaC::power::do_print_csrc\(\)](#), [GiNaC::power::do_print_csrc_cl_N\(\)](#), [GiNaC::power::do_print_dflt\(\)](#), [GiNaC::integral::do_print_latex\(\)](#), [GiNaC::mul::do_print_latex\(\)](#), [GiNaC::power::do_print_latex\(\)](#), [GiNaC::add::do_print_python_repr\(\)](#), [GiNaC::mul::do_print_python_repr\(\)](#), [GiNaC::power::do_print_python_repr\(\)](#), [GiNaC::pseries::do_print_python_repr\(\)](#), [GiNaC::relational::do_print_python_repr\(\)](#), [GiNaC::basic::do_print_tree\(\)](#), [GiNaC::clifford::do_print_tree\(\)](#), [GiNaC::expairseq::do_print_tree\(\)](#), [GiNaC::idx::do_print_tree\(\)](#), [GiNaC::varidx::do_print_tree\(\)](#), [GiNaC::spinidx::do_print_tree\(\)](#), [GiNaC::pseries::do_print_tree\(\)](#), [GiNaC::factorial_print_dflt_latex\(\)](#), [GiNaC::H_print_latex\(\)](#), [GiNaC::imag_part_print_latex\(\)](#), [GiNaC::operator<<\(\)](#), [GiNaC::expair::print\(\)](#), [GiNaC::add::print_add\(\)](#), [GiNaC::idx::print_index\(\)](#), [GiNaC::mul::print_overall_coeff\(\)](#), [GiNaC::power::print_power\(\)](#), [GiNaC::pseries::print_series\(\)](#), [GiNaC::print_sym_pow\(\)](#), [GiNaC::expairseq::printpair\(\)](#), [GiNaC::expairseq::printseq\(\)](#), [GiNaC::real_part_print_latex\(\)](#), [GiNaC::S_print_latex\(\)](#), and [GiNaC::zeta1_print_latex\(\)](#).

6.48.3.14 dbgprint()

```
void GiNaC::ex::dbgprint ( ) const
```

Little wrapper around print to be called within a debugger.

References [bp](#).

6.48.3.15 dbgprinttree()

```
void GiNaC::ex::dbgprinttree ( ) const
```

Little wrapper around printtree to be called within a debugger.

References [bp](#).

6.48.3.16 info()

```
bool GiNaC::ex::info (
    unsigned int ) const [inline]
```

References [bp](#).

Referenced by [GiNaC::abs_eval\(\)](#), [GiNaC::abs_info\(\)](#), [GiNaC::abs_power\(\)](#), [GiNaC::acos_eval\(\)](#), [GiNaC::acosh_eval\(\)](#), [GiNaC::asin_eval\(\)](#), [GiNaC::asin_info\(\)](#), [GiNaC::asinh_conjugate\(\)](#), [GiNaC::asinh_eval\(\)](#), [GiNaC::atan2_eval\(\)](#), [GiNaC::atan2_info\(\)](#), [GiNaC::atan_conjugate\(\)](#), [GiNaC::atan_eval\(\)](#), [GiNaC::atan_info\(\)](#), [GiNaC::atanh_eval\(\)](#), [GiNaC::beta_eval\(\)](#), [GiNaC::beta_series\(\)](#), [GiNaC::mul::can_be_further_expanded\(\)](#), [GiNaC::mul::can_make_flat\(\)](#), [GiNaC::power::conjugate\(\)](#), [GiNaC::pseries::conjugate\(\)](#), [GiNaC::expairseq::construct_from_2_ex\(\)](#), [content\(\)](#), [GiNaC::cos_eval\(\)](#), [GiNaC::cosh_eval\(\)](#), [GiNaC::csgn_series\(\)](#), [GiNaC::matrix::determinant\(\)](#), [GiNaC::divide\(\)](#), [GiNaC::divide_in_z\(\)](#), [GiNaC::add::do_print_csrc\(\)](#), [GiNaC::idx::do_print_csrc\(\)](#), [GiNaC::power::do_print_csrc\(\)](#), [GiNaC::eta_eval\(\)](#), [GiNaC::eta_evalf\(\)](#), [GiNaC::eta_series\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::exp_eval\(\)](#), [GiNaC::exp_info\(\)](#), [GiNaC::exp_power\(\)](#), [GiNaC::power::expand\(\)](#), [GiNaC::find_common_factor\(\)](#), [GiNaC::func_arg_info\(\)](#), [GiNaC::G2_eval\(\)](#), [GiNaC::G2_evalf\(\)](#), [GiNaC::G3_eval\(\)](#), [GiNaC::G3_evalf\(\)](#), [GiNaC::gcd\(\)](#), [GiNaC::H_eval\(\)](#), [GiNaC::H_evalf\(\)](#), [GiNaC::power::has\(\)](#), [GiNaC::heur_gcd\(\)](#), [GiNaC::idx::idx\(\)](#), [GiNaC::power::imag_part\(\)](#), [GiNaC::pseries::imag_part\(\)](#), [GiNaC::add::info\(\)](#), [GiNaC::mul::info\(\)](#), [GiNaC::power::info\(\)](#), [GiNaC::multiple_polylog_kernel::is_numeric\(\)](#), [GiNaC::ELi_kernel::is_numeric\(\)](#), [GiNaC::Ebar_kernel::is_numeric\(\)](#), [GiNaC::Kronecker_dtau_kernel::is_numeric\(\)](#), [GiNaC::Kronecker_dz_kernel::is_numeric\(\)](#), [GiNaC::Eisenstein_kernel::is_numeric\(\)](#), [GiNaC::Eisenstein_h_kernel::is_numeric\(\)](#), [GiNaC::modular_form_kernel::is_numeric\(\)](#), [GiNaC::user_defined_kernel::is_numeric\(\)](#), [GiNaC::power::is_polynomial\(\)](#), [GiNaC::iterated_integral2_eval\(\)](#), [GiNaC::iterated_integral3_eval\(\)](#), [GiNaC::iterated_integral_evalf_impl\(\)](#), [GiNaC::lcm\(\)](#), [GiNaC::lcmcoeff\(\)](#), [GiNaC::lgamma_conjugate\(\)](#), [GiNaC::lgamma_eval\(\)](#), [GiNaC::lgamma_series\(\)](#), [GiNaC::Li2_conjugate\(\)](#), [GiNaC::Li2_eval\(\)](#), [GiNaC::Li2_series\(\)](#), [GiNaC::Li_eval\(\)](#), [GiNaC::Li_evalf\(\)](#), [GiNaC::Li_series\(\)](#), [GiNaC::log_conjugate\(\)](#), [GiNaC::log_eval\(\)](#), [GiNaC::log_expand\(\)](#), [GiNaC::log_imag_part\(\)](#), [GiNaC::log_info\(\)](#), [GiNaC::log_real_part\(\)](#), [GiNaC::log_series\(\)](#), [GiNaC::lsolve\(\)](#), [GiNaC::basic::normal\(\)](#), [GiNaC::power::normal\(\)](#), [GiNaC::relational::operator safe_bool\(\)](#), [GiNaC::Order_imag_part\(\)](#), [GiNaC::Order_power\(\)](#), [GiNaC::matrix::pow\(\)](#), [GiNaC::prem\(\)](#), [GiNaC::psi1_eval\(\)](#), [GiNaC::psi1_series\(\)](#), [GiNaC::psi2_eval\(\)](#), [GiNaC::psi2_series\(\)](#), [GiNaC::quo\(\)](#), [GiNaC::power::real_part\(\)](#), [GiNaC::pseries::real_part\(\)](#), [GiNaC::rem\(\)](#), [GiNaC::resultant\(\)](#), [GiNaC::S_eval\(\)](#), [GiNaC::S_evalf\(\)](#), [GiNaC::S_series\(\)](#), [GiNaC::mul::series\(\)](#), [GiNaC::power::series\(\)](#), [GiNaC::sin_eval\(\)](#), [GiNaC::sinh_eval\(\)](#), [GiNaC::sprem\(\)](#), [GiNaC::step_series\(\)](#), [subs\(\)](#), [GiNaC::tan_eval\(\)](#), [GiNaC::tanh_eval\(\)](#), [GiNaC::tgamma_eval\(\)](#), [GiNaC::tgamma_series\(\)](#), [GiNaC::expairseq::to_polynomial\(\)](#), [GiNaC::power::to_polynomial\(\)](#), [GiNaC::expairseq::to_rational\(\)](#), [GiNaC::power::to_rational\(\)](#), [GiNaC::matrix::trace\(\)](#), [GiNaC::trig_info\(\)](#), [GiNaC::tryfactsubs\(\)](#), [unitcontprim\(\)](#), [GiNaC::zeta2_deriv\(\)](#), and [GiNaC::zeta2_evalf\(\)](#).

6.48.3.17 nops()

```
size_t GiNaC::ex::nops ( ) const [inline]
```

References [bp](#).

Referenced by [GiNaC::abs_expand\(\)](#), [GiNaC::matrix::add_indexed\(\)](#), [GiNaC::algebraic_match_mul_with_mul\(\)](#), [GiNaC::ncmul::append_factors\(\)](#), [GiNaC::basic::collect\(\)](#), [GiNaC::collect_symbols\(\)](#), [GiNaC::color_trace\(\)](#), [GiNaC::ncmul::count_factors\(\)](#), [GiNaC::csgn_eval\(\)](#), [GiNaC::const_postorder_iterator::descend\(\)](#), [GiNaC::divide\(\)](#), [end\(\)](#), [GiNaC::indexed::eval\(\)](#), [GiNaC::exp_expand\(\)](#), [GiNaC::indexed::expand\(\)](#), [GiNaC::integral::expand\(\)](#), [GiNaC::mul::expand\(\)](#), [find\(\)](#), [GiNaC::find_common_factor\(\)](#), [GiNaC::G2_eval\(\)](#), [GiNaC::G2_evalf\(\)](#), [GiNaC::G3_eval\(\)](#), [GiNaC::G3_evalf\(\)](#), [GiNaC::gcd_pf_mul\(\)](#), [GiNaC::get_all_dummy_indices_safely\(\)](#), [GiNaC::get_first_symbol\(\)](#), [GiNaC::get_symbol_stats\(\)](#), [GiNaC::H_evalf\(\)](#), [GiNaC::hasindex\(\)](#), [GiNaC::haswild\(\)](#), [GiNaC::const_preorder_iterator::increment\(\)](#), [GiNaC::lcmcoeff\(\)](#), [GiNaC::Li2_series\(\)](#), [GiNaC::Li_deriv\(\)](#), [GiNaC::Li_eval\(\)](#), [GiNaC::Li_evalf\(\)](#), [GiNaC::log_expand\(\)](#), [GiNaC::lsolve\(\)](#), [GiNaC::expairseq::match\(\)](#), [GiNaC::basic::match\(\)](#), [GiNaC::multiply_lcm\(\)](#), [GiNaC::nops\(\)](#), [postorder_begin\(\)](#), [preorder_begin\(\)](#), [GiNaC::product_to_exvector\(\)](#), [GiNaC::rename_dummy_indices_uniquely\(\)](#), [GiNaC::matrix::scalar_mul_indexed\(\)](#), [GiNaC::integral::series\(\)](#), [GiNaC::step_eval\(\)](#), [GiNaC::symminfo::symminfo\(\)](#), [traverse_postorder\(\)](#), [traverse_preorder\(\)](#), [GiNaC::zeta1_evalf\(\)](#), and [GiNaC::zeta2_evalf\(\)](#).

6.48.3.18 op()

```
ex GiNaC::ex::op (
    size_t i ) const [inline]
```

References [bp](#).

Referenced by [GiNaC::abs_eval\(\)](#), [GiNaC::matrix::add_indexed\(\)](#), [GiNaC::algebraic_match_mul_with_mul\(\)](#), [GiNaC::ncmul::append_factors\(\)](#), [GiNaC::atan_series\(\)](#), [GiNaC::atanh_series\(\)](#), [GiNaC::mul::can_be_further_expanded\(\)](#), [GiNaC::basic::collect\(\)](#), [GiNaC::collect_symbols\(\)](#), [GiNaC::color_trace\(\)](#), [GiNaC::su3f::contract_with\(\)](#), [GiNaC::su3d::contract_with\(\)](#), [GiNaC::matrix::contract_with\(\)](#), [GiNaC::cos_eval\(\)](#), [GiNaC::cosh_eval\(\)](#), [GiNaC::ncmul::count_factors\(\)](#), [GiNaC::csgn_eval\(\)](#), [GiNaC::decomp_rational\(\)](#), [denom\(\)](#), [GiNaC::const_postorder_iterator::descend\(\)](#), [GiNaC::divide\(\)](#), [GiNaC::divide_in_z\(\)](#), [GiNaC::epsilon_tensor\(\)](#), [GiNaC::indexed::eval\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::integral::eval_integ\(\)](#), [GiNaC::exp_eval\(\)](#), [GiNaC::indexed::expand\(\)](#), [GiNaC::integral::expand\(\)](#), [GiNaC::mul::expand\(\)](#), [find\(\)](#), [GiNaC::find_common_factor\(\)](#), [GiNaC::matrix::fraction_free_elimination\(\)](#), [GiNaC::G2_eval\(\)](#), [GiNaC::G2_evalf\(\)](#), [GiNaC::G3_eval\(\)](#), [GiNaC::G3_evalf\(\)](#), [GiNaC::gcd_pf_mul\(\)](#), [GiNaC::gcd_pf_pow\(\)](#), [GiNaC::gcd_pf_pow_pow\(\)](#), [GiNaC::get_all_dummy_indices_safely\(\)](#), [GiNaC::get_first_symbol\(\)](#), [GiNaC::clifford::get_metric\(\)](#), [GiNaC::H_evalf\(\)](#), [GiNaC::power::has\(\)](#), [GiNaC::hasindex\(\)](#), [GiNaC::haswild\(\)](#), [GiNaC::const_preorder_iterator::increment\(\)](#), [GiNaC::lcmcoeff\(\)](#), [GiNaC::Li2_series\(\)](#), [GiNaC::Li_deriv\(\)](#), [GiNaC::Li_evalf\(\)](#), [GiNaC::log_eval\(\)](#), [GiNaC::lorentz_eps\(\)](#), [GiNaC::lsolve\(\)](#), [GiNaC::expairseq::match\(\)](#), [GiNaC::basic::match\(\)](#), [GiNaC::multiply_lcm\(\)](#), [normal\(\)](#), [GiNaC::basic::normal\(\)](#), [GiNaC::power::normal\(\)](#), [numer\(\)](#), [GiNaC::op\(\)](#), [GiNaC::op0_is_equal::operator\(\)\(\)](#), [GiNaC::ex_base_is_less::operator\(\)\(\)](#), [GiNaC::const_iterator::operator*\(\)](#), [GiNaC::const_iterator::operator\[\]\(\)](#), [GiNaC::product_to_exvector\(\)](#), [GiNaC::replace_with_symbol\(\)](#), [GiNaC::clifford::same_metric\(\)](#), [GiNaC::matrix::scalar_mul_indexed\(\)](#), [GiNaC::sin_eval\(\)](#), [GiNaC::sinh_eval\(\)](#), [GiNaC::spmapkey::spmapkey\(\)](#), [GiNaC::sqrfree_parfrac\(\)](#), [GiNaC::step_eval\(\)](#), [subs\(\)](#), [GiNaC::symminfo::symminfo\(\)](#), [GiNaC::tan_eval\(\)](#), [GiNaC::tanh_eval\(\)](#), [traverse_postorder\(\)](#), [traverse_preorder\(\)](#), [GiNaC::tryfactsubs\(\)](#), and [GiNaC::zeta2_deriv\(\)](#).

6.48.3.19 operator[]() [1/4]

```
ex GiNaC::ex::operator[] (
    const ex & index ) const [inline]
```

References [bp](#).

6.48.3.20 operator[]() [2/4]

```
ex GiNaC::ex::operator[] (
    size_t i ) const [inline]
```

References [bp](#).

6.48.3.21 let_op()

```
ex & GiNaC::ex::let_op (
    size_t i )
```

Return modifiable operand/member at position i.

References [bp](#), and [makewritable\(\)](#).

6.48.3.22 operator[]() [3/4]

```
ex & GiNaC::ex::operator[] (
    const ex & index )
```

References [bp](#), and [makewriteable\(\)](#).

6.48.3.23 operator[]() [4/4]

```
ex & GiNaC::ex::operator[] (
    size_t i )
```

References [bp](#), and [makewriteable\(\)](#).

6.48.3.24 lhs()

```
ex GiNaC::ex::lhs ( ) const
```

Left hand side of relational expression.

References [bp](#).

Referenced by [GiNaC::fsolve\(\)](#), [GiNaC::lhs\(\)](#), [GiNaC::pseries::pseries\(\)](#), and [GiNaC::Eisenstein_h_kernel::series\(\)](#).

6.48.3.25 rhs()

```
ex GiNaC::ex::rhs ( ) const
```

Right hand side of relational expression.

References [bp](#).

Referenced by [GiNaC::fsolve\(\)](#), [GiNaC::pseries::pseries\(\)](#), [GiNaC::rhs\(\)](#), and [GiNaC::Eisenstein_h_kernel::series\(\)](#).

6.48.3.26 conjugate()

```
ex GiNaC::ex::conjugate ( ) const [inline]
```

References [bp](#).

Referenced by [GiNaC::abs_expl_derivative\(\)](#), [GiNaC::abs_power\(\)](#), [GiNaC::acos_conjugate\(\)](#), [GiNaC::acosh_conjugate\(\)](#), [GiNaC::asin_conjugate\(\)](#), [GiNaC::asinh_conjugate\(\)](#), [GiNaC::atan_conjugate\(\)](#), [GiNaC::atanh_conjugate\(\)](#), [GiNaC::expair::conjugate\(\)](#), [GiNaC::add::conjugate\(\)](#), [GiNaC::expairseq::conjugate\(\)](#), [GiNaC::integral::conjugate\(\)](#), [GiNaC::mul::conjugate\(\)](#), [GiNaC::power::conjugate\(\)](#), [GiNaC::pseries::conjugate\(\)](#), [GiNaC::conjugate\(\)](#), [GiNaC::conjugate_eval\(\)](#), [GiNaC::conjugate_evalf\(\)](#), [GiNaC::conjugateepvector\(\)](#), [GiNaC::cos_conjugate\(\)](#), [GiNaC::cosh_conjugate\(\)](#), [GiNaC::exp_conjugate\(\)](#), [GiNaC::lgamma_conjugate\(\)](#), [GiNaC::Li2_conjugate\(\)](#), [GiNaC::log_conjugate\(\)](#), [GiNaC::sin_conjugate\(\)](#), [GiNaC::sinh_conjugate\(\)](#), [GiNaC::tan_conjugate\(\)](#), [GiNaC::tanh_conjugate\(\)](#), and [GiNaC::tgamma_conjugate\(\)](#).

6.48.3.27 real_part()

```
ex GiNaC::ex::real_part ( ) const [inline]
```

References [bp](#).

Referenced by [GiNaC::abs_eval\(\)](#), [GiNaC::asinh_conjugate\(\)](#), [GiNaC::atan_conjugate\(\)](#), [GiNaC::conjugate_real_part\(\)](#), [GiNaC::mul::find_real_imag\(\)](#), [GiNaC::power::imag_part\(\)](#), [GiNaC::pseries::imag_part\(\)](#), [GiNaC::add::real_part\(\)](#), [GiNaC::power::real_part\(\)](#), [GiNaC::pseries::real_part\(\)](#), [GiNaC::real_part\(\)](#), and [GiNaC::real_part_eval\(\)](#).

6.48.3.28 imag_part()

```
ex GiNaC::ex::imag_part ( ) const [inline]
```

References [bp](#).

Referenced by [GiNaC::acos_conjugate\(\)](#), [GiNaC::acosh_conjugate\(\)](#), [GiNaC::asin_conjugate\(\)](#), [GiNaC::asinh_conjugate\(\)](#), [GiNaC::atan_conjugate\(\)](#), [GiNaC::atanh_conjugate\(\)](#), [GiNaC::conjugate_imag_part\(\)](#), [GiNaC::mul::find_real_imag\(\)](#), [GiNaC::add::imag_part\(\)](#), [GiNaC::power::imag_part\(\)](#), [GiNaC::imag_part\(\)](#), [GiNaC::imag_part_eval\(\)](#), [GiNaC::lgamma_conjugate\(\)](#), [GiNaC::Li2_conjugate\(\)](#), [GiNaC::log_conjugate\(\)](#), and [GiNaC::power::real_part\(\)](#).

6.48.3.29 has()

```
bool GiNaC::ex::has (
    const ex & pattern,
    unsigned options = 0 ) const [inline]
```

References [bp](#), and [options](#).

Referenced by [GiNaC::power::degree\(\)](#), [GiNaC::integral::eval\(\)](#), [GiNaC::integral::eval_integ\(\)](#), [GiNaC::integral::expand\(\)](#), [GiNaC::basic::has\(\)](#), [GiNaC::has\(\)](#), [GiNaC::power::is_polynomial\(\)](#), and [GiNaC::power::ldegree\(\)](#).

6.48.3.30 find()

```
bool GiNaC::ex::find (
    const ex & pattern,
    exset & found ) const
```

Find all occurrences of a pattern.

The found matches are appended to the "found" list. If the expression itself matches the pattern, the children are not further examined. This function returns true when any matches were found.

References [find\(\)](#), [match\(\)](#), [nops\(\)](#), and [op\(\)](#).

Referenced by [GiNaC::divide_in_z\(\)](#), [find\(\)](#), [GiNaC::find\(\)](#), [GiNaC::pseries::mul_series\(\)](#), and [GiNaC::replace_with_symbol\(\)](#).

6.48.3.31 match() [1/2]

```
bool GiNaC::ex::match (
    const ex & pattern ) const
```

Check whether expression matches a specified pattern.

References [bp](#).

Referenced by [find\(\)](#), [GiNaC::power::has\(\)](#), [GiNaC::basic::match\(\)](#), [GiNaC::match\(\)](#), and [GiNaC::tryfactsubs\(\)](#).

6.48.3.32 match() [2/2]

```
bool GiNaC::ex::match (
    const ex & pattern,
    exmap & repls ) const [inline]
```

References [bp](#).

6.48.3.33 subs() [1/3]

```
ex GiNaC::ex::subs (
    const exmap & m,
    unsigned options = 0 ) const [inline]
```

References [bp](#), [m](#), and [options](#).

Referenced by [GiNaC::adaptivesimpson\(\)](#), [GiNaC::mul::algebraic_subs_mul\(\)](#), [GiNaC::atan_series\(\)](#), [GiNaC::atanh_series\(\)](#), [GiNaC::beta_series\(\)](#), [GiNaC::collect_common_factors\(\)](#), [GiNaC::integral::conjugate\(\)](#), [GiNaC::csgn_series\(\)](#), [denom\(\)](#), [GiNaC::integral::derivative\(\)](#), [GiNaC::divide_in_z\(\)](#), [GiNaC::EllipticE_series\(\)](#), [GiNaC::EllipticK_series\(\)](#), [GiNaC::eta_series\(\)](#), [GiNaC::tensdelta::eval_indexed\(\)](#), [GiNaC::integral::eval_integ\(\)](#), [GiNaC::integral::evalf\(\)](#), [GiNaC::expand_dummy_sum\(\)](#), [GiNaC::fsolve\(\)](#), [GiNaC::gcd\(\)](#), [GiNaC::clifford::get_metric\(\)](#), [GiNaC::H_evalf\(\)](#), [GiNaC::heur_gcd_z\(\)](#), [GiNaC::modular_form_kernel::is_numeric\(\)](#), [GiNaC::user_defined_kernel::is_numeric\(\)](#), [GiNaC::user_defined_kernel::Laurent_series\(\)](#), [GiNaC::lgamma_series\(\)](#), [GiNaC::Li2_series\(\)](#), [GiNaC::Li_series\(\)](#), [GiNaC::log_series\(\)](#), [normal\(\)](#), [GiNaC::basic::normal\(\)](#), [GiNaC::power::normal\(\)](#), [numer\(\)](#), [numer_denom\(\)](#), [GiNaC::psi1_series\(\)](#), [GiNaC::psi2_series\(\)](#), [GiNaC::rename_dummy_indices\(\)](#), [GiNaC::rename_dummy_indices_uniquely\(\)](#), [GiNaC::tensor::replace_contr_index\(\)](#), [GiNaC::replace_with_symbol\(\)](#), [GiNaC::S_series\(\)](#), [GiNaC::basic::series\(\)](#), [GiNaC::integral::series\(\)](#), [GiNaC::power::series\(\)](#), [GiNaC::step_series\(\)](#), [GiNaC::subs\(\)](#), [GiNaC::basic::subs\(\)](#), [GiNaC::clifford::subs\(\)](#), [GiNaC::idx::subs\(\)](#), [GiNaC::power::subs\(\)](#), [GiNaC::pseries::subs\(\)](#), [GiNaC::relational::subs\(\)](#), [GiNaC::basic::subs_one_level\(\)](#), [GiNaC::container< C >::subchildren\(\)](#), [GiNaC::expairseq::subchildren\(\)](#), [GiNaC::subsvalue\(\)](#), [GiNaC::symm\(\)](#), [GiNaC::symmetrize_cyclic\(\)](#), [GiNaC::tan_series\(\)](#), [GiNaC::tanh_series\(\)](#), and [GiNaC::tgamma_series\(\)](#).

6.48.3.34 subs() [2/3]

```
ex GiNaC::ex::subs (
    const lst & ls,
    const lst & lr,
    unsigned options = 0 ) const
```

Substitute objects in an expression (syntactic substitution) and return the result as a new expression.

References [GiNaC::container< C >::begin\(\)](#), [bp](#), [GiNaC::container< C >::end\(\)](#), [GINAC_ASSERT](#), [lr](#), [m](#), [GiNaC::container< C >::nops\(\)](#), [options](#), [GiNaC::subs_options::pattern_is_not_product](#), and [GiNaC::subs_options::pattern_is_product](#).

6.48.3.35 subs() [3/3]

```
ex GiNaC::ex::subs (
    const ex & e,
    unsigned options = 0 ) const
```

Substitute objects in an expression (syntactic substitution) and return the result as a new expression.

There are two valid types of replacement arguments: 1) a relational like `object==ex` and 2) a list of relationals `lst{object1==ex1,object2==ex2,...}`.

References [bp](#), [GINAC_ASSERT](#), [info\(\)](#), [GiNaC::info_flags::list](#), [m](#), [op\(\)](#), [options](#), [GiNaC::subs_options::pattern_is_not_product](#), [GiNaC::subs_options::pattern_is_product](#), [r](#), and [GiNaC::info_flags::relation_equal](#).

6.48.3.36 map() [1/2]

```
ex GiNaC::ex::map (
    map_function & f ) const [inline]
```

References [bp](#).

Referenced by [GiNaC::color_trace\(\)](#), and [GiNaC::expand_dummy_sum\(\)](#).

6.48.3.37 map() [2/2]

```
ex GiNaC::ex::map (
    ex(*) (const ex &e) f ) const
```

6.48.3.38 `accept()`

```
void GiNaC::ex::accept (
    visitor & v ) const [inline]
```

References [bp](#).

Referenced by [traverse_postorder\(\)](#), and [traverse_preorder\(\)](#).

6.48.3.39 `traverse_preorder()`

```
void GiNaC::ex::traverse_preorder (
    visitor & v ) const
```

Traverse expression tree with given visitor, preorder traversal.

References [accept\(\)](#), [n](#), [nops\(\)](#), [op\(\)](#), and [traverse_preorder\(\)](#).

Referenced by [traverse\(\)](#), and [traverse_preorder\(\)](#).

6.48.3.40 `traverse_postorder()`

```
void GiNaC::ex::traverse_postorder (
    visitor & v ) const
```

Traverse expression tree with given visitor, postorder traversal.

References [accept\(\)](#), [n](#), [nops\(\)](#), [op\(\)](#), and [traverse_postorder\(\)](#).

Referenced by [traverse_postorder\(\)](#).

6.48.3.41 `traverse()`

```
void GiNaC::ex::traverse (
    visitor & v ) const [inline]
```

References [traverse_preorder\(\)](#).

6.48.3.42 is_polynomial()

```
bool GiNaC::ex::is_polynomial (
    const ex & vars ) const
```

Check whether expression is a polynomial.

References [bp](#).

Referenced by [GiNaC::is_polynomial\(\)](#), and [GiNaC::power::is_polynomial\(\)](#).

6.48.3.43 degree()

```
int GiNaC::ex::degree (
    const ex & s ) const [inline]
```

References [bp](#).

Referenced by [GiNaC::basic::collect\(\)](#), [GiNaC::mul::degree\(\)](#), [GiNaC::power::degree\(\)](#), [GiNaC::degree\(\)](#), [GiNaC::divide\(\)](#), [GiNaC::divide_in_z\(\)](#), [GiNaC::get_symbol_stats\(\)](#), [GiNaC::heur_gcd_z\(\)](#), [lcoeff\(\)](#), [GiNaC::prem\(\)](#), [GiNaC::quo\(\)](#), [GiNaC::rem\(\)](#), [GiNaC::resultant\(\)](#), [GiNaC::sprem\(\)](#), and [GiNaC::sr_gcd\(\)](#).

6.48.3.44 ldegree()

```
int GiNaC::ex::ldegree (
    const ex & s ) const [inline]
```

References [bp](#).

Referenced by [GiNaC::gcd_pf_pow\(\)](#), [GiNaC::get_symbol_stats\(\)](#), [GiNaC::mul::ldegree\(\)](#), [GiNaC::power::ldegree\(\)](#), [GiNaC::ldegree\(\)](#), [GiNaC::Order_series\(\)](#), [GiNaC::resultant\(\)](#), [GiNaC::mul::series\(\)](#), [GiNaC::power::series\(\)](#), and [tcoeff\(\)](#).

6.48.3.45 coeff()

```
ex GiNaC::ex::coeff (
    const ex & s,
    int n = 1 ) const [inline]
```

References [bp](#), and [n](#).

Referenced by [GiNaC::Bernoulli_polynomial\(\)](#), [GiNaC::add::coeff\(\)](#), [GiNaC::mul::coeff\(\)](#), [GiNaC::pseries::coeff\(\)](#), [GiNaC::coeff\(\)](#), [GiNaC::basic::collect\(\)](#), [GiNaC::pseries::convert_to_poly\(\)](#), [GiNaC::mul::derivative\(\)](#), [GiNaC::divide\(\)](#), [GiNaC::divide_in_z\(\)](#), [GiNaC::mul::eval\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::pseries::eval_integ\(\)](#), [GiNaC::pseries::evalm\(\)](#), [GiNaC::pseries::expand\(\)](#), [GiNaC::power::expand_add_2\(\)](#), [GiNaC::expairseq::expandchildren\(\)](#), [GiNaC::generalised_Bernoulli_num\(\)](#), [GiNaC::add::imag_part\(\)](#), [lcoeff\(\)](#), [GiNaC::lsolve\(\)](#), [GiNaC::expairseq::make_flat\(\)](#), [GiNaC::pseries::normal\(\)](#), [GiNaC::prem\(\)](#), [GiNaC::pseries::print_series\(\)](#), [GiNaC::quo\(\)](#), [GiNaC::add::real_part\(\)](#), [GiNaC::rem\(\)](#), [GiNaC::resultant\(\)](#), [GiNaC::mul::series\(\)](#), [GiNaC::integration_kernel::series_coeff\(\)](#), [GiNaC::sprem\(\)](#), [GiNaC::sqfree_parfrac\(\)](#), [GiNaC::expairseq::subschildren\(\)](#), and [tcoeff\(\)](#).

6.48.3.46 lcoeff()

```
ex GiNaC::ex::lcoeff (
    const ex & s ) const [inline]
```

References [coeff\(\)](#), and [degree\(\)](#).

Referenced by [content\(\)](#), [GiNaC::get_symbol_stats\(\)](#), and [unit\(\)](#).

6.48.3.47 tcoeff()

```
ex GiNaC::ex::tcoeff (
    const ex & s ) const [inline]
```

References [coeff\(\)](#), and [ldegree\(\)](#).

6.48.3.48 expand()

```
ex GiNaC::ex::expand (
    unsigned options = 0 ) const
```

Expand an expression.

Parameters

<i>options</i>	see GiNaC::expand_options
----------------	---

References [bp](#), [GiNaC::status_flags::expanded](#), and [options](#).

Referenced by [GiNaC::abs_expand\(\)](#), [GiNaC::binomial_sym\(\)](#), [GiNaC::color_trace\(\)](#), [content\(\)](#), [GiNaC::matrix::determinant_minor\(\)](#), [GiNaC::divide\(\)](#), [GiNaC::divide_in_z\(\)](#), [GiNaC::exp_expand\(\)](#), [GiNaC::expand\(\)](#), [GiNaC::indexed::expand\(\)](#), [GiNaC::integral::expand\(\)](#), [GiNaC::mul::expand\(\)](#), [GiNaC::power::expand\(\)](#), [GiNaC::pseries::expand\(\)](#), [GiNaC::expand_dummy_sum\(\)](#), [GiNaC::expairseq::expandchildren\(\)](#), [GiNaC::mul::expandchildren\(\)](#), [GiNaC::ncmul::expandchildren\(\)](#), [GiNaC::mul::find_real_imag\(\)](#), [GiNaC::frac_cancel\(\)](#), [GiNaC::gcd\(\)](#), [GiNaC::heur_gcd_z\(\)](#), [GiNaC::log_expand\(\)](#), [GiNaC::lsolve\(\)](#), [GiNaC::expand_map_function::op\(\)](#), [GiNaC::prem\(\)](#), [GiNaC::quo\(\)](#), [GiNaC::rem\(\)](#), [GiNaC::resultant\(\)](#), [GiNaC::basic::series\(\)](#), [GiNaC::mul::series\(\)](#), [GiNaC::power::series\(\)](#), [GiNaC::sprem\(\)](#), [GiNaC::sqfree_parfrac\(\)](#), [GiNaC::matrix::trace\(\)](#), [unit\(\)](#), and [unitcontprim\(\)](#).

6.48.3.49 collect()

```
ex GiNaC::ex::collect (
    const ex & s,
    bool distributed = false ) const [inline]
```

References [bp](#).

Referenced by [GiNaC::matrix::charpoly\(\)](#), and [GiNaC::collect\(\)](#).

6.48.3.50 diff()

```
ex GiNaC::ex::diff (
    const symbol & s,
    unsigned nth = 1 ) const
```

Compute partial derivative of an expression.

Parameters

<i>s</i>	symbol by which the expression is derived
<i>nth</i>	order of derivative (default 1)

Returns

partial derivative as a new expression

References [bp](#).

Referenced by [GiNaC::abs_expl_derivative\(\)](#), [GiNaC::conjugate_expl_derivative\(\)](#), [GiNaC::integral::derivative\(\)](#), [GiNaC::power::derivative\(\)](#), [GiNaC::diff\(\)](#), [GiNaC::basic::diff\(\)](#), [GiNaC::fsolve\(\)](#), [GiNaC::imag_part_expl_derivative\(\)](#), [GiNaC::log_series\(\)](#), [GiNaC::Order_expl_derivative\(\)](#), [GiNaC::real_part_expl_derivative\(\)](#), [GiNaC::basic::series\(\)](#), and [GiNaC::sqrfree_yun\(\)](#).

6.48.3.51 series()

```
ex GiNaC::ex::series (
    const ex & r,
    int order,
    unsigned options = 0 ) const
```

Compute the truncated series expansion of an expression.

This function returns an expression containing an object of class `pseries` to represent the series. If the series does not terminate within the given truncation order, the last term of the series will be an order term.

Parameters

<i>r</i>	expansion relation, lhs holds variable and rhs holds point
<i>order</i>	truncation order of series calculations
<i>options</i>	of class series_options

Returns

an expression holding a `pseries` object

References [GiNaC::_ex0](#), [bp](#), [options](#), [order](#), and [r](#).

Referenced by [GiNaC::Bernoulli_polynomial\(\)](#), [GiNaC::EllipticE_series\(\)](#), [GiNaC::EllipticK_series\(\)](#), [GiNaC::generalised_Bernoulli_nu](#), [GiNaC::modular_form_kernel::Laurent_series\(\)](#), [GiNaC::integration_kernel::Laurent_series\(\)](#), [GiNaC::Eisenstein_kernel::Laurent_ser](#)

[GiNaC::Eisenstein_h_kernel::Laurent_series\(\)](#), [GiNaC::user_defined_kernel::Laurent_series\(\)](#), [GiNaC::Li2_series\(\)](#), [GiNaC::Li_series\(\)](#), [GiNaC::log_series\(\)](#), [GiNaC::Eisenstein_h_kernel::q_expansion_modular_form\(\)](#), [GiNaC::S_series\(\)](#), [GiNaC::series\(\)](#), [GiNaC::add::series\(\)](#), [GiNaC::integral::series\(\)](#), [GiNaC::Eisenstein_kernel::series\(\)](#), [GiNaC::Eisenstein_h_kernel::series\(\)](#), [GiNaC::modular_form_kernel::series\(\)](#), [GiNaC::pseries::series\(\)](#), [GiNaC::mul::series\(\)](#), [GiNaC::power::series\(\)](#), and [GiNaC::tgamma_series\(\)](#).

6.48.3.52 normal()

```
ex GiNaC::ex::normal ( ) const
```

Normalization of rational functions.

This function converts an expression to its normal form "numerator/denominator", where numerator and denominator are (relatively prime) polynomials. Any subexpressions which are not rational functions (like non-rational numbers, non-integer powers or functions like [sin\(\)](#), [cos\(\)](#) etc.) are replaced by temporary symbols which are re-substituted by the (normalized) subexpressions before [normal\(\)](#) returns (this way, any expression can be treated as a rational function). [normal\(\)](#) is applied recursively to arguments of functions etc.

Returns

normalized expression

References [bp](#), [GINAC_ASSERT](#), [GiNaC::subs_options::no_pattern](#), [GiNaC::container< C >::nops\(\)](#), [op\(\)](#), [GiNaC::container< C >::op\(\)](#), and [subs\(\)](#).

Referenced by [GiNaC::matrix::determinant\(\)](#), [GiNaC::matrix::fraction_free_elimination\(\)](#), [GiNaC::matrix::gauss_elimination\(\)](#), [GiNaC::normal\(\)](#), [GiNaC::power::normal\(\)](#), [GiNaC::pseries::normal\(\)](#), and [GiNaC::matrix::trace\(\)](#).

6.48.3.53 to_rational()

```
ex GiNaC::ex::to_rational (
    exmap & repl ) const
```

Rationalization of non-rational functions.

This function converts a general expression to a rational function by replacing all non-rational subexpressions (like non-rational numbers, non-integer powers or functions like [sin\(\)](#), [cos\(\)](#) etc.) to temporary symbols. This makes it possible to use functions like [gcd\(\)](#) and [divide\(\)](#) on non-rational functions by applying [to_rational\(\)](#) on the arguments, calling the desired function and re-substituting the temporary symbols in the result. To make the last step possible, all temporary symbols and their associated expressions are collected in the map specified by the repl parameter, ready to be passed as an argument to [ex::subs\(\)](#).

Parameters

<i>repl</i>	collects all temporary symbols and their replacements
-------------	---

Returns

rationalized expression

References [bp](#).

Referenced by [GiNaC::matrix::fraction_free_elimination\(\)](#), [GiNaC::to_rational\(\)](#), [GiNaC::expairseq::to_rational\(\)](#), and [GiNaC::power::to_rational\(\)](#).

6.48.3.54 to_polynomial()

```
ex GiNaC::ex::to_polynomial (
    exmap & repl ) const
```

References [bp](#).

Referenced by [GiNaC::find_common_factor\(\)](#), [GiNaC::to_polynomial\(\)](#), [GiNaC::expairseq::to_polynomial\(\)](#), and [GiNaC::power::to_polynomial\(\)](#).

6.48.3.55 numer()

```
ex GiNaC::ex::numer ( ) const
```

Get numerator of an expression.

If the expression is not of the normal form "numerator/denominator", it is first converted to this form and then the numerator is returned.

See also

[ex::normal](#)

Returns

numerator

References [bp](#), [GINAC_ASSERT](#), [GiNaC::subs_options::no_pattern](#), [GiNaC::container< C >::nops\(\)](#), [op\(\)](#), [GiNaC::container< C >::op\(\)](#), and [subs\(\)](#).

Referenced by [GiNaC::numer\(\)](#).

6.48.3.56 denom()

```
ex GiNaC::ex::denom ( ) const
```

Get denominator of an expression.

If the expression is not of the normal form "numerator/denominator", it is first converted to this form and then the denominator is returned.

See also

[ex::normal](#)

Returns

denominator

References [bp](#), [GINAC_ASSERT](#), [GiNaC::subs_options::no_pattern](#), [GiNaC::container< C >::nops\(\)](#), [op\(\)](#), [GiNaC::container< C >::op\(\)](#), and [subs\(\)](#).

Referenced by [GiNaC::denom\(\)](#).

6.48.3.57 numer_denom()

```
ex GiNaC::ex::numer_denom ( ) const
```

Get numerator and denominator of an expression.

If the expression is not of the normal form "numerator/denominator", it is first converted to this form and then a list [numerator, denominator] is returned.

See also

[ex::normal](#)

Returns

a list [numerator, denominator]

References [bp](#), [GINAC_ASSERT](#), [GiNaC::subs_options::no_pattern](#), [GiNaC::container< C >::nops\(\)](#), [GiNaC::container< C >::op\(\)](#), and [subs\(\)](#).

Referenced by [GiNaC::matrix::fraction_free_elimination\(\)](#), and [GiNaC::numer_denom\(\)](#).

6.48.3.58 unit()

```
ex GiNaC::ex::unit (
    const ex & x ) const
```

Compute unit part (= sign of leading coefficient) of a multivariate polynomial in Q[x].

The product of unit part, content part, and primitive part is the polynomial itself.

Parameters

<code>x</code>	main variable
----------------	---------------

Returns

unit part

See also

[ex::content](#), [ex::primpart](#), [ex::unitcontprim](#)

References [GiNaC::_ex1](#), [GiNaC::_ex_1](#), [c](#), [expand\(\)](#), [GiNaC::get_first_symbol\(\)](#), [lcoeff\(\)](#), [GiNaC::info_flags::negative](#), and [x](#).

Referenced by [content\(\)](#), and [GiNaC::frac_cancel\(\)](#).

6.48.3.59 content()

```
ex GiNaC::ex::content (
    const ex & x ) const
```

Compute content part (= unit normal GCD of all coefficients) of a multivariate polynomial in $\mathbb{Q}[x]$.

The product of unit part, content part, and primitive part is the polynomial itself.

Parameters

<code>x</code>	main variable
----------------	---------------

Returns

content part

See also

[ex::unit](#), [ex::primpart](#), [ex::unitcontprim](#)

References [GiNaC::_ex0](#), [c](#), [cont](#), [expand\(\)](#), [GiNaC::gcd\(\)](#), [info\(\)](#), [GiNaC::info_flags::integer](#), [integer_content\(\)](#), [is_zero\(\)](#), [lcoeff\(\)](#), [GiNaC::info_flags::negative](#), [r](#), [unit\(\)](#), and [x](#).

Referenced by [GiNaC::sr_gcd\(\)](#), and [unitcontprim\(\)](#).

6.48.3.60 integer_content()

```
numeric GiNaC::ex::integer_content ( ) const
```

Compute the integer content (= GCD of all numeric coefficients) of an expanded polynomial.

For a polynomial with rational coefficients, this returns g/l where g is the GCD of the coefficients' numerators and l is the LCM of the coefficients' denominators.

Returns

integer content

References [bp](#).

Referenced by [content\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::gcd\(\)](#), and [GiNaC::heur_gcd_z\(\)](#).

6.48.3.61 primpart() [1/2]

```
ex GiNaC::ex::primpart (
    const ex & x ) const
```

Compute primitive part of a multivariate polynomial in $\mathbb{Q}[x]$.

The result will be a unit-normal polynomial with a content part of 1. The product of unit part, content part, and primitive part is the polynomial itself.

Parameters

x	main variable
-----	---------------

Returns

primitive part

See also

[ex::unit](#), [ex::content](#), [ex::unitcontprim](#)

References [c](#), [unitcontprim\(\)](#), and [x](#).

Referenced by [GiNaC::sr_gcd\(\)](#).

6.48.3.62 primpart() [2/2]

```
ex GiNaC::ex::primpart (
    const ex & x,
    const ex & c ) const
```

Compute primitive part of a multivariate polynomial in $\mathbb{Q}[x]$ when the content part is already known.

This function is faster in computing the primitive part than the previous function.

Parameters

x	main variable
c	previously computed content part

Returns

primitive part

References [GiNaC::_ex0](#), [GiNaC::_ex1](#), [c](#), [is_zero\(\)](#), [GiNaC::quo\(\)](#), [unit](#), and [x](#).

6.48.3.63 unitcontprim()

```
void GiNaC::ex::unitcontprim (
    const ex &  $x$ ,
    ex &  $u$ ,
    ex &  $c$ ,
    ex &  $p$  ) const
```

Compute unit part, content part, and primitive part of a multivariate polynomial in $\mathbb{Q}[x]$.

The product of the three parts is the polynomial itself.

Parameters

x	main variable
u	unit part (returned)
c	content part (returned)
p	primitive part (returned)

See also

[ex::unit](#), [ex::content](#), [ex::primpart](#)

References [GiNaC::_ex0](#), [GiNaC::_ex1](#), [GiNaC::_ex_1](#), [GiNaC::abs\(\)](#), [c](#), [content\(\)](#), [expand\(\)](#), [info\(\)](#), [is_zero\(\)](#), [GiNaC::info_flags::negative](#), [GiNaC::quo\(\)](#), [unit](#), and [x](#).

Referenced by [GiNaC::gcd\(\)](#), and [primpart\(\)](#).

6.48.3.64 smod()

```
ex GiNaC::ex::smod (
    const numeric &  $xi$  ) const [inline]
```

References [bp](#).

Referenced by [GiNaC::interpolate\(\)](#).

6.48.3.65 max_coefficient()

```
numeric GiNaC::ex::max_coefficient ( ) const
```

Return maximum (absolute value) coefficient of a polynomial.

This function is used internally by [heur_gcd\(\)](#).

Returns

maximum coefficient

See also

[heur_gcd](#)

References [bp](#).

Referenced by [GiNaC::heur_gcd_z\(\)](#).

6.48.3.66 get_free_indices()

```
exvector GiNaC::ex::get_free_indices ( ) const [inline]
```

References [bp](#).

Referenced by [antisymmetrize\(\)](#), [GiNaC::get_all_dummy_indices_safely\(\)](#), [GiNaC::add::get_free_indices\(\)](#), [GiNaC::integral::get_free_indices\(\)](#), [GiNaC::mul::get_free_indices\(\)](#), [GiNaC::ncmul::get_free_indices\(\)](#), [GiNaC::clifford::get_metric\(\)](#), [GiNaC::clifford::same_metric\(\)](#), [symmetrize\(\)](#), and [symmetrize_cyclic\(\)](#).

6.48.3.67 simplify_indexed() [1/2]

```
ex GiNaC::ex::simplify_indexed (
    unsigned options = 0 ) const
```

Simplify/canonicalize expression containing indexed objects.

This performs contraction of dummy indices where possible and checks whether the free indices in sums are consistent.

Parameters

<i>options</i>	Simplification options (currently unused)
----------------	---

Returns

simplified expression

References [GiNaC::simplify_indexed\(\)](#).

Referenced by [GiNaC::tensepsilon::contract_with\(\)](#), and [GiNaC::simplify_indexed\(\)](#).

6.48.3.68 simplify_indexed() [2/2]

```
ex GiNaC::ex::simplify_indexed (
    const scalar_products & sp,
    unsigned options = 0 ) const
```

Simplify/canonicalize expression containing indexed objects.

This performs contraction of dummy indices where possible, checks whether the free indices in sums are consistent, and automatically replaces scalar products by known values if desired.

Parameters

<i>sp</i>	Scalar products to be replaced automatically
<i>options</i>	Simplification options (currently unused)

Returns

simplified expression

References [GiNaC::simplify_indexed\(\)](#).

6.48.3.69 compare()

```
int GiNaC::ex::compare (
    const ex & other ) const [inline]
```

References [bp](#), and [share\(\)](#).

Referenced by [GiNaC::expair::compare\(\)](#), [GiNaC::expairseq::construct_from_2_ex\(\)](#), [GiNaC::expair::is_less\(\)](#), [GiNaC::error_and_integral_is_less::operator\(\)](#), [GiNaC::ex_is_less::operator\(\)](#), [GiNaC::expair_rest_is_less::operator\(\)](#), [GiNaC::symminfo_is_less_by_symmterm::operator\(\)](#), [GiNaC::symminfo_is_less_by_orig::operator\(\)](#), [GiNaC::terminfo_is_less::operator\(\)](#), [GiNaC::spmapkey::operator<\(\)](#), and [GiNaC::spmapkey::spmapkey\(\)](#).

6.48.3.70 `is_equal()`

```
bool GiNaC::ex::is_equal (
    const ex & other ) const [inline]
```

References [bp](#), and [share\(\)](#).

Referenced by [GiNaC::abs_power\(\)](#), [GiNaC::acos_eval\(\)](#), [GiNaC::acosh_eval\(\)](#), [GiNaC::matrix::add_indexed\(\)](#), [GiNaC::asin_eval\(\)](#), [GiNaC::atan2_eval\(\)](#), [GiNaC::atan_eval\(\)](#), [GiNaC::atan_series\(\)](#), [GiNaC::atanh_eval\(\)](#), [GiNaC::atanh_series\(\)](#), [GiNaC::beta_eval\(\)](#), [GiNaC::power::coeff\(\)](#), [GiNaC::pseries::coeff\(\)](#), [GiNaC::add::combine_ex_with_coeff_to\(\)](#), [GiNaC::mul::combine_pair_with_coeff_to_pair\(\)](#), [GiNaC::conjugateepvector\(\)](#), [GiNaC::power::degree\(\)](#), [GiNaC::pseries::degree\(\)](#), [GiNaC::divide\(\)](#), [GiNaC::divide_in_z\(\)](#), [GiNaC::mul::do_print_csrc\(\)](#), [GiNaC::power::do_print_csrc\(\)](#), [GiNaC::power::do_print_csrc_cl\(\)](#), [GiNaC::power::do_print_dflt\(\)](#), [GiNaC::power::do_print_latex\(\)](#), [GiNaC::expairseq::do_print_tree\(\)](#), [GiNaC::epsilon_tensor\(\)](#), [GiNaC::mul::eval\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::matrix::eval_indexed\(\)](#), [GiNaC::tensdelta::eval_indexed\(\)](#), [GiNaC::tensmetric::eval_indexed\(\)](#), [GiNaC::mul::expand\(\)](#), [GiNaC::find_common_factor\(\)](#), [GiNaC::frac_cancel\(\)](#), [GiNaC::gcd\(\)](#), [GiNaC::gcd_pf_pow\(\)](#), [GiNaC::gcd_pf_pow_pow\(\)](#), [GiNaC::make_flat_inserter::handle_factor\(\)](#), [GiNaC::power::imag_part\(\)](#), [GiNaC::mul::info\(\)](#), [GiNaC::expair::is_canonical_numeric\(\)](#), [GiNaC::pseries::is_compatible_to\(\)](#), [GiNaC::idx::is_dummy_pair_same_type\(\)](#), [GiNaC::expair::is_equal\(\)](#), [GiNaC::expairseq::is_equal_same_type\(\)](#), [is_zero\(\)](#), [GiNaC::power::ldegree\(\)](#), [GiNaC::pseries::ldegree\(\)](#), [GiNaC::Li2_eval\(\)](#), [GiNaC::Li2_series\(\)](#), [GiNaC::Li_eval\(\)](#), [GiNaC::log_eval\(\)](#), [GiNaC::lorentz_eps\(\)](#), [GiNaC::expairseq::map\(\)](#), [GiNaC::expairseq::match\(\)](#), [GiNaC::idx::match_same_type\(\)](#), [GiNaC::minimal_dim\(\)](#), [GiNaC::pseries::mul_series\(\)](#), [GiNaC::multiply_lcm\(\)](#), [GiNaC::expairseq::nops\(\)](#), [GiNaC::power::normal\(\)](#), [GiNaC::expairseq::op\(\)](#), [GiNaC::ex_is_equal::operator\(\)](#), [GiNaC::op0_is_equal::operator\(\)](#), [GiNaC::idx_is_equal_ignore_dim::operator\(\)](#), [GiNaC::spmapkey::operator==\(\)](#), [GiNaC::add::print_add\(\)](#), [GiNaC::mul::print_overall_coeff\(\)](#), [GiNaC::expairseq::printseq\(\)](#), [GiNaC::product_to_exvector\(\)](#), [GiNaC::quo\(\)](#), [GiNaC::power::real_part\(\)](#), [GiNaC::mul::recombine_pair_to_ex\(\)](#), [GiNaC::rem\(\)](#), [GiNaC::replace_with_symbol\(\)](#), [GiNaC::clifford::same_metric\(\)](#), [GiNaC::pseries::series\(\)](#), [GiNaC::power::series\(\)](#), [GiNaC::add::split_ex_to_pair\(\)](#), and [GiNaC::sqrfree_yun\(\)](#).

6.48.3.71 `is_zero()`

```
bool GiNaC::ex::is_zero ( ) const [inline]
```

References [GiNaC::_ex0](#), and [is_equal\(\)](#).

Referenced by [GiNaC::acos_conjugate\(\)](#), [GiNaC::acos_eval\(\)](#), [GiNaC::acosh_conjugate\(\)](#), [GiNaC::acosh_eval\(\)](#), [GiNaC::pseries::add_series\(\)](#), [GiNaC::asin_conjugate\(\)](#), [GiNaC::asin_eval\(\)](#), [GiNaC::asinh_eval\(\)](#), [GiNaC::atan\(\)](#), [GiNaC::atan2_eval\(\)](#), [GiNaC::atan_eval\(\)](#), [GiNaC::atanh_conjugate\(\)](#), [GiNaC::atanh_eval\(\)](#), [GiNaC::add::coeff\(\)](#), [content\(\)](#), [GiNaC::cosh_eval\(\)](#), [GiNaC::add::degree\(\)](#), [GiNaC::fderivative::derivative\(\)](#), [GiNaC::function::derivative\(\)](#), [GiNaC::matrix::determinant\(\)](#), [GiNaC::matrix::determinant_minor\(\)](#), [GiNaC::basic::diff\(\)](#), [GiNaC::divide\(\)](#), [GiNaC::divide_in_z\(\)](#), [GiNaC::add::do_print_csrc\(\)](#), [GiNaC::add::eval\(\)](#), [GiNaC::function::eval\(\)](#), [GiNaC::indexed::eval\(\)](#), [GiNaC::mul::eval\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::pseries::evalm\(\)](#), [GiNaC::exp_eval\(\)](#), [GiNaC::mul::expand\(\)](#), [GiNaC::pseries::expand\(\)](#), [GiNaC::power::expand_add\(\)](#), [GiNaC::power::expand_add_2\(\)](#), [GiNaC::find_common_factor\(\)](#), [GiNaC::mul::find_real_imag\(\)](#), [GiNaC::frac_cancel\(\)](#), [GiNaC::gcd\(\)](#), [GiNaC::heur_gcd_z\(\)](#), [GiNaC::add::imag_part\(\)](#), [GiNaC::add::info\(\)](#), [GiNaC::interpolate\(\)](#), [GiNaC::is_zero\(\)](#), [is_zero_matrix\(\)](#), [GiNaC::add::ldegree\(\)](#), [GiNaC::lgamma_conjugate\(\)](#), [GiNaC::Li2_conjugate\(\)](#), [GiNaC::Li2_eval\(\)](#), [GiNaC::Li2_series\(\)](#), [GiNaC::Li3_eval\(\)](#), [GiNaC::Li_series\(\)](#), [GiNaC::log\(\)](#), [GiNaC::log_conjugate\(\)](#), [GiNaC::log_eval\(\)](#), [GiNaC::log_series\(\)](#), [GiNaC::matrix::markowitz_elimination\(\)](#), [GiNaC::pseries::mul_series\(\)](#), [GiNaC::pseries::normal\(\)](#), [GiNaC::relational::operator safe_bool\(\)](#), [GiNaC::Order_eval\(\)](#), [GiNaC::prem\(\)](#), [primpart\(\)](#), [GiNaC::add::print_add\(\)](#), [GiNaC::pseries::print_series\(\)](#), [GiNaC::quo\(\)](#), [GiNaC::add::real_part\(\)](#), [GiNaC::rem\(\)](#), [GiNaC::S_series\(\)](#), [GiNaC::clifford::same_metric\(\)](#), [GiNaC::basic::series\(\)](#), [GiNaC::power::series\(\)](#), [GiNaC::symbol::series\(\)](#), [GiNaC::sinh_eval\(\)](#), [GiNaC::add::smod\(\)](#), [GiNaC::sprem\(\)](#), [GiNaC::sqrfree_yun\(\)](#), [GiNaC::tanh_eval\(\)](#), [unitcontprim\(\)](#), and [GiNaC::indexed::validate\(\)](#).

6.48.3.72 is_zero_matrix()

```
bool GiNaC::ex::is_zero_matrix ( ) const
```

Check whether expression is zero or zero matrix.

References [evalm\(\)](#), and [is_zero\(\)](#).

6.48.3.73 symmetrize() [1/2]

```
ex GiNaC::ex::symmetrize ( ) const
```

Symmetrize expression over its free indices.

References [get_free_indices\(\)](#), and [GiNaC::symmetrize\(\)](#).

Referenced by [GiNaC::symmetrize\(\)](#).

6.48.3.74 symmetrize() [2/2]

```
ex GiNaC::ex::symmetrize (
    const lst & l ) const
```

Symmetrize expression over a list of objects (symbols, indices).

References [GiNaC::container< C >::begin\(\)](#), [GiNaC::container< C >::end\(\)](#), and [GiNaC::symm\(\)](#).

6.48.3.75 antisymmetrize() [1/2]

```
ex GiNaC::ex::antisymmetrize ( ) const
```

Antisymmetrize expression over its free indices.

References [GiNaC::antisymmetrize\(\)](#), and [get_free_indices\(\)](#).

Referenced by [GiNaC::antisymmetrize\(\)](#).

6.48.3.76 antisymmetrize() [2/2]

```
ex GiNaC::ex::antisymmetrize (
    const lst & l ) const
```

Antisymmetrize expression over a list of objects (symbols, indices).

References [GiNaC::container< C >::begin\(\)](#), [GiNaC::container< C >::end\(\)](#), and [GiNaC::symm\(\)](#).

6.48.3.77 symmetrize_cyclic() [1/2]

```
ex GiNaC::ex::symmetrize_cyclic ( ) const
```

Symmetrize expression by cyclic permutation over its free indices.

References [get_free_indices\(\)](#), and [GiNaC::symmetrize_cyclic\(\)](#).

Referenced by [GiNaC::symmetrize_cyclic\(\)](#).

6.48.3.78 symmetrize_cyclic() [2/2]

```
ex GiNaC::ex::symmetrize_cyclic (
    const lst & l ) const
```

Symmetrize expression by cyclic permutation over a list of objects (symbols, indices).

References [GiNaC::container< C >::begin\(\)](#), [GiNaC::container< C >::end\(\)](#), and [GiNaC::symmetrize_cyclic\(\)](#).

6.48.3.79 return_type()

```
unsigned GiNaC::ex::return_type ( ) const [inline]
```

References [bp](#).

Referenced by [GiNaC::ncmul::append_factors\(\)](#), [GiNaC::ncmul::count_factors\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::exmul\(\)](#), [GiNaC::matrix::mul_scalar\(\)](#), [GiNaC::indexed::return_type\(\)](#), [GiNaC::integral::return_type\(\)](#), [GiNaC::power::return_type\(\)](#), and [GiNaC::relational::return_type\(\)](#).

6.48.3.80 return_type_tinfo()

```
return_type_t GiNaC::ex::return_type_tinfo ( ) const [inline]
```

References [bp](#).

Referenced by [GiNaC::color_trace\(\)](#), [GiNaC::indexed::return_type_tinfo\(\)](#), [GiNaC::integral::return_type_tinfo\(\)](#), [GiNaC::power::return_type_tinfo\(\)](#), and [GiNaC::relational::return_type_tinfo\(\)](#).

6.48.3.81 gethash()

```
unsigned GiNaC::ex::gethash ( ) const [inline]
```

References [bp](#).

Referenced by [GiNaC::basic::calchash\(\)](#), [GiNaC::expairseq::calchash\(\)](#), [GiNaC::function::calchash\(\)](#), [GiNaC::idx::calchash\(\)](#), and [GiNaC::relational::calchash\(\)](#).

6.48.3.82 construct_from_basic()

```
ptr< basic > GiNaC::ex::construct_from_basic (
    const basic & other ) [static], [private]
```

Helper function for the ex-from-basic constructor.

This is where [GiNaC](#)'s automatic evaluator and memory management are implemented.

See also

[ex::ex\(const basic &\)](#)

References [bp](#), [GiNaC::basic::duplicate\(\)](#), [GiNaC::status_flags::dynallocated](#), [GiNaC::basic::eval\(\)](#), [GiNaC::status_flags::evaluated](#), [GiNaC::basic::flags](#), [GiNaC::refcounted::get_refcount\(\)](#), and [GINAC_ASSERT](#).

6.48.3.83 construct_from_int()

```
basic & GiNaC::ex::construct_from_int (
    int i ) [static], [private]
```

References [GiNaC::_num0_p](#), [GiNaC::_num10_p](#), [GiNaC::_num11_p](#), [GiNaC::_num12_p](#), [GiNaC::_num1_p](#), [GiNaC::_num2_p](#), [GiNaC::_num3_p](#), [GiNaC::_num4_p](#), [GiNaC::_num5_p](#), [GiNaC::_num6_p](#), [GiNaC::_num7_p](#), [GiNaC::_num8_p](#), [GiNaC::_num9_p](#), [GiNaC::_num_10_p](#), [GiNaC::_num_11_p](#), [GiNaC::_num_12_p](#), [GiNaC::_num_1_p](#), [GiNaC::_num_2_p](#), [GiNaC::_num_3_p](#), [GiNaC::_num_4_p](#), [GiNaC::_num_5_p](#), [GiNaC::_num_6_p](#), [GiNaC::_num_7_p](#), [GiNaC::_num_8_p](#), and [GiNaC::_num_9_p](#).

Referenced by [construct_from_longlong\(\)](#).

6.48.3.84 construct_from_uint()

```
basic & GiNaC::ex::construct_from_uint (
    unsigned int i ) [static], [private]
```

References [GiNaC::_num0_p](#), [GiNaC::_num10_p](#), [GiNaC::_num11_p](#), [GiNaC::_num12_p](#), [GiNaC::_num1_p](#), [GiNaC::_num2_p](#), [GiNaC::_num3_p](#), [GiNaC::_num4_p](#), [GiNaC::_num5_p](#), [GiNaC::_num6_p](#), [GiNaC::_num7_p](#), [GiNaC::_num8_p](#), and [GiNaC::_num9_p](#).

Referenced by [construct_from_ulonglong\(\)](#).

6.48.3.85 construct_from_long()

```
basic & GiNaC::ex::construct_from_long (
    long i ) [static], [private]
```

References [GiNaC::_num0_p](#), [GiNaC::_num10_p](#), [GiNaC::_num11_p](#), [GiNaC::_num12_p](#), [GiNaC::_num1_p](#), [GiNaC::_num2_p](#), [GiNaC::_num3_p](#), [GiNaC::_num4_p](#), [GiNaC::_num5_p](#), [GiNaC::_num6_p](#), [GiNaC::_num7_p](#), [GiNaC::_num8_p](#), [GiNaC::_num9_p](#), [GiNaC::_num_10_p](#), [GiNaC::_num_11_p](#), [GiNaC::_num_12_p](#), [GiNaC::_num_1_p](#), [GiNaC::_num_2_p](#), [GiNaC::_num_3_p](#), [GiNaC::_num_4_p](#), [GiNaC::_num_5_p](#), [GiNaC::_num_6_p](#), [GiNaC::_num_7_p](#), [GiNaC::_num_8_p](#), and [GiNaC::_num_9_p](#).

6.48.3.86 `construct_from_ulong()`

```
basic & GiNaC::ex::construct_from_ulong (
    unsigned long i ) [static], [private]
```

References [GiNaC::_num0_p](#), [GiNaC::_num10_p](#), [GiNaC::_num11_p](#), [GiNaC::_num12_p](#), [GiNaC::_num1_p](#), [GiNaC::_num2_p](#), [GiNaC::_num3_p](#), [GiNaC::_num4_p](#), [GiNaC::_num5_p](#), [GiNaC::_num6_p](#), [GiNaC::_num7_p](#), [GiNaC::_num8_p](#), and [GiNaC::_num9_p](#).

6.48.3.87 `construct_from_longlong()`

```
basic & GiNaC::ex::construct_from_longlong (
    long long i ) [static], [private]
```

References [construct_from_int\(\)](#).

6.48.3.88 `construct_from_ulonglong()`

```
basic & GiNaC::ex::construct_from_ulonglong (
    unsigned long long i ) [static], [private]
```

References [construct_from_uint\(\)](#).

6.48.3.89 `construct_from_double()`

```
basic & GiNaC::ex::construct_from_double (
    double d ) [static], [private]
```

6.48.3.90 `construct_from_string_and_lst()`

```
static ptr< basic > GiNaC::ex::construct_from_string_and_lst (
    const std::string & s,
    const ex & l ) [static], [private]
```

6.48.3.91 makewriteable()

```
void GiNaC::ex::makewriteable ( ) [private]
```

Make this ex writable (if more than one ex handle the same basic) by unlinking the object and creating an unshared copy of it.

References [bp](#), [GiNaC::status_flags::dynallocated](#), and [GINAC_ASSERT](#).

Referenced by [let_op\(\)](#), and [operator\[\]\(\)](#).

6.48.3.92 share()

```
void GiNaC::ex::share (
    const ex & other ) const [private]
```

Share equal objects between expressions.

See also

[ex::compare\(const ex &\)](#)

References [bp](#), and [GiNaC::status_flags::not_shareable](#).

Referenced by [compare\(\)](#), and [is_equal\(\)](#).

6.48.4 Friends And Related Function Documentation

6.48.4.1 archive_node

```
friend class archive\_node [friend]
```

6.48.4.2 are_ex_trivially_equal

```
bool are_ex_trivially_equal (
    const ex & e1,
    const ex & e2 ) [friend]
```

Compare two objects of class quickly without doing a deep tree traversal.

Returns

"true" if they are equal "false" if equality cannot be established quickly (e1 and e2 may still be equal, in this case).

6.48.4.3 `ex_to`

```
template<class T >
const T & ex_to (
    const ex & e ) [friend]
```

Return a reference to the basic-derived class T object embedded in an expression.

This is fast but unsafe: the result is undefined if the expression does not contain a T object at its top level. Hence, you should generally check the type of e first. Also, you shouldn't cache the returned reference because [GiNaC](#)'s garbage collector may destroy the referenced object any time it's used in another expression.

Parameters

<code>e</code>	expression
----------------	------------

Returns

reference to object of class T

See also

[is_exactly_a<class T>\(\)](#)

6.48.4.4 is_a

```
template<class T >
bool is_a (
    const ex & obj ) [friend]
```

Check if `ex` is a handle to a T, including base classes.

6.48.4.5 is_exactly_a

```
template<class T >
bool is_exactly_a (
    const ex & obj ) [friend]
```

Check if `ex` is a handle to a T, not including base classes.

6.48.5 Member Data Documentation

6.48.5.1 bp

```
ptr<basic> GiNaC::ex::bp [mutable], [private]
```

pointer to basic object managed by this

Referenced by [accept\(\)](#), [GiNaC::archive_node::archive_node\(\)](#), [coeff\(\)](#), [collect\(\)](#), [compare\(\)](#), [conjugate\(\)](#), [construct_from_basic\(\)](#), [dbgprint\(\)](#), [dbgprinttree\(\)](#), [degree\(\)](#), [denom\(\)](#), [diff\(\)](#), [eval\(\)](#), [eval_integ\(\)](#), [eval_ncmul\(\)](#), [evalf\(\)](#), [evalm\(\)](#), [ex\(\)](#), [expand\(\)](#), [get_free_indices\(\)](#), [gethash\(\)](#), [has\(\)](#), [GiNaC::archive_node::has_same_ex_as\(\)](#), [imag_part\(\)](#), [info\(\)](#), [integer_content\(\)](#), [is_equal\(\)](#), [is_polynomial\(\)](#), [ldegree\(\)](#), [let_op\(\)](#), [lhs\(\)](#), [makewriteable\(\)](#), [map\(\)](#), [match\(\)](#), [max_coefficient\(\)](#), [nops\(\)](#), [normal\(\)](#), [numer\(\)](#), [numer_denom\(\)](#), [op\(\)](#), [operator\[\]\(\)](#), [print\(\)](#), [GiNaC::archive_node::printraw\(\)](#), [real_part\(\)](#), [return_type\(\)](#), [return_type_tinfo\(\)](#), [rhs\(\)](#), [series\(\)](#), [share\(\)](#), [smod\(\)](#), [subs\(\)](#), [swap\(\)](#), [to_polynomial\(\)](#), and [to_rational\(\)](#).

The documentation for this class was generated from the following files:

- [ex.h](#)
- [ex.cpp](#)
- [indexed.cpp](#)
- [normal.cpp](#)
- [pseries.cpp](#)
- [symmetry.cpp](#)

6.49 GiNaC::ex_base_is_less Struct Reference

Public Member Functions

- bool [operator\(\)](#) (const [ex](#) &lh, const [ex](#) &rh) const

6.49.1 Member Function Documentation

6.49.1.1 operator()

```
bool GiNaC::ex_base_is_less::operator() (
    const ex & lh,
    const ex & rh ) const    [inline]
```

References [GiNaC::ex::op\(\)](#).

The documentation for this struct was generated from the following file:

- [indexed.cpp](#)

6.50 GiNaC::ex_is_equal Struct Reference

```
#include <ex.h>
```

Public Member Functions

- bool [operator\(\)](#) (const [ex](#) &lh, const [ex](#) &rh) const

6.50.1 Member Function Documentation

6.50.1.1 operator()

```
bool GiNaC::ex_is_equal::operator() (
    const ex & lh,
    const ex & rh ) const    [inline]
```

References [GiNaC::ex::is_equal\(\)](#).

The documentation for this struct was generated from the following file:

- [ex.h](#)

6.51 GiNaC::ex_is_less Struct Reference

```
#include <ex.h>
```

Public Member Functions

- bool [operator\(\)](#) (const [ex](#) &lh, const [ex](#) &rh) const

6.51.1 Member Function Documentation

6.51.1.1 operator()

```
bool GiNaC::ex_is_less::operator() (
    const ex & lh,
    const ex & rh ) const [inline]
```

References [GiNaC::ex::compare\(\)](#).

The documentation for this struct was generated from the following file:

- [ex.h](#)

6.52 GiNaC::ex_swap Struct Reference

```
#include <ex.h>
```

Public Member Functions

- void [operator\(\)](#) ([ex](#) &lh, [ex](#) &rh) const

6.52.1 Member Function Documentation

6.52.1.1 operator()

```
void GiNaC::ex_swap::operator() (
    ex & lh,
    ex & rh ) const [inline]
```

References [GiNaC::ex::swap\(\)](#).

The documentation for this struct was generated from the following file:

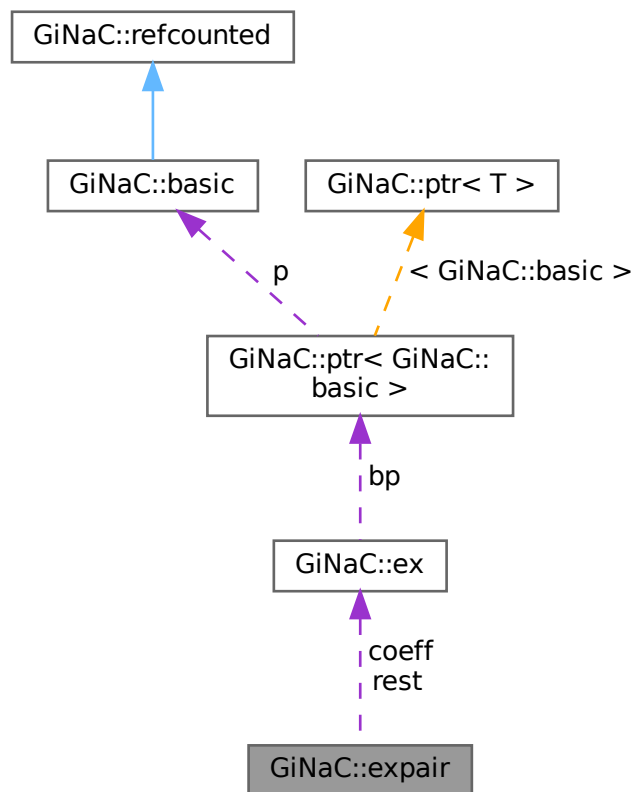
- [ex.h](#)

6.53 GiNaC::expair Class Reference

A pair of expressions.

```
#include <expair.h>
```

Collaboration diagram for GiNaC::expair:



Public Member Functions

- [expair](#) ()
- [expair](#) (const [ex](#) &r, const [ex](#) &c)
Construct an expair from two ex.
- bool [is_equal](#) (const [expair](#) &other) const
Member-wise check for canonical ordering equality.
- bool [is_less](#) (const [expair](#) &other) const
Member-wise check for canonical ordering lessness.
- int [compare](#) (const [expair](#) &other) const
Member-wise check for canonical ordering.
- void [print](#) (std::ostream &os) const
- bool [is_canonical_numeric](#) () const
True if this is of the form (numeric,ex(1)).
- void [swap](#) ([expair](#) &other)
Swap contents with other expair.
- const [expair](#) [conjugate](#) () const

Public Attributes

- [ex rest](#)
first member of pair, an arbitrary expression
- [ex coeff](#)
second member of pair, must be numeric

6.53.1 Detailed Description

A pair of expressions.

This is similar to STL's `pair<>`. It is slightly extended since we need to account for methods like `.compare()`. Also, since this is meant for use by class `expairseq` it must satisfy the invariance that the member `coeff` must be of type `numeric`.

6.53.2 Constructor & Destructor Documentation

6.53.2.1 `expair()` [1/2]

```
GiNaC::expair::expair ( ) [inline]
```

Referenced by [conjugate\(\)](#).

6.53.2.2 `expair()` [2/2]

```
GiNaC::expair::expair (
    const ex & r,
    const ex & c ) [inline]
```

Construct an `expair` from two `ex`.

References [coeff](#), and [GINAC_ASSERT](#).

6.53.3 Member Function Documentation

6.53.3.1 `is_equal()`

```
bool GiNaC::expair::is_equal (
    const expair & other ) const [inline]
```

Member-wise check for canonical ordering equality.

References [coeff](#), [GiNaC::ex::is_equal\(\)](#), and [rest](#).

Referenced by [GiNaC::expairseq::evalchildren\(\)](#), [GiNaC::mul::expair_needs_further_processing\(\)](#), and [GiNaC::expairseq::subschildre](#)

6.53.3.2 is_less()

```
bool GiNaC::expair::is_less (
    const expair & other ) const [inline]
```

Member-wise check for canonical ordering lessness.

References [coeff](#), [GiNaC::ex::compare\(\)](#), and [rest](#).

Referenced by [GiNaC::expair_is_less::operator\(\)](#).

6.53.3.3 compare()

```
int GiNaC::expair::compare (
    const expair & other ) const [inline]
```

Member-wise check for canonical ordering.

References [coeff](#), [GiNaC::ex::compare\(\)](#), and [rest](#).

6.53.3.4 print()

```
void GiNaC::expair::print (
    std::ostream & os ) const
```

References [c](#), [coeff](#), [GiNaC::ex::print\(\)](#), and [rest](#).

6.53.3.5 is_canonical_numeric()

```
bool GiNaC::expair::is_canonical_numeric ( ) const [inline]
```

True if this is of the form (numeric,ex(1)).

References [coeff](#), [GINAC_ASSERT](#), [GiNaC::ex::is_equal\(\)](#), and [rest](#).

6.53.3.6 swap()

```
void GiNaC::expair::swap (
    expair & other ) [inline]
```

Swap contents with other expair.

References [coeff](#), [rest](#), and [GiNaC::ex::swap\(\)](#).

Referenced by [GiNaC::mul::derivative\(\)](#), [GiNaC::expair_swap::operator\(\)](#), and [GiNaC::swap\(\)](#).

6.53.3.7 conjugate()

```
const expair GiNaC::expair::conjugate ( ) const
```

References [GiNaC::are_ex_trivially_equal\(\)](#), [coeff](#), [GiNaC::ex::conjugate\(\)](#), [expair\(\)](#), and [rest](#).

6.53.4 Member Data Documentation

6.53.4.1 rest

```
ex GiNaC::expair::rest
```

first member of pair, an arbitrary expression

Referenced by [GiNaC::expairseq::combine_pair_with_coeff_to_pair\(\)](#), [GiNaC::add::combine_pair_with_coeff_to_pair\(\)](#), [GiNaC::mul::combine_pair_with_coeff_to_pair\(\)](#), [compare\(\)](#), [conjugate\(\)](#), [GiNaC::expairseq::construct_from_2_ex\(\)](#), [GiNaC::expairseq::construct_from_expairseq_ex\(\)](#), [is_canonical_numeric\(\)](#), [is_equal\(\)](#), [is_less\(\)](#), [GiNaC::expair_rest_is_less::operator\(\)](#), [print\(\)](#), [GiNaC::expairseq::printpair\(\)](#), [GiNaC::expairseq::recombine_pair_to_ex\(\)](#), [GiNaC::add::recombine_pair_to_ex\(\)](#), [GiNaC::mul::recombine_pair_to_ex\(\)](#), and [swap\(\)](#).

6.53.4.2 coeff

```
ex GiNaC::expair::coeff
```

second member of pair, must be numeric

Referenced by [GiNaC::mul::can_make_flat\(\)](#), [GiNaC::expairseq::combine_pair_with_coeff_to_pair\(\)](#), [GiNaC::add::combine_pair_with_coeff_to_pair\(\)](#), [GiNaC::mul::combine_pair_with_coeff_to_pair\(\)](#), [compare\(\)](#), [conjugate\(\)](#), [GiNaC::expairseq::construct_from_2_ex\(\)](#), [GiNaC::expairseq::construct_from_expairseq_ex\(\)](#), [expair\(\)](#), [GiNaC::power::expand_mul\(\)](#), [is_canonical_numeric\(\)](#), [is_equal\(\)](#), [is_less\(\)](#), [print\(\)](#), [GiNaC::expairseq::printpair\(\)](#), [GiNaC::expairseq::recombine_pair_to_ex\(\)](#), [GiNaC::add::recombine_pair_to_ex\(\)](#), [GiNaC::mul::recombine_pair_to_ex\(\)](#), and [swap\(\)](#).

The documentation for this class was generated from the following files:

- [expair.h](#)
- [expair.cpp](#)

6.54 GiNaC::expair_is_less Struct Reference

Function object for insertion into third argument of STL's [sort\(\)](#) etc.

```
#include <expair.h>
```

Public Member Functions

- `bool operator()` (const `expair` &lh, const `expair` &rh) const

6.54.1 Detailed Description

Function object for insertion into third argument of STL's sort() etc.

6.54.2 Member Function Documentation

6.54.2.1 operator()

```
bool GiNaC::expair_is_less::operator() (
    const expair & lh,
    const expair & rh ) const [inline]
```

References `GiNaC::expair::is_less()`.

The documentation for this struct was generated from the following file:

- `expair.h`

6.55 GiNaC::expair_rest_is_less Struct Reference

Function object not caring about the numerical coefficients for insertion into third argument of STL's sort().

```
#include <expair.h>
```

Public Member Functions

- `bool operator()` (const `expair` &lh, const `expair` &rh) const

6.55.1 Detailed Description

Function object not caring about the numerical coefficients for insertion into third argument of STL's sort().

Note that this does not define a strict weak ordering since for any symbol x we have neither $3*x < 2*x$ or $2*x < 3*x$. Handle with care!

6.55.2 Member Function Documentation

6.55.2.1 operator()

```
bool GiNaC::expair_rest_is_less::operator() (
    const expair & lh,
    const expair & rh ) const [inline]
```

References [GiNaC::ex::compare\(\)](#), and [GiNaC::expair::rest](#).

The documentation for this struct was generated from the following file:

- [expair.h](#)

6.56 GiNaC::expair_swap Struct Reference

```
#include <expair.h>
```

Public Member Functions

- void [operator\(\)](#) ([expair](#) &lh, [expair](#) &rh) const

6.56.1 Member Function Documentation

6.56.1.1 operator()

```
void GiNaC::expair_swap::operator() (
    expair & lh,
    expair & rh ) const [inline]
```

References [GiNaC::expair::swap\(\)](#).

The documentation for this struct was generated from the following file:

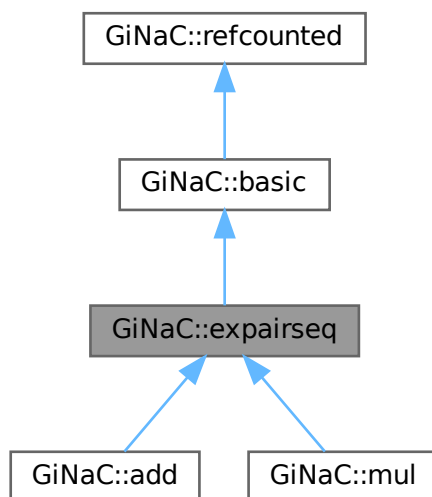
- [expair.h](#)

6.57 GiNaC::expairseq Class Reference

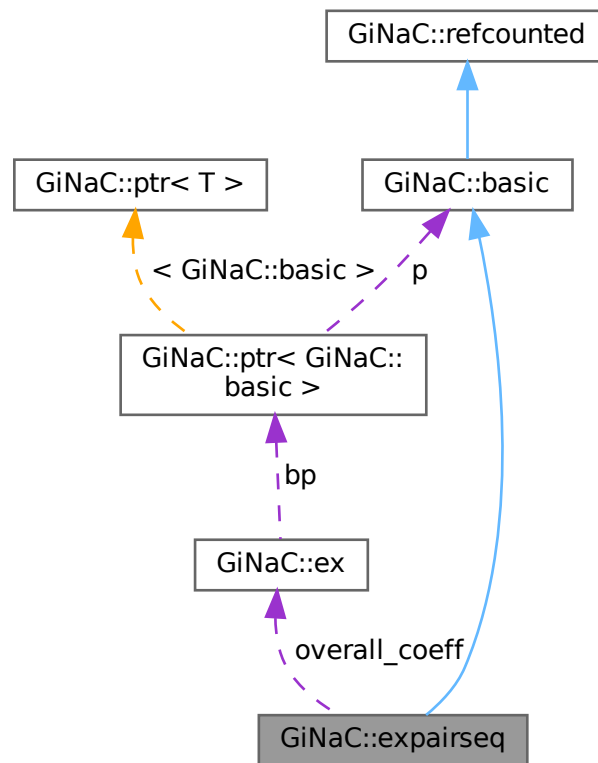
A sequence of class expair.

```
#include <expairseq.h>
```

Inheritance diagram for GiNaC::expairseq:



Collaboration diagram for GiNaC::expairseq:



Public Member Functions

- `expairseq` (const `ex` &lh, const `ex` &rh)
- `expairseq` (const `exvector` &v)
- `expairseq` (const `epvector` &v, const `ex` &oc, bool do_index_renaming=false)
- `expairseq` (`epvector` &&vp, const `ex` &oc, bool do_index_renaming=false)
- unsigned `precedence` () const override
Return relative operator precedence (for parenthezing output).
- bool `info` (unsigned inf) const override
Information about the object.
- size_t `nops` () const override
Number of operands/members.
- `ex op` (size_t i) const override
Return operand/member at position i.
- `ex map` (`map_function` &f) const override
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- `ex eval` () const override
Perform coefficient-wise automatic term rewriting rules in this class.
- `ex to_rational` (`exmap` &repl) const override
Implementation of `ex::to_rational()` for expairseqs.

- `ex to_polynomial` (`exmap` &`repl`) const override
Implementation of `ex::to_polynomial()` for `expairseqs`.
- bool `match` (const `ex` &`pattern`, `exmap` &`repl_lst`) const override
Check whether the expression matches a given pattern.
- `ex subs` (const `exmap` &`m`, unsigned `options`=0) const override
Substitute a set of objects by arbitrary expressions.
- `ex conjugate` () const override
- void `archive` (`archive_node` &`n`) const override
Save (serialize) the object into archive node.
- void `read_archive` (const `archive_node` &`n`, `lst` &`syms`) override
Load (deserialize) the object from an archive node.

Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()
basic destructor, virtual because class `ex` will delete objects of derived classes via a `basic`.*
- `basic` (const `basic` &`other`)
- const `basic` & `operator=` (const `basic` &`other`)
basic assignment operator: the other object might be of a derived class.
- virtual `basic * duplicate` () const
Create a clone of this object on the heap.
- virtual `ex eval` () const
Perform automatic non-interruptive term rewriting rules.
- virtual `ex evalf` () const
Evaluate object numerically.
- virtual `ex evalm` () const
Evaluate sums, products and integer powers of matrices.
- virtual `ex eval_integ` () const
Evaluate integrals, if result is known.
- virtual `ex eval_indexed` (const `basic` &`i`) const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void `print` (const `print_context` &`c`, unsigned `level`=0) const
Output to stream.
- virtual void `dbgprint` () const
Little wrapper around `print` to be called within a debugger.
- virtual void `dbgprinttree` () const
Little wrapper around `printtree` to be called within a debugger.
- virtual unsigned `precedence` () const
Return relative operator precedence (for parenthezing output).
- virtual bool `info` (unsigned `inf`) const
Information about the object.
- virtual size_t `nops` () const
Number of operands/members.
- virtual `ex op` (size_t `i`) const
Return operand/member at position `i`.
- virtual `ex operator[]` (const `ex` &`index`) const
- virtual `ex operator[]` (size_t `i`) const
- virtual `ex & let_op` (size_t `i`)
Return modifiable operand/member at position `i`.
- virtual `ex & operator[]` (const `ex` &`index`)

- virtual `ex & operator[]` (size_t i)
- virtual bool `has` (const `ex` &other, unsigned `options`=0) const
Test for occurrence of a pattern.
- virtual bool `match` (const `ex` &pattern, `exmap` &repls) const
Check whether the expression matches a given pattern.
- virtual `ex subs` (const `exmap` &m, unsigned `options`=0) const
Substitute a set of objects by arbitrary expressions.
- virtual `ex map` (`map_function` &f) const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void `accept` (GiNaC::visitor &v) const
- virtual bool `is_polynomial` (const `ex` &var) const
Check whether this is a polynomial in the given variables.
- virtual int `degree` (const `ex` &s) const
Return degree of highest power in object s.
- virtual int `ldegree` (const `ex` &s) const
Return degree of lowest power in object s.
- virtual `ex coeff` (const `ex` &s, int `n`=1) const
Return coefficient of degree n in object s.
- virtual `ex expand` (unsigned `options`=0) const
Expand expression, i.e.
- virtual `ex collect` (const `ex` &s, bool `distributed`=false) const
Sort expanded expression in terms of powers of some object(s).
- virtual `ex series` (const `relational` &r, int `order`, unsigned `options`=0) const
Default implementation of `ex::series()`.
- virtual `ex normal` (`exmap` &repl, `exmap` &rev_lookup, `lst` &modifier) const
Default implementation of `ex::normal()`.
- virtual `ex to_rational` (`exmap` &repl) const
Default implementation of `ex::to_rational()`.
- virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const
Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- virtual `numeric max_coefficient` () const
Implementation `ex::max_coefficient()`.
- virtual `exvector get_free_indices` () const
Return a vector containing the free indices of an expression.
- virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
Add two indexed expressions.
- virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
Multiply an indexed expression with a scalar.
- virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const
Try to contract two indexed expressions that appear in the same product.
- virtual unsigned `return_type` () const
- virtual `return_type_t return_type_info` () const
- virtual `ex conjugate` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const
- template<class T >
void `print_dispatch` (const `print_context` &c, unsigned level) const
Like `print()`, but dispatch to the specified class.
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const

- Like `print()`, but dispatch to the specified class.
- virtual void `archive` (`archive_node` &n) const
Save (serialize) the object into archive node.
- virtual void `read_archive` (const `archive_node` &n, `lst` &syms)
Load (deserialize) the object from an archive node.
- `ex subs_one_level` (const `exmap` &m, unsigned `options`) const
Helper function for `subs()`.
- `ex diff` (const `symbol` &s, unsigned `nth`=1) const
Default interface of `nth` derivative `ex::diff(s, n)`.
- int `compare` (const `basic` &other) const
Compare objects syntactically to establish canonical ordering.
- bool `is_equal` (const `basic` &other) const
Test for syntactic equality.
- const `basic` & `hold` () const
Stop further evaluation.
- unsigned `gethash` () const
- const `basic` & `setflag` (unsigned `f`) const
Set some `status_flags`.
- const `basic` & `clearflag` (unsigned `f`) const
Clear some `status_flags`.

Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- unsigned int `add_reference` () noexcept
- unsigned int `remove_reference` () noexcept
- unsigned int `get_refcount` () const noexcept
- void `set_refcount` (unsigned int `r`) noexcept

Protected Member Functions

- bool `is_equal_same_type` (const `basic` &other) const override
Returns true if two objects of same type are equal.
- unsigned `return_type` () const override
- unsigned `calchash` () const override
Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.
- `ex expand` (unsigned `options`=0) const override
Expand expression, i.e.
- virtual `ex thisexpairseq` (const `epvector` &v, const `ex` &oc, bool `do_index_renaming`=false) const
Create an object of this type.
- virtual `ex thisexpairseq` (`epvector` &&vp, const `ex` &oc, bool `do_index_renaming`=false) const
- virtual void `printseq` (const `print_context` &c, char `delim`, unsigned `this_precedence`, unsigned `upper_precedence`) const
- virtual void `printpair` (const `print_context` &c, const `expair` &p, unsigned `upper_precedence`) const
- virtual `expair split_ex_to_pair` (const `ex` &e) const
Form an `expair` from an `ex`, using the corresponding semantics.
- virtual `expair combine_ex_with_coeff_to_pair` (const `ex` &e, const `ex` &c) const
- virtual `expair combine_pair_with_coeff_to_pair` (const `expair` &p, const `ex` &c) const
- virtual `ex recombine_pair_to_ex` (const `expair` &p) const
Form an `ex` out of an `expair`, using the corresponding semantics.

- virtual bool [expair_needs_further_processing](#) (epp it)
- virtual [ex default_overall_coeff](#) () const
- virtual void [combine_overall_coeff](#) (const [ex](#) &c)
- virtual void [combine_overall_coeff](#) (const [ex](#) &c1, const [ex](#) &c2)
- virtual bool [can_make_flat](#) (const [expair](#) &p) const
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
- void [construct_from_2_ex](#) (const [ex](#) &lh, const [ex](#) &rh)
- void [construct_from_2_expairseq](#) (const [expairseq](#) &s1, const [expairseq](#) &s2)
- void [construct_from_expairseq_ex](#) (const [expairseq](#) &s, const [ex](#) &e)
- void [construct_from_exvector](#) (const [exvector](#) &v)
- void [construct_from_epvector](#) (const [epvector](#) &v, bool do_index_renaming=false)
- void [construct_from_epvector](#) ([epvector](#) &&v, bool do_index_renaming=false)
- void [make_flat](#) (const [exvector](#) &v)
Combine this expairseq with argument exvector.
- void [make_flat](#) (const [epvector](#) &v, bool do_index_renaming=false)
Combine this expairseq with argument epvector.
- void [canonicalize](#) ()
Brings this expairseq into a sorted (canonical) form.
- void [combine_same_terms_sorted_seq](#) ()
Compact a presorted expairseq by combining all matching expairs to one each.
- bool [is_canonical](#) () const
Check if this expairseq is in sorted (canonical) form.
- [epvector expandchildren](#) (unsigned [options](#)) const
Member-wise expand the expairs in this sequence.
- [epvector evalchildren](#) () const
Member-wise evaluate the expairs in this sequence.
- [epvector subschildren](#) (const [exmap](#) &m, unsigned [options](#)=0) const
Member-wise substitute in this sequence.

Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match_same_type](#) (const [basic](#) &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual [ex derivative](#) (const [symbol](#) &s) const
Default implementation of [ex::diff\(\)](#).
- virtual int [compare_same_type](#) (const [basic](#) &other) const
Returns order relation between two objects of same type.
- virtual bool [is_equal_same_type](#) (const [basic](#) &other) const
Returns true if two objects of same type are equal.
- virtual unsigned [calchash](#) () const
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- void [ensure_if_modifiable](#) () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
Default output to stream.
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
Tree output to stream.
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
Python parsable output to stream.

Protected Attributes

- [epvector seq](#)
- [ex overall_coeff](#)

Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)
of type [status_flags](#)
- unsigned [hashvalue](#)
hash value

6.57.1 Detailed Description

A sequence of class `expair`.

This is used for time-critical classes like sums and products of terms since handling a list of `coeff` and `rest` is much faster than handling a list of products or powers, respectively. (Not incidentally, Maple does it the same way, maybe others too.) The semantics is (at least) twofold: one for addition and one for multiplication and several methods have to be overridden by derived classes to reflect the change in semantics. However, most functionality turns out to be shared between addition and multiplication, which is the reason why there is this base class.

6.57.2 Constructor & Destructor Documentation

6.57.2.1 `expairseq()` [1/4]

```
GiNaC::expairseq::expairseq (
    const ex & lh,
    const ex & rh )
```

References [construct_from_2_ex\(\)](#), [GINAC_ASSERT](#), and [is_canonical\(\)](#).

6.57.2.2 `expairseq()` [2/4]

```
GiNaC::expairseq::expairseq (
    const exvector & v )
```

References [construct_from_exvector\(\)](#), [GINAC_ASSERT](#), and [is_canonical\(\)](#).

6.57.2.3 expairseq() [3/4]

```
GiNaC::expairseq::expairseq (
    const epvector & v,
    const ex & oc,
    bool do_index_renaming = false )
```

References [construct_from_epvector\(\)](#), [GINAC_ASSERT](#), and [is_canonical\(\)](#).

6.57.2.4 expairseq() [4/4]

```
GiNaC::expairseq::expairseq (
    epvector && vp,
    const ex & oc,
    bool do_index_renaming = false )
```

References [construct_from_epvector\(\)](#), [GINAC_ASSERT](#), and [is_canonical\(\)](#).

6.57.3 Member Function Documentation

6.57.3.1 precedence()

```
unsigned GiNaC::expairseq::precedence ( ) const \[inline\], \[override\], \[virtual\]
```

Return relative operator precedence (for parenthezing output).

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::mul](#).

Referenced by [do_print\(\)](#), and [printpair\(\)](#).

6.57.3.2 info()

```
bool GiNaC::expairseq::info (
    unsigned inf ) const \[override\], \[virtual\]
```

Information about the object.

See also

class [info_flags](#)

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::mul](#).

References [GiNaC::basic::clearflag\(\)](#), [GiNaC::status_flags::expanded](#), [GiNaC::info_flags::expanded](#), [GiNaC::basic::flags](#), [GiNaC::status_flags::has_indices](#), [GiNaC::info_flags::has_indices](#), [GiNaC::status_flags::has_no_indices](#), [seq](#), and [GiNaC::basic::setflag\(\)](#).

6.57.3.3 nops()

```
size_t GiNaC::expairseq::nops ( ) const [override], [virtual]
```

Number of operands/members.

Reimplemented from [GiNaC::basic](#).

References [default_overall_coeff\(\)](#), [GiNaC::ex::is_equal\(\)](#), [overall_coeff](#), and [seq](#).

Referenced by [GiNaC::algebraic_match_mul_with_mul\(\)](#), [GiNaC::mul::algebraic_subs_mul\(\)](#), [GiNaC::add::conjugate\(\)](#), [GiNaC::add::do_print_python_repr\(\)](#), [GiNaC::mul::do_print_python_repr\(\)](#), [do_print_tree\(\)](#), [GiNaC::power::expand_add\(\)](#), [GiNaC::power::expand_add_2\(\)](#), [GiNaC::add::get_free_indices\(\)](#), [GiNaC::mul::get_free_indices\(\)](#), [GiNaC::mul::has\(\)](#), and [match\(\)](#).

6.57.3.4 op()

```
ex GiNaC::expairseq::op (
    size_t i ) const [override], [virtual]
```

Return operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [default_overall_coeff\(\)](#), [GINAC_ASSERT](#), [GiNaC::ex::is_equal\(\)](#), [overall_coeff](#), [recombine_pair_to_ex\(\)](#), and [seq](#).

Referenced by [GiNaC::algebraic_match_mul_with_mul\(\)](#), [GiNaC::mul::algebraic_subs_mul\(\)](#), [GiNaC::add::conjugate\(\)](#), [GiNaC::add::do_print_python_repr\(\)](#), [GiNaC::mul::do_print_python_repr\(\)](#), [GiNaC::add::get_free_indices\(\)](#), [GiNaC::mul::get_free_indices\(\)](#), [match\(\)](#), [GiNaC::add::series\(\)](#), and [GiNaC::mul::series\(\)](#).

6.57.3.5 map()

```
ex GiNaC::expairseq::map (
    map_function & f ) const [override], [virtual]
```

Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).

Reimplemented from [GiNaC::basic](#).

References [default_overall_coeff\(\)](#), [GiNaC::ex::is_equal\(\)](#), [overall_coeff](#), [recombine_pair_to_ex\(\)](#), [seq](#), [split_ex_to_pair\(\)](#), and [thisexpairseq\(\)](#).

6.57.3.6 eval()

```
ex GiNaC::expairseq::eval ( ) const [override], [virtual]
```

Perform coefficient-wise automatic term rewriting rules in this class.

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::mul](#).

References [evalchildren\(\)](#), [GiNaC::status_flags::evaluated](#), [GiNaC::basic::flags](#), [GiNaC::basic::hold\(\)](#), and [overall_coeff](#).

6.57.3.7 to_rational()

```
ex GiNaC::expairseq::to_rational (
    exmap & repl ) const [override], [virtual]
```

Implementation of [ex::to_rational\(\)](#) for expairseqs.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex1](#), [default_overall_coeff\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::numeric](#), [overall_coeff](#), [recombine_pair_to_ex\(\)](#), [seq](#), [split_ex_to_pair\(\)](#), [thisexpairseq\(\)](#), [GiNaC::ex::to_rational\(\)](#), and [to_rational\(\)](#).

Referenced by [to_rational\(\)](#).

6.57.3.8 to_polynomial()

```
ex GiNaC::expairseq::to_polynomial (
    exmap & repl ) const [override], [virtual]
```

Implementation of [ex::to_polynomial\(\)](#) for expairseqs.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex1](#), [default_overall_coeff\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::numeric](#), [overall_coeff](#), [recombine_pair_to_ex\(\)](#), [seq](#), [split_ex_to_pair\(\)](#), [thisexpairseq\(\)](#), [GiNaC::ex::to_polynomial\(\)](#), and [to_polynomial\(\)](#).

Referenced by [to_polynomial\(\)](#).

6.57.3.9 match()

```
bool GiNaC::expairseq::match (
    const ex & pattern,
    exmap & repl_lst ) const [override], [virtual]
```

Check whether the expression matches a given pattern.

For every wildcard object in the pattern, a pair with the wildcard as a key and matching expression as a value is added to *repl_lst*.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::ex::begin\(\)](#), [default_overall_coeff\(\)](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::ex::nops\(\)](#), [nops\(\)](#), [GiNaC::ex::op\(\)](#), [op\(\)](#), [split_ex_to_pair\(\)](#), and [thisexpairseq\(\)](#).

6.57.3.10 subs()

```
ex GiNaC::expairseq::subs (
    const exmap & m,
    unsigned options = 0 ) const [override], [virtual]
```

Substitute a set of objects by arbitrary expressions.

The *ex* returned will already be evaluated.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::subs_options::algebraic](#), [m](#), [GiNaC::subs_options::no_index_renaming](#), [options](#), [overall_coeff](#), [GiNaC::basic::subs_one_level\(\)](#), [subschildren\(\)](#), and [thisexpairseq\(\)](#).

6.57.3.11 conjugate()

```
ex GiNaC::expairseq::conjugate ( ) const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::mul](#).

References [GiNaC::are_ex_trivially_equal\(\)](#), [GiNaC::ex::conjugate\(\)](#), [GiNaC::conjugateepvector\(\)](#), [overall_coeff](#), [seq](#), [thisexpairseq\(\)](#), and [x](#).

6.57.3.12 archive()

```
void GiNaC::expairseq::archive (
    archive_node & n ) const [override], [virtual]
```

Save (serialize) the object into archive node.

Archive the object.

Loosely speaking, this method turns an expression into a byte stream (which can be saved and restored later on, or sent via network, etc.)

Reimplemented from [GiNaC::basic](#).

References [n](#), [overall_coeff](#), and [seq](#).

6.57.3.13 read_archive()

```
void GiNaC::expairseq::read_archive (
    const archive_node & n,
    lst & syms ) [override], [virtual]
```

Load (deserialize) the object from an archive node.

Construct object from [archive_node](#).

Note

This method is essentially a constructor. However, constructors can't be virtual. So, if unarchiving routines are implemented as constructors one would need to define such a constructor in every class, even if all it does is simply calling constructor of a superclass.

Reimplemented from [GiNaC::basic](#).

References [canonicalize\(\)](#), [GiNaC::basic::coeff\(\)](#), [GINAC_ASSERT](#), [is_canonical\(\)](#), [n](#), [overall_coeff](#), and [seq](#).

6.57.3.14 is_equal_same_type()

```
bool GiNaC::expairseq::is_equal_same_type (
    const basic & other ) const [override], [protected], [virtual]
```

Returns true if two objects of same type are equal.

Normally needs not be reimplemented as long as it wasn't overwritten by some parent class, since it just calls [compare_same_type\(\)](#). The reason why this function exists is that sometimes it is easier to determine equality than an order relation and then it can be overridden.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::ex::is_equal\(\)](#), [overall_coeff](#), and [seq](#).

6.57.3.15 return_type()

```
unsigned GiNaC::expairseq::return_type ( ) const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::mul](#).

References [GiNaC::return_types::noncommutative_composite](#).

6.57.3.16 calchash()

```
unsigned GiNaC::expairseq::calchash ( ) const [override], [protected], [virtual]
```

Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.

The method inherited from class basic computes a hash value based on the type and hash values of possible members. For this reason it is well suited for container classes but atomic classes should override this implementation because otherwise they would all end up with the same hashvalue.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::status_flags::evaluated](#), [GiNaC::basic::flags](#), [GiNaC::ex::gethash\(\)](#), [GiNaC::status_flags::hash_calculated](#), [GiNaC::basic::hashvalue](#), [GiNaC::make_hash_seed\(\)](#), [overall_coeff](#), [GiNaC::rotate_left\(\)](#), [seq](#), and [GiNaC::basic::setflag\(\)](#).

6.57.3.17 expand()

```
ex GiNaC::expairseq::expand (
    unsigned options = 0 ) const [override], [protected], [virtual]
```

Expand expression, i.e.

multiply it out and return the result as a new expression.

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::mul](#).

References [expandchildren\(\)](#), [GiNaC::status_flags::expanded](#), [options](#), [overall_coeff](#), [GiNaC::basic::setflag\(\)](#), and [thisexpairseq\(\)](#).

6.57.3.18 thisexpairseq() [1/2]

```
ex GiNaC::expairseq::thisexpairseq (
    const epvector & v,
    const ex & oc,
    bool do_index_renaming = false ) const [protected], [virtual]
```

Create an object of this type.

This method works similar to a constructor. It is useful because expairseq has (at least) two possible different semantics but we want to inherit methods thus avoiding code duplication. Sometimes a method in expairseq has to create a new one of the same semantics, which cannot be done by a ctor because the name (add, mul,...) is unknown on the expairseq level. In order for this trick to work a derived class must of course override this definition.

Reimplemented in [GiNaC::add](#), and [GiNaC::mul](#).

Referenced by [conjugate\(\)](#), [expand\(\)](#), [map\(\)](#), [match\(\)](#), [subs\(\)](#), [to_polynomial\(\)](#), and [to_rational\(\)](#).

6.57.3.19 thisexpairseq() [2/2]

```
ex GiNaC::expairseq::thisexpairseq (
    epvector && vp,
    const ex & oc,
    bool do_index_renaming = false ) const [protected], [virtual]
```

Reimplemented in [GiNaC::add](#), and [GiNaC::mul](#).

6.57.3.20 printseq()

```
void GiNaC::expairseq::printseq (
    const print_context & c,
    char delim,
    unsigned this_precedence,
    unsigned upper_precedence ) const [protected], [virtual]
```

References [c](#), [default_overall_coeff\(\)](#), [GiNaC::ex::is_equal\(\)](#), [overall_coeff](#), [GiNaC::ex::print\(\)](#), [printpair\(\)](#), and [seq](#).

Referenced by [do_print\(\)](#).

6.57.3.21 printpair()

```
void GiNaC::expairseq::printpair (
    const print_context & c,
    const expair & p,
    unsigned upper_precedence ) const [protected], [virtual]
```

References [c](#), [GiNaC::expair::coeff](#), [precedence\(\)](#), [GiNaC::ex::print\(\)](#), and [GiNaC::expair::rest](#).

Referenced by [is_canonical\(\)](#), and [printseq\(\)](#).

6.57.3.22 split_ex_to_pair()

```
expair GiNaC::expairseq::split_ex_to_pair (
    const ex & e ) const [protected], [virtual]
```

Form an expair from an ex, using the corresponding semantics.

See also

[expairseq::recombine_pair_to_ex\(\)](#)

Reimplemented in [GiNaC::add](#), and [GiNaC::mul](#).

References [GiNaC::_ex1](#).

Referenced by [construct_from_2_ex\(\)](#), [construct_from_expairseq_ex\(\)](#), [make_flat\(\)](#), [map\(\)](#), [match\(\)](#), [subschildren\(\)](#), [to_polynomial\(\)](#), and [to_rational\(\)](#).

6.57.3.23 combine_ex_with_coeff_to_pair()

```
expair GiNaC::expairseq::combine_ex_with_coeff_to_pair (
    const ex & e,
    const ex & c ) const [protected], [virtual]
```

Reimplemented in [GiNaC::add](#), and [GiNaC::mul](#).

References [c](#), and [GINAC_ASSERT](#).

Referenced by [evalchildren\(\)](#), and [subschildren\(\)](#).

6.57.3.24 combine_pair_with_coeff_to_pair()

```
expair GiNaC::expairseq::combine_pair_with_coeff_to_pair (
    const expair & p,
    const ex & c ) const [protected], [virtual]
```

Reimplemented in [GiNaC::add](#), and [GiNaC::mul](#).

References [c](#), [GiNaC::expair::coeff](#), [GINAC_ASSERT](#), and [GiNaC::expair::rest](#).

6.57.3.25 recombine_pair_to_ex()

```
ex GiNaC::expairseq::recombine_pair_to_ex (
    const expair & p ) const [protected], [virtual]
```

Form an ex out of an expair, using the corresponding semantics.

See also

[expairseq::split_ex_to_pair\(\)](#)

Reimplemented in [GiNaC::add](#), and [GiNaC::mul](#).

References [GiNaC::expair::coeff](#), and [GiNaC::expair::rest](#).

Referenced by [map\(\)](#), [op\(\)](#), [subschildren\(\)](#), [to_polynomial\(\)](#), and [to_rational\(\)](#).

6.57.3.26 expair_needs_further_processing()

```
bool GiNaC::expairseq::expair_needs_further_processing (
    exp it ) [protected], [virtual]
```

Reimplemented in [GiNaC::mul](#).

References [GiNaC::_ex1](#).

Referenced by [combine_same_terms_sorted_seq\(\)](#), [construct_from_2_expairseq\(\)](#), and [construct_from_expairseq_ex\(\)](#).

6.57.3.27 default_overall_coeff()

```
ex GiNaC::expairseq::default_overall_coeff ( ) const [protected], [virtual]
```

Reimplemented in [GiNaC::mul](#).

References [GiNaC::_ex0](#).

Referenced by [do_print_tree\(\)](#), [map\(\)](#), [match\(\)](#), [nops\(\)](#), [op\(\)](#), [printseq\(\)](#), [to_polynomial\(\)](#), and [to_rational\(\)](#).

6.57.3.28 combine_overall_coeff() [1/2]

```
void GiNaC::expairseq::combine_overall_coeff (
    const ex & c ) [protected], [virtual]
```

Reimplemented in [GiNaC::mul](#).

References [c](#), [GINAC_ASSERT](#), and [overall_coeff](#).

Referenced by [construct_from_2_ex\(\)](#), [construct_from_2_expairseq\(\)](#), [construct_from_expairseq_ex\(\)](#), and [make_flat\(\)](#).

6.57.3.29 combine_overall_coeff() [2/2]

```
void GiNaC::expairseq::combine_overall_coeff (
    const ex & c1,
    const ex & c2 ) [protected], [virtual]
```

Reimplemented in [GiNaC::mul](#).

References [GINAC_ASSERT](#), and [overall_coeff](#).

6.57.3.30 can_make_flat()

```
bool GiNaC::expairseq::can_make_flat (
    const expair & p ) const [protected], [virtual]
```

Reimplemented in [GiNaC::mul](#).

6.57.3.31 do_print()

```
void GiNaC::expairseq::do_print (
    const print\_context & c,
    unsigned level ) const [protected]
```

References [c](#), [precedence\(\)](#), and [printseq\(\)](#).

6.57.3.32 do_print_tree()

```
void GiNaC::expairseq::do_print_tree (
    const print\_tree & c,
    unsigned level ) const [protected]
```

References [c](#), [default_overall_coeff\(\)](#), [GiNaC::basic::flags](#), [GiNaC::basic::hashvalue](#), [GiNaC::ex::is_equal\(\)](#), [nops\(\)](#), [overall_coeff](#), [GiNaC::ex::print\(\)](#), and [seq](#).

6.57.3.33 construct_from_2_ex()

```
void GiNaC::expairseq::construct_from_2_ex (
    const ex & lh,
    const ex & rh ) [protected]
```

References [GiNaC::expair::coeff](#), [combine_overall_coeff\(\)](#), [GiNaC::ex::compare\(\)](#), [construct_from_2_expairseq\(\)](#), [construct_from_expairseq_ex\(\)](#), [GiNaC::info_flags::has_indices](#), [GiNaC::ex::info\(\)](#), [GiNaC::rename_dummy_indices_uniquely\(\)](#), [GiNaC::expair::rest](#), [seq](#), and [split_ex_to_pair\(\)](#).

Referenced by [GiNaC::add::add\(\)](#), [expairseq\(\)](#), and [GiNaC::mul::mul\(\)](#).

6.57.3.34 construct_from_2_expairseq()

```
void GiNaC::expairseq::construct_from_2_expairseq (
    const expairseq & s1,
    const expairseq & s2 ) [protected]
```

References [combine_overall_coeff\(\)](#), [construct_from_epvector\(\)](#), [expair_needs_further_processing\(\)](#), [GiNaC::numeric::is_zero\(\)](#), [overall_coeff](#), and [seq](#).

Referenced by [construct_from_2_ex\(\)](#).

6.57.3.35 construct_from_expairseq_ex()

```
void GiNaC::expairseq::construct_from_expairseq_ex (
    const expairseq & s,
    const ex & e ) [protected]
```

References [GiNaC::expair::coeff](#), [combine_overall_coeff\(\)](#), [construct_from_epvector\(\)](#), [expair_needs_further_processing\(\)](#), [GiNaC::numeric::is_zero\(\)](#), [last](#), [overall_coeff](#), [GiNaC::expair::rest](#), [seq](#), and [split_ex_to_pair\(\)](#).

Referenced by [construct_from_2_ex\(\)](#).

6.57.3.36 construct_from_exvector()

```
void GiNaC::expairseq::construct_from_exvector (
    const exvector & v ) [protected]
```

References [canonicalize\(\)](#), [combine_same_terms_sorted_seq\(\)](#), and [make_flat\(\)](#).

Referenced by [GiNaC::add::add\(\)](#), [expairseq\(\)](#), and [GiNaC::mul::mul\(\)](#).

6.57.3.37 construct_from_epvector() [1/2]

```
void GiNaC::expairseq::construct_from_epvector (
    const epvector & v,
    bool do_index_renaming = false ) [protected]
```

References [canonicalize\(\)](#), [combine_same_terms_sorted_seq\(\)](#), and [make_flat\(\)](#).

Referenced by [GiNaC::add::add\(\)](#), [combine_same_terms_sorted_seq\(\)](#), [construct_from_2_expairseq\(\)](#), [construct_from_expairseq_ex\(\)](#), [expairseq\(\)](#), and [GiNaC::mul::mul\(\)](#).

6.57.3.38 construct_from_epvector() [2/2]

```
void GiNaC::expairseq::construct_from_epvector (
    epvector && v,
    bool do_index_renaming = false ) [protected]
```

References [canonicalize\(\)](#), [combine_same_terms_sorted_seq\(\)](#), and [make_flat\(\)](#).

6.57.3.39 make_flat() [1/2]

```
void GiNaC::expairseq::make_flat (
    const exvector & v ) [protected]
```

Combine this expairseq with argument exvector.

It cares for associativity as well as for special handling of numerics.

References [GiNaC::ex1](#), [combine_overall_coeff\(\)](#), [GiNaC::make_flat_inserter::handle_factor\(\)](#), [GiNaC::info_flags::has_indices](#), [overall_coeff](#), [seq](#), and [split_ex_to_pair\(\)](#).

Referenced by [construct_from_epvector\(\)](#), and [construct_from_exvector\(\)](#).

6.57.3.40 make_flat() [2/2]

```
void GiNaC::expairseq::make_flat (
    const epvector & v,
    bool do_index_renaming = false ) [protected]
```

Combine this expairseq with argument epvector.

It cares for associativity as well as for special handling of numerics.

References [GiNaC::ex1](#), [GiNaC::are_ex_trivially_equal\(\)](#), [GiNaC::ex::coeff\(\)](#), [combine_overall_coeff\(\)](#), [GiNaC::make_flat_inserter::h](#), [GiNaC::info_flags::has_indices](#), [overall_coeff](#), and [seq](#).

6.57.3.41 canonicalize()

```
void GiNaC::expairseq::canonicalize ( ) [protected]
```

Brings this expairseq into a sorted (canonical) form.

References [seq](#).

Referenced by [construct_from_epvector\(\)](#), [construct_from_exvector\(\)](#), and [read_archive\(\)](#).

6.57.3.42 combine_same_terms_sorted_seq()

```
void GiNaC::expairseq::combine_same_terms_sorted_seq ( ) [protected]
```

Compact a presorted expairseq by combining all matching expairs to one each.

On an add object, this is responsible for $2*x+3*x+y \rightarrow 5*x+y$, for instance.

References [construct_from_epvector\(\)](#), [expair_needs_further_processing\(\)](#), [last](#), and [seq](#).

Referenced by [construct_from_epvector\(\)](#), and [construct_from_exvector\(\)](#).

6.57.3.43 is_canonical()

```
bool GiNaC::expairseq::is_canonical ( ) const [protected]
```

Check if this expairseq is in sorted (canonical) form.

Useful mainly for debugging or in assertions since being sorted is an invariance.

References [printpair\(\)](#), and [seq](#).

Referenced by [GiNaC::add::add\(\)](#), [expairseq\(\)](#), [GiNaC::mul::mul\(\)](#), and [read_archive\(\)](#).

6.57.3.44 expandchildren()

```
epvector GiNaC::expairseq::expandchildren (
    unsigned options ) const [protected]
```

Member-wise expand the expairs in this sequence.

See also

[expairseq::expand\(\)](#)

Returns

epvector containing expanded pairs, empty if no members had to be changed.

References [GiNaC::are_ex_trivially_equal\(\)](#), [GiNaC::ex::coeff\(\)](#), [GiNaC::ex::expand\(\)](#), [last](#), [options](#), and [seq](#).

Referenced by [GiNaC::add::expand\(\)](#), and [expand\(\)](#).

6.57.3.45 evalchildren()

```
epvector GiNaC::expairseq::evalchildren ( ) const [protected]
```

Member-wise evaluate the expairs in this sequence.

See also

[expairseq::eval\(\)](#)

Returns

epvector containing evaluated pairs, empty if no members had to be changed.

References [combine_ex_with_coeff_to_pair\(\)](#), [GiNaC::expair::is_equal\(\)](#), [last](#), [seq](#), and [unlikely](#).

Referenced by [GiNaC::add::eval\(\)](#), [eval\(\)](#), and [GiNaC::mul::eval\(\)](#).

6.57.3.46 subschildren()

```
epvector GiNaC::expairseq::subschildren (
    const exmap & m,
    unsigned options = 0 ) const [protected]
```

Member-wise substitute in this sequence.

See also

[expairseq::subs\(\)](#)

Returns

epvector containing expanded pairs, empty if no members had to be changed.

References [GiNaC::are_ex_trivially_equal\(\)](#), [GiNaC::ex::coeff\(\)](#), [combine_ex_with_coeff_to_pair\(\)](#), [GiNaC::expair::is_equal\(\)](#), [last](#), [m](#), [options](#), [GiNaC::subs_options::pattern_is_not_product](#), [GiNaC::subs_options::pattern_is_product](#), [recombine_pair_to_ex\(\)](#), [seq](#), [split_ex_to_pair\(\)](#), and [GiNaC::ex::subs\(\)](#).

Referenced by [subs\(\)](#).

6.57.4 Member Data Documentation

6.57.4.1 seq

```
epvector GiNaC::expairseq::seq [protected]
```

Referenced by [archive\(\)](#), [calchash\(\)](#), [GiNaC::mul::can_be_further_expanded\(\)](#), [canonicalize\(\)](#), [GiNaC::add::coeff\(\)](#), [GiNaC::mul::coeff\(\)](#), [combine_same_terms_sorted_seq\(\)](#), [conjugate\(\)](#), [GiNaC::mul::conjugate\(\)](#), [construct_from_2_ex\(\)](#), [construct_from_2_expairseq\(\)](#), [construct_from_expairseq_ex\(\)](#), [GiNaC::add::degree\(\)](#), [GiNaC::mul::degree\(\)](#), [GiNaC::add::derivative\(\)](#), [GiNaC::mul::derivative\(\)](#), [GiNaC::mul::do_print\(\)](#), [GiNaC::add::do_print_csrc\(\)](#), [GiNaC::mul::do_print_csrc\(\)](#), [GiNaC::mul::do_print_latex\(\)](#), [do_print_tree\(\)](#), [GiNaC::add::eval\(\)](#), [GiNaC::mul::eval\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::add::eval_ncmul\(\)](#), [GiNaC::mul::eval_ncmul\(\)](#), [evalchildren\(\)](#), [GiNaC::mul::evalf\(\)](#), [GiNaC::add::evalm\(\)](#), [GiNaC::mul::evalm\(\)](#), [GiNaC::mul::expand\(\)](#), [GiNaC::power::expand\(\)](#), [GiNaC::power::expand_add\(\)](#), [GiNaC::power::expand_add_2\(\)](#), [expandchildren\(\)](#), [GiNaC::mul::expandchildren\(\)](#), [GiNaC::mul::find_real_imag\(\)](#), [GiNaC::add::imag_part\(\)](#), [GiNaC::add::info\(\)](#), [info\(\)](#), [GiNaC::mul::info\(\)](#), [GiNaC::add::integer_content\(\)](#), [GiNaC::mul::integer_content\(\)](#), [is_canonical\(\)](#), [is_equal_same_type\(\)](#), [GiNaC::add::is_polynomial\(\)](#), [GiNaC::mul::is_polynomial\(\)](#), [GiNaC::add::lddegree\(\)](#), [GiNaC::mul::lddegree\(\)](#), [make_flat\(\)](#), [map\(\)](#), [GiNaC::add::max_coefficient\(\)](#), [GiNaC::mul::max_coefficient\(\)](#), [nops\(\)](#), [GiNaC::add::normal\(\)](#), [GiNaC::mul::normal\(\)](#), [op\(\)](#), [GiNaC::add::print_add\(\)](#), [printseq\(\)](#), [read_archive\(\)](#), [GiNaC::add::real_part\(\)](#), [GiNaC::add::return_type\(\)](#), [GiNaC::mul::return_type\(\)](#), [GiNaC::add::return_type_tinfo\(\)](#), [GiNaC::mul::return_type_tinfo\(\)](#), [GiNaC::add::series\(\)](#), [GiNaC::mul::series\(\)](#), [GiNaC::add::smod\(\)](#), [GiNaC::mul::smod\(\)](#), [subschildren\(\)](#), [to_polynomial\(\)](#), and [to_rational\(\)](#).

6.57.4.2 overall_coeff

```
ex GiNaC::expairseq::overall_coeff [protected]
```

Referenced by [GiNaC::add::add\(\)](#), [archive\(\)](#), [calchash\(\)](#), [GiNaC::add::coeff\(\)](#), [GiNaC::mul::coeff\(\)](#), [GiNaC::add::combine_ex_with_coeff\(\)](#), [combine_overall_coeff\(\)](#), [GiNaC::mul::combine_overall_coeff\(\)](#), [conjugate\(\)](#), [GiNaC::mul::conjugate\(\)](#), [construct_from_2_expairseq\(\)](#), [construct_from_expairseq_ex\(\)](#), [GiNaC::add::degree\(\)](#), [GiNaC::mul::derivative\(\)](#), [GiNaC::add::do_print_csrc\(\)](#), [GiNaC::mul::do_print_csrc\(\)](#), [do_print_tree\(\)](#), [GiNaC::add::eval\(\)](#), [eval\(\)](#), [GiNaC::mul::eval\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::mul::evalf\(\)](#), [GiNaC::add::evalm\(\)](#), [GiNaC::mul::evalm\(\)](#), [GiNaC::add::expand\(\)](#), [expand\(\)](#), [GiNaC::mul::expand\(\)](#), [GiNaC::power::expand\(\)](#), [GiNaC::power::expand_add\(\)](#), [GiNaC::power::expand_add_2\(\)](#), [GiNaC::mul::find_real_imag\(\)](#), [GiNaC::add::imag_part\(\)](#), [GiNaC::add::info\(\)](#), [GiNaC::mul::info\(\)](#), [GiNaC::add::integer_content\(\)](#), [GiNaC::mul::integer_content\(\)](#), [is_equal_same_type\(\)](#), [GiNaC::add::lddegree\(\)](#), [make_flat\(\)](#), [map\(\)](#), [GiNaC::add::max_coefficient\(\)](#), [GiNaC::mul::max_coefficient\(\)](#), [GiNaC::mul::mul\(\)](#), [nops\(\)](#), [GiNaC::add::normal\(\)](#), [GiNaC::mul::normal\(\)](#), [op\(\)](#), [GiNaC::add::print_add\(\)](#), [GiNaC::mul::print_overall_coeff\(\)](#), [printseq\(\)](#), [read_archive\(\)](#), [GiNaC::add::real_part\(\)](#), [GiNaC::add::series\(\)](#), [GiNaC::mul::series\(\)](#), [GiNaC::add::smod\(\)](#), [GiNaC::mul::smod\(\)](#), [GiNaC::add::split_ex_to_pair\(\)](#), [subs\(\)](#), [to_polynomial\(\)](#), and [to_rational\(\)](#).

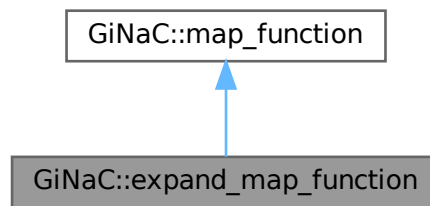
The documentation for this class was generated from the following files:

- [expairseq.h](#)
- [expairseq.cpp](#)
- [normal.cpp](#)

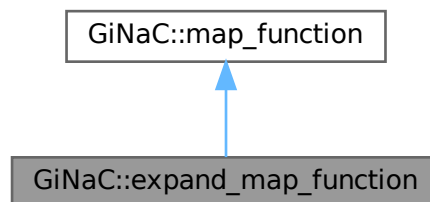
6.58 GiNaC::expand_map_function Struct Reference

Function object to be applied by [basic::expand\(\)](#).

Inheritance diagram for `GiNaC::expand_map_function`:



Collaboration diagram for `GiNaC::expand_map_function`:



Public Member Functions

- `expand_map_function` (unsigned o)
- `ex operator()` (const `ex` &e) override

Public Member Functions inherited from `GiNaC::map_function`

- virtual `~map_function` ()
- virtual `ex operator()` (const `ex` &e)=0

Public Attributes

- unsigned `options`

Additional Inherited Members

Public Types inherited from `GiNaC::map_function`

- typedef const `ex` & `argument_type`
- typedef `ex` `result_type`

6.58.1 Detailed Description

Function object to be applied by [basic::expand\(\)](#).

6.58.2 Constructor & Destructor Documentation

6.58.2.1 expand_map_function()

```
GiNaC::expand_map_function::expand_map_function (
    unsigned o ) [inline]
```

6.58.3 Member Function Documentation

6.58.3.1 operator>()

```
ex GiNaC::expand_map_function::operator() (
    const ex & e ) [inline], [override], [virtual]
```

Implements [GiNaC::map_function](#).

References [GiNaC::ex::expand\(\)](#), and [options](#).

6.58.4 Member Data Documentation

6.58.4.1 options

```
unsigned GiNaC::expand_map_function::options
```

The documentation for this struct was generated from the following file:

- [basic.cpp](#)

6.59 GiNaC::expand_options Class Reference

Flags to control the behavior of [expand\(\)](#).

```
#include <flags.h>
```

Public Types

- enum { [expand_indexed](#) = 0x0001 , [expand_function_args](#) = 0x0002 , [expand_rename_idx](#) = 0x0004 , [expand_transcendental](#) = 0x0008 }

6.59.1 Detailed Description

Flags to control the behavior of [expand\(\)](#).

6.59.2 Member Enumeration Documentation

6.59.2.1 anonymous enum

anonymous enum

Enumerator

expand_indexed	expands (a+b).i to a.i+b.i
expand_function_args	expands the arguments of functions
expand_rename_idx	used internally by mul::expand()
expand_transcendental	expands transcendental functions like log and exp

The documentation for this class was generated from the following file:

- [flags.h](#)

6.60 GiNaC::factor_options Class Reference

Flags to control the polynomial factorization.

```
#include <flags.h>
```

Public Types

- enum { [polynomial](#) = 0x0000 , [all](#) = 0x0001 }

6.60.1 Detailed Description

Flags to control the polynomial factorization.

6.60.2 Member Enumeration Documentation

6.60.2.1 anonymous enum

anonymous enum

Enumerator

polynomial	factor only expressions that are polynomials
all	factor all polynomial subexpressions

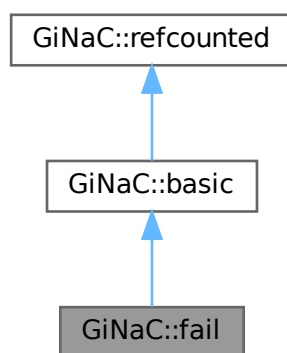
The documentation for this class was generated from the following file:

- [flags.h](#)

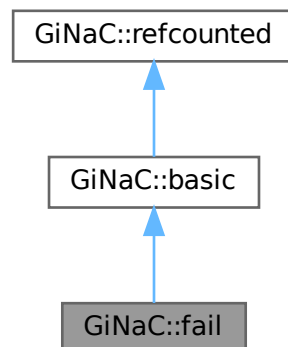
6.61 GiNaC::fail Class Reference

```
#include <fail.h>
```

Inheritance diagram for GiNaC::fail:



Collaboration diagram for `GiNaC::fail`:



Protected Member Functions

- unsigned `return_type` () const override
- void `do_print` (const `print_context` &c, unsigned level) const

Protected Member Functions inherited from `GiNaC::basic`

- `basic` ()
- virtual `ex eval_ncmul` (const `exvector` &v) const
- virtual bool `match_same_type` (const `basic` &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual `ex derivative` (const `symbol` &s) const
Default implementation of `ex::diff()`.
- virtual int `compare_same_type` (const `basic` &other) const
Returns order relation between two objects of same type.
- virtual bool `is_equal_same_type` (const `basic` &other) const
Returns true if two objects of same type are equal.
- virtual unsigned `calchash` () const
Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.
- void `ensure_if_modifiable` () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void `do_print` (const `print_context` &c, unsigned level) const
Default output to stream.
- void `do_print_tree` (const `print_tree` &c, unsigned level) const
Tree output to stream.
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const
Python parsable output to stream.

Additional Inherited Members

Public Member Functions inherited from [GiNaC::basic](#)

- virtual [~basic](#) ()
basic destructor, virtual because class ex will delete objects of derived classes via a basic.*
- [basic](#) (const [basic](#) &other)
- const [basic](#) & [operator=](#) (const [basic](#) &other)
basic assignment operator: the other object might be of a derived class.
- virtual [basic](#) * [duplicate](#) () const
Create a clone of this object on the heap.
- virtual [ex eval](#) () const
Perform automatic non-interruptive term rewriting rules.
- virtual [ex evalf](#) () const
Evaluate object numerically.
- virtual [ex evalm](#) () const
Evaluate sums, products and integer powers of matrices.
- virtual [ex eval_integ](#) () const
Evaluate integrals, if result is known.
- virtual [ex eval_indexed](#) (const [basic](#) &i) const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void [print](#) (const [print_context](#) &c, unsigned level=0) const
Output to stream.
- virtual void [dbgprint](#) () const
Little wrapper around print to be called within a debugger.
- virtual void [dbgprinttree](#) () const
Little wrapper around printtree to be called within a debugger.
- virtual unsigned [precedence](#) () const
Return relative operator precedence (for parenthezing output).
- virtual bool [info](#) (unsigned inf) const
Information about the object.
- virtual size_t [nops](#) () const
Number of operands/members.
- virtual [ex op](#) (size_t i) const
Return operand/member at position i.
- virtual [ex operator\[\]](#) (const [ex](#) &index) const
- virtual [ex operator\[\]](#) (size_t i) const
- virtual [ex](#) & [let_op](#) (size_t i)
Return modifiable operand/member at position i.
- virtual [ex](#) & [operator\[\]](#) (const [ex](#) &index)
- virtual [ex](#) & [operator\[\]](#) (size_t i)
- virtual bool [has](#) (const [ex](#) &other, unsigned [options](#)=0) const
Test for occurrence of a pattern.
- virtual bool [match](#) (const [ex](#) &pattern, [exmap](#) &repls) const
Check whether the expression matches a given pattern.
- virtual [ex subs](#) (const [exmap](#) &m, unsigned [options](#)=0) const
Substitute a set of objects by arbitrary expressions.
- virtual [ex map](#) ([map_function](#) &f) const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void [accept](#) ([GiNaC::visitor](#) &v) const
- virtual bool [is_polynomial](#) (const [ex](#) &var) const

- Check whether this is a polynomial in the given variables.*

 - virtual int `degree` (const `ex` &`s`) const

Return degree of highest power in object `s`.
- virtual int `ldegree` (const `ex` &`s`) const

Return degree of lowest power in object `s`.
- virtual `ex` `coeff` (const `ex` &`s`, int `n`=1) const

Return coefficient of degree `n` in object `s`.
- virtual `ex` `expand` (unsigned `options`=0) const

Expand expression, i.e.
- virtual `ex` `collect` (const `ex` &`s`, bool `distributed`=false) const

Sort expanded expression in terms of powers of some object(s).
- virtual `ex` `series` (const `relational` &`r`, int `order`, unsigned `options`=0) const

Default implementation of `ex::series()`.
- virtual `ex` `normal` (`exmap` &`repl`, `exmap` &`rev_lookup`, `lst` &`modifier`) const

Default implementation of `ex::normal()`.
- virtual `ex` `to_rational` (`exmap` &`repl`) const

Default implementation of `ex::to_rational()`.
- virtual `ex` `to_polynomial` (`exmap` &`repl`) const
- virtual `numeric` `integer_content` () const
- virtual `ex` `smod` (const `numeric` &`xi`) const

Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- virtual `numeric` `max_coefficient` () const

Implementation `ex::max_coefficient()`.
- virtual `exvector` `get_free_indices` () const

Return a vector containing the free indices of an expression.
- virtual `ex` `add_indexed` (const `ex` &`self`, const `ex` &`other`) const

Add two indexed expressions.
- virtual `ex` `scalar_mul_indexed` (const `ex` &`self`, const `numeric` &`other`) const

Multiply an indexed expression with a scalar.
- virtual bool `contract_with` (`exvector::iterator` `self`, `exvector::iterator` `other`, `exvector` &`v`) const

Try to contract two indexed expressions that appear in the same product.
- virtual unsigned `return_type` () const
- virtual `return_type_t` `return_type_tinfo` () const
- virtual `ex` `conjugate` () const
- virtual `ex` `real_part` () const
- virtual `ex` `imag_part` () const
- template<class `T` >
- void `print_dispatch` (const `print_context` &`c`, unsigned `level`) const

Like `print()`, but dispatch to the specified class.
- void `print_dispatch` (const `registered_class_info` &`ri`, const `print_context` &`c`, unsigned `level`) const

Like `print()`, but dispatch to the specified class.
- virtual void `archive` (`archive_node` &`n`) const

Save (serialize) the object into archive node.
- virtual void `read_archive` (const `archive_node` &`n`, `lst` &`syms`)

Load (deserialize) the object from an archive node.
- `ex` `subs_one_level` (const `exmap` &`m`, unsigned `options`) const

Helper function for `subs()`.
- `ex` `diff` (const `symbol` &`s`, unsigned `nth`=1) const

Default interface of `nth` derivative `ex::diff(s, n)`.
- int `compare` (const `basic` &`other`) const

Compare objects syntactically to establish canonical ordering.

- bool [is_equal](#) (const [basic](#) &other) const
Test for syntactic equality.
- const [basic](#) & [hold](#) () const
Stop further evaluation.
- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const
Set some [status_flags](#).
- const [basic](#) & [clearflag](#) (unsigned f) const
Clear some [status_flags](#).

Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add_reference](#) () noexcept
- unsigned int [remove_reference](#) () noexcept
- unsigned int [get_refcount](#) () const noexcept
- void [set_refcount](#) (unsigned int r) noexcept

Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)
of type [status_flags](#)
- unsigned [hashvalue](#)
hash value

6.61.1 Member Function Documentation

6.61.1.1 [return_type\(\)](#)

```
unsigned GiNaC::fail::return_type ( ) const [inline], [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::return_types::noncommutative_composite](#).

6.61.1.2 [do_print\(\)](#)

```
void GiNaC::fail::do_print (
    const print\_context & c,
    unsigned level ) const [protected]
```

The documentation for this class was generated from the following file:

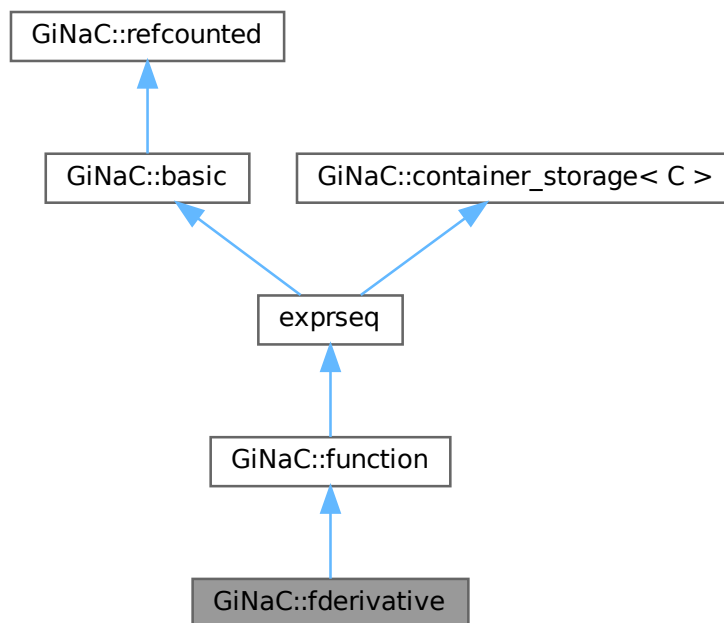
- [fail.h](#)

6.62 GiNaC::fderivative Class Reference

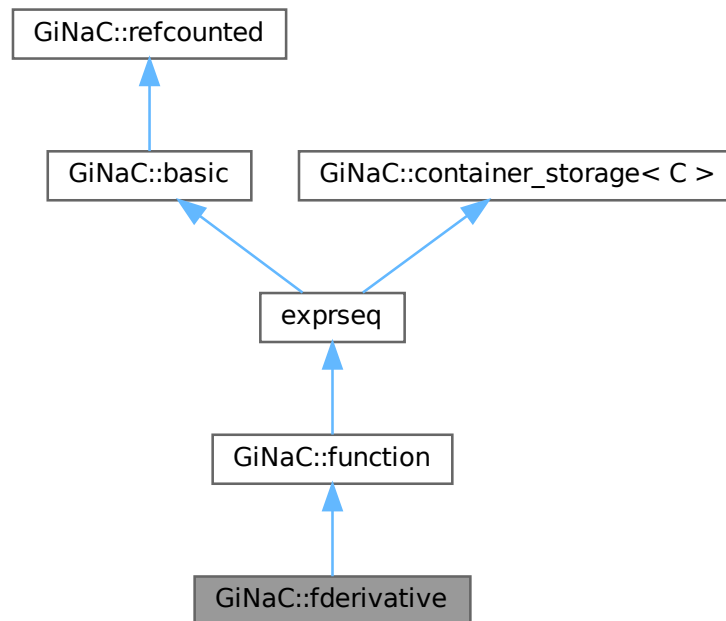
This class represents the (abstract) derivative of a symbolic function.

```
#include <fderivative.h>
```

Inheritance diagram for GiNaC::fderivative:



Collaboration diagram for GiNaC::fderivative:



Public Member Functions

- `fderivative` (unsigned ser, unsigned param, const `exvector` &args)
Construct derivative with respect to one parameter.
- `fderivative` (unsigned ser, const `paramset` ¶ms, const `exvector` &args)
Construct derivative with respect to multiple parameters.
- `fderivative` (unsigned ser, const `paramset` ¶ms, `exvector` &&v)
- void `print` (const `print_context` &c, unsigned level=0) const override
Output to stream.
- `ex eval` () const override
Perform automatic non-interruptive term rewriting rules.
- `ex series` (const `relational` &r, int order, unsigned options=0) const override
The series expansion of derivatives falls back to Taylor expansion.
- `ex thiscontainer` (const `exvector` &v) const override
- `ex thiscontainer` (`exvector` &&v) const override
- void `archive` (`archive_node` &n) const override
Archive the object.
- void `read_archive` (const `archive_node` &n, `lst` &syms) override
Load (deserialize) the object from an archive node.
- const `paramset` & `derivatives` () const
Expose this object's derivative structure.

Public Member Functions inherited from `GiNaC::function`

- `function` (unsigned ser)
- `function` (unsigned ser, const `ex` ¶m1)
- `function` (unsigned ser, const `ex` ¶m1, const `ex` ¶m2)
- `function` (unsigned ser, const `ex` ¶m1, const `ex` ¶m2, const `ex` ¶m3)
- `function` (unsigned ser, const `ex` ¶m1, const `ex` ¶m2, const `ex` ¶m3, const `ex` ¶m4)
- `function` (unsigned ser, const `ex` ¶m1, const `ex` ¶m2, const `ex` ¶m3, const `ex` ¶m4, const `ex` ¶m5)
- `function` (unsigned ser, const `ex` ¶m1, const `ex` ¶m2, const `ex` ¶m3, const `ex` ¶m4, const `ex` ¶m5, const `ex` ¶m6)
- `function` (unsigned ser, const `ex` ¶m1, const `ex` ¶m2, const `ex` ¶m3, const `ex` ¶m4, const `ex` ¶m5, const `ex` ¶m6, const `ex` ¶m7)
- `function` (unsigned ser, const `ex` ¶m1, const `ex` ¶m2, const `ex` ¶m3, const `ex` ¶m4, const `ex` ¶m5, const `ex` ¶m6, const `ex` ¶m7, const `ex` ¶m8)
- `function` (unsigned ser, const `ex` ¶m1, const `ex` ¶m2, const `ex` ¶m3, const `ex` ¶m4, const `ex` ¶m5, const `ex` ¶m6, const `ex` ¶m7, const `ex` ¶m8, const `ex` ¶m9)
- `function` (unsigned ser, const `ex` ¶m1, const `ex` ¶m2, const `ex` ¶m3, const `ex` ¶m4, const `ex` ¶m5, const `ex` ¶m6, const `ex` ¶m7, const `ex` ¶m8, const `ex` ¶m9, const `ex` ¶m10)
- `function` (unsigned ser, const `ex` ¶m1, const `ex` ¶m2, const `ex` ¶m3, const `ex` ¶m4, const `ex` ¶m5, const `ex` ¶m6, const `ex` ¶m7, const `ex` ¶m8, const `ex` ¶m9, const `ex` ¶m10, const `ex` ¶m11)
- `function` (unsigned ser, const `ex` ¶m1, const `ex` ¶m2, const `ex` ¶m3, const `ex` ¶m4, const `ex` ¶m5, const `ex` ¶m6, const `ex` ¶m7, const `ex` ¶m8, const `ex` ¶m9, const `ex` ¶m10, const `ex` ¶m11, const `ex` ¶m12)
- `function` (unsigned ser, const `ex` ¶m1, const `ex` ¶m2, const `ex` ¶m3, const `ex` ¶m4, const `ex` ¶m5, const `ex` ¶m6, const `ex` ¶m7, const `ex` ¶m8, const `ex` ¶m9, const `ex` ¶m10, const `ex` ¶m11, const `ex` ¶m12, const `ex` ¶m13)
- `function` (unsigned ser, const `ex` ¶m1, const `ex` ¶m2, const `ex` ¶m3, const `ex` ¶m4, const `ex` ¶m5, const `ex` ¶m6, const `ex` ¶m7, const `ex` ¶m8, const `ex` ¶m9, const `ex` ¶m10, const `ex` ¶m11, const `ex` ¶m12, const `ex` ¶m13, const `ex` ¶m14)
- `function` (unsigned ser, const `exprseq` &es)
- `function` (unsigned ser, const `exvector` &v)
- `function` (unsigned ser, `exvector` &&v)
- void `print` (const `print_context` &c, unsigned level=0) const override
Output to stream.
- unsigned `precedence` () const override
Return relative operator precedence (for parenthezing output).
- `ex expand` (unsigned `options`=0) const override
Expand expression, i.e.
- `ex eval` () const override
Perform automatic non-interruptive term rewriting rules.
- `ex evalf` () const override
Evaluate object numerically.
- `ex eval_ncmul` (const `exvector` &v) const override
This method is defined to be in line with behavior of `function::return_type()`
- unsigned `calchash` () const override
Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.
- `ex series` (const `relational` &r, int `order`, unsigned `options`=0) const override
Implementation of `ex::series` for functions.
- `ex thiscontainer` (const `exvector` &v) const override
- `ex thiscontainer` (`exvector` &&v) const override
- `ex conjugate` () const override
Implementation of `ex::conjugate` for functions.

- `ex real_part ()` const override
Implementation of `ex::real_part` for functions.
- `ex imag_part ()` const override
Implementation of `ex::imag_part` for functions.
- `void archive (archive_node &n)` const override
Archive the object.
- `void read_archive (const archive_node &n, lst &syms)` override
Construct object from `archive_node`.
- `bool info (unsigned inf)` const override
Implementation of `ex::info` for functions.
- `ex power (const ex &exp)` const
- `unsigned get_serial ()` const
- `std::string get_name ()` const
Return the print name of the function.

Public Member Functions inherited from `GiNaC::container< C >`

- `container (STLT const &s)`
- `container (STLT &&v)`
- `container (exvector::const_iterator b, exvector::const_iterator e)`
- `container (std::initializer_list< ex > il)`
- `bool info (unsigned inf)` const override
Information about the object.
- `unsigned precedence ()` const override
Return relative operator precedence (for parenthezing output).
- `size_t nops ()` const override
Number of operands/members.
- `ex op (size_t i)` const override
*Return operand/member at position *i*.*
- `ex & let_op (size_t i)` override
*Return modifiable operand/member at position *i*.*
- `ex subs (const exmap &m, unsigned options=0)` const override
Substitute a set of objects by arbitrary expressions.
- `void read_archive (const archive_node &n, lst &sym_lst)` override
Load (deserialize) the object from an archive node.
- `void archive (archive_node &n)` const override
Archive the object.
- `container & prepend (const ex &b)`
Add element at front.
- `container & append (const ex &b)`
Add element at back.
- `container & remove_first ()`
Remove first element.
- `container & remove_last ()`
Remove last element.
- `container & remove_all ()`
Remove all elements.
- `container & sort ()`
Sort elements.
- `container & unique ()`
Remove adjacent duplicate elements.
- `const_iterator begin ()` const
- `const_iterator end ()` const
- `const_reverse_iterator rbegin ()` const
- `const_reverse_iterator rend ()` const

Public Member Functions inherited from [GiNaC::basic](#)

- virtual [~basic](#) ()
basic destructor, virtual because class ex will delete objects of derived classes via a basic.*
- [basic](#) (const [basic](#) &other)
- const [basic](#) & [operator=](#) (const [basic](#) &other)
basic assignment operator: the other object might be of a derived class.
- virtual [basic](#) * [duplicate](#) () const
Create a clone of this object on the heap.
- virtual [ex eval](#) () const
Perform automatic non-interruptive term rewriting rules.
- virtual [ex evalf](#) () const
Evaluate object numerically.
- virtual [ex evalm](#) () const
Evaluate sums, products and integer powers of matrices.
- virtual [ex eval_integ](#) () const
Evaluate integrals, if result is known.
- virtual [ex eval_indexed](#) (const [basic](#) &i) const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void [print](#) (const [print_context](#) &c, unsigned level=0) const
Output to stream.
- virtual void [dbgprint](#) () const
Little wrapper around print to be called within a debugger.
- virtual void [dbgprinttree](#) () const
Little wrapper around printtree to be called within a debugger.
- virtual unsigned [precedence](#) () const
Return relative operator precedence (for parenthezing output).
- virtual bool [info](#) (unsigned inf) const
Information about the object.
- virtual size_t [nops](#) () const
Number of operands/members.
- virtual [ex op](#) (size_t i) const
Return operand/member at position i.
- virtual [ex operator\[\]](#) (const [ex](#) &index) const
- virtual [ex operator\[\]](#) (size_t i) const
- virtual [ex](#) & [let_op](#) (size_t i)
Return modifiable operand/member at position i.
- virtual [ex](#) & [operator\[\]](#) (const [ex](#) &index)
- virtual [ex](#) & [operator\[\]](#) (size_t i)
- virtual bool [has](#) (const [ex](#) &other, unsigned [options](#)=0) const
Test for occurrence of a pattern.
- virtual bool [match](#) (const [ex](#) &pattern, [exmap](#) &repls) const
Check whether the expression matches a given pattern.
- virtual [ex subs](#) (const [exmap](#) &m, unsigned [options](#)=0) const
Substitute a set of objects by arbitrary expressions.
- virtual [ex map](#) ([map_function](#) &f) const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void [accept](#) ([GiNaC::visitor](#) &v) const
- virtual bool [is_polynomial](#) (const [ex](#) &var) const
Check whether this is a polynomial in the given variables.
- virtual int [degree](#) (const [ex](#) &s) const

- Return degree of highest power in object s.*

 - virtual int [ldegree](#) (const [ex](#) &s) const
- Return degree of lowest power in object s.*

 - virtual [ex coeff](#) (const [ex](#) &s, int [n](#)=1) const
- Return coefficient of degree n in object s.*

 - virtual [ex expand](#) (unsigned [options](#)=0) const
- Expand expression, i.e.*

 - virtual [ex collect](#) (const [ex](#) &s, bool distributed=false) const
- Sort expanded expression in terms of powers of some object(s).*

 - virtual [ex series](#) (const [relational](#) &r, int [order](#), unsigned [options](#)=0) const
- Default implementation of [ex::series\(\)](#).*

 - virtual [ex normal](#) ([exmap](#) &repl, [exmap](#) &rev_lookup, [lst](#) &modifier) const
- Default implementation of [ex::normal\(\)](#).*

 - virtual [ex to_rational](#) ([exmap](#) &repl) const
- Default implementation of [ex::to_rational\(\)](#).*

 - virtual [ex to_polynomial](#) ([exmap](#) &repl) const
- virtual [numeric integer_content](#) () const
- virtual [ex smod](#) (const [numeric](#) &xi) const
- Apply symmetric modular homomorphism to an expanded multivariate polynomial.*

 - virtual [numeric max_coefficient](#) () const
- Implementation [ex::max_coefficient\(\)](#).*

 - virtual [exvector get_free_indices](#) () const
- Return a vector containing the free indices of an expression.*

 - virtual [ex add_indexed](#) (const [ex](#) &self, const [ex](#) &other) const
- Add two indexed expressions.*

 - virtual [ex scalar_mul_indexed](#) (const [ex](#) &self, const [numeric](#) &other) const
- Multiply an indexed expression with a scalar.*

 - virtual bool [contract_with](#) (exvector::iterator self, exvector::iterator other, [exvector](#) &v) const
- Try to contract two indexed expressions that appear in the same product.*

 - virtual unsigned [return_type](#) () const
 - virtual [return_type_t](#) [return_type_tinfo](#) () const
 - virtual [ex conjugate](#) () const
 - virtual [ex real_part](#) () const
 - virtual [ex imag_part](#) () const
- template<class T >

 - void [print_dispatch](#) (const [print_context](#) &c, unsigned level) const

Like [print\(\)](#), but dispatch to the specified class.

 - void [print_dispatch](#) (const [registered_class_info](#) &ri, const [print_context](#) &c, unsigned level) const

Like [print\(\)](#), but dispatch to the specified class.

 - virtual void [archive](#) ([archive_node](#) &n) const

Save (serialize) the object into archive node.

 - virtual void [read_archive](#) (const [archive_node](#) &n, [lst](#) &syms)

Load (deserialize) the object from an archive node.

 - [ex subs_one_level](#) (const [exmap](#) &m, unsigned [options](#)) const

Helper function for [subs\(\)](#).

 - [ex diff](#) (const [symbol](#) &s, unsigned nth=1) const

Default interface of nth derivative [ex::diff\(s, n\)](#).

 - int [compare](#) (const [basic](#) &other) const

Compare objects syntactically to establish canonical ordering.

 - bool [is_equal](#) (const [basic](#) &other) const

Test for syntactic equality.

- const [basic](#) & [hold](#) () const
Stop further evaluation.
- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const
Set some [status_flags](#).
- const [basic](#) & [clearflag](#) (unsigned f) const
Clear some [status_flags](#).

Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add_reference](#) () noexcept
- unsigned int [remove_reference](#) () noexcept
- unsigned int [get_refcount](#) () const noexcept
- void [set_refcount](#) (unsigned int r) noexcept

Protected Member Functions

- [ex_derivative](#) (const [symbol](#) &s) const override
Implementation of [ex::diff\(\)](#) for derivatives.
- bool [is_equal_same_type](#) (const [basic](#) &other) const override
Returns true if two objects of same type are equal.
- bool [match_same_type](#) (const [basic](#) &other) const override
Returns true if the attributes of two objects are similar enough for a match.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
- void [do_print_latex](#) (const [print_context](#) &c, unsigned level) const
- void [do_print_csrc](#) (const [print_csrc](#) &c, unsigned level) const
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const

Protected Member Functions inherited from [GiNaC::function](#)

- [ex_derivative](#) (const [symbol](#) &s) const override
Implementation of [ex::diff\(\)](#) for functions.
- bool [is_equal_same_type](#) (const [basic](#) &other) const override
Returns true if two objects of same type are equal.
- bool [match_same_type](#) (const [basic](#) &other) const override
Returns true if the attributes of two objects are similar enough for a match.
- unsigned [return_type](#) () const override
- [return_type_t](#) [return_type_tinfo](#) () const override
- [ex_pderivative](#) (unsigned diff_param) const
- [ex_expl_derivative](#) (const [symbol](#) &s) const
- bool [lookup_remember_table](#) ([ex](#) &result) const
- void [store_remember_table](#) ([ex](#) const &result) const

Protected Member Functions inherited from [GiNaC::container< C >](#)

- [ex conjugate](#) () const override
- [ex real_part](#) () const override
- [ex imag_part](#) () const override
- bool [is_equal_same_type](#) (const [basic](#) &other) const override
Returns true if two objects of same type are equal.
- virtual [ex thiscontainer](#) (const [STLT](#) &v) const
Similar to [duplicate\(\)](#), but with a preset sequence.
- virtual [ex thiscontainer](#) ([STLT](#) &&v) const
Similar to [duplicate\(\)](#), but with a preset sequence (which gets pilfered).
- virtual void [printseq](#) (const [print_context](#) &c, char openbracket, char delim, char closebracket, unsigned this↔_precedence, unsigned upper_precedence=0) const
Print sequence of contained elements.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
- void [do_print_python](#) (const [print_python](#) &c, unsigned level) const
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
- [STLT](#) [subchildren](#) (const [exmap](#) &m, unsigned [options](#)=0) const

Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match_same_type](#) (const [basic](#) &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual [ex derivative](#) (const [symbol](#) &s) const
Default implementation of [ex::diff\(\)](#).
- virtual int [compare_same_type](#) (const [basic](#) &other) const
Returns order relation between two objects of same type.
- virtual bool [is_equal_same_type](#) (const [basic](#) &other) const
Returns true if two objects of same type are equal.
- virtual unsigned [calchash](#) () const
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- void [ensure_if_modifiable](#) () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
Default output to stream.
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
Tree output to stream.
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
Python parsable output to stream.

Protected Member Functions inherited from [GiNaC::container_storage< C >](#)

- [container_storage](#) ()
- [container_storage](#) (size_t n, const [ex](#) &e)
- [container_storage](#) (std::initializer_list< [ex](#) > il)
- template<class In >
 [container_storage](#) (In b, In e)
- void [reserve](#) (size_t)
- [~container_storage](#) ()
- void [reserve](#) (size_t n)
- void [reserve](#) (std::vector< [ex](#) > &v, size_t n)

Protected Attributes

- [paramset parameter_set](#)
Set of parameter numbers with respect to which to take the derivative.

Protected Attributes inherited from [GiNaC::function](#)

- unsigned [serial](#)

Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)
of type [status_flags](#)
- unsigned [hashvalue](#)
hash value

Protected Attributes inherited from [GiNaC::container_storage< C >](#)

- [STLT seq](#)

Additional Inherited Members

Public Types inherited from [GiNaC::container< C >](#)

- typedef [STLT::const_iterator](#) [const_iterator](#)
- typedef [STLT::const_reverse_iterator](#) [const_reverse_iterator](#)

Static Public Member Functions inherited from [GiNaC::function](#)

- static unsigned [register_new](#) ([function_options](#) const &opt)
- static unsigned [find_function](#) (const std::string &name, unsigned nparams)
Find serial number of function by name and number of parameters.
- static std::vector< [function_options](#) > [get_registered_functions](#) ()

Static Public Attributes inherited from [GiNaC::function](#)

- static unsigned [current_serial](#) = 0
This can be used as a hook for external applications.

Protected Types inherited from [GiNaC::container< C >](#)

- typedef [container_storage< C >::STLT](#) [STLT](#)

Protected Types inherited from [GiNaC::container_storage< C >](#)

- typedef C< [ex](#) > [STLT](#)

Static Protected Member Functions inherited from [GiNaC::function](#)

- static `std::vector< function_options > & registered_functions ()`

Static Protected Member Functions inherited from [GiNaC::container< C >](#)

- static unsigned [get_default_flags](#) ()
Specialization of [container::get_default_flags\(\)](#) for `lst`.
- static char [get_open_delim](#) ()
Specialization of [container::get_open_delim\(\)](#) for `lst`.
- static char [get_close_delim](#) ()
Specialization of [container::get_close_delim\(\)](#) for `lst`.

Static Protected Member Functions inherited from [GiNaC::container_storage< C >](#)

- static void [reserve](#) ([STLT](#) &, `size_t`)

6.62.1 Detailed Description

This class represents the (abstract) derivative of a symbolic function.

It is used to represent the derivatives of functions that do not have a derivative or series expansion procedure defined.

6.62.2 Constructor & Destructor Documentation**6.62.2.1 [fderivative\(\)](#) [1/3]**

```
GiNaC::fderivative::fderivative (
    unsigned ser,
    unsigned param,
    const exvector & args )
```

Construct derivative with respect to one parameter.

Parameters

<i>ser</i>	Serial number of function
<i>param</i>	Number of parameter with respect to which to take the derivative
<i>args</i>	Arguments of derivative function

References [parameter_set](#).

6.62.2.2 fderivative() [2/3]

```
GiNaC::fderivative::fderivative (
    unsigned ser,
    const paramset & params,
    const exvector & args )
```

Construct derivative with respect to multiple parameters.

Parameters

<i>ser</i>	Serial number of function
<i>params</i>	Set of numbers of parameters with respect to which to take the derivative
<i>args</i>	Arguments of derivative function

6.62.2.3 fderivative() [3/3]

```
GiNaC::fderivative::fderivative (
    unsigned ser,
    const paramset & params,
    exvector && v )
```

6.62.3 Member Function Documentation

6.62.3.1 print()

```
void GiNaC::fderivative::print (
    const print_context & c,
    unsigned level = 0 ) const [override], [virtual]
```

Output to stream.

This performs double dispatch on the dynamic type of *this and the dynamic type of the supplied print context.

Parameters

<i>c</i>	print context object that describes the output formatting
<i>level</i>	value that is used to identify the precedence or indentation level for placing parentheses and formatting

Reimplemented from [GiNaC::basic](#).

References [c](#), and [GiNaC::basic::print\(\)](#).

6.62.3.2 eval()

```
ex GiNaC::fderivative::eval ( ) const [override], [virtual]
```

Perform automatic non-interruptive term rewriting rules.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::hold\(\)](#), [parameter_set](#), [GiNaC::function::pderivative\(\)](#), [GiNaC::function::registered_functions\(\)](#), [GiNaC::container_storage< C >::seq](#), and [GiNaC::function::serial](#).

6.62.3.3 series()

```
ex GiNaC::fderivative::series (
    const relational & r,
    int order,
    unsigned options = 0 ) const [override], [virtual]
```

The series expansion of derivatives falls back to Taylor expansion.

See also

[basic::series](#)

Reimplemented from [GiNaC::basic](#).

References [options](#), [order](#), [r](#), and [GiNaC::basic::series\(\)](#).

6.62.3.4 thiscontainer() [1/2]

```
ex GiNaC::fderivative::thiscontainer (
    const exvector & v ) const [override]
```

References [parameter_set](#), and [GiNaC::function::serial](#).

6.62.3.5 thiscontainer() [2/2]

```
ex GiNaC::fderivative::thiscontainer (
    exvector && v ) const [override]
```

References [parameter_set](#), and [GiNaC::function::serial](#).

6.62.3.6 archive()

```
void GiNaC::fderivative::archive (
    archive_node & n ) const [override], [virtual]
```

Archive the object.

Reimplemented from [GiNaC::container< C >](#).

References [GiNaC::container< C >::end\(\)](#), [n](#), and [parameter_set](#).

6.62.3.7 read_archive()

```
void GiNaC::fderivative::read_archive (
    const archive_node & n,
    lst & syms ) [override], [virtual]
```

Load (deserialize) the object from an archive node.

Construct object from [archive_node](#).

Note

This method is essentially a constructor. However, constructors can't be virtual. So, if unarchiving routines are implemented as constructors one would need to define such a constructor in every class, even if all it does is simply calling constructor of a superclass.

Reimplemented from [GiNaC::container< C >](#).

References [n](#), and [parameter_set](#).

6.62.3.8 derivative()

```
ex GiNaC::fderivative::derivative (
    const symbol & s ) const [override], [protected], [virtual]
```

Implementation of [ex::diff\(\)](#) for derivatives.

It applies the chain rule.

See also

[ex::diff](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::ex::is_zero\(\)](#), [parameter_set](#), [GiNaC::container_storage< C >::seq](#), and [GiNaC::function::serial](#).

6.62.3.9 is_equal_same_type()

```
bool GiNaC::fderivative::is_equal_same_type (
    const basic & other ) const [override], [protected], [virtual]
```

Returns true if two objects of same type are equal.

Normally needs not be reimplemented as long as it wasn't overwritten by some parent class, since it just calls [compare_same_type\(\)](#). The reason why this function exists is that sometimes it is easier to determine equality than an order relation and then it can be overridden.

Reimplemented from [GiNaC::container< C >](#).

References [GINAC_ASSERT](#), and [parameter_set](#).

6.62.3.10 match_same_type()

```
bool GiNaC::fderivative::match_same_type (
    const basic & other ) const [override], [protected], [virtual]
```

Returns true if the attributes of two objects are similar enough for a match.

This function must not match subexpressions (this is already done by [basic::match\(\)](#)). Only attributes not accessible by [op\(\)](#) should be compared. This is also the reason why this function doesn't take the wildcard replacement list from [match\(\)](#) as an argument: only subexpressions are subject to wildcard matches. Also, this function only needs to be implemented for container classes because [is_equal_same_type\(\)](#) is automatically used instead of [match_same_type\(\)](#) if [nops\(\)](#) == 0.

See also

[basic::match](#)

Reimplemented from [GiNaC::basic](#).

References [GINAC_ASSERT](#), and [parameter_set](#).

6.62.3.11 derivatives()

```
const paramset & GiNaC::fderivative::derivatives ( ) const
```

Expose this object's derivative structure.

Parameter numbers occurring more than once stand for repeated differentiation with respect to that parameter. If a symbolic function $f(x,y)$ is differentiated with respect to x , this method will return $\{0\}$. If $f(x,y)$ is differentiated twice with respect to y , it will return $\{1,1\}$. (This corresponds to the way this object is printed.)

Returns

multiset of function's parameter numbers that are abstractly differentiated.

References [parameter_set](#).

6.62.3.12 do_print()

```
void GiNaC::fderivative::do_print (
    const print\_context & c,
    unsigned level ) const [protected]
```

References [c](#), [GiNaC::container< C >::end\(\)](#), [parameter_set](#), [GiNaC::container< C >::precedence\(\)](#), [GiNaC::function::precedence\(\)](#), [GiNaC::container< C >::printseq\(\)](#), [GiNaC::function::registered_functions\(\)](#), and [GiNaC::function::serial](#).

6.62.3.13 do_print_latex()

```
void GiNaC::fderivative::do_print_latex (
    const print\_context & c,
    unsigned level ) const [protected]
```

References [c](#), [GiNaC::container< C >::end\(\)](#), [order](#), [parameter_set](#), [GiNaC::container< C >::precedence\(\)](#), [GiNaC::function::precedence\(\)](#), [GiNaC::container< C >::printseq\(\)](#), [GiNaC::function::registered_functions\(\)](#), and [GiNaC::function::serial](#).

6.62.3.14 do_print_csrc()

```
void GiNaC::fderivative::do_print_csrc (
    const print\_csrc & c,
    unsigned level ) const [protected]
```

References [c](#), [GiNaC::container< C >::end\(\)](#), [parameter_set](#), [GiNaC::container< C >::precedence\(\)](#), [GiNaC::function::precedence\(\)](#), [GiNaC::container< C >::printseq\(\)](#), [GiNaC::function::registered_functions\(\)](#), and [GiNaC::function::serial](#).

6.62.3.15 do_print_tree()

```
void GiNaC::fderivative::do_print_tree (
    const print\_tree & c,
    unsigned level ) const [protected]
```

References [c](#), [GiNaC::container< C >::end\(\)](#), [GiNaC::basic::flags](#), [GiNaC::basic::hashvalue](#), [GiNaC::container< C >::nops\(\)](#), [parameter_set](#), [GiNaC::function::registered_functions\(\)](#), [GiNaC::container_storage< C >::seq](#), and [GiNaC::function::serial](#).

6.62.4 Member Data Documentation

6.62.4.1 parameter_set

```
paramset GiNaC::fderivative::parameter_set [protected]
```

Set of parameter numbers with respect to which to take the derivative.

Referenced by [archive\(\)](#), [derivative\(\)](#), [derivatives\(\)](#), [do_print\(\)](#), [do_print_csrc\(\)](#), [do_print_latex\(\)](#), [do_print_tree\(\)](#), [eval\(\)](#), [fderivative\(\)](#), [is_equal_same_type\(\)](#), [match_same_type\(\)](#), [read_archive\(\)](#), and [thiscontainer\(\)](#).

The documentation for this class was generated from the following files:

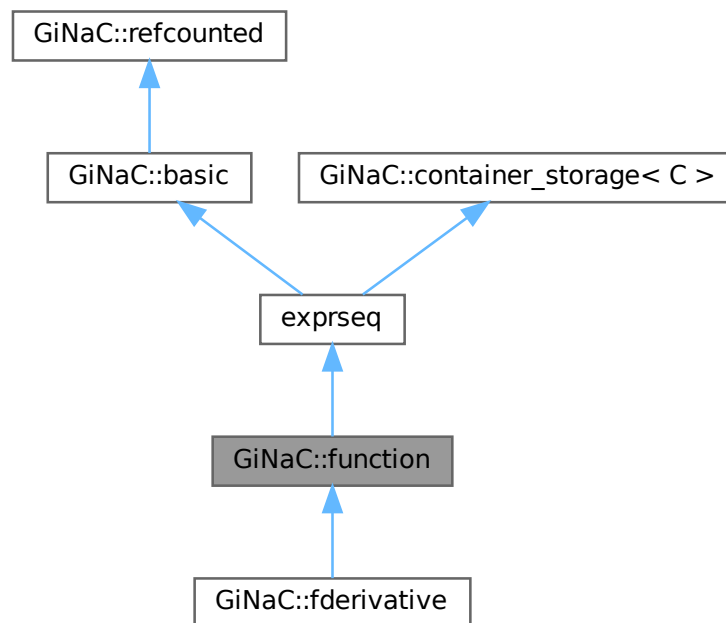
- [fderivative.h](#)
- [fderivative.cpp](#)

6.63 GiNaC::function Class Reference

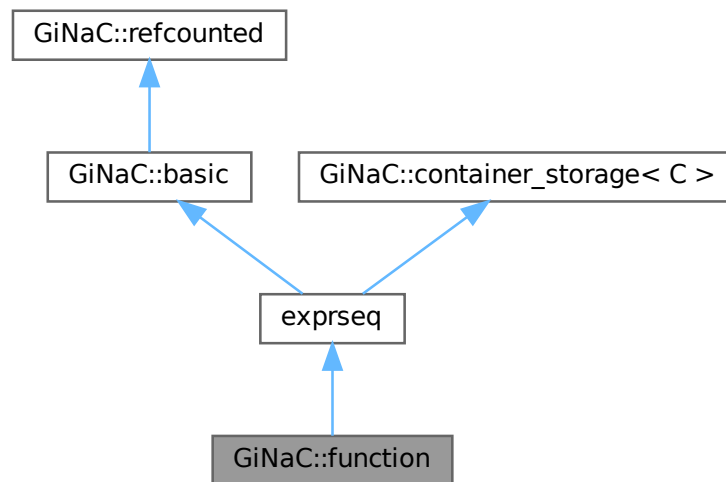
The class function is used to implement builtin functions like sin, cos... and user defined functions.

```
#include <function.h>
```

Inheritance diagram for GiNaC::function:



Collaboration diagram for GiNaC::function:



Public Member Functions

- [function](#) (unsigned ser)
- [function](#) (unsigned ser, const [ex](#) ¶m1)
- [function](#) (unsigned ser, const [ex](#) ¶m1, const [ex](#) ¶m2)
- [function](#) (unsigned ser, const [ex](#) ¶m1, const [ex](#) ¶m2, const [ex](#) ¶m3)
- [function](#) (unsigned ser, const [ex](#) ¶m1, const [ex](#) ¶m2, const [ex](#) ¶m3, const [ex](#) ¶m4)
- [function](#) (unsigned ser, const [ex](#) ¶m1, const [ex](#) ¶m2, const [ex](#) ¶m3, const [ex](#) ¶m4, const [ex](#) ¶m5)
- [function](#) (unsigned ser, const [ex](#) ¶m1, const [ex](#) ¶m2, const [ex](#) ¶m3, const [ex](#) ¶m4, const [ex](#) ¶m5, const [ex](#) ¶m6)
- [function](#) (unsigned ser, const [ex](#) ¶m1, const [ex](#) ¶m2, const [ex](#) ¶m3, const [ex](#) ¶m4, const [ex](#) ¶m5, const [ex](#) ¶m6, const [ex](#) ¶m7)
- [function](#) (unsigned ser, const [ex](#) ¶m1, const [ex](#) ¶m2, const [ex](#) ¶m3, const [ex](#) ¶m4, const [ex](#) ¶m5, const [ex](#) ¶m6, const [ex](#) ¶m7, const [ex](#) ¶m8)
- [function](#) (unsigned ser, const [ex](#) ¶m1, const [ex](#) ¶m2, const [ex](#) ¶m3, const [ex](#) ¶m4, const [ex](#) ¶m5, const [ex](#) ¶m6, const [ex](#) ¶m7, const [ex](#) ¶m8, const [ex](#) ¶m9)
- [function](#) (unsigned ser, const [ex](#) ¶m1, const [ex](#) ¶m2, const [ex](#) ¶m3, const [ex](#) ¶m4, const [ex](#) ¶m5, const [ex](#) ¶m6, const [ex](#) ¶m7, const [ex](#) ¶m8, const [ex](#) ¶m9, const [ex](#) ¶m10)
- [function](#) (unsigned ser, const [ex](#) ¶m1, const [ex](#) ¶m2, const [ex](#) ¶m3, const [ex](#) ¶m4, const [ex](#) ¶m5, const [ex](#) ¶m6, const [ex](#) ¶m7, const [ex](#) ¶m8, const [ex](#) ¶m9, const [ex](#) ¶m10, const [ex](#) ¶m11)
- [function](#) (unsigned ser, const [ex](#) ¶m1, const [ex](#) ¶m2, const [ex](#) ¶m3, const [ex](#) ¶m4, const [ex](#) ¶m5, const [ex](#) ¶m6, const [ex](#) ¶m7, const [ex](#) ¶m8, const [ex](#) ¶m9, const [ex](#) ¶m10, const [ex](#) ¶m11, const [ex](#) ¶m12)
- [function](#) (unsigned ser, const [ex](#) ¶m1, const [ex](#) ¶m2, const [ex](#) ¶m3, const [ex](#) ¶m4, const [ex](#) ¶m5, const [ex](#) ¶m6, const [ex](#) ¶m7, const [ex](#) ¶m8, const [ex](#) ¶m9, const [ex](#) ¶m10, const [ex](#) ¶m11, const [ex](#) ¶m12, const [ex](#) ¶m13)
- [function](#) (unsigned ser, const [ex](#) ¶m1, const [ex](#) ¶m2, const [ex](#) ¶m3, const [ex](#) ¶m4, const [ex](#) ¶m5, const [ex](#) ¶m6, const [ex](#) ¶m7, const [ex](#) ¶m8, const [ex](#) ¶m9, const [ex](#) ¶m10, const [ex](#) ¶m11, const [ex](#) ¶m12, const [ex](#) ¶m13, const [ex](#) ¶m14)

- `function` (unsigned ser, const `exprseq` &es)
- `function` (unsigned ser, const `exvector` &v)
- `function` (unsigned ser, `exvector` &&v)
- void `print` (const `print_context` &c, unsigned level=0) const override
Output to stream.
- unsigned `precedence` () const override
Return relative operator precedence (for parenthezing output).
- `ex expand` (unsigned `options`=0) const override
Expand expression, i.e.
- `ex eval` () const override
Perform automatic non-interruptive term rewriting rules.
- `ex evalf` () const override
Evaluate object numerically.
- `ex eval_ncmul` (const `exvector` &v) const override
This method is defined to be in line with behavior of `function::return_type()`
- unsigned `calchash` () const override
Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.
- `ex series` (const `relational` &r, int `order`, unsigned `options`=0) const override
Implementation of `ex::series` for functions.
- `ex thiscontainer` (const `exvector` &v) const override
- `ex thiscontainer` (`exvector` &&v) const override
- `ex conjugate` () const override
Implementation of `ex::conjugate` for functions.
- `ex real_part` () const override
Implementation of `ex::real_part` for functions.
- `ex imag_part` () const override
Implementation of `ex::imag_part` for functions.
- void `archive` (`archive_node` &n) const override
Archive the object.
- void `read_archive` (const `archive_node` &n, `lst` &syms) override
Construct object from `archive_node`.
- bool `info` (unsigned inf) const override
Implementation of `ex::info` for functions.
- `ex power` (const `ex` &exp) const
- unsigned `get_serial` () const
- std::string `get_name` () const
Return the print name of the function.

Public Member Functions inherited from `GiNaC::container< C >`

- `container` (STLT const &s)
- `container` (STLT &&v)
- `container` (`exvector::const_iterator` b, `exvector::const_iterator` e)
- `container` (std::initializer_list< `ex` > il)
- bool `info` (unsigned inf) const override
Information about the object.
- unsigned `precedence` () const override
Return relative operator precedence (for parenthezing output).
- size_t `nops` () const override
Number of operands/members.
- `ex op` (size_t i) const override

- *Return operand/member at position i.*
- `ex & let_op (size_t i)` override
- *Return modifiable operand/member at position i.*
- `ex subs (const exmap &m, unsigned options=0)` const override
- *Substitute a set of objects by arbitrary expressions.*
- `void read_archive (const archive_node &n, lst &sym_lst)` override
- *Load (deserialize) the object from an archive node.*
- `void archive (archive_node &n)` const override
- *Archive the object.*
- `container & prepend (const ex &b)`
- *Add element at front.*
- `container & append (const ex &b)`
- *Add element at back.*
- `container & remove_first ()`
- *Remove first element.*
- `container & remove_last ()`
- *Remove last element.*
- `container & remove_all ()`
- *Remove all elements.*
- `container & sort ()`
- *Sort elements.*
- `container & unique ()`
- *Remove adjacent duplicate elements.*
- `const_iterator begin ()` const
- `const_iterator end ()` const
- `const_reverse_iterator rbegin ()` const
- `const_reverse_iterator rend ()` const

Public Member Functions inherited from `GiNaC::basic`

- `virtual ~basic ()`
- *basic destructor, virtual because class ex will delete objects of derived classes via a basic*.*
- `basic (const basic &other)`
- `const basic & operator= (const basic &other)`
- *basic assignment operator: the other object might be of a derived class.*
- `virtual basic * duplicate ()` const
- *Create a clone of this object on the heap.*
- `virtual ex eval ()` const
- *Perform automatic non-interruptive term rewriting rules.*
- `virtual ex evalf ()` const
- *Evaluate object numerically.*
- `virtual ex evalm ()` const
- *Evaluate sums, products and integer powers of matrices.*
- `virtual ex eval_integ ()` const
- *Evaluate integrals, if result is known.*
- `virtual ex eval_indexed (const basic &i)` const
- *Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- `virtual void print (const print_context &c, unsigned level=0)` const
- *Output to stream.*
- `virtual void dbgprint ()` const

- Little wrapper around print to be called within a debugger.*

 - virtual void `dbgprinttree` () const
- Little wrapper around printtree to be called within a debugger.*

 - virtual unsigned `precedence` () const
- Return relative operator precedence (for parenthezing output).*

 - virtual bool `info` (unsigned inf) const
- Information about the object.*

 - virtual size_t `nops` () const
- Number of operands/members.*

 - virtual `ex op` (size_t i) const
- Return operand/member at position i.*

 - virtual `ex operator[]` (const `ex` &index) const
 - virtual `ex operator[]` (size_t i) const
 - virtual `ex & let_op` (size_t i)
- Return modifiable operand/member at position i.*

 - virtual `ex & operator[]` (const `ex` &index)
 - virtual `ex & operator[]` (size_t i)
 - virtual bool `has` (const `ex` &other, unsigned `options`=0) const
- Test for occurrence of a pattern.*

 - virtual bool `match` (const `ex` &pattern, `exmap` &repls) const
- Check whether the expression matches a given pattern.*

 - virtual `ex subs` (const `exmap` &m, unsigned `options`=0) const
- Substitute a set of objects by arbitrary expressions.*

 - virtual `ex map` (`map_function` &f) const
- Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*

 - virtual void `accept` (GiNaC::visitor &v) const
 - virtual bool `is_polynomial` (const `ex` &var) const
- Check whether this is a polynomial in the given variables.*

 - virtual int `degree` (const `ex` &s) const
- Return degree of highest power in object s.*

 - virtual int `ldegree` (const `ex` &s) const
- Return degree of lowest power in object s.*

 - virtual `ex coeff` (const `ex` &s, int n=1) const
- Return coefficient of degree n in object s.*

 - virtual `ex expand` (unsigned `options`=0) const
- Expand expression, i.e.*

 - virtual `ex collect` (const `ex` &s, bool distributed=false) const
- Sort expanded expression in terms of powers of some object(s).*

 - virtual `ex series` (const `relational` &r, int `order`, unsigned `options`=0) const
- Default implementation of `ex::series()`.*

 - virtual `ex normal` (`exmap` &repl, `exmap` &rev_lookup, `lst` &modifier) const
- Default implementation of `ex::normal()`.*

 - virtual `ex to_rational` (`exmap` &repl) const
- Default implementation of `ex::to_rational()`.*

 - virtual `ex to_polynomial` (`exmap` &repl) const
 - virtual `numeric integer_content` () const
 - virtual `ex smod` (const `numeric` &xi) const
- Apply symmetric modular homomorphism to an expanded multivariate polynomial.*

 - virtual `numeric max_coefficient` () const
- Implementation `ex::max_coefficient()`.*

 - virtual `exvector get_free_indices` () const

- *Return a vector containing the free indices of an expression.*
- virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
- *Add two indexed expressions.*
- virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
- *Multiply an indexed expression with a scalar.*
- virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const
- *Try to contract two indexed expressions that appear in the same product.*
- virtual unsigned `return_type` () const
- virtual `return_type_t return_type_tinfo` () const
- virtual `ex conjugate` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const
- template<class T >
- void `print_dispatch` (const `print_context` &c, unsigned level) const
- *Like `print()`, but dispatch to the specified class.*
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const
- *Like `print()`, but dispatch to the specified class.*
- virtual void `archive` (`archive_node` &n) const
- *Save (serialize) the object into archive node.*
- virtual void `read_archive` (const `archive_node` &n, `lst` &syms)
- *Load (deserialize) the object from an archive node.*
- `ex subs_one_level` (const `exmap` &m, unsigned `options`) const
- *Helper function for `subs()`.*
- `ex diff` (const `symbol` &s, unsigned nth=1) const
- *Default interface of nth derivative `ex::diff(s, n)`.*
- int `compare` (const `basic` &other) const
- *Compare objects syntactically to establish canonical ordering.*
- bool `is_equal` (const `basic` &other) const
- *Test for syntactic equality.*
- const `basic` & `hold` () const
- *Stop further evaluation.*
- unsigned `gethash` () const
- const `basic` & `setflag` (unsigned f) const
- *Set some `status_flags`.*
- const `basic` & `clearflag` (unsigned f) const
- *Clear some `status_flags`.*

Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- unsigned int `add_reference` () noexcept
- unsigned int `remove_reference` () noexcept
- unsigned int `get_refcount` () const noexcept
- void `set_refcount` (unsigned int r) noexcept

Static Public Member Functions

- static unsigned `register_new` (`function_options` const &opt)
- static unsigned `find_function` (const std::string &name, unsigned nparams)
- *Find serial number of function by name and number of parameters.*
- static std::vector< `function_options` > `get_registered_functions` ()

Static Public Attributes

- static unsigned `current_serial` = 0

This can be used as a hook for external applications.

Protected Member Functions

- `ex derivative` (const `symbol` &s) const override
Implementation of `ex::diff()` for functions.
- bool `is_equal_same_type` (const `basic` &other) const override
Returns true if two objects of same type are equal.
- bool `match_same_type` (const `basic` &other) const override
Returns true if the attributes of two objects are similar enough for a match.
- unsigned `return_type` () const override
- `return_type_t` `return_type_tinfo` () const override
- `ex pderivative` (unsigned diff_param) const
- `ex expl_derivative` (const `symbol` &s) const
- bool `lookup_remember_table` (ex &result) const
- void `store_remember_table` (ex const &result) const

Protected Member Functions inherited from `GiNaC::container< C >`

- `ex conjugate` () const override
- `ex real_part` () const override
- `ex imag_part` () const override
- bool `is_equal_same_type` (const `basic` &other) const override
Returns true if two objects of same type are equal.
- virtual `ex thiscontainer` (const `STLT` &v) const
Similar to `duplicate()`, but with a preset sequence.
- virtual `ex thiscontainer` (`STLT` &&v) const
Similar to `duplicate()`, but with a preset sequence (which gets pilfered).
- virtual void `printseq` (const `print_context` &c, char openbracket, char delim, char closebracket, unsigned this←_precedence, unsigned upper_precedence=0) const
Print sequence of contained elements.
- void `do_print` (const `print_context` &c, unsigned level) const
- void `do_print_tree` (const `print_tree` &c, unsigned level) const
- void `do_print_python` (const `print_python` &c, unsigned level) const
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const
- `STLT` `subchildren` (const `exmap` &m, unsigned `options`=0) const

Protected Member Functions inherited from `GiNaC::basic`

- `basic` ()
- virtual `ex eval_ncmul` (const `exvector` &v) const
- virtual bool `match_same_type` (const `basic` &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual `ex derivative` (const `symbol` &s) const
Default implementation of `ex::diff()`.
- virtual int `compare_same_type` (const `basic` &other) const
Returns order relation between two objects of same type.

- virtual bool `is_equal_same_type` (const `basic` &other) const
Returns true if two objects of same type are equal.
- virtual unsigned `calchash` () const
Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.
- void `ensure_if_modifiable` () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void `do_print` (const `print_context` &c, unsigned level) const
Default output to stream.
- void `do_print_tree` (const `print_tree` &c, unsigned level) const
Tree output to stream.
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const
Python parsable output to stream.

Protected Member Functions inherited from `GiNaC::container_storage< C >`

- `container_storage` ()
- `container_storage` (size_t n, const `ex` &e)
- `container_storage` (std::initializer_list< `ex` > il)
- template<class In >
`container_storage` (In b, In e)
- void `reserve` (size_t)
- `~container_storage` ()
- void `reserve` (size_t n)
- void `reserve` (std::vector< `ex` > &v, size_t n)

Static Protected Member Functions

- static std::vector< `function_options` > &`registered_functions` ()

Static Protected Member Functions inherited from `GiNaC::container< C >`

- static unsigned `get_default_flags` ()
Specialization of `container::get_default_flags()` for `lst`.
- static char `get_open_delim` ()
Specialization of `container::get_open_delim()` for `lst`.
- static char `get_close_delim` ()
Specialization of `container::get_close_delim()` for `lst`.

Static Protected Member Functions inherited from `GiNaC::container_storage< C >`

- static void `reserve` (STLT &, size_t)

Protected Attributes

- unsigned `serial`

Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)
of type [status_flags](#)
- unsigned [hashvalue](#)
hash value

Protected Attributes inherited from [GiNaC::container_storage< C >](#)

- [STLT seq](#)

Friends

- class [remember_table_entry](#)

Additional Inherited Members**Public Types inherited from [GiNaC::container< C >](#)**

- typedef [STLT::const_iterator](#) [const_iterator](#)
- typedef [STLT::const_reverse_iterator](#) [const_reverse_iterator](#)

Protected Types inherited from [GiNaC::container< C >](#)

- typedef [container_storage< C >::STLT](#) [STLT](#)

Protected Types inherited from [GiNaC::container_storage< C >](#)

- typedef [C< ex >](#) [STLT](#)

6.63.1 Detailed Description

The class function is used to implement builtin functions like sin, cos... and user defined functions.

6.63.2 Constructor & Destructor Documentation**6.63.2.1 [function\(\)](#) [1/18]**

```
GiNaC::function::function (
    unsigned ser )
```

6.63.2.2 function() [2/18]

```
GiNaC::function::function (
    unsigned ser,
    const ex & param1 )
```

6.63.2.3 function() [3/18]

```
GiNaC::function::function (
    unsigned ser,
    const ex & param1,
    const ex & param2 )
```

6.63.2.4 function() [4/18]

```
GiNaC::function::function (
    unsigned ser,
    const ex & param1,
    const ex & param2,
    const ex & param3 )
```

6.63.2.5 function() [5/18]

```
GiNaC::function::function (
    unsigned ser,
    const ex & param1,
    const ex & param2,
    const ex & param3,
    const ex & param4 )
```

6.63.2.6 function() [6/18]

```
GiNaC::function::function (
    unsigned ser,
    const ex & param1,
    const ex & param2,
    const ex & param3,
    const ex & param4,
    const ex & param5 )
```


6.63.2.7 function() [7/18]

```
GiNaC::function::function (
    unsigned ser,
    const ex & param1,
    const ex & param2,
    const ex & param3,
    const ex & param4,
    const ex & param5,
    const ex & param6 )
```

6.63.2.8 function() [8/18]

```
GiNaC::function::function (
    unsigned ser,
    const ex & param1,
    const ex & param2,
    const ex & param3,
    const ex & param4,
    const ex & param5,
    const ex & param6,
    const ex & param7 )
```

6.63.2.9 function() [9/18]

```
GiNaC::function::function (
    unsigned ser,
    const ex & param1,
    const ex & param2,
    const ex & param3,
    const ex & param4,
    const ex & param5,
    const ex & param6,
    const ex & param7,
    const ex & param8 )
```

6.63.2.10 function() [10/18]

```
GiNaC::function::function (
    unsigned ser,
    const ex & param1,
    const ex & param2,
    const ex & param3,
    const ex & param4,
    const ex & param5,
    const ex & param6,
    const ex & param7,
    const ex & param8,
    const ex & param9 )
```

6.63.2.11 function() [11/18]

```
GiNaC::function::function (
    unsigned ser,
    const ex & param1,
    const ex & param2,
    const ex & param3,
    const ex & param4,
    const ex & param5,
    const ex & param6,
    const ex & param7,
    const ex & param8,
    const ex & param9,
    const ex & param10 )
```

6.63.2.12 function() [12/18]

```
GiNaC::function::function (
    unsigned ser,
    const ex & param1,
    const ex & param2,
    const ex & param3,
    const ex & param4,
    const ex & param5,
    const ex & param6,
    const ex & param7,
    const ex & param8,
    const ex & param9,
    const ex & param10,
    const ex & param11 )
```

6.63.2.13 function() [13/18]

```
GiNaC::function::function (
    unsigned ser,
    const ex & param1,
    const ex & param2,
    const ex & param3,
    const ex & param4,
    const ex & param5,
    const ex & param6,
    const ex & param7,
    const ex & param8,
    const ex & param9,
    const ex & param10,
    const ex & param11,
    const ex & param12 )
```

6.63.2.14 function() [14/18]

```
GiNaC::function::function (
    unsigned ser,
    const ex & param1,
    const ex & param2,
    const ex & param3,
    const ex & param4,
    const ex & param5,
    const ex & param6,
    const ex & param7,
    const ex & param8,
    const ex & param9,
    const ex & param10,
    const ex & param11,
    const ex & param12,
    const ex & param13 )
```

6.63.2.15 function() [15/18]

```
GiNaC::function::function (
    unsigned ser,
    const ex & param1,
    const ex & param2,
    const ex & param3,
    const ex & param4,
    const ex & param5,
    const ex & param6,
    const ex & param7,
    const ex & param8,
    const ex & param9,
    const ex & param10,
    const ex & param11,
    const ex & param12,
    const ex & param13,
    const ex & param14 )
```

6.63.2.16 function() [16/18]

```
GiNaC::function::function (
    unsigned ser,
    const exprseq & es )
```

References [GiNaC::basic::clearflag\(\)](#), and [GiNaC::status_flags::evaluated](#).

6.63.2.17 function() [17/18]

```
GiNaC::function::function (
    unsigned ser,
    const exvector & v )
```

6.63.2.18 function() [18/18]

```
GiNaC::function::function (
    unsigned ser,
    exvector && v )
```

6.63.3 Member Function Documentation**6.63.3.1 print()**

```
void GiNaC::function::print (
    const print_context & c,
    unsigned level = 0 ) const [override], [virtual]
```

Output to stream.

This performs double dispatch on the dynamic type of *this and the dynamic type of the supplied print context.

Parameters

<i>c</i>	print context object that describes the output formatting
<i>level</i>	value that is used to identify the precedence or indentation level for placing parentheses and formatting

Reimplemented from [GiNaC::basic](#).

References [c](#), [current_serial](#), [GiNaC::basic::flags](#), [GiNaC::class_info< OPT >::get_parent\(\)](#), [GINAC_ASSERT](#), [GiNaC::basic::hashvalue](#), [GiNaC::function_options::name](#), [GiNaC::container< C >::nops\(\)](#), [GiNaC::function_options::nparams](#), [GiNaC::class_info< OPT >::options](#), [GiNaC::container< C >::precedence\(\)](#), [precedence\(\)](#), [print\(\)](#), [GiNaC::function_options::print_di](#), [GiNaC::function_options::print_use_exvector_args](#), [GiNaC::container< C >::printseq\(\)](#), [registered_functions\(\)](#), [GiNaC::container_storage< C >::seq](#), [serial](#), and [GiNaC::function_options::TeX_name](#).

Referenced by [print\(\)](#).

6.63.3.2 precedence()

```
unsigned GiNaC::function::precedence ( ) const [inline], [override], [virtual]
```

Return relative operator precedence (for parenthezing output).

Reimplemented from [GiNaC::container< C >](#).

Referenced by [GiNaC::fderivative::do_print\(\)](#), [GiNaC::fderivative::do_print_csrc\(\)](#), [GiNaC::fderivative::do_print_latex\(\)](#), and [print\(\)](#).

6.63.3.3 expand()

```
ex GiNaC::function::expand (
    unsigned options = 0 ) const [override], [virtual]
```

Expand expression, i.e.

multiply it out and return the result as a new expression.

Reimplemented from [GiNaC::basic](#).

References [current_serial](#), [GiNaC::function_options::expand_f](#), [GiNaC::expand_options::expand_function_args](#), [GiNaC::function_options::expand_use_exvector_args](#), [GiNaC::status_flags::expanded](#), [GINAC_ASSERT](#), [GiNaC::function_options::nparams](#), [registered_functions\(\)](#), [GiNaC::container_storage< C >::seq](#), [serial](#), and [GiNaC::basic::setflag\(\)](#).

6.63.3.4 eval()

```
ex GiNaC::function::eval ( ) const [override], [virtual]
```

Perform automatic non-interruptive term rewriting rules.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex0](#), [GiNaC::canonicalize\(\)](#), [current_serial](#), [GiNaC::function_options::eval_f](#), [GiNaC::function_options::eval_use_exvector_args](#), [GiNaC::status_flags::evaluated](#), [GiNaC::basic::flags](#), [GINAC_ASSERT](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::is_zero\(\)](#), [lookup_remember_table\(\)](#), [GiNaC::function_options::nparams](#), [registered_functions\(\)](#), [GiNaC::container_storage< C >::seq](#), [serial](#), [store_remember_table\(\)](#), [GiNaC::function_options::symtree](#), [thiscontainer\(\)](#), and [GiNaC::function_options::use_remember](#).

6.63.3.5 evalf()

```
ex GiNaC::function::evalf ( ) const [override], [virtual]
```

Evaluate object numerically.

Reimplemented from [GiNaC::basic](#).

References [current_serial](#), [GiNaC::function_options::evalf_f](#), [GiNaC::function_options::evalf_params_first](#), [GiNaC::function_options::evalf_use_exvector_args](#), [GINAC_ASSERT](#), [GiNaC::basic::hold\(\)](#), [GiNaC::function_options::nparams](#), [registered_functions\(\)](#), [GiNaC::container_storage< C >::seq](#), and [serial](#).

Referenced by [GiNaC::iterated_integral2_eval\(\)](#), and [GiNaC::iterated_integral3_eval\(\)](#).

6.63.3.6 eval_ncmul()

```
ex GiNaC::function::eval_ncmul (
    const exvector & v ) const [override], [virtual]
```

This method is defined to be in line with behavior of [function::return_type\(\)](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::container_storage< C >::seq](#).

6.63.3.7 calchash()

```
unsigned GiNaC::function::calchash ( ) const [override], [virtual]
```

Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.

The method inherited from class basic computes a hash value based on the type and hash values of possible members. For this reason it is well suited for container classes but atomic classes should override this implementation because otherwise they would all end up with the same hashvalue.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::status_flags::evaluated](#), [GiNaC::basic::flags](#), [GiNaC::ex::gethash\(\)](#), [GiNaC::golden_ratio_hash\(\)](#), [GiNaC::status_flags::hash_calculated](#), [GiNaC::basic::hashvalue](#), [GiNaC::make_hash_seed\(\)](#), [GiNaC::container< C >::nops\(\)](#), [GiNaC::container< C >::op\(\)](#), [GiNaC::rotate_left\(\)](#), [serial](#), and [GiNaC::basic::setflag\(\)](#).

6.63.3.8 series()

```
ex GiNaC::function::series (
    const relational & r,
    int order,
    unsigned options = 0 ) const [override], [virtual]
```

Implementation of [ex::series](#) for functions.

@see [ex::series](#)

Reimplemented from [GiNaC::basic](#).

References [current_serial](#), [GINAC_ASSERT](#), [GiNaC::function_options::nparams](#), [options](#), [order](#), [r](#), [registered_functions\(\)](#), [GiNaC::container_storage< C >::seq](#), [serial](#), [GiNaC::basic::series\(\)](#), [GiNaC::function_options::series_f](#), and [GiNaC::function_options::series_use_exvector_args](#).

6.63.3.9 thiscontainer() [1/2]

```
ex GiNaC::function::thiscontainer (
    const exvector & v ) const [override]
```

References [serial](#).

Referenced by [eval\(\)](#).

6.63.3.10 thiscontainer() [2/2]

```
ex GiNaC::function::thiscontainer (
    exvector && v ) const [override]
```

References [serial](#).

6.63.3.11 conjugate()

```
ex GiNaC::function::conjugate ( ) const [override], [virtual]
```

Implementation of [ex::conjugate](#) for functions.

Reimplemented from [GiNaC::container< C >](#).

References [GiNaC::function_options::conjugate_f](#), [GiNaC::function_options::conjugate_use_exvector_args](#), [GINAC_ASSERT](#), [GiNaC::function_options::nparams](#), [registered_functions\(\)](#), [GiNaC::container_storage< C >::seq](#), and [serial](#).

6.63.3.12 real_part()

```
ex GiNaC::function::real_part ( ) const [override], [virtual]
```

Implementation of [ex::real_part](#) for functions.

Reimplemented from [GiNaC::container< C >](#).

References [GINAC_ASSERT](#), [GiNaC::function_options::nparams](#), [GiNaC::basic::real_part\(\)](#), [GiNaC::function_options::real_part_f](#), [GiNaC::function_options::real_part_use_exvector_args](#), [registered_functions\(\)](#), [GiNaC::container_storage< C >::seq](#), and [serial](#).

6.63.3.13 `imag_part()`

```
ex GiNaC::function::imag_part ( ) const [override], [virtual]
```

Implementation of [ex::imag_part](#) for functions.

Reimplemented from [GiNaC::container< C >](#).

References [GINAC_ASSERT](#), [GiNaC::basic::imag_part\(\)](#), [GiNaC::function_options::imag_part_f](#), [GiNaC::function_options::imag_part](#), [GiNaC::function_options::nparams](#), [registered_functions\(\)](#), [GiNaC::container_storage< C >::seq](#), and [serial](#).

6.63.3.14 `archive()`

```
void GiNaC::function::archive (
    archive_node & n ) const [override], [virtual]
```

Archive the object.

Reimplemented from [GiNaC::container< C >](#).

References [GINAC_ASSERT](#), [n](#), [registered_functions\(\)](#), and [serial](#).

6.63.3.15 `read_archive()`

```
void GiNaC::function::read_archive (
    const archive_node & n,
    lst & syms ) [override], [virtual]
```

Construct object from [archive_node](#).

Reimplemented from [GiNaC::container< C >](#).

References [n](#), [registered_functions\(\)](#), [GiNaC::container_storage< C >::seq](#), and [serial](#).

6.63.3.16 `info()`

```
bool GiNaC::function::info (
    unsigned inf ) const [override], [virtual]
```

Implementation of [ex::info](#) for functions.

Reimplemented from [GiNaC::container< C >](#).

References [GINAC_ASSERT](#), [GiNaC::basic::info\(\)](#), [GiNaC::function_options::info_f](#), [GiNaC::function_options::info_use_exvector_arg](#), [GiNaC::function_options::nparams](#), [registered_functions\(\)](#), [GiNaC::container_storage< C >::seq](#), and [serial](#).

6.63.3.17 derivative()

```
ex GiNaC::function::derivative (
    const symbol & s ) const [override], [protected], [virtual]
```

Implementation of [ex::diff\(\)](#) for functions.

It applies the chain rule, except for the Order term function. @see [ex::diff](#)

Reimplemented from [GiNaC::basic](#).

References [expl_derivative\(\)](#), [GiNaC::ex::is_zero\(\)](#), [pderivative\(\)](#), and [GiNaC::container_storage< C >::seq](#).

6.63.3.18 is_equal_same_type()

```
bool GiNaC::function::is_equal_same_type (
    const basic & other ) const [override], [protected], [virtual]
```

Returns true if two objects of same type are equal.

Normally needs not be reimplemented as long as it wasn't overwritten by some parent class, since it just calls [compare_same_type\(\)](#). The reason why this function exists is that sometimes it is easier to determine equality than an order relation and then it can be overridden.

Reimplemented from [GiNaC::container< C >](#).

References [GINAC_ASSERT](#), [GiNaC::container< C >::is_equal_same_type\(\)](#), and [serial](#).

6.63.3.19 match_same_type()

```
bool GiNaC::function::match_same_type (
    const basic & other ) const [override], [protected], [virtual]
```

Returns true if the attributes of two objects are similar enough for a match.

This function must not match subexpressions (this is already done by [basic::match\(\)](#)). Only attributes not accessible by [op\(\)](#) should be compared. This is also the reason why this function doesn't take the wildcard replacement list from [match\(\)](#) as an argument: only subexpressions are subject to wildcard matches. Also, this function only needs to be implemented for container classes because [is_equal_same_type\(\)](#) is automatically used instead of [match_same_type\(\)](#) if [nops\(\)](#) == 0.

See also

[basic::match](#)

Reimplemented from [GiNaC::basic](#).

References [GINAC_ASSERT](#), and [serial](#).

6.63.3.20 return_type()

```
unsigned GiNaC::function::return_type ( ) const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::return_types::commutative](#), [GINAC_ASSERT](#), [registered_functions\(\)](#), [GiNaC::function_options::return_type](#), [GiNaC::container_storage< C >::seq](#), [serial](#), and [GiNaC::function_options::use_return_type](#).

6.63.3.21 return_type_tinfo()

```
return_type_t GiNaC::function::return_type_tinfo ( ) const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GINAC_ASSERT](#), [registered_functions\(\)](#), [GiNaC::function_options::return_type_tinfo](#), [GiNaC::container_storage< C >::seq](#), [serial](#), and [GiNaC::function_options::use_return_type](#).

6.63.3.22 pderivative()

```
ex GiNaC::function::pderivative (
    unsigned diff_param ) const [protected]
```

References [GiNaC::function_options::derivative_f](#), [GiNaC::function_options::derivative_use_exvector_args](#), [GINAC_ASSERT](#), and [GiNaC::function_options::nparams](#).

Referenced by [derivative\(\)](#), and [GiNaC::fderivative::eval\(\)](#).

6.63.3.23 expl_derivative()

```
ex GiNaC::function::expl_derivative (
    const symbol & s ) const [protected]
```

References [GiNaC::function_options::expl_derivative_f](#), [GiNaC::function_options::expl_derivative_use_exvector_args](#), [GINAC_ASSERT](#), and [GiNaC::function_options::nparams](#).

Referenced by [derivative\(\)](#).

6.63.3.24 registered_functions()

```
std::vector< function\_options > & GiNaC::function::registered_functions ( ) [static], [protected]
```

Referenced by [archive\(\)](#), [conjugate\(\)](#), [GiNaC::fderivative::do_print\(\)](#), [GiNaC::fderivative::do_print_csrc\(\)](#), [GiNaC::fderivative::do_print_latex\(\)](#), [GiNaC::fderivative::do_print_tree\(\)](#), [GiNaC::fderivative::eval\(\)](#), [eval\(\)](#), [evalf\(\)](#), [expand\(\)](#), [find_function\(\)](#), [get_name\(\)](#), [get_registered_functions\(\)](#), [imag_part\(\)](#), [info\(\)](#), [print\(\)](#), [read_archive\(\)](#), [real_part\(\)](#), [register_new\(\)](#), [return_type\(\)](#), [return_type_tinfo\(\)](#), and [series\(\)](#).

6.63.3.25 lookup_remember_table()

```
bool GiNaC::function::lookup_remember_table (
    ex & result ) const [protected]
```

References [GiNaC::remember_table::remember_tables\(\)](#), and [serial](#).

Referenced by [eval\(\)](#).

6.63.3.26 store_remember_table()

```
void GiNaC::function::store_remember_table (
    ex const & result ) const [protected]
```

References [GiNaC::remember_table::remember_tables\(\)](#), and [serial](#).

Referenced by [eval\(\)](#).

6.63.3.27 power()

```
ex GiNaC::function::power (
    const ex & exp ) const
```

References [GiNaC::status_flags::evaluated](#), [GINAC_ASSERT](#), [GiNaC::function_options::nparams](#), [GiNaC::function_options::power_f](#), and [GiNaC::function_options::power_use_exvector_args](#).

6.63.3.28 register_new()

```
unsigned GiNaC::function::register_new (
    function\_options const & opt ) [static]
```

References [GiNaC::function_options::functions_with_same_name](#), [GiNaC::function_options::name](#), [registered_functions\(\)](#), [GiNaC::function_options::remember_assoc_size](#), [GiNaC::function_options::remember_size](#), [GiNaC::function_options::remember_str](#), [GiNaC::remember_table::remember_tables\(\)](#), and [GiNaC::function_options::use_remember](#).

6.63.3.29 find_function()

```
unsigned GiNaC::function::find_function (
    const std::string & name,
    unsigned nparams ) [static]
```

Find serial number of function by name and number of parameters.

Throws exception if function was not found.

References [registered_functions\(\)](#), and [serial](#).

6.63.3.30 get_registered_functions()

```
static std::vector< function\_options > GiNaC::function::get_registered_functions ( ) [inline],
[static]
```

References [registered_functions\(\)](#).

6.63.3.31 get_serial()

```
unsigned GiNaC::function::get_serial ( ) const [inline]
```

References [serial](#).

6.63.3.32 get_name()

```
std::string GiNaC::function::get_name ( ) const
```

Return the print name of the function.

References [GINAC_ASSERT](#), [registered_functions\(\)](#), and [serial](#).

6.63.4 Friends And Related Function Documentation

6.63.4.1 remember_table_entry

```
friend class remember\_table\_entry [friend]
```

6.63.5 Member Data Documentation

6.63.5.1 current_serial

```
unsigned GiNaC::function::current_serial = 0 [static]
```

This can be used as a hook for external applications.

Referenced by [eval\(\)](#), [evalf\(\)](#), [expand\(\)](#), [print\(\)](#), and [series\(\)](#).

6.63.5.2 serial

```
unsigned GiNaC::function::serial [protected]
```

Referenced by [archive\(\)](#), [calchash\(\)](#), [conjugate\(\)](#), [GiNaC::fderivative::derivative\(\)](#), [GiNaC::fderivative::do_print\(\)](#), [GiNaC::fderivative::do_print_csrc\(\)](#), [GiNaC::fderivative::do_print_latex\(\)](#), [GiNaC::fderivative::do_print_tree\(\)](#), [GiNaC::fderivative::eval\(\)](#), [eval\(\)](#), [evalf\(\)](#), [expand\(\)](#), [find_function\(\)](#), [get_name\(\)](#), [get_serial\(\)](#), [imag_part\(\)](#), [info\(\)](#), [is_equal_same_type\(\)](#), [lookup_remember_table\(\)](#), [match_same_type\(\)](#), [print\(\)](#), [read_archive\(\)](#), [real_part\(\)](#), [return_type\(\)](#), [return_type_tinfo\(\)](#), [series\(\)](#), [store_remember_table\(\)](#), [GiNaC::fderivative::thiscontainer\(\)](#), and [thiscontainer\(\)](#).

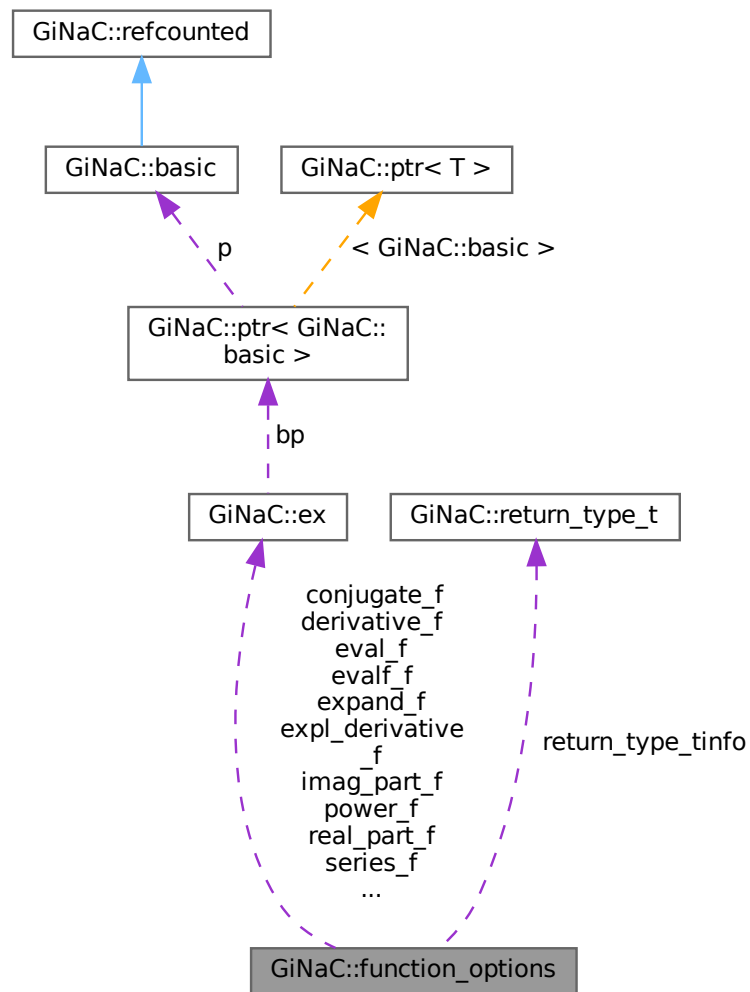
The documentation for this class was generated from the following files:

- [function.h](#)
- [function.cpp](#)

6.64 GiNaC::function_options Class Reference

```
#include <function.h>
```

Collaboration diagram for GiNaC::function_options:



Public Member Functions

- `function_options` ()
- `function_options` (std::string const &n, std::string const &tn=std::string())
- `function_options` (std::string const &n, unsigned np)
- `~function_options` ()
- void `initialize` ()
- `function_options` & `dummy` ()
- `function_options` & `set_name` (std::string const &n, std::string const &tn=std::string())
- `function_options` & `latex_name` (std::string const &tn)
- `function_options` & `eval_func` (eval_funcp_1 e)
- `function_options` & `eval_func` (eval_funcp_2 e)
- `function_options` & `eval_func` (eval_funcp_3 e)
- `function_options` & `eval_func` (eval_funcp_4 e)
- `function_options` & `eval_func` (eval_funcp_5 e)

- Generated by Doxygen

- [function_options & power_func \(power_funcp_4 e\)](#)
- [function_options & power_func \(power_funcp_5 e\)](#)
- [function_options & power_func \(power_funcp_6 e\)](#)
- [function_options & power_func \(power_funcp_7 e\)](#)
- [function_options & power_func \(power_funcp_8 e\)](#)
- [function_options & power_func \(power_funcp_9 e\)](#)
- [function_options & power_func \(power_funcp_10 e\)](#)
- [function_options & power_func \(power_funcp_11 e\)](#)
- [function_options & power_func \(power_funcp_12 e\)](#)
- [function_options & power_func \(power_funcp_13 e\)](#)
- [function_options & power_func \(power_funcp_14 e\)](#)
- [function_options & series_func \(series_funcp_1 e\)](#)
- [function_options & series_func \(series_funcp_2 e\)](#)
- [function_options & series_func \(series_funcp_3 e\)](#)
- [function_options & series_func \(series_funcp_4 e\)](#)
- [function_options & series_func \(series_funcp_5 e\)](#)
- [function_options & series_func \(series_funcp_6 e\)](#)
- [function_options & series_func \(series_funcp_7 e\)](#)
- [function_options & series_func \(series_funcp_8 e\)](#)
- [function_options & series_func \(series_funcp_9 e\)](#)
- [function_options & series_func \(series_funcp_10 e\)](#)
- [function_options & series_func \(series_funcp_11 e\)](#)
- [function_options & series_func \(series_funcp_12 e\)](#)
- [function_options & series_func \(series_funcp_13 e\)](#)
- [function_options & series_func \(series_funcp_14 e\)](#)
- [function_options & info_func \(info_funcp_1 e\)](#)
- [function_options & info_func \(info_funcp_2 e\)](#)
- [function_options & info_func \(info_funcp_3 e\)](#)
- [function_options & info_func \(info_funcp_4 e\)](#)
- [function_options & info_func \(info_funcp_5 e\)](#)
- [function_options & info_func \(info_funcp_6 e\)](#)
- [function_options & info_func \(info_funcp_7 e\)](#)
- [function_options & info_func \(info_funcp_8 e\)](#)
- [function_options & info_func \(info_funcp_9 e\)](#)
- [function_options & info_func \(info_funcp_10 e\)](#)
- [function_options & info_func \(info_funcp_11 e\)](#)
- [function_options & info_func \(info_funcp_12 e\)](#)
- [function_options & info_func \(info_funcp_13 e\)](#)
- [function_options & info_func \(info_funcp_14 e\)](#)
- [function_options & eval_func \(eval_funcp_exvector e\)](#)
- [function_options & evalf_func \(evalf_funcp_exvector e\)](#)
- [function_options & conjugate_func \(conjugate_funcp_exvector e\)](#)
- [function_options & real_part_func \(real_part_funcp_exvector e\)](#)
- [function_options & imag_part_func \(imag_part_funcp_exvector e\)](#)
- [function_options & expand_func \(expand_funcp_exvector e\)](#)
- [function_options & derivative_func \(derivative_funcp_exvector e\)](#)
- [function_options & expl_derivative_func \(expl_derivative_funcp_exvector e\)](#)
- [function_options & power_func \(power_funcp_exvector e\)](#)
- [function_options & series_func \(series_funcp_exvector e\)](#)
- [function_options & info_func \(info_funcp_exvector e\)](#)
- [template<class Ctx >
function_options & print_func \(print_funcp_1 p\)](#)
- [template<class Ctx >
function_options & print_func \(print_funcp_2 p\)](#)

- `template<class Ctx >`
`function_options` & `print_func` (`print_funcp_3` p)
- `template<class Ctx >`
`function_options` & `print_func` (`print_funcp_4` p)
- `template<class Ctx >`
`function_options` & `print_func` (`print_funcp_5` p)
- `template<class Ctx >`
`function_options` & `print_func` (`print_funcp_6` p)
- `template<class Ctx >`
`function_options` & `print_func` (`print_funcp_7` p)
- `template<class Ctx >`
`function_options` & `print_func` (`print_funcp_8` p)
- `template<class Ctx >`
`function_options` & `print_func` (`print_funcp_9` p)
- `template<class Ctx >`
`function_options` & `print_func` (`print_funcp_10` p)
- `template<class Ctx >`
`function_options` & `print_func` (`print_funcp_11` p)
- `template<class Ctx >`
`function_options` & `print_func` (`print_funcp_12` p)
- `template<class Ctx >`
`function_options` & `print_func` (`print_funcp_13` p)
- `template<class Ctx >`
`function_options` & `print_func` (`print_funcp_14` p)
- `template<class Ctx >`
`function_options` & `print_func` (`print_funcp_exvector` p)
- `function_options` & `set_return_type` (unsigned rt, const `return_type_t` *rtt=nullptr)
- `function_options` & `do_not_evalf_params` ()
- `function_options` & `remember` (unsigned size, unsigned assoc_size=0, unsigned strategy=`remember_strategies::delete_never`)
- `function_options` & `overloaded` (unsigned o)
- `function_options` & `set_symmetry` (const `symmetry` &s)
- `std::string` `get_name` () const
- unsigned `get_nparams` () const

Protected Member Functions

- bool `has_derivative` () const
- bool `has_power` () const
- void `test_and_set_nparams` (unsigned n)
- void `set_print_func` (unsigned id, `print_funcp` f)

Protected Attributes

- `std::string` `name`
- `std::string` `TeX_name`
- unsigned `nparams`
- `eval_funcp` `eval_f`
- `evalf_funcp` `evalf_f`
- `conjugate_funcp` `conjugate_f`
- `real_part_funcp` `real_part_f`
- `imag_part_funcp` `imag_part_f`
- `expand_funcp` `expand_f`
- `derivative_funcp` `derivative_f`

- [expl_derivative_funcp](#) [expl_derivative_f](#)
- [power_funcp](#) [power_f](#)
- [series_funcp](#) [series_f](#)
- `std::vector< print_funcp > print_dispatch_table`
- [info_funcp](#) [info_f](#)
- `bool evalf_params_first`
- `bool use_return_type`
- `unsigned return_type`
- `return_type_t return_type_tinfo`
- `bool use_remember`
- `unsigned remember_size`
- `unsigned remember_assoc_size`
- `unsigned remember_strategy`
- `bool eval_use_exvector_args`
- `bool evalf_use_exvector_args`
- `bool conjugate_use_exvector_args`
- `bool real_part_use_exvector_args`
- `bool imag_part_use_exvector_args`
- `bool expand_use_exvector_args`
- `bool derivative_use_exvector_args`
- `bool expl_derivative_use_exvector_args`
- `bool power_use_exvector_args`
- `bool series_use_exvector_args`
- `bool print_use_exvector_args`
- `bool info_use_exvector_args`
- `unsigned functions_with_same_name`
- [ex](#) [symtree](#)

Friends

- class [function](#)
- class [fderivative](#)

6.64.1 Constructor & Destructor Documentation

6.64.1.1 [function_options\(\)](#) [1/3]

GiNaC::function_options::function_options ()

References [initialize\(\)](#).

6.64.1.2 [function_options\(\)](#) [2/3]

```
GiNaC::function_options::function_options (
    std::string const & n,
    std::string const & tn = std::string() )
```

References [initialize\(\)](#), [n](#), and [set_name\(\)](#).

6.64.1.3 `function_options()` [3/3]

```
GiNaC::function_options::function_options (
    std::string const & n,
    unsigned np )
```

References [initialize\(\)](#), [n](#), [nparams](#), and [set_name\(\)](#).

6.64.1.4 `~function_options()`

```
GiNaC::function_options::~~function_options ( )
```

6.64.2 Member Function Documentation

6.64.2.1 `initialize()`

```
void GiNaC::function_options::initialize ( )
```

References [conjugate_f](#), [conjugate_use_exvector_args](#), [derivative_f](#), [derivative_use_exvector_args](#), [eval_f](#), [eval_use_exvector_args](#), [evalf_f](#), [evalf_params_first](#), [evalf_use_exvector_args](#), [expand_f](#), [expand_use_exvector_args](#), [expl_derivative_f](#), [expl_derivative_use_exvector_args](#), [functions_with_same_name](#), [imag_part_f](#), [imag_part_use_exvector_args](#), [info_f](#), [info_use_exvector_args](#), [nparams](#), [power_f](#), [power_use_exvector_args](#), [print_use_exvector_args](#), [real_part_f](#), [real_part_use_exvector_args](#), [series_f](#), [series_use_exvector_args](#), [set_name\(\)](#), [symtree](#), [use_remember](#), and [use_return_type](#).

Referenced by [function_options\(\)](#).

6.64.2.2 `dummy()`

```
function\_options & GiNaC::function_options::dummy ( ) [inline]
```

6.64.2.3 `set_name()`

```
function\_options & GiNaC::function_options::set_name (
    std::string const & n,
    std::string const & tn = std::string() )
```

References [n](#), [name](#), and [TeX_name](#).

Referenced by [function_options\(\)](#), and [initialize\(\)](#).

6.64.2.4 latex_name()

```
function_options & GiNaC::function_options::latex_name (
    std::string const & tn )
```

References [TeX_name](#).

6.64.2.5 eval_func() [1/15]

```
function_options & GiNaC::function_options::eval_func (
    eval_funcp_1 e )
```

References [eval_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.6 eval_func() [2/15]

```
function_options & GiNaC::function_options::eval_func (
    eval_funcp_2 e )
```

References [eval_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.7 eval_func() [3/15]

```
function_options & GiNaC::function_options::eval_func (
    eval_funcp_3 e )
```

References [eval_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.8 eval_func() [4/15]

```
function_options & GiNaC::function_options::eval_func (
    eval_funcp_4 e )
```

References [eval_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.9 eval_func() [5/15]

```
function_options & GiNaC::function_options::eval_func (
    eval_funcp_5 e )
```

References [eval_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.10 eval_func() [6/15]

```
function_options & GiNaC::function_options::eval_func (
    eval_funcp_6 e )
```

References [eval_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.11 eval_func() [7/15]

```
function_options & GiNaC::function_options::eval_func (
    eval_funcp_7 e )
```

References [eval_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.12 eval_func() [8/15]

```
function_options & GiNaC::function_options::eval_func (
    eval_funcp_8 e )
```

References [eval_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.13 eval_func() [9/15]

```
function_options & GiNaC::function_options::eval_func (
    eval_funcp_9 e )
```

References [eval_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.14 eval_func() [10/15]

```
function_options & GiNaC::function_options::eval_func (
    eval_funcp_10 e )
```

References [eval_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.15 eval_func() [11/15]

```
function_options & GiNaC::function_options::eval_func (
    eval_funcp_11 e )
```

References [eval_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.16 eval_func() [12/15]

```
function_options & GiNaC::function_options::eval_func (
    eval_funcp_12 e )
```

References [eval_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.17 eval_func() [13/15]

```
function_options & GiNaC::function_options::eval_func (
    eval_funcp_13 e )
```

References [eval_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.18 eval_func() [14/15]

```
function_options & GiNaC::function_options::eval_func (
    eval_funcp_14 e )
```

References [eval_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.19 evalf_func() [1/15]

```
function_options & GiNaC::function_options::evalf_func (
    evalf_funcp_1 e )
```

References [evalf_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.20 evalf_func() [2/15]

```
function_options & GiNaC::function_options::evalf_func (
    evalf_funcp_2 e )
```

References [evalf_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.21 evalf_func() [3/15]

```
function_options & GiNaC::function_options::evalf_func (
    evalf_funcp_3 e )
```

References [evalf_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.22 evalf_func() [4/15]

```
function_options & GiNaC::function_options::evalf_func (
    evalf_funcp_4 e )
```

References [evalf_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.23 evalf_func() [5/15]

```
function_options & GiNaC::function_options::evalf_func (
    evalf_funcp_5 e )
```

References [evalf_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.24 evalf_func() [6/15]

```
function_options & GiNaC::function_options::evalf_func (
    evalf_funcp_6 e )
```

References [evalf_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.25 evalf_func() [7/15]

```
function_options & GiNaC::function_options::evalf_func (
    evalf_funcp_7 e )
```

References [evalf_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.26 evalf_func() [8/15]

```
function_options & GiNaC::function_options::evalf_func (
    evalf_funcp_8 e )
```

References [evalf_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.27 evalf_func() [9/15]

```
function_options & GiNaC::function_options::evalf_func (
    evalf_funcp_9 e )
```

References [evalf_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.28 evalf_func() [10/15]

```
function_options & GiNaC::function_options::evalf_func (
    evalf_funcp_10 e )
```

References [evalf_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.29 evalf_func() [11/15]

```
function_options & GiNaC::function_options::evalf_func (
    evalf_funcp_11 e )
```

References [evalf_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.30 evalf_func() [12/15]

```
function_options & GiNaC::function_options::evalf_func (
    evalf_funcp_12 e )
```

References [evalf_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.31 evalf_func() [13/15]

```
function_options & GiNaC::function_options::evalf_func (
    evalf_funcp_13 e )
```

References [evalf_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.32 evalf_func() [14/15]

```
function_options & GiNaC::function_options::evalf_func (
    evalf_funcp_14 e )
```

References [evalf_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.33 conjugate_func() [1/15]

```
function_options & GiNaC::function_options::conjugate_func (
    conjugate_funcp_1 e )
```

References [conjugate_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.34 conjugate_func() [2/15]

```
function_options & GiNaC::function_options::conjugate_func (
    conjugate_funcp_2 e )
```

References [conjugate_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.35 conjugate_func() [3/15]

```
function_options & GiNaC::function_options::conjugate_func (
    conjugate_funcp_3 e )
```

References [conjugate_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.36 conjugate_func() [4/15]

```
function_options & GiNaC::function_options::conjugate_func (
    conjugate_funcp_4 e )
```

References [conjugate_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.37 conjugate_func() [5/15]

```
function_options & GiNaC::function_options::conjugate_func (
    conjugate_funcp_5 e )
```

References [conjugate_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.38 conjugate_func() [6/15]

```
function_options & GiNaC::function_options::conjugate_func (
    conjugate_funcp_6 e )
```

References [conjugate_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.39 conjugate_func() [7/15]

```
function_options & GiNaC::function_options::conjugate_func (
    conjugate_funcp_7 e )
```

References [conjugate_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.40 conjugate_func() [8/15]

```
function_options & GiNaC::function_options::conjugate_func (
    conjugate_funcp_8 e )
```

References [conjugate_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.41 conjugate_func() [9/15]

```
function_options & GiNaC::function_options::conjugate_func (
    conjugate_funcp_9 e )
```

References [conjugate_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.42 conjugate_func() [10/15]

```
function_options & GiNaC::function_options::conjugate_func (
    conjugate_funcp_10 e )
```

References [conjugate_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.43 conjugate_func() [11/15]

```
function_options & GiNaC::function_options::conjugate_func (
    conjugate_funcp_11 e )
```

References [conjugate_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.44 conjugate_func() [12/15]

```
function_options & GiNaC::function_options::conjugate_func (
    conjugate_funcp_12 e )
```

References [conjugate_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.45 conjugate_func() [13/15]

```
function_options & GiNaC::function_options::conjugate_func (
    conjugate_funcp_13 e )
```

References [conjugate_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.46 conjugate_func() [14/15]

```
function_options & GiNaC::function_options::conjugate_func (
    conjugate_funcp_14 e )
```

References [conjugate_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.47 real_part_func() [1/15]

```
function_options & GiNaC::function_options::real_part_func (
    real_part_funcp_1 e )
```

References [real_part_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.48 real_part_func() [2/15]

```
function_options & GiNaC::function_options::real_part_func (
    real_part_funcp_2 e )
```

References [real_part_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.49 real_part_func() [3/15]

```
function_options & GiNaC::function_options::real_part_func (
    real_part_funcp_3 e )
```

References [real_part_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.50 real_part_func() [4/15]

```
function_options & GiNaC::function_options::real_part_func (
    real_part_funcp_4 e )
```

References [real_part_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.51 real_part_func() [5/15]

```
function_options & GiNaC::function_options::real_part_func (
    real_part_funcp_5 e )
```

References [real_part_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.52 real_part_func() [6/15]

```
function_options & GiNaC::function_options::real_part_func (
    real_part_funcp_6 e )
```

References [real_part_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.53 real_part_func() [7/15]

```
function_options & GiNaC::function_options::real_part_func (
    real_part_funcp_7 e )
```

References [real_part_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.54 real_part_func() [8/15]

```
function_options & GiNaC::function_options::real_part_func (
    real_part_funcp_8 e )
```

References [real_part_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.55 real_part_func() [9/15]

```
function_options & GiNaC::function_options::real_part_func (
    real_part_funcp_9 e )
```

References [real_part_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.56 real_part_func() [10/15]

```
function_options & GiNaC::function_options::real_part_func (
    real_part_funcp_10 e )
```

References [real_part_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.57 real_part_func() [11/15]

```
function_options & GiNaC::function_options::real_part_func (
    real_part_funcp_11 e )
```

References [real_part_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.58 real_part_func() [12/15]

```
function_options & GiNaC::function_options::real_part_func (
    real_part_funcp_12 e )
```

References [real_part_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.59 real_part_func() [13/15]

```
function_options & GiNaC::function_options::real_part_func (
    real_part_funcp_13 e )
```

References [real_part_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.60 real_part_func() [14/15]

```
function_options & GiNaC::function_options::real_part_func (
    real_part_funcp_14 e )
```

References [real_part_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.61 imag_part_func() [1/15]

```
function_options & GiNaC::function_options::imag_part_func (
    imag_part_funcp_1 e )
```

References [imag_part_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.62 imag_part_func() [2/15]

```
function_options & GiNaC::function_options::imag_part_func (
    imag_part_funcp_2 e )
```

References [imag_part_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.63 imag_part_func() [3/15]

```
function_options & GiNaC::function_options::imag_part_func (
    imag_part_funcp_3 e )
```

References [imag_part_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.64 imag_part_func() [4/15]

```
function_options & GiNaC::function_options::imag_part_func (
    imag_part_funcp_4 e )
```

References [imag_part_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.65 imag_part_func() [5/15]

```
function_options & GiNaC::function_options::imag_part_func (
    imag_part_funcp_5 e )
```

References [imag_part_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.66 imag_part_func() [6/15]

```
function_options & GiNaC::function_options::imag_part_func (
    imag_part_funcp_6 e )
```

References [imag_part_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.67 imag_part_func() [7/15]

```
function_options & GiNaC::function_options::imag_part_func (
    imag_part_funcp_7 e )
```

References [imag_part_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.68 imag_part_func() [8/15]

```
function_options & GiNaC::function_options::imag_part_func (
    imag_part_funcp_8 e )
```

References [imag_part_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.69 imag_part_func() [9/15]

```
function_options & GiNaC::function_options::imag_part_func (
    imag_part_funcp_9 e )
```

References [imag_part_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.70 imag_part_func() [10/15]

```
function_options & GiNaC::function_options::imag_part_func (
    imag_part_funcp_10 e )
```

References [imag_part_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.71 imag_part_func() [11/15]

```
function_options & GiNaC::function_options::imag_part_func (
    imag_part_funcp_11 e )
```

References [imag_part_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.72 imag_part_func() [12/15]

```
function_options & GiNaC::function_options::imag_part_func (
    imag_part_funcp_12 e )
```

References [imag_part_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.73 imag_part_func() [13/15]

```
function_options & GiNaC::function_options::imag_part_func (
    imag_part_funcp_13 e )
```

References [imag_part_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.74 imag_part_func() [14/15]

```
function_options & GiNaC::function_options::imag_part_func (
    imag_part_funcp_14 e )
```

References [imag_part_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.75 expand_func() [1/15]

```
function_options & GiNaC::function_options::expand_func (
    expand_funcp_1 e )
```

References [expand_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.76 expand_func() [2/15]

```
function_options & GiNaC::function_options::expand_func (
    expand_funcp_2 e )
```

References [expand_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.77 expand_func() [3/15]

```
function_options & GiNaC::function_options::expand_func (
    expand_funcp_3 e )
```

References [expand_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.78 expand_func() [4/15]

```
function_options & GiNaC::function_options::expand_func (
    expand_funcp_4 e )
```

References [expand_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.79 expand_func() [5/15]

```
function_options & GiNaC::function_options::expand_func (
    expand_funcp_5 e )
```

References [expand_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.80 expand_func() [6/15]

```
function_options & GiNaC::function_options::expand_func (
    expand_funcp_6 e )
```

References [expand_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.81 expand_func() [7/15]

```
function_options & GiNaC::function_options::expand_func (
    expand_funcp_7 e )
```

References [expand_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.82 expand_func() [8/15]

```
function_options & GiNaC::function_options::expand_func (
    expand_funcp_8 e )
```

References [expand_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.83 expand_func() [9/15]

```
function_options & GiNaC::function_options::expand_func (
    expand_funcp_9 e )
```

References [expand_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.84 expand_func() [10/15]

```
function_options & GiNaC::function_options::expand_func (
    expand_funcp_10 e )
```

References [expand_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.85 expand_func() [11/15]

```
function_options & GiNaC::function_options::expand_func (
    expand_funcp_11 e )
```

References [expand_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.86 expand_func() [12/15]

```
function_options & GiNaC::function_options::expand_func (
    expand_funcp_12 e )
```

References [expand_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.87 expand_func() [13/15]

```
function_options & GiNaC::function_options::expand_func (
    expand_funcp_13 e )
```

References [expand_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.88 expand_func() [14/15]

```
function_options & GiNaC::function_options::expand_func (
    expand_funcp_14 e )
```

References [expand_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.89 derivative_func() [1/15]

```
function_options & GiNaC::function_options::derivative_func (
    derivative_funcp_1 e )
```

References [derivative_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.90 derivative_func() [2/15]

```
function_options & GiNaC::function_options::derivative_func (
    derivative_funcp_2 e )
```

References [derivative_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.91 derivative_func() [3/15]

```
function_options & GiNaC::function_options::derivative_func (
    derivative_funcp_3 e )
```

References [derivative_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.92 derivative_func() [4/15]

```
function_options & GiNaC::function_options::derivative_func (
    derivative_funcp_4 e )
```

References [derivative_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.93 derivative_func() [5/15]

```
function_options & GiNaC::function_options::derivative_func (
    derivative_funcp_5 e )
```

References [derivative_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.94 derivative_func() [6/15]

```
function_options & GiNaC::function_options::derivative_func (
    derivative_funcp_6 e )
```

References [derivative_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.95 derivative_func() [7/15]

```
function_options & GiNaC::function_options::derivative_func (
    derivative_funcp_7 e )
```

References [derivative_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.96 derivative_func() [8/15]

```
function_options & GiNaC::function_options::derivative_func (
    derivative_funcp_8 e )
```

References [derivative_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.97 derivative_func() [9/15]

```
function_options & GiNaC::function_options::derivative_func (
    derivative_funcp_9 e )
```

References [derivative_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.98 derivative_func() [10/15]

```
function_options & GiNaC::function_options::derivative_func (
    derivative_funcp_10 e )
```

References [derivative_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.99 derivative_func() [11/15]

```
function_options & GiNaC::function_options::derivative_func (
    derivative_funcp_11 e )
```

References [derivative_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.100 derivative_func() [12/15]

```
function_options & GiNaC::function_options::derivative_func (
    derivative_funcp_12 e )
```

References [derivative_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.101 derivative_func() [13/15]

```
function_options & GiNaC::function_options::derivative_func (
    derivative_funcp_13 e )
```

References [derivative_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.102 derivative_func() [14/15]

```
function_options & GiNaC::function_options::derivative_func (
    derivative_funcp_14 e )
```

References [derivative_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.103 expl_derivative_func() [1/15]

```
function_options & GiNaC::function_options::expl_derivative_func (
    expl_derivative_funcp_1 e )
```

References [expl_derivative_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.104 expl_derivative_func() [2/15]

```
function_options & GiNaC::function_options::expl_derivative_func (
    expl_derivative_funcp_2 e )
```

References [expl_derivative_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.105 expl_derivative_func() [3/15]

```
function_options & GiNaC::function_options::expl_derivative_func (
    expl_derivative_funcp_3 e )
```

References [expl_derivative_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.106 expl_derivative_func() [4/15]

```
function_options & GiNaC::function_options::expl_derivative_func (  
    expl_derivative_funcp_4 e )
```

References [expl_derivative_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.107 expl_derivative_func() [5/15]

```
function_options & GiNaC::function_options::expl_derivative_func (  
    expl_derivative_funcp_5 e )
```

References [expl_derivative_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.108 expl_derivative_func() [6/15]

```
function_options & GiNaC::function_options::expl_derivative_func (  
    expl_derivative_funcp_6 e )
```

References [expl_derivative_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.109 expl_derivative_func() [7/15]

```
function_options & GiNaC::function_options::expl_derivative_func (  
    expl_derivative_funcp_7 e )
```

References [expl_derivative_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.110 expl_derivative_func() [8/15]

```
function_options & GiNaC::function_options::expl_derivative_func (  
    expl_derivative_funcp_8 e )
```

References [expl_derivative_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.111 expl_derivative_func() [9/15]

```
function_options & GiNaC::function_options::expl_derivative_func (  
    expl_derivative_funcp_9 e )
```

References [expl_derivative_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.112 expl_derivative_func() [10/15]

```
function_options & GiNaC::function_options::expl_derivative_func (
    expl_derivative_funcp_10 e )
```

References [expl_derivative_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.113 expl_derivative_func() [11/15]

```
function_options & GiNaC::function_options::expl_derivative_func (
    expl_derivative_funcp_11 e )
```

References [expl_derivative_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.114 expl_derivative_func() [12/15]

```
function_options & GiNaC::function_options::expl_derivative_func (
    expl_derivative_funcp_12 e )
```

References [expl_derivative_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.115 expl_derivative_func() [13/15]

```
function_options & GiNaC::function_options::expl_derivative_func (
    expl_derivative_funcp_13 e )
```

References [expl_derivative_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.116 expl_derivative_func() [14/15]

```
function_options & GiNaC::function_options::expl_derivative_func (
    expl_derivative_funcp_14 e )
```

References [expl_derivative_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.117 power_func() [1/15]

```
function_options & GiNaC::function_options::power_func (
    power_funcp_1 e )
```

References [power_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.118 power_func() [2/15]

```
function_options & GiNaC::function_options::power_func (
    power_funcp_2 e )
```

References [power_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.119 power_func() [3/15]

```
function_options & GiNaC::function_options::power_func (
    power_funcp_3 e )
```

References [power_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.120 power_func() [4/15]

```
function_options & GiNaC::function_options::power_func (
    power_funcp_4 e )
```

References [power_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.121 power_func() [5/15]

```
function_options & GiNaC::function_options::power_func (
    power_funcp_5 e )
```

References [power_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.122 power_func() [6/15]

```
function_options & GiNaC::function_options::power_func (
    power_funcp_6 e )
```

References [power_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.123 power_func() [7/15]

```
function_options & GiNaC::function_options::power_func (
    power_funcp_7 e )
```

References [power_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.124 power_func() [8/15]

```
function_options & GiNaC::function_options::power_func (
    power_funcp_8 e )
```

References [power_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.125 power_func() [9/15]

```
function_options & GiNaC::function_options::power_func (
    power_funcp_9 e )
```

References [power_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.126 power_func() [10/15]

```
function_options & GiNaC::function_options::power_func (
    power_funcp_10 e )
```

References [power_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.127 power_func() [11/15]

```
function_options & GiNaC::function_options::power_func (
    power_funcp_11 e )
```

References [power_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.128 power_func() [12/15]

```
function_options & GiNaC::function_options::power_func (
    power_funcp_12 e )
```

References [power_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.129 power_func() [13/15]

```
function_options & GiNaC::function_options::power_func (
    power_funcp_13 e )
```

References [power_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.130 power_func() [14/15]

```
function_options & GiNaC::function_options::power_func (
    power_funcp_14 e )
```

References [power_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.131 series_func() [1/15]

```
function_options & GiNaC::function_options::series_func (
    series_funcp_1 e )
```

References [series_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.132 series_func() [2/15]

```
function_options & GiNaC::function_options::series_func (
    series_funcp_2 e )
```

References [series_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.133 series_func() [3/15]

```
function_options & GiNaC::function_options::series_func (
    series_funcp_3 e )
```

References [series_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.134 series_func() [4/15]

```
function_options & GiNaC::function_options::series_func (
    series_funcp_4 e )
```

References [series_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.135 series_func() [5/15]

```
function_options & GiNaC::function_options::series_func (
    series_funcp_5 e )
```

References [series_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.136 series_func() [6/15]

```
function_options & GiNaC::function_options::series_func (
    series_funcp_6 e )
```

References [series_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.137 series_func() [7/15]

```
function_options & GiNaC::function_options::series_func (
    series_funcp_7 e )
```

References [series_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.138 series_func() [8/15]

```
function_options & GiNaC::function_options::series_func (
    series_funcp_8 e )
```

References [series_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.139 series_func() [9/15]

```
function_options & GiNaC::function_options::series_func (
    series_funcp_9 e )
```

References [series_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.140 series_func() [10/15]

```
function_options & GiNaC::function_options::series_func (
    series_funcp_10 e )
```

References [series_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.141 series_func() [11/15]

```
function_options & GiNaC::function_options::series_func (
    series_funcp_11 e )
```

References [series_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.142 series_func() [12/15]

```
function_options & GiNaC::function_options::series_func (
    series_funcp_12 e )
```

References [series_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.143 series_func() [13/15]

```
function_options & GiNaC::function_options::series_func (
    series_funcp_13 e )
```

References [series_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.144 series_func() [14/15]

```
function_options & GiNaC::function_options::series_func (
    series_funcp_14 e )
```

References [series_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.145 info_func() [1/15]

```
function_options & GiNaC::function_options::info_func (
    info_funcp_1 e )
```

References [info_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.146 info_func() [2/15]

```
function_options & GiNaC::function_options::info_func (
    info_funcp_2 e )
```

References [info_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.147 info_func() [3/15]

```
function_options & GiNaC::function_options::info_func (
    info_funcp_3 e )
```

References [info_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.148 info_func() [4/15]

```
function_options & GiNaC::function_options::info_func (
    info_funcp_4 e )
```

References [info_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.149 info_func() [5/15]

```
function_options & GiNaC::function_options::info_func (
    info_funcp_5 e )
```

References [info_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.150 info_func() [6/15]

```
function_options & GiNaC::function_options::info_func (
    info_funcp_6 e )
```

References [info_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.151 info_func() [7/15]

```
function_options & GiNaC::function_options::info_func (
    info_funcp_7 e )
```

References [info_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.152 info_func() [8/15]

```
function_options & GiNaC::function_options::info_func (
    info_funcp_8 e )
```

References [info_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.153 info_func() [9/15]

```
function_options & GiNaC::function_options::info_func (
    info_funcp_9 e )
```

References [info_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.154 info_func() [10/15]

```
function_options & GiNaC::function_options::info_func (  
    info_funcp_10 e )
```

References [info_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.155 info_func() [11/15]

```
function_options & GiNaC::function_options::info_func (  
    info_funcp_11 e )
```

References [info_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.156 info_func() [12/15]

```
function_options & GiNaC::function_options::info_func (  
    info_funcp_12 e )
```

References [info_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.157 info_func() [13/15]

```
function_options & GiNaC::function_options::info_func (  
    info_funcp_13 e )
```

References [info_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.158 info_func() [14/15]

```
function_options & GiNaC::function_options::info_func (  
    info_funcp_14 e )
```

References [info_f](#), and [test_and_set_nparams\(\)](#).

6.64.2.159 eval_func() [15/15]

```
function_options & GiNaC::function_options::eval_func (  
    eval_funcp_exvector e )
```

References [eval_f](#), and [eval_use_exvector_args](#).

6.64.2.160 evalf_func() [15/15]

```
function_options & GiNaC::function_options::evalf_func (
    evalf_funcp_exvector e )
```

References [evalf_f](#), and [evalf_use_exvector_args](#).

6.64.2.161 conjugate_func() [15/15]

```
function_options & GiNaC::function_options::conjugate_func (
    conjugate_funcp_exvector e )
```

References [conjugate_f](#), and [conjugate_use_exvector_args](#).

6.64.2.162 real_part_func() [15/15]

```
function_options & GiNaC::function_options::real_part_func (
    real_part_funcp_exvector e )
```

References [real_part_f](#), and [real_part_use_exvector_args](#).

6.64.2.163 imag_part_func() [15/15]

```
function_options & GiNaC::function_options::imag_part_func (
    imag_part_funcp_exvector e )
```

References [imag_part_f](#), and [imag_part_use_exvector_args](#).

6.64.2.164 expand_func() [15/15]

```
function_options & GiNaC::function_options::expand_func (
    expand_funcp_exvector e )
```

References [expand_f](#), and [expand_use_exvector_args](#).

6.64.2.165 derivative_func() [15/15]

```
function_options & GiNaC::function_options::derivative_func (
    derivative_funcp_exvector e )
```

References [derivative_f](#), and [derivative_use_exvector_args](#).

6.64.2.166 `expl_derivative_func()` [15/15]

```
function_options & GiNaC::function_options::expl_derivative_func (
    expl_derivative_funcp_exvector e )
```

References [expl_derivative_f](#), and [expl_derivative_use_exvector_args](#).

6.64.2.167 `power_func()` [15/15]

```
function_options & GiNaC::function_options::power_func (
    power_funcp_exvector e )
```

References [power_f](#), and [power_use_exvector_args](#).

6.64.2.168 `series_func()` [15/15]

```
function_options & GiNaC::function_options::series_func (
    series_funcp_exvector e )
```

References [series_f](#), and [series_use_exvector_args](#).

6.64.2.169 `info_func()` [15/15]

```
function_options & GiNaC::function_options::info_func (
    info_funcp_exvector e )
```

References [info_f](#), and [info_use_exvector_args](#).

6.64.2.170 `print_func()` [1/15]

```
template<class Ctx >
function_options & GiNaC::function_options::print_func (
    print_funcp_1 p ) [inline]
```

References [options](#), [set_print_func\(\)](#), and [test_and_set_nparams\(\)](#).

6.64.2.171 print_func() [2/15]

```
template<class Ctx >
function_options & GiNaC::function_options::print_func (
    print_funcp_2 p ) [inline]
```

References [options](#), [set_print_func\(\)](#), and [test_and_set_nparams\(\)](#).

6.64.2.172 print_func() [3/15]

```
template<class Ctx >
function_options & GiNaC::function_options::print_func (
    print_funcp_3 p ) [inline]
```

References [options](#), [set_print_func\(\)](#), and [test_and_set_nparams\(\)](#).

6.64.2.173 print_func() [4/15]

```
template<class Ctx >
function_options & GiNaC::function_options::print_func (
    print_funcp_4 p ) [inline]
```

References [options](#), [set_print_func\(\)](#), and [test_and_set_nparams\(\)](#).

6.64.2.174 print_func() [5/15]

```
template<class Ctx >
function_options & GiNaC::function_options::print_func (
    print_funcp_5 p ) [inline]
```

References [options](#), [set_print_func\(\)](#), and [test_and_set_nparams\(\)](#).

6.64.2.175 print_func() [6/15]

```
template<class Ctx >
function_options & GiNaC::function_options::print_func (
    print_funcp_6 p ) [inline]
```

References [options](#), [set_print_func\(\)](#), and [test_and_set_nparams\(\)](#).

6.64.2.176 print_func() [7/15]

```
template<class Ctx >
function_options & GiNaC::function_options::print_func (
    print_funcp_7 p ) [inline]
```

References [options](#), [set_print_func\(\)](#), and [test_and_set_nparams\(\)](#).

6.64.2.177 print_func() [8/15]

```
template<class Ctx >
function_options & GiNaC::function_options::print_func (
    print_funcp_8 p ) [inline]
```

References [options](#), [set_print_func\(\)](#), and [test_and_set_nparams\(\)](#).

6.64.2.178 print_func() [9/15]

```
template<class Ctx >
function_options & GiNaC::function_options::print_func (
    print_funcp_9 p ) [inline]
```

References [options](#), [set_print_func\(\)](#), and [test_and_set_nparams\(\)](#).

6.64.2.179 print_func() [10/15]

```
template<class Ctx >
function_options & GiNaC::function_options::print_func (
    print_funcp_10 p ) [inline]
```

References [options](#), [set_print_func\(\)](#), and [test_and_set_nparams\(\)](#).

6.64.2.180 print_func() [11/15]

```
template<class Ctx >
function_options & GiNaC::function_options::print_func (
    print_funcp_11 p ) [inline]
```

References [options](#), [set_print_func\(\)](#), and [test_and_set_nparams\(\)](#).

6.64.2.181 print_func() [12/15]

```
template<class Ctx >
function_options & GiNaC::function_options::print_func (
    print_funcp_12 p ) [inline]
```

References [options](#), [set_print_func\(\)](#), and [test_and_set_nparams\(\)](#).

6.64.2.182 print_func() [13/15]

```
template<class Ctx >
function_options & GiNaC::function_options::print_func (
    print_funcp_13 p ) [inline]
```

References [options](#), [set_print_func\(\)](#), and [test_and_set_nparams\(\)](#).

6.64.2.183 print_func() [14/15]

```
template<class Ctx >
function_options & GiNaC::function_options::print_func (
    print_funcp_14 p ) [inline]
```

References [options](#), [set_print_func\(\)](#), and [test_and_set_nparams\(\)](#).

6.64.2.184 print_func() [15/15]

```
template<class Ctx >
function_options & GiNaC::function_options::print_func (
    print_funcp_exvector p ) [inline]
```

References [options](#), [print_use_exvector_args](#), and [set_print_func\(\)](#).

6.64.2.185 set_return_type()

```
function_options & GiNaC::function_options::set_return_type (
    unsigned rt,
    const return_type_t * rtt = nullptr )
```

References [return_type](#), [return_type_tinfo](#), and [use_return_type](#).

6.64.2.186 do_not_evalf_params()

`function_options` & GiNaC::function_options::do_not_evalf_params ()

References [evalf_params_first](#).

6.64.2.187 remember()

`function_options` & GiNaC::function_options::remember (
 unsigned *size*,
 unsigned *assoc_size* = 0,
 unsigned *strategy* = [remember_strategies::delete_never](#))

References [remember_assoc_size](#), [remember_size](#), [remember_strategy](#), and [use_remember](#).

6.64.2.188 overloaded()

`function_options` & GiNaC::function_options::overloaded (
 unsigned *o*)

References [functions_with_same_name](#).

6.64.2.189 set_symmetry()

`function_options` & GiNaC::function_options::set_symmetry (
 const [symmetry](#) & *s*)

References [symtree](#).

6.64.2.190 get_name()

std::string GiNaC::function_options::get_name () const [inline]

References [name](#).

6.64.2.191 get_nparams()

unsigned GiNaC::function_options::get_nparams () const [inline]

References [nparams](#).

6.64.2.192 has_derivative()

```
bool GiNaC::function_options::has_derivative ( ) const [inline], [protected]
```

References [derivative_f](#).

6.64.2.193 has_power()

```
bool GiNaC::function_options::has_power ( ) const [inline], [protected]
```

References [power_f](#).

6.64.2.194 test_and_set_nparams()

```
void GiNaC::function_options::test_and_set_nparams (
    unsigned n ) [protected]
```

References [n](#), [name](#), and [nparams](#).

Referenced by [conjugate_func\(\)](#), [derivative_func\(\)](#), [eval_func\(\)](#), [evalf_func\(\)](#), [expand_func\(\)](#), [expl_derivative_func\(\)](#), [imag_part_func\(\)](#), [info_func\(\)](#), [power_func\(\)](#), [print_func\(\)](#), [real_part_func\(\)](#), and [series_func\(\)](#).

6.64.2.195 set_print_func()

```
void GiNaC::function_options::set_print_func (
    unsigned id,
    print_funcp f ) [protected]
```

References [print_dispatch_table](#).

Referenced by [print_func\(\)](#).

6.64.3 Friends And Related Function Documentation

6.64.3.1 function

```
friend class function [friend]
```

6.64.3.2 fderivative

```
friend class fderivative [friend]
```

6.64.4 Member Data Documentation

6.64.4.1 name

```
std::string GiNaC::function_options::name [protected]
```

Referenced by [get_name\(\)](#), [GiNaC::function::print\(\)](#), [GiNaC::function::register_new\(\)](#), [set_name\(\)](#), and [test_and_set_nparams\(\)](#).

6.64.4.2 TeX_name

```
std::string GiNaC::function_options::TeX_name [protected]
```

Referenced by [latex_name\(\)](#), [GiNaC::function::print\(\)](#), and [set_name\(\)](#).

6.64.4.3 nparams

```
unsigned GiNaC::function_options::nparams [protected]
```

Referenced by [GiNaC::function::conjugate\(\)](#), [GiNaC::function::eval\(\)](#), [GiNaC::function::evalf\(\)](#), [GiNaC::function::expand\(\)](#), [GiNaC::function::expl_derivative\(\)](#), [function_options\(\)](#), [get_nparams\(\)](#), [GiNaC::function::imag_part\(\)](#), [GiNaC::function::info\(\)](#), [initialize\(\)](#), [GiNaC::function::pderivative\(\)](#), [GiNaC::function::power\(\)](#), [GiNaC::function::print\(\)](#), [GiNaC::function::real_part\(\)](#), [GiNaC::function::series\(\)](#), and [test_and_set_nparams\(\)](#).

6.64.4.4 eval_f

```
eval_funcp GiNaC::function_options::eval_f [protected]
```

Referenced by [GiNaC::function::eval\(\)](#), [eval_func\(\)](#), and [initialize\(\)](#).

6.64.4.5 evalf_f

```
evalf_funcp GiNaC::function_options::evalf_f [protected]
```

Referenced by [GiNaC::function::evalf\(\)](#), [evalf_func\(\)](#), and [initialize\(\)](#).

6.64.4.6 conjugate_f

`conjugate_funcp` GiNaC::function_options::conjugate_f [protected]

Referenced by [GiNaC::function::conjugate\(\)](#), [conjugate_func\(\)](#), and [initialize\(\)](#).

6.64.4.7 real_part_f

`real_part_funcp` GiNaC::function_options::real_part_f [protected]

Referenced by [initialize\(\)](#), [GiNaC::function::real_part\(\)](#), and [real_part_func\(\)](#).

6.64.4.8 imag_part_f

`imag_part_funcp` GiNaC::function_options::imag_part_f [protected]

Referenced by [GiNaC::function::imag_part\(\)](#), [imag_part_func\(\)](#), and [initialize\(\)](#).

6.64.4.9 expand_f

`expand_funcp` GiNaC::function_options::expand_f [protected]

Referenced by [GiNaC::function::expand\(\)](#), [expand_func\(\)](#), and [initialize\(\)](#).

6.64.4.10 derivative_f

`derivative_funcp` GiNaC::function_options::derivative_f [protected]

Referenced by [derivative_func\(\)](#), [has_derivative\(\)](#), [initialize\(\)](#), and [GiNaC::function::pderivative\(\)](#).

6.64.4.11 expl_derivative_f

`expl_derivative_funcp` GiNaC::function_options::expl_derivative_f [protected]

Referenced by [GiNaC::function::expl_derivative\(\)](#), [expl_derivative_func\(\)](#), and [initialize\(\)](#).

6.64.4.12 power_f

`power_funcp` `GiNaC::function_options::power_f` [protected]

Referenced by [has_power\(\)](#), [initialize\(\)](#), [GiNaC::function::power\(\)](#), and [power_func\(\)](#).

6.64.4.13 series_f

`series_funcp` `GiNaC::function_options::series_f` [protected]

Referenced by [initialize\(\)](#), [GiNaC::function::series\(\)](#), and [series_func\(\)](#).

6.64.4.14 print_dispatch_table

`std::vector<print_funcp>` `GiNaC::function_options::print_dispatch_table` [protected]

Referenced by [GiNaC::function::print\(\)](#), and [set_print_func\(\)](#).

6.64.4.15 info_f

`info_funcp` `GiNaC::function_options::info_f` [protected]

Referenced by [GiNaC::function::info\(\)](#), [info_func\(\)](#), and [initialize\(\)](#).

6.64.4.16 evalf_params_first

`bool` `GiNaC::function_options::evalf_params_first` [protected]

Referenced by [do_not_evalf_params\(\)](#), [GiNaC::function::evalf\(\)](#), and [initialize\(\)](#).

6.64.4.17 use_return_type

`bool` `GiNaC::function_options::use_return_type` [protected]

Referenced by [initialize\(\)](#), [GiNaC::function::return_type\(\)](#), [GiNaC::function::return_type_tinfo\(\)](#), and [set_return_type\(\)](#).

6.64.4.18 return_type

`unsigned GiNaC::function_options::return_type [protected]`

Referenced by [GiNaC::function::return_type\(\)](#), and [set_return_type\(\)](#).

6.64.4.19 return_type_tinfo

`return_type_t GiNaC::function_options::return_type_tinfo [protected]`

Referenced by [GiNaC::function::return_type_tinfo\(\)](#), and [set_return_type\(\)](#).

6.64.4.20 use_remember

`bool GiNaC::function_options::use_remember [protected]`

Referenced by [GiNaC::function::eval\(\)](#), [initialize\(\)](#), [GiNaC::function::register_new\(\)](#), and [remember\(\)](#).

6.64.4.21 remember_size

`unsigned GiNaC::function_options::remember_size [protected]`

Referenced by [GiNaC::function::register_new\(\)](#), and [remember\(\)](#).

6.64.4.22 remember_assoc_size

`unsigned GiNaC::function_options::remember_assoc_size [protected]`

Referenced by [GiNaC::function::register_new\(\)](#), and [remember\(\)](#).

6.64.4.23 remember_strategy

`unsigned GiNaC::function_options::remember_strategy [protected]`

Referenced by [GiNaC::function::register_new\(\)](#), and [remember\(\)](#).

6.64.4.24 eval_use_exvector_args

```
bool GiNaC::function_options::eval_use_exvector_args [protected]
```

Referenced by [GiNaC::function::eval\(\)](#), [eval_func\(\)](#), and [initialize\(\)](#).

6.64.4.25 evalf_use_exvector_args

```
bool GiNaC::function_options::evalf_use_exvector_args [protected]
```

Referenced by [GiNaC::function::evalf\(\)](#), [evalf_func\(\)](#), and [initialize\(\)](#).

6.64.4.26 conjugate_use_exvector_args

```
bool GiNaC::function_options::conjugate_use_exvector_args [protected]
```

Referenced by [GiNaC::function::conjugate\(\)](#), [conjugate_func\(\)](#), and [initialize\(\)](#).

6.64.4.27 real_part_use_exvector_args

```
bool GiNaC::function_options::real_part_use_exvector_args [protected]
```

Referenced by [initialize\(\)](#), [GiNaC::function::real_part\(\)](#), and [real_part_func\(\)](#).

6.64.4.28 imag_part_use_exvector_args

```
bool GiNaC::function_options::imag_part_use_exvector_args [protected]
```

Referenced by [GiNaC::function::imag_part\(\)](#), [imag_part_func\(\)](#), and [initialize\(\)](#).

6.64.4.29 expand_use_exvector_args

```
bool GiNaC::function_options::expand_use_exvector_args [protected]
```

Referenced by [GiNaC::function::expand\(\)](#), [expand_func\(\)](#), and [initialize\(\)](#).

6.64.4.30 derivative_use_exvector_args

```
bool GiNaC::function_options::derivative_use_exvector_args [protected]
```

Referenced by [derivative_func\(\)](#), [initialize\(\)](#), and [GiNaC::function::pderivative\(\)](#).

6.64.4.31 expl_derivative_use_exvector_args

```
bool GiNaC::function_options::expl_derivative_use_exvector_args [protected]
```

Referenced by [GiNaC::function::expl_derivative\(\)](#), [expl_derivative_func\(\)](#), and [initialize\(\)](#).

6.64.4.32 power_use_exvector_args

```
bool GiNaC::function_options::power_use_exvector_args [protected]
```

Referenced by [initialize\(\)](#), [GiNaC::function::power\(\)](#), and [power_func\(\)](#).

6.64.4.33 series_use_exvector_args

```
bool GiNaC::function_options::series_use_exvector_args [protected]
```

Referenced by [initialize\(\)](#), [GiNaC::function::series\(\)](#), and [series_func\(\)](#).

6.64.4.34 print_use_exvector_args

```
bool GiNaC::function_options::print_use_exvector_args [protected]
```

Referenced by [initialize\(\)](#), [GiNaC::function::print\(\)](#), and [print_func\(\)](#).

6.64.4.35 info_use_exvector_args

```
bool GiNaC::function_options::info_use_exvector_args [protected]
```

Referenced by [GiNaC::function::info\(\)](#), [info_func\(\)](#), and [initialize\(\)](#).

6.64.4.36 functions_with_same_name

`unsigned GiNaC::function_options::functions_with_same_name [protected]`

Referenced by [initialize\(\)](#), [overloaded\(\)](#), and [GiNaC::function::register_new\(\)](#).

6.64.4.37 symtree

`ex GiNaC::function_options::symtree [protected]`

Referenced by [GiNaC::function::eval\(\)](#), [initialize\(\)](#), and [set_symmetry\(\)](#).

The documentation for this class was generated from the following files:

- [function.h](#)
- [function.cpp](#)

6.65 GiNaC::G2_SERIAL Class Reference

Generalized multiple polylogarithm.

```
#include <inifcns.h>
```

Static Public Attributes

- static unsigned [serial](#)

6.65.1 Detailed Description

Generalized multiple polylogarithm.

6.65.2 Member Data Documentation

6.65.2.1 serial

`unsigned GiNaC::G2_SERIAL::serial [static]`

Initial value:

```
= function::register_new(function_options("G", 2).
    evalf_func(G2_evalf).
    eval_func(G2_eval).
    overloaded(2))
```

Referenced by [GiNaC::G\(\)](#).

The documentation for this class was generated from the following files:

- [inifcns.h](#)
- [inifcns_nstdsums.cpp](#)

6.66 GiNaC::G3_SERIAL Class Reference

Generalized multiple polylogarithm with explicit imaginary parts.

```
#include <inifcns.h>
```

Static Public Attributes

- static unsigned [serial](#)

6.66.1 Detailed Description

Generalized multiple polylogarithm with explicit imaginary parts.

6.66.2 Member Data Documentation

6.66.2.1 serial

```
unsigned GiNaC::G3_SERIAL::serial [static]
```

Initial value:

```
= function::register_new(function_options("G", 3).
    evalf_func(G3_evalf).
    eval_func(G3_eval).
    overloaded(2))
```

Referenced by [GiNaC::G\(\)](#).

The documentation for this class was generated from the following files:

- [inifcns.h](#)
- [inifcns_nstdsums.cpp](#)

6.67 GiNaC::gcd_options Struct Reference

Flags to control the behavior of [gcd\(\)](#) and friends.

```
#include <normal.h>
```

Public Types

- enum { [no_heur_gcd](#) = 2 , [no_part_factored](#) = 4 , [use_sr_gcd](#) = 8 }

6.67.1 Detailed Description

Flags to control the behavior of [gcd\(\)](#) and friends.

6.67.2 Member Enumeration Documentation

6.67.2.1 anonymous enum

```
anonymous enum
```

Enumerator

no_heur_gcd	Usually GiNaC tries heuristic GCD first, because typically it's much faster than anything else. Even if heuristic algorithm fails, the overhead is negligible w.r.t. cost of computing the GCD by some other method. However, some people dislike it, so here's a flag which tells GiNaC to NOT use the heuristic algorithm.
no_part_factored	GiNaC tries to avoid expanding expressions when computing GCDs. This is a good idea, but some people dislike it. Hence the flag to disable special handling of partially factored polynomials. DON'T SET THIS unless you <i>really</i> know what are you doing!
use_sr_gcd	By default GiNaC uses modular GCD algorithm. Typically it's much faster than PRS (pseudo remainder sequence) algorithm. This flag forces GiNaC to use PRS algorithm

The documentation for this struct was generated from the following file:

- [normal.h](#)

6.68 GiNaC::gcdheu_failed Class Reference

Exception thrown by [heur_gcd\(\)](#) to signal failure.

6.68.1 Detailed Description

Exception thrown by [heur_gcd\(\)](#) to signal failure.

The documentation for this class was generated from the following file:

- [normal.cpp](#)

6.69 GiNaC::has_distance< T > Class Template Reference

SFINAE test for distance.

```
#include <utils_multi_iterator.h>
```

Public Types

- enum { [value](#) = sizeof(test<T>(0)) == sizeof(yes_type) }

Private Types

- typedef char [yes_type](#)[1]
- typedef char [no_type](#)[2]

Static Private Member Functions

- `template<typename C >`
`static yes_type & test (decltype(std::distance< C >))`
- `template<typename C >`
`static no_type & test (...)`

6.69.1 Detailed Description

```
template<typename T>
class GiNaC::has_distance< T >
```

SFINAE test for distance.

6.69.2 Member Typedef Documentation

6.69.2.1 `yes_type`

```
template<typename T >
typedef char GiNaC::has\_distance< T >::yes_type[1] [private]
```

6.69.2.2 `no_type`

```
template<typename T >
typedef char GiNaC::has\_distance< T >::no_type[2] [private]
```

6.69.3 Member Enumeration Documentation

6.69.3.1 `anonymous enum`

```
template<typename T >
anonymous enum
```

Enumerator

value	
-------	--

6.69.4 Member Function Documentation

6.69.4.1 test() [1/2]

```
template<typename T >
template<typename C >
static yes\_type & GiNaC::has\_distance< T >::test (
    decltype(std::distance< C >) ) [static], [private]
```

6.69.4.2 test() [2/2]

```
template<typename T >
template<typename C >
static no\_type & GiNaC::has\_distance< T >::test (
    ... ) [static], [private]
```

The documentation for this class was generated from the following file:

- [utils_multi_iterator.h](#)

6.70 GiNaC::has_options Class Reference

Flags to control the behavior of [has\(\)](#).

```
#include <flags.h>
```

Public Types

- enum { [algebraic](#) = 0x0001 }

6.70.1 Detailed Description

Flags to control the behavior of [has\(\)](#).

6.70.2 Member Enumeration Documentation

6.70.2.1 anonymous enum

```
anonymous enum
```


Enumerator

algebraic	enable algebraic matching
-----------	---------------------------

The documentation for this class was generated from the following file:

- [flags.h](#)

6.71 std::hash< GiNaC::ex > Struct Reference

Specialization of std::hash() for ex objects.

```
#include <ex.h>
```

Public Member Functions

- std::size_t [operator\(\)](#) (const [GiNaC::ex](#) &e) const noexcept

6.71.1 Detailed Description

Specialization of std::hash() for ex objects.

6.71.2 Member Function Documentation

6.71.2.1 operator()

```
std::size_t std::hash< GiNaC::ex >::operator() (  
    const GiNaC::ex & e ) const [inline], [noexcept]
```

The documentation for this struct was generated from the following file:

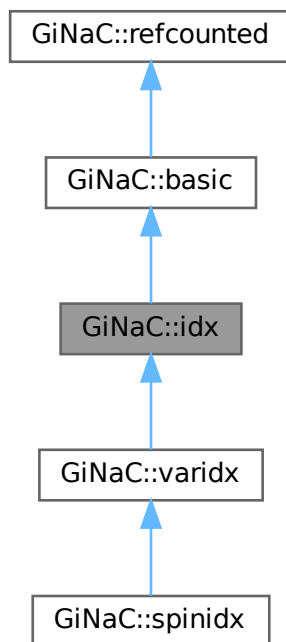
- [ex.h](#)

6.72 GiNaC::idx Class Reference

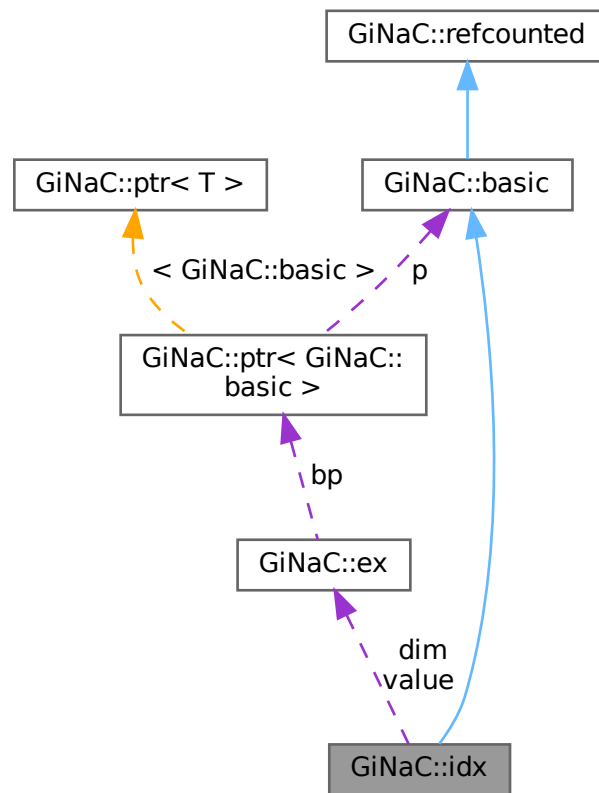
This class holds one index of an indexed object.

```
#include <idx.h>
```

Inheritance diagram for GiNaC::idx:



Collaboration diagram for GiNaC::idx:



Public Member Functions

- `idx` (const `ex` &`v`, const `ex` &`dim`)
Construct index with given value and dimension.
- bool `info` (unsigned `inf`) const override
Information about the object.
- `size_t nops` () const override
Number of operands/members.
- `ex op` (size_t `i`) const override
Return operand/member at position `i`.
- `ex map` (map_function &`f`) const override
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- `ex evalf` () const override
By default, `basic::evalf` would evaluate the index value but we don't want `a.1` to become `a`.
- `ex subs` (const `exmap` &`m`, unsigned `options`=0) const override
Substitute a set of objects by arbitrary expressions.
- void `archive` (archive_node &`n`) const override
Save (serialize) the object into archive node.
- void `read_archive` (const archive_node &`n`, lst &`syms`) override

- Load (deserialize) the object from an archive node.*

 - virtual bool `is_dummy_pair_same_type` (const `basic` &other) const

Check whether the index forms a dummy index pair with another index of the same type.
- `ex get_value` () const

Get value of index.
- bool `is_numeric` () const

Check whether the index is numeric.
- bool `is_symbolic` () const

Check whether the index is symbolic.
- `ex get_dim` () const

Get dimension of index space.
- bool `is_dim_numeric` () const

Check whether the dimension is numeric.
- bool `is_dim_symbolic` () const

Check whether the dimension is symbolic.
- `ex replace_dim` (const `ex` &new_dim) const

Make a new index with the same value but a different dimension.
- `ex minimal_dim` (const `idx` &other) const

Return the minimum of the dimensions of this and another index.

Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()

basic destructor, virtual because class `ex` will delete objects of derived classes via a `basic`.*
- `basic` (const `basic` &other)
- const `basic` & `operator=` (const `basic` &other)

basic assignment operator: the other object might be of a derived class.
- virtual `basic` * `duplicate` () const

Create a clone of this object on the heap.
- virtual `ex eval` () const

Perform automatic non-interruptive term rewriting rules.
- virtual `ex evalf` () const

Evaluate object numerically.
- virtual `ex evalm` () const

Evaluate sums, products and integer powers of matrices.
- virtual `ex eval_integ` () const

Evaluate integrals, if result is known.
- virtual `ex eval_indexed` (const `basic` &i) const

Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void `print` (const `print_context` &c, unsigned level=0) const

Output to stream.
- virtual void `dbgprint` () const

Little wrapper around `print` to be called within a debugger.
- virtual void `dbgprinttree` () const

Little wrapper around `printtree` to be called within a debugger.
- virtual unsigned `precedence` () const

Return relative operator precedence (for parenthesizing output).
- virtual bool `info` (unsigned inf) const

Information about the object.
- virtual size_t `nops` () const

- virtual `ex op` (size_t i) const
Number of operands/members.
- virtual `ex operator[]` (const `ex` &index) const
Return operand/member at position i.
- virtual `ex operator[]` (size_t i) const
- virtual `ex & let_op` (size_t i)
Return modifiable operand/member at position i.
- virtual `ex & operator[]` (const `ex` &index)
- virtual `ex & operator[]` (size_t i)
- virtual bool `has` (const `ex` &other, unsigned `options`=0) const
Test for occurrence of a pattern.
- virtual bool `match` (const `ex` &pattern, `exmap` &repls) const
Check whether the expression matches a given pattern.
- virtual `ex subs` (const `exmap` &m, unsigned `options`=0) const
Substitute a set of objects by arbitrary expressions.
- virtual `ex map` (`map_function` &f) const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void `accept` (`GiNaC::visitor` &v) const
- virtual bool `is_polynomial` (const `ex` &var) const
Check whether this is a polynomial in the given variables.
- virtual int `degree` (const `ex` &s) const
Return degree of highest power in object s.
- virtual int `ldegree` (const `ex` &s) const
Return degree of lowest power in object s.
- virtual `ex coeff` (const `ex` &s, int n=1) const
Return coefficient of degree n in object s.
- virtual `ex expand` (unsigned `options`=0) const
Expand expression, i.e.
- virtual `ex collect` (const `ex` &s, bool distributed=false) const
Sort expanded expression in terms of powers of some object(s).
- virtual `ex series` (const `relational` &r, int `order`, unsigned `options`=0) const
Default implementation of `ex::series()`.
- virtual `ex normal` (`exmap` &repl, `exmap` &rev_lookup, `lst` &modifier) const
Default implementation of `ex::normal()`.
- virtual `ex to_rational` (`exmap` &repl) const
Default implementation of `ex::to_rational()`.
- virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const
Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- virtual `numeric max_coefficient` () const
Implementation `ex::max_coefficient()`.
- virtual `exvector get_free_indices` () const
Return a vector containing the free indices of an expression.
- virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
Add two indexed expressions.
- virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
Multiply an indexed expression with a scalar.
- virtual bool `contract_with` (`exvector::iterator` self, `exvector::iterator` other, `exvector` &v) const
Try to contract two indexed expressions that appear in the same product.
- virtual unsigned `return_type` () const

- virtual [return_type_t return_type_tinfo](#) () const
- virtual [ex conjugate](#) () const
- virtual [ex real_part](#) () const
- virtual [ex imag_part](#) () const
- template<class T >
void [print_dispatch](#) (const [print_context](#) &c, unsigned level) const
Like [print\(\)](#), but dispatch to the specified class.
- void [print_dispatch](#) (const [registered_class_info](#) &ri, const [print_context](#) &c, unsigned level) const
Like [print\(\)](#), but dispatch to the specified class.
- virtual void [archive](#) ([archive_node](#) &n) const
Save (serialize) the object into archive node.
- virtual void [read_archive](#) (const [archive_node](#) &n, [lst](#) &syms)
Load (deserialize) the object from an archive node.
- [ex subs_one_level](#) (const [exmap](#) &m, unsigned [options](#)) const
Helper function for [subs\(\)](#).
- [ex diff](#) (const [symbol](#) &s, unsigned nth=1) const
Default interface of nth derivative [ex::diff\(s, n\)](#).
- int [compare](#) (const [basic](#) &other) const
Compare objects syntactically to establish canonical ordering.
- bool [is_equal](#) (const [basic](#) &other) const
Test for syntactic equality.
- const [basic](#) & [hold](#) () const
Stop further evaluation.
- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const
Set some [status_flags](#).
- const [basic](#) & [clearflag](#) (unsigned f) const
Clear some [status_flags](#).

Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add_reference](#) () noexcept
- unsigned int [remove_reference](#) () noexcept
- unsigned int [get_refcount](#) () const noexcept
- void [set_refcount](#) (unsigned int r) noexcept

Protected Member Functions

- [ex derivative](#) (const [symbol](#) &s) const override
Implementation of [ex::diff\(\)](#) for an index always returns 0.
- bool [match_same_type](#) (const [basic](#) &other) const override
Returns true if the attributes of two objects are similar enough for a match.
- unsigned [calchash](#) () const override
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- void [print_index](#) (const [print_context](#) &c, unsigned level) const
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
- void [do_print_csrc](#) (const [print_csric](#) &c, unsigned level) const
- void [do_print_latex](#) (const [print_latex](#) &c, unsigned level) const
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const

Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match_same_type](#) (const [basic](#) &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual [ex derivative](#) (const [symbol](#) &s) const
Default implementation of [ex::diff\(\)](#).
- virtual int [compare_same_type](#) (const [basic](#) &other) const
Returns order relation between two objects of same type.
- virtual bool [is_equal_same_type](#) (const [basic](#) &other) const
Returns true if two objects of same type are equal.
- virtual unsigned [calchash](#) () const
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- void [ensure_if_modifiable](#) () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
Default output to stream.
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
Tree output to stream.
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
Python parsable output to stream.

Protected Attributes

- [ex value](#)
Expression that constitutes the index (numeric or symbolic name)
- [ex dim](#)
Dimension of space (can be symbolic or numeric)

Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)
of type [status_flags](#)
- unsigned [hashvalue](#)
hash value

6.72.1 Detailed Description

This class holds one index of an indexed object.

Indices can theoretically consist of any symbolic expression but they are usually only just a symbol (e.g. "mu", "i") or numeric (integer). Indices belong to a space with a certain numeric or symbolic dimension.

6.72.2 Constructor & Destructor Documentation**6.72.2.1 idx()**

```
GiNaC::idx::idx (
    const ex & v,
    const ex & dim ) [explicit]
```

Construct index with given value and dimension.

Parameters

<i>v</i>	Value of index (numeric or symbolic)
<i>dim</i>	Dimension of index space (numeric or symbolic)

References [dim](#), [GiNaC::ex::info\(\)](#), [is_dim_numeric\(\)](#), and [GiNaC::info_flags::posint](#).

6.72.3 Member Function Documentation

6.72.3.1 info()

```
bool GiNaC::idx::info (
    unsigned inf ) const [override], [virtual]
```

Information about the object.

See also

class [info_flags](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::info_flags::has_indices](#), and [GiNaC::info_flags::idx](#).

6.72.3.2 nops()

```
size_t GiNaC::idx::nops ( ) const [override], [virtual]
```

Number of operands/members.

Reimplemented from [GiNaC::basic](#).

6.72.3.3 op()

```
ex GiNaC::idx::op (
    size_t i ) const [override], [virtual]
```

Return operand/member at position *i*.

Reimplemented from [GiNaC::basic](#).

References [GINAC_ASSERT](#), and [value](#).

6.72.3.4 map()

```
ex GiNaC::idx::map (
    map_function & f ) const [override], [virtual]
```

Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).

Reimplemented from [GiNaC::basic](#).

References [GiNaC::are_ex_trivially_equal\(\)](#), [GiNaC::basic::clearflag\(\)](#), [GiNaC::basic::duplicate\(\)](#), [GiNaC::status_flags::hash_calculate](#) and [value](#).

6.72.3.5 evalf()

```
ex GiNaC::idx::evalf ( ) const [override], [virtual]
```

By default, [basic::evalf](#) would evaluate the index value but we don't want a.1 to become a.(1.0).

Reimplemented from [GiNaC::basic](#).

6.72.3.6 subs()

```
ex GiNaC::idx::subs (
    const exmap & m,
    unsigned options = 0 ) const [override], [virtual]
```

Substitute a set of objects by arbitrary expressions.

The ex returned will already be evaluated.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::are_ex_trivially_equal\(\)](#), [GiNaC::basic::clearflag\(\)](#), [GiNaC::basic::duplicate\(\)](#), [GiNaC::status_flags::hash_calculate](#), [m](#), [options](#), [GiNaC::subs_options::really_subs_idx](#), [GiNaC::ex::subs\(\)](#), and [value](#).

6.72.3.7 archive()

```
void GiNaC::idx::archive (
    archive_node & n ) const [override], [virtual]
```

Save (serialize) the object into archive node.

Archive the object.

Loosely speaking, this method turns an expression into a byte stream (which can be saved and restored later on, or sent via network, etc.)

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::varidx](#), and [GiNaC::spinidx](#).

References [dim](#), [n](#), and [value](#).

6.72.3.8 read_archive()

```
void GiNaC::idx::read_archive (
    const archive_node & n,
    lst & syms ) [override], [virtual]
```

Load (deserialize) the object from an archive node.

Construct object from [archive_node](#).

Note

This method is essentially a constructor. However, constructors can't be virtual. So, if unarchiving routines are implemented as constructors one would need to define such a constructor in every class, even if all it does is simply calling constructor of a superclass.

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::varidx](#), and [GiNaC::spinidx](#).

References [dim](#), [n](#), and [value](#).

6.72.3.9 derivative()

```
ex GiNaC::idx::derivative (
    const symbol & s ) const [override], [protected], [virtual]
```

Implementation of [ex::diff\(\)](#) for an index always returns 0.

See also

[ex::diff](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex0](#).

6.72.3.10 match_same_type()

```
bool GiNaC::idx::match_same_type (
    const basic & other ) const [override], [protected], [virtual]
```

Returns true if the attributes of two objects are similar enough for a match.

This function must not match subexpressions (this is already done by [basic::match\(\)](#)). Only attributes not accessible by [op\(\)](#) should be compared. This is also the reason why this function doesn't take the wildcard replacement list from [match\(\)](#) as an argument: only subexpressions are subject to wildcard matches. Also, this function only needs to be implemented for container classes because [is_equal_same_type\(\)](#) is automatically used instead of [match_same_type\(\)](#) if [nops\(\)](#) == 0.

See also

[basic::match](#)

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::varidx](#), and [GiNaC::spinidx](#).

References [dim](#), [GINAC_ASSERT](#), and [GiNaC::ex::is_equal\(\)](#).

6.72.3.11 calchash()

```
unsigned GiNaC::idx::calchash ( ) const [override], [protected], [virtual]
```

Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.

The method inherited from class `basic` computes a hash value based on the type and hash values of possible members. For this reason it is well suited for container classes but atomic classes should override this implementation because otherwise they would all end up with the same hashvalue.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::status_flags::evaluated](#), [GiNaC::basic::flags](#), [GiNaC::ex::gethash\(\)](#), [GiNaC::status_flags::hash_calculated](#), [GiNaC::basic::hashvalue](#), [GiNaC::make_hash_seed\(\)](#), [GiNaC::rotate_left\(\)](#), [GiNaC::basic::setflag\(\)](#), and [value](#).

6.72.3.12 is_dummy_pair_same_type()

```
bool GiNaC::idx::is_dummy_pair_same_type (
    const basic & other ) const [virtual]
```

Check whether the index forms a dummy index pair with another index of the same type.

Reimplemented in [GiNaC::varidx](#), and [GiNaC::spinidx](#).

References [dim](#), [GiNaC::ex::is_equal\(\)](#), and [value](#).

Referenced by [GiNaC::is_dummy_pair\(\)](#).

6.72.3.13 get_value()

```
ex GiNaC::idx::get_value ( ) const [inline]
```

Get value of index.

References [value](#).

Referenced by [GiNaC::matrix::eval_indexed\(\)](#), [GiNaC::tensdelta::eval_indexed\(\)](#), [GiNaC::minkmetric::eval_indexed\(\)](#), and [GiNaC::spinmetric::eval_indexed\(\)](#).

6.72.3.14 is_numeric()

```
bool GiNaC::idx::is_numeric ( ) const [inline]
```

Check whether the index is numeric.

References [value](#).

6.72.3.15 is_symbolic()

```
bool GiNaC::idx::is_symbolic ( ) const [inline]
```

Check whether the index is symbolic.

References [value](#).

Referenced by [GiNaC::spinmetric::contract_with\(\)](#), and [GiNaC::tensor::replace_contr_index\(\)](#).

6.72.3.16 get_dim()

```
ex GiNaC::idx::get_dim ( ) const [inline]
```

Get dimension of index space.

References [dim](#).

Referenced by [GiNaC::matrix::eval_indexed\(\)](#), [GiNaC::tensdelta::eval_indexed\(\)](#), and [GiNaC::tensmetric::eval_indexed\(\)](#).

6.72.3.17 is_dim_numeric()

```
bool GiNaC::idx::is_dim_numeric ( ) const [inline]
```

Check whether the dimension is numeric.

References [dim](#).

Referenced by [idx\(\)](#).

6.72.3.18 is_dim_symbolic()

```
bool GiNaC::idx::is_dim_symbolic ( ) const [inline]
```

Check whether the dimension is symbolic.

References [dim](#).

6.72.3.19 replace_dim()

```
ex GiNaC::idx::replace_dim (
    const ex & new_dim ) const
```

Make a new index with the same value but a different dimension.

References [GiNaC::basic::clearflag\(\)](#), [dim](#), [GiNaC::basic::duplicate\(\)](#), and [GiNaC::status_flags::hash_calculated](#).

Referenced by [GiNaC::tensdelta::eval_indexed\(\)](#), [GiNaC::tensmetric::eval_indexed\(\)](#), and [GiNaC::tensor::replace_contr_index\(\)](#).

6.72.3.20 minimal_dim()

```
ex GiNaC::idx::minimal_dim (
    const idx & other ) const
```

Return the minimum of the dimensions of this and another index.

If this is undecidable, throw an exception.

References [dim](#), and [GiNaC::minimal_dim\(\)](#).

Referenced by [GiNaC::tensdelta::eval_indexed\(\)](#), [GiNaC::tensmetric::eval_indexed\(\)](#), and [GiNaC::tensor::replace_contr_index\(\)](#).

6.72.3.21 print_index()

```
void GiNaC::idx::print_index (
    const print_context & c,
    unsigned level ) const [protected]
```

References [c](#), [dim](#), [GiNaC::ex::print\(\)](#), [GiNaC::print_options::print_index_dimensions](#), and [value](#).

Referenced by [do_print\(\)](#), [GiNaC::varidx::do_print\(\)](#), [GiNaC::spinidx::do_print\(\)](#), [do_print_latex\(\)](#), and [GiNaC::spinidx::do_print_latex\(\)](#).

6.72.3.22 do_print()

```
void GiNaC::idx::do_print (
    const print_context & c,
    unsigned level ) const [protected]
```

References [c](#), and [print_index\(\)](#).

6.72.3.23 do_print_csrc()

```
void GiNaC::idx::do_print_csrc (
    const print\_csrc & c,
    unsigned level ) const    [protected]
```

References [c](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::integer](#), [GiNaC::ex::print\(\)](#), and [value](#).

6.72.3.24 do_print_latex()

```
void GiNaC::idx::do_print_latex (
    const print\_latex & c,
    unsigned level ) const    [protected]
```

References [c](#), and [print_index\(\)](#).

6.72.3.25 do_print_tree()

```
void GiNaC::idx::do_print_tree (
    const print\_tree & c,
    unsigned level ) const    [protected]
```

References [c](#), [dim](#), [GiNaC::basic::flags](#), [GiNaC::basic::hashvalue](#), [GiNaC::ex::print\(\)](#), and [value](#).

6.72.4 Member Data Documentation

6.72.4.1 value

```
ex GiNaC::idx::value    [protected]
```

Expression that constitutes the index (numeric or symbolic name)

Referenced by [archive\(\)](#), [calchash\(\)](#), [do_print_csrc\(\)](#), [do_print_tree\(\)](#), [GiNaC::varidx::do_print_tree\(\)](#), [GiNaC::spinidx::do_print_tree\(\)](#), [get_value\(\)](#), [is_dummy_pair_same_type\(\)](#), [is_numeric\(\)](#), [is_symbolic\(\)](#), [map\(\)](#), [op\(\)](#), [print_index\(\)](#), [read_archive\(\)](#), and [subs\(\)](#).

6.72.4.2 dim

```
ex GiNaC::idx::dim [protected]
```

Dimension of space (can be symbolic or numeric)

Referenced by [archive\(\)](#), [do_print_tree\(\)](#), [GiNaC::varidx::do_print_tree\(\)](#), [GiNaC::spinidx::do_print_tree\(\)](#), [get_dim\(\)](#), [idx\(\)](#), [is_dim_numeric\(\)](#), [is_dim_symbolic\(\)](#), [is_dummy_pair_same_type\(\)](#), [match_same_type\(\)](#), [minimal_dim\(\)](#), [print_index\(\)](#), [read_archive\(\)](#), and [replace_dim\(\)](#).

The documentation for this class was generated from the following files:

- [idx.h](#)
- [idx.cpp](#)

6.73 GiNaC::idx_is_equal_ignore_dim Struct Reference

Public Member Functions

- [bool operator\(\)](#) (const [ex](#) &lh, const [ex](#) &rh) const

6.73.1 Member Function Documentation

6.73.1.1 operator()

```
bool GiNaC::idx_is_equal_ignore_dim::operator() (
    const ex & lh,
    const ex & rh ) const [inline]
```

References [GiNaC::ex::is_equal\(\)](#).

The documentation for this struct was generated from the following file:

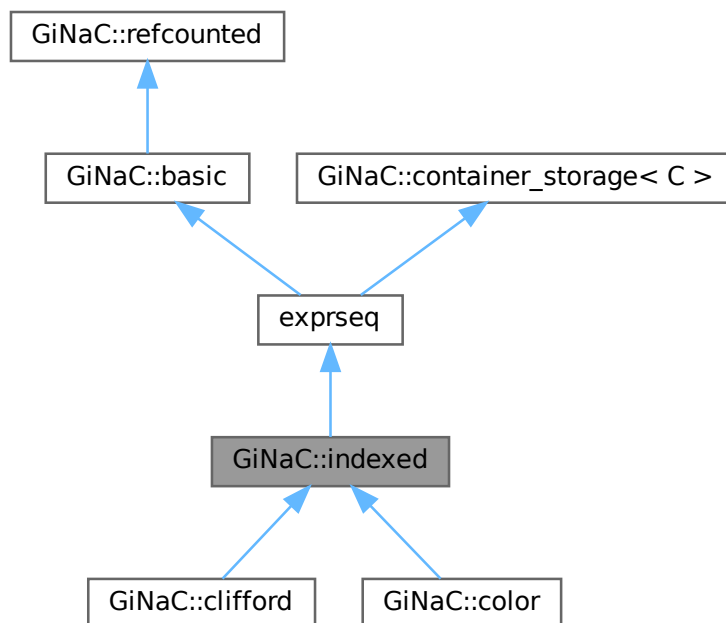
- [indexed.cpp](#)

6.74 GiNaC::indexed Class Reference

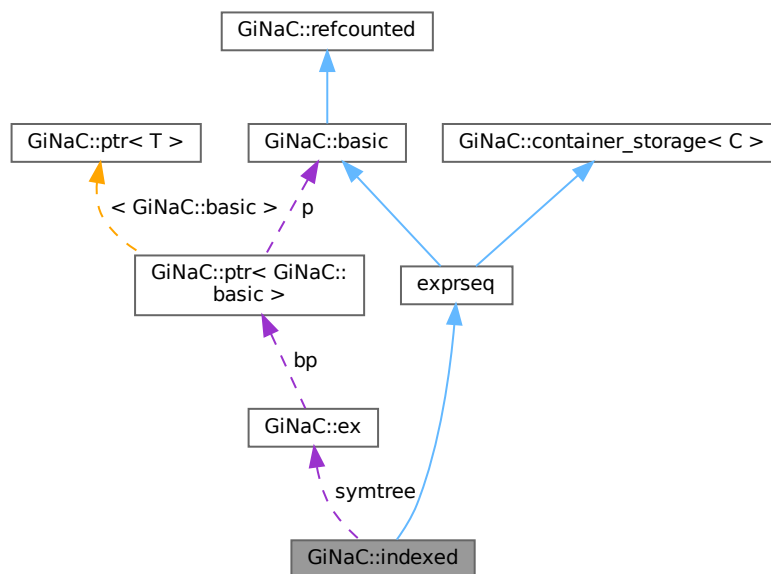
This class holds an indexed expression.

```
#include <indexed.h>
```

Inheritance diagram for GiNaC::indexed:



Collaboration diagram for GiNaC::indexed:



Public Member Functions

- `indexed` (const `ex` &b)
Construct indexed object with no index.
- `indexed` (const `ex` &b, const `ex` &i1)
Construct indexed object with one index.
- `indexed` (const `ex` &b, const `ex` &i1, const `ex` &i2)
Construct indexed object with two indices.
- `indexed` (const `ex` &b, const `ex` &i1, const `ex` &i2, const `ex` &i3)
Construct indexed object with three indices.
- `indexed` (const `ex` &b, const `ex` &i1, const `ex` &i2, const `ex` &i3, const `ex` &i4)
Construct indexed object with four indices.
- `indexed` (const `ex` &b, const `symmetry` &symm, const `ex` &i1, const `ex` &i2)
Construct indexed object with two indices and a specified symmetry.
- `indexed` (const `ex` &b, const `symmetry` &symm, const `ex` &i1, const `ex` &i2, const `ex` &i3)
Construct indexed object with three indices and a specified symmetry.
- `indexed` (const `ex` &b, const `symmetry` &symm, const `ex` &i1, const `ex` &i2, const `ex` &i3, const `ex` &i4)
Construct indexed object with four indices and a specified symmetry.
- `indexed` (const `ex` &b, const `exvector` &iv)
Construct indexed object with a specified vector of indices.
- `indexed` (const `ex` &b, const `symmetry` &symm, const `exvector` &iv)
Construct indexed object with a specified vector of indices and symmetry.
- `indexed` (const `symmetry` &symm, const `exprseq` &es)
- `indexed` (const `symmetry` &symm, const `exvector` &v)
- `indexed` (const `symmetry` &symm, `exvector` &&v)
- unsigned `precedence` () const override
Return relative operator precedence (for parenthezing output).

- `bool info` (unsigned inf) const override
Information about the object.
- `ex eval` () const override
Perform automatic non-interruptive term rewriting rules.
- `ex real_part` () const override
- `ex imag_part` () const override
- `exvector get_free_indices` () const override
Return a vector containing the free indices of an expression.
- `void archive` (archive_node &n) const override
Save (a.k.a.
- `void read_archive` (const archive_node &n, lst &syms) override
Read (a.k.a.
- `bool all_index_values_are` (unsigned inf) const
Check whether all index values have a certain property.
- `exvector get_indices` () const
Return a vector containing the object's indices.
- `exvector get_dummy_indices` () const
Return a vector containing the dummy indices of the object, if any.
- `exvector get_dummy_indices` (const indexed &other) const
Return a vector containing the dummy indices in the contraction with another indexed object.
- `bool has_dummy_index_for` (const ex &i) const
Check whether the object has an index that forms a dummy index pair with a given index.
- `ex get_symmetry` () const
Return symmetry properties.

Public Member Functions inherited from `GiNaC::container< C >`

- `container` (STLT const &s)
- `container` (STLT &&v)
- `container` (exvector::const_iterator b, exvector::const_iterator e)
- `container` (std::initializer_list< ex > il)
- `bool info` (unsigned inf) const override
Information about the object.
- `unsigned precedence` () const override
Return relative operator precedence (for parenthezing output).
- `size_t nops` () const override
Number of operands/members.
- `ex op` (size_t i) const override
Return operand/member at position i.
- `ex & let_op` (size_t i) override
Return modifiable operand/member at position i.
- `ex subs` (const exmap &m, unsigned options=0) const override
Substitute a set of objects by arbitrary expressions.
- `void read_archive` (const archive_node &n, lst &sym_lst) override
Load (deserialize) the object from an archive node.
- `void archive` (archive_node &n) const override
Archive the object.
- `container & prepend` (const ex &b)
Add element at front.
- `container & append` (const ex &b)

- Add element at back.*
- `container & remove_first ()`
- Remove first element.*
- `container & remove_last ()`
- Remove last element.*
- `container & remove_all ()`
- Remove all elements.*
- `container & sort ()`
- Sort elements.*
- `container & unique ()`
- Remove adjacent duplicate elements.*
- `const_iterator begin () const`
- `const_iterator end () const`
- `const_reverse_iterator rbegin () const`
- `const_reverse_iterator rend () const`

Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic ()`
basic destructor, virtual because class ex will delete objects of derived classes via a basic.*
- `basic (const basic &other)`
- `const basic & operator= (const basic &other)`
basic assignment operator: the other object might be of a derived class.
- virtual `basic * duplicate () const`
Create a clone of this object on the heap.
- virtual `ex eval () const`
Perform automatic non-interruptive term rewriting rules.
- virtual `ex evalf () const`
Evaluate object numerically.
- virtual `ex evalm () const`
Evaluate sums, products and integer powers of matrices.
- virtual `ex eval_integ () const`
Evaluate integrals, if result is known.
- virtual `ex eval_indexed (const basic &i) const`
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void `print (const print_context &c, unsigned level=0) const`
Output to stream.
- virtual void `dbgprint () const`
Little wrapper around print to be called within a debugger.
- virtual void `dbgprinttree () const`
Little wrapper around printtree to be called within a debugger.
- virtual unsigned `precedence () const`
Return relative operator precedence (for parenthezing output).
- virtual bool `info (unsigned inf) const`
Information about the object.
- virtual size_t `nops () const`
Number of operands/members.
- virtual `ex op (size_t i) const`
Return operand/member at position i.
- virtual `ex operator[] (const ex &index) const`
- virtual `ex operator[] (size_t i) const`

- virtual `ex & let_op` (size_t i)
Return modifiable operand/member at position i.
- virtual `ex & operator[]` (const `ex` &index)
- virtual `ex & operator[]` (size_t i)
- virtual bool `has` (const `ex` &other, unsigned `options`=0) const
Test for occurrence of a pattern.
- virtual bool `match` (const `ex` &pattern, `exmap` &repls) const
Check whether the expression matches a given pattern.
- virtual `ex subs` (const `exmap` &m, unsigned `options`=0) const
Substitute a set of objects by arbitrary expressions.
- virtual `ex map` (`map_function` &f) const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void `accept` (`GiNaC::visitor` &v) const
- virtual bool `is_polynomial` (const `ex` &var) const
Check whether this is a polynomial in the given variables.
- virtual int `degree` (const `ex` &s) const
Return degree of highest power in object s.
- virtual int `ldegree` (const `ex` &s) const
Return degree of lowest power in object s.
- virtual `ex coeff` (const `ex` &s, int n=1) const
Return coefficient of degree n in object s.
- virtual `ex expand` (unsigned `options`=0) const
Expand expression, i.e.
- virtual `ex collect` (const `ex` &s, bool distributed=false) const
Sort expanded expression in terms of powers of some object(s).
- virtual `ex series` (const `relational` &r, int `order`, unsigned `options`=0) const
Default implementation of `ex::series()`.
- virtual `ex normal` (`exmap` &repl, `exmap` &rev_lookup, `lst` &modifier) const
Default implementation of `ex::normal()`.
- virtual `ex to_rational` (`exmap` &repl) const
Default implementation of `ex::to_rational()`.
- virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const
Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- virtual `numeric max_coefficient` () const
Implementation `ex::max_coefficient()`.
- virtual `exvector get_free_indices` () const
Return a vector containing the free indices of an expression.
- virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
Add two indexed expressions.
- virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
Multiply an indexed expression with a scalar.
- virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const
Try to contract two indexed expressions that appear in the same product.
- virtual unsigned `return_type` () const
- virtual `return_type_t return_type_tinfo` () const
- virtual `ex conjugate` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const

- `template<class T >`
`void print_dispatch (const print_context &c, unsigned level) const`
Like `print()`, but dispatch to the specified class.
- `void print_dispatch (const registered_class_info &ri, const print_context &c, unsigned level) const`
Like `print()`, but dispatch to the specified class.
- `virtual void archive (archive_node &n) const`
Save (serialize) the object into archive node.
- `virtual void read_archive (const archive_node &n, lst &syms)`
Load (deserialize) the object from an archive node.
- `ex subs_one_level (const exmap &m, unsigned options) const`
Helper function for `subs()`.
- `ex diff (const symbol &s, unsigned nth=1) const`
Default interface of `nth` derivative `ex::diff(s, n)`.
- `int compare (const basic &other) const`
Compare objects syntactically to establish canonical ordering.
- `bool is_equal (const basic &other) const`
Test for syntactic equality.
- `const basic & hold () const`
Stop further evaluation.
- `unsigned gethash () const`
- `const basic & setflag (unsigned f) const`
Set some `status_flags`.
- `const basic & clearflag (unsigned f) const`
Clear some `status_flags`.

Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted () noexcept`
- `unsigned int add_reference () noexcept`
- `unsigned int remove_reference () noexcept`
- `unsigned int get_refcount () const noexcept`
- `void set_refcount (unsigned int r) noexcept`

Protected Member Functions

- `ex derivative (const symbol &s) const override`
Implementation of `ex::diff()` for an indexed object always returns 0.
- `ex thiscontainer (const exvector &v) const override`
- `ex thiscontainer (exvector &&v) const override`
- `unsigned return_type () const override`
- `return_type_t return_type_tinfo () const override`
- `ex expand (unsigned options=0) const override`
Expand expression, i.e.
- `void printindices (const print_context &c, unsigned level) const`
- `void print_indexed (const print_context &c, const char *openbrace, const char *closebrace, unsigned level) const`
- `void do_print (const print_context &c, unsigned level) const`
- `void do_print_latex (const print_latex &c, unsigned level) const`
- `void do_print_tree (const print_tree &c, unsigned level) const`
- `void validate () const`
Check whether all indices are of class `idx` and validate the symmetry tree.

Protected Member Functions inherited from [GiNaC::container< C >](#)

- [ex conjugate](#) () const override
- [ex real_part](#) () const override
- [ex imag_part](#) () const override
- bool [is_equal_same_type](#) (const [basic](#) &other) const override
Returns true if two objects of same type are equal.
- virtual [ex thiscontainer](#) (const [STLT](#) &v) const
Similar to [duplicate\(\)](#), but with a preset sequence.
- virtual [ex thiscontainer](#) ([STLT](#) &&v) const
Similar to [duplicate\(\)](#), but with a preset sequence (which gets pilfered).
- virtual void [printseq](#) (const [print_context](#) &c, char openbracket, char delim, char closebracket, unsigned this↔_precedence, unsigned upper_precedence=0) const
Print sequence of contained elements.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
- void [do_print_python](#) (const [print_python](#) &c, unsigned level) const
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
- [STLT](#) [subchildren](#) (const [exmap](#) &m, unsigned [options](#)=0) const

Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match_same_type](#) (const [basic](#) &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual [ex derivative](#) (const [symbol](#) &s) const
Default implementation of [ex::diff\(\)](#).
- virtual int [compare_same_type](#) (const [basic](#) &other) const
Returns order relation between two objects of same type.
- virtual bool [is_equal_same_type](#) (const [basic](#) &other) const
Returns true if two objects of same type are equal.
- virtual unsigned [calchash](#) () const
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- void [ensure_if_modifiable](#) () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
Default output to stream.
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
Tree output to stream.
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
Python parsable output to stream.

Protected Member Functions inherited from [GiNaC::container_storage< C >](#)

- [container_storage](#) ()
- [container_storage](#) (size_t n, const [ex](#) &e)
- [container_storage](#) (std::initializer_list< [ex](#) > il)
- template<class In >
 [container_storage](#) (In b, In e)
- void [reserve](#) (size_t)
- [~container_storage](#) ()
- void [reserve](#) (size_t n)
- void [reserve](#) (std::vector< [ex](#) > &v, size_t n)

Protected Attributes

- [ex symtree](#)
Index symmetry (tree of symmetry objects)

Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)
of type [status_flags](#)
- unsigned [hashvalue](#)
hash value

Protected Attributes inherited from [GiNaC::container_storage< C >](#)

- [STLT seq](#)

Friends

- [ex simplify_indexed](#) (const [ex](#) &e, [exvector](#) &free_indices, [exvector](#) &dummy_indices, const [scalar_products](#) &sp)
Simplify indexed expression, return list of free indices.
- [ex simplify_indexed_product](#) (const [ex](#) &e, [exvector](#) &free_indices, [exvector](#) &dummy_indices, const [scalar_products](#) &sp)
Simplify product of indexed expressions (commutative, noncommutative and simple squares), return list of free indices.
- bool [reposition_dummy_indices](#) ([ex](#) &e, [exvector](#) &variant_dummy_indices, [exvector](#) &moved_indices)
Raise/lower dummy indices in a single indexed objects to canonicalize their variance.

Additional Inherited Members

Public Types inherited from [GiNaC::container< C >](#)

- typedef STLT::const_iterator [const_iterator](#)
- typedef STLT::const_reverse_iterator [const_reverse_iterator](#)

Protected Types inherited from [GiNaC::container< C >](#)

- typedef [container_storage< C >::STLT](#) [STLT](#)

Protected Types inherited from [GiNaC::container_storage< C >](#)

- typedef C< [ex](#) > [STLT](#)

Static Protected Member Functions inherited from [GiNaC::container< C >](#)

- static unsigned [get_default_flags](#) ()
*Specialization of [container::get_default_flags\(\)](#) for *lst*.*
- static char [get_open_delim](#) ()
*Specialization of [container::get_open_delim\(\)](#) for *lst*.*
- static char [get_close_delim](#) ()
*Specialization of [container::get_close_delim\(\)](#) for *lst*.*

Static Protected Member Functions inherited from [GiNaC::container_storage< C >](#)

- static void [reserve](#) (STLT &, size_t)

6.74.1 Detailed Description

This class holds an indexed expression.

It consists of a 'base' expression (the expression being indexed) which can be accessed as `op(0)`, and `n` (`n >= 0`) indices (all of class `idx`), accessible as `op(1)..op(n)`.

6.74.2 Constructor & Destructor Documentation

6.74.2.1 `indexed()` [1/13]

```
GiNaC::indexed::indexed (
    const ex & b )
```

Construct indexed object with no index.

Parameters

<i>b</i>	Base expression
----------	-----------------

References [GiNaC::not_symmetric\(\)](#), and [validate\(\)](#).

6.74.2.2 `indexed()` [2/13]

```
GiNaC::indexed::indexed (
    const ex & b,
    const ex & il )
```

Construct indexed object with one index.

The index must be of class `idx`.

Parameters

<i>b</i>	Base expression
<i>i1</i>	The index

References [validate\(\)](#).

6.74.2.3 indexed() [3/13]

```
GiNaC::indexed::indexed (
    const ex & b,
    const ex & i1,
    const ex & i2 )
```

Construct indexed object with two indices.

The indices must be of class idx.

Parameters

<i>b</i>	Base expression
<i>i1</i>	First index
<i>i2</i>	Second index

References [validate\(\)](#).

6.74.2.4 indexed() [4/13]

```
GiNaC::indexed::indexed (
    const ex & b,
    const ex & i1,
    const ex & i2,
    const ex & i3 )
```

Construct indexed object with three indices.

The indices must be of class idx.

Parameters

<i>b</i>	Base expression
<i>i1</i>	First index
<i>i2</i>	Second index
<i>i3</i>	Third index

References [validate\(\)](#).

6.74.2.5 indexed() [5/13]

```
GiNaC::indexed::indexed (
    const ex & b,
    const ex & i1,
    const ex & i2,
    const ex & i3,
    const ex & i4 )
```

Construct indexed object with four indices.

The indices must be of class `idx`.

Parameters

<i>b</i>	Base expression
<i>i1</i>	First index
<i>i2</i>	Second index
<i>i3</i>	Third index
<i>i4</i>	Fourth index

References [validate\(\)](#).

6.74.2.6 indexed() [6/13]

```
GiNaC::indexed::indexed (
    const ex & b,
    const symmetry & symm,
    const ex & i1,
    const ex & i2 )
```

Construct indexed object with two indices and a specified symmetry.

The indices must be of class `idx`.

Parameters

<i>b</i>	Base expression
<i>symm</i>	Symmetry of indices
<i>i1</i>	First index
<i>i2</i>	Second index

References [validate\(\)](#).

6.74.2.7 indexed() [7/13]

```
GiNaC::indexed::indexed (
    const ex & b,
    const symmetry & symm,
    const ex & i1,
    const ex & i2,
    const ex & i3 )
```

Construct indexed object with three indices and a specified symmetry.

The indices must be of class `idx`.

Parameters

<i>b</i>	Base expression
<i>symm</i>	Symmetry of indices
<i>i1</i>	First index
<i>i2</i>	Second index
<i>i3</i>	Third index

References [validate\(\)](#).

6.74.2.8 indexed() [8/13]

```
GiNaC::indexed::indexed (
    const ex & b,
    const symmetry & symm,
    const ex & i1,
    const ex & i2,
    const ex & i3,
    const ex & i4 )
```

Construct indexed object with four indices and a specified symmetry.

The indices must be of class `idx`.

Parameters

<i>b</i>	Base expression
<i>symm</i>	Symmetry of indices
<i>i1</i>	First index
<i>i2</i>	Second index
<i>i3</i>	Third index
<i>i4</i>	Fourth index

References [validate\(\)](#).

6.74.2.9 indexed() [9/13]

```
GiNaC::indexed::indexed (
    const ex & b,
    const exvector & iv )
```

Construct indexed object with a specified vector of indices.

The indices must be of class `idx`.

Parameters

<i>b</i>	Base expression
<i>iv</i>	Vector of indices

References [GiNaC::container_storage< C >::seq](#), and [validate\(\)](#).

6.74.2.10 indexed() [10/13]

```
GiNaC::indexed::indexed (
    const ex & b,
    const symmetry & symm,
    const exvector & iv )
```

Construct indexed object with a specified vector of indices and symmetry.

The indices must be of class `idx`.

Parameters

<i>b</i>	Base expression
<i>symm</i>	Symmetry of indices
<i>iv</i>	Vector of indices

References [GiNaC::container_storage< C >::seq](#), and [validate\(\)](#).

6.74.2.11 indexed() [11/13]

```
GiNaC::indexed::indexed (
    const symmetry & symm,
    const exprseq & es )
```

6.74.2.12 indexed() [12/13]

```
GiNaC::indexed::indexed (
    const symmetry & symm,
    const exvector & v )
```

6.74.2.13 indexed() [13/13]

```
GiNaC::indexed::indexed (
    const symmetry & symm,
    exvector && v )
```

6.74.3 Member Function Documentation**6.74.3.1 precedence()**

```
unsigned GiNaC::indexed::precedence ( ) const [inline], [override], [virtual]
```

Return relative operator precedence (for parenthezing output).

Reimplemented from [GiNaC::container< C >](#).

Referenced by [print_indexed\(\)](#).

6.74.3.2 info()

```
bool GiNaC::indexed::info (
    unsigned inf ) const [override], [virtual]
```

Information about the object.

See also

class [info_flags](#)

Reimplemented from [GiNaC::container< C >](#).

References [GiNaC::info_flags::has_indices](#), [GiNaC::info_flags::indexed](#), and [GiNaC::container_storage< C >::seq](#).

Referenced by [imag_part\(\)](#), and [real_part\(\)](#).

6.74.3.3 eval()

```
ex GiNaC::indexed::eval ( ) const [override], [virtual]
```

Perform automatic non-interruptive term rewriting rules.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex0](#), [GiNaC::canonicalize\(\)](#), [GINAC_ASSERT](#), [GiNaC::ex::is_zero\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), [GiNaC::container_storage< C >::seq](#), [symtree](#), and [thiscontainer\(\)](#).

6.74.3.4 real_part()

```
ex GiNaC::indexed::real_part ( ) const [override], [virtual]
```

Reimplemented from [GiNaC::container< C >](#).

References [info\(\)](#), [GiNaC::container< C >::op\(\)](#), and [GiNaC::info_flags::real](#).

6.74.3.5 imag_part()

```
ex GiNaC::indexed::imag_part ( ) const [override], [virtual]
```

Reimplemented from [GiNaC::container< C >](#).

References [info\(\)](#), [GiNaC::container< C >::op\(\)](#), and [GiNaC::info_flags::real](#).

6.74.3.6 get_free_indices()

```
exvector GiNaC::indexed::get_free_indices ( ) const [override], [virtual]
```

Return a vector containing the free indices of an expression.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::find_free_and_dummy\(\)](#), and [GiNaC::container_storage< C >::seq](#).

Referenced by [get_dummy_indices\(\)](#).

6.74.3.7 archive()

```
void GiNaC::indexed::archive (
    archive_node & n ) const [override], [virtual]
```

Save (a.k.a.

serialize) indexed object into archive.

Reimplemented from [GiNaC::container< C >](#).

References [n](#), and [symtree](#).

6.74.3.8 read_archive()

```
void GiNaC::indexed::read_archive (
    const archive_node & n,
    lst & syms ) [override], [virtual]
```

Read (a.k.a.

deserialize) indexed object from archive.

Reimplemented from [GiNaC::container< C >](#).

References [n](#), [GiNaC::not_symmetric\(\)](#), [GiNaC::container_storage< C >::seq](#), [GiNaC::sy_anti\(\)](#), [GiNaC::sy_symm\(\)](#), [GiNaC::syemm\(\)](#), [symtree](#), and [validate\(\)](#).

6.74.3.9 derivative()

```
ex GiNaC::indexed::derivative (
    const symbol & s ) const [override], [protected], [virtual]
```

Implementation of [ex::diff\(\)](#) for an indexed object always returns 0.

See also

[ex::diff](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex0](#).

6.74.3.10 thiscontainer() [1/2]

```
ex GiNaC::indexed::thiscontainer (
    const exvector & v ) const [override], [protected]
```

References [symtree](#).

Referenced by [eval\(\)](#), and [expand\(\)](#).

6.74.3.11 thiscontainer() [2/2]

```
ex GiNaC::indexed::thiscontainer (
    exvector && v ) const [override], [protected]
```

References [symtree](#).

6.74.3.12 return_type()

```
unsigned GiNaC::indexed::return_type ( ) const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::return_types::commutative](#), [GiNaC::container< C >::op\(\)](#), and [GiNaC::ex::return_type\(\)](#).

6.74.3.13 return_type_tinfo()

```
return\_type\_t GiNaC::indexed::return_type_tinfo ( ) const [inline], [override], [protected],
[virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::container< C >::op\(\)](#), and [GiNaC::ex::return_type_tinfo\(\)](#).

6.74.3.14 expand()

```
ex GiNaC::indexed::expand (
    unsigned options = 0 ) const [override], [protected], [virtual]
```

Expand expression, i.e.

multiply it out and return the result as a new expression.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex0](#), [GiNaC::are_ex_trivially_equal\(\)](#), [GiNaC::ex::expand\(\)](#), [GiNaC::expand_options::expand_indexed](#), [GINAC_ASSERT](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), [options](#), [GiNaC::container_storage< C >::seq](#), and [thiscontainer\(\)](#).

6.74.3.15 `all_index_values_are()`

```
bool GiNaC::indexed::all_index_values_are (
    unsigned inf ) const
```

Check whether all index values have a certain property.

See also

class [info_flags](#)

References [GiNaC::container_storage< C >::seq](#).

6.74.3.16 `get_indices()`

```
exvector GiNaC::indexed::get_indices ( ) const
```

Return a vector containing the object's indices.

References [GINAC_ASSERT](#), and [GiNaC::container_storage< C >::seq](#).

6.74.3.17 `get_dummy_indices()` [1/2]

```
exvector GiNaC::indexed::get_dummy_indices ( ) const
```

Return a vector containing the dummy indices of the object, if any.

References [GiNaC::find_free_and_dummy\(\)](#), and [GiNaC::container_storage< C >::seq](#).

6.74.3.18 `get_dummy_indices()` [2/2]

```
exvector GiNaC::indexed::get_dummy_indices (
    const indexed & other ) const
```

Return a vector containing the dummy indices in the contraction with another indexed object.

This is symmetric: `a.get_dummy_indices(b) == b.get_dummy_indices(a)`

References [GiNaC::find_dummy_indices\(\)](#), and [get_free_indices\(\)](#).

6.74.3.19 `has_dummy_index_for()`

```
bool GiNaC::indexed::has_dummy_index_for (
    const ex & i ) const
```

Check whether the object has an index that forms a dummy index pair with a given index.

References [GiNaC::is_dummy_pair\(\)](#), and [GiNaC::container_storage< C >::seq](#).

6.74.3.20 `get_symmetry()`

```
ex GiNaC::indexed::get_symmetry ( ) const [inline]
```

Return symmetry properties.

References [symtree](#).

Referenced by [GiNaC::clifford::get_metric\(\)](#).

6.74.3.21 `printindices()`

```
void GiNaC::indexed::printindices (
    const print\_context & c,
    unsigned level ) const [protected]
```

References [c](#), and [GiNaC::container_storage< C >::seq](#).

Referenced by [GiNaC::clifford::do_print_dflt\(\)](#), [GiNaC::clifford::do_print_tree\(\)](#), [do_print_tree\(\)](#), and [print_indexed\(\)](#).

6.74.3.22 `print_indexed()`

```
void GiNaC::indexed::print_indexed (
    const print\_context & c,
    const char * openbrace,
    const char * closebrace,
    unsigned level ) const [protected]
```

References [c](#), [precedence\(\)](#), [printindices\(\)](#), and [GiNaC::container_storage< C >::seq](#).

Referenced by [do_print\(\)](#), and [do_print_latex\(\)](#).

6.74.3.23 do_print()

```
void GiNaC::indexed::do_print (
    const print\_context & c,
    unsigned level ) const [protected]
```

References [c](#), and [print_indexed\(\)](#).

6.74.3.24 do_print_latex()

```
void GiNaC::indexed::do_print_latex (
    const print\_latex & c,
    unsigned level ) const [protected]
```

References [c](#), and [print_indexed\(\)](#).

6.74.3.25 do_print_tree()

```
void GiNaC::indexed::do_print_tree (
    const print\_tree & c,
    unsigned level ) const [protected]
```

References [c](#), [GiNaC::basic::flags](#), [GiNaC::basic::hashvalue](#), [printindices\(\)](#), [GiNaC::container_storage< C >::seq](#), and [symtree](#).

6.74.3.26 validate()

```
void GiNaC::indexed::validate ( ) const [protected]
```

Check whether all indices are of class `idx` and validate the symmetry tree.

This function is used internally to make sure that all constructed indexed objects really carry indices and not some other classes.

References [GINAC_ASSERT](#), [GiNaC::ex::is_zero\(\)](#), [GiNaC::container_storage< C >::seq](#), [symtree](#), and [validate\(\)](#).

Referenced by [indexed\(\)](#), [read_archive\(\)](#), and [validate\(\)](#).

6.74.4 Friends And Related Function Documentation

6.74.4.1 simplify_indexed

```
ex simplify_indexed (
    const ex & e,
    exvector & free_indices,
    exvector & dummy_indices,
    const scalar_products & sp ) [friend]
```

Simplify indexed expression, return list of free indices.

Referenced by [GiNaC::clifford::get_metric\(\)](#), and [GiNaC::clifford::same_metric\(\)](#).

6.74.4.2 simplify_indexed_product

```
ex simplify_indexed_product (
    const ex & e,
    exvector & free_indices,
    exvector & dummy_indices,
    const scalar_products & sp ) [friend]
```

Simplify product of indexed expressions (commutative, noncommutative and simple squares), return list of free indices.

6.74.4.3 reposition_dummy_indices

```
bool reposition_dummy_indices (
    ex & e,
    exvector & variant_dummy_indices,
    exvector & moved_indices ) [friend]
```

Raise/lower dummy indices in a single indexed objects to canonicalize their variance.

Parameters

<i>e</i>	Object to work on
<i>variant_dummy_indices</i>	The set of indices that might need repositioning (will be changed by this function)
<i>moved_indices</i>	The set of indices that have been repositioned (will be changed by this function)

Returns

true if 'e' was changed

6.74.5 Member Data Documentation

6.74.5.1 symtree

`ex` `GiNaC::indexed::symtree` [protected]

Index symmetry (tree of symmetry objects)

Referenced by [archive\(\)](#), [GiNaC::clifford::do_print_tree\(\)](#), [do_print_tree\(\)](#), [eval\(\)](#), [get_symmetry\(\)](#), [read_archive\(\)](#), [thiscontainer\(\)](#), and [validate\(\)](#).

The documentation for this class was generated from the following files:

- [indexed.h](#)
- [indexed.cpp](#)

6.75 GiNaC::info_flags Class Reference

Possible attributes an object can have.

```
#include <flags.h>
```

Public Types

- enum {
[numeric](#) , [real](#) , [rational](#) , [integer](#) ,
[crational](#) , [cinteger](#) , [positive](#) , [negative](#) ,
[nonnegative](#) , [posint](#) , [negint](#) , [nonnegint](#) ,
[even](#) , [odd](#) , [prime](#) , [relation](#) ,
[relation_equal](#) , [relation_not_equal](#) , [relation_less](#) , [relation_less_or_equal](#) ,
[relation_greater](#) , [relation_greater_or_equal](#) , [symbol](#) , [list](#) ,
[exprseq](#) , [polynomial](#) , [integer_polynomial](#) , [cinteger_polynomial](#) ,
[rational_polynomial](#) , [crational_polynomial](#) , [rational_function](#) , [indexed](#) ,
[has_indices](#) , [idx](#) , [expanded](#) , [indefinite](#) }

6.75.1 Detailed Description

Possible attributes an object can have.

6.75.2 Member Enumeration Documentation

6.75.2.1 anonymous enum

anonymous enum

Enumerator

numeric	
real	
rational	
integer	
crational	
cinteger	
positive	
negative	
nonnegative	
posint	
negint	
nonnegint	
even	
odd	
prime	
relation	
relation_equal	
relation_not_equal	
relation_less	
relation_less_or_equal	
relation_greater	
relation_greater_or_equal	
symbol	
list	
exprseq	
polynomial	
integer_polynomial	
cinteger_polynomial	
rational_polynomial	
crational_polynomial	
rational_function	
indexed	
has_indices	
idx	
expanded	
indefinite	

The documentation for this class was generated from the following file:

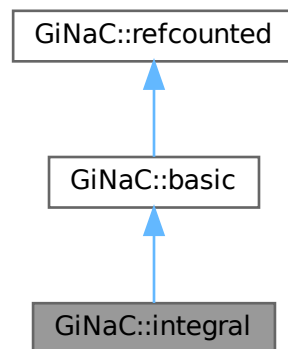
- [flags.h](#)

6.76 GiNaC::integral Class Reference

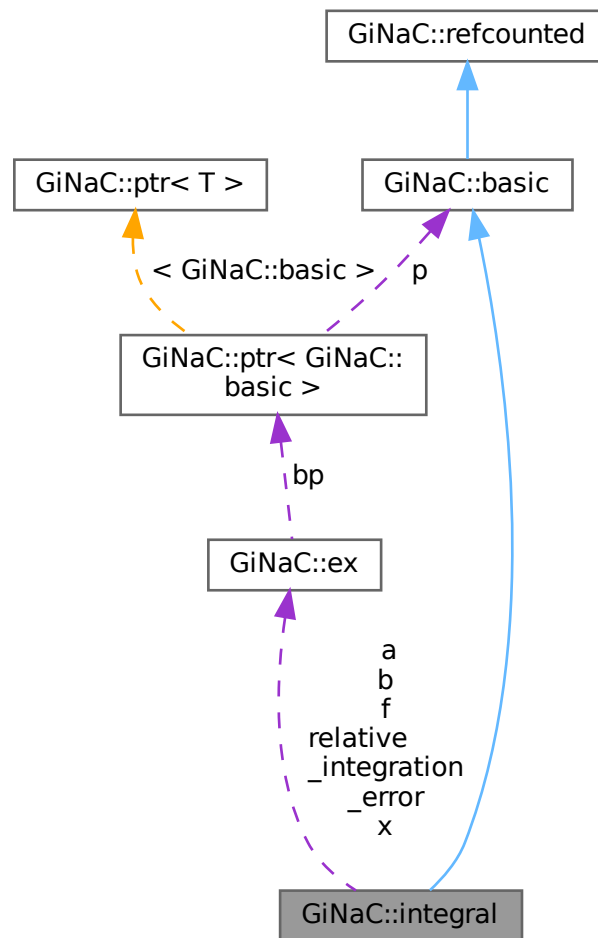
Symbolic integral.

```
#include <integral.h>
```

Inheritance diagram for GiNaC::integral:



Collaboration diagram for GiNaC::integral:



Public Member Functions

- `integral` (const `ex` &`x_`, const `ex` &`a_`, const `ex` &`b_`, const `ex` &`f_`)
- unsigned `precedence` () const override
Return relative operator precedence (for parenthezing output).
- `ex eval` () const override
Perform automatic non-interruptive term rewriting rules.
- `ex evalf` () const override
Evaluate object numerically.
- int `degree` (const `ex` &`s`) const override
Return degree of highest power in object s.
- int `ldegree` (const `ex` &`s`) const override
Return degree of lowest power in object s.
- `ex eval_ncmul` (const `exvector` &`v`) const override
- `size_t nops` () const override

- *Number of operands/members.*
- `ex op` (`size_t i`) `const` override
Return operand/member at position i.
- `ex & let_op` (`size_t i`) override
Return modifiable operand/member at position i.
- `ex expand` (`unsigned options=0`) `const` override
Expand expression, i.e.
- `exvector get_free_indices` () `const` override
Return a vector containing the free indices of an expression.
- `unsigned return_type` () `const` override
- `return_type_t return_type_tinfo` () `const` override
- `ex conjugate` () `const` override
- `ex eval_integ` () `const` override
Evaluate integrals, if result is known.
- `void archive` (`archive_node &n`) `const` override
Save (a.k.a.
- `void read_archive` (`const archive_node &n`, `lst &syms`) override
Read (a.k.a.

Public Member Functions inherited from `GiNaC::basic`

- `virtual ~basic` ()
basic destructor, virtual because class ex will delete objects of derived classes via a basic.*
- `basic` (`const basic &other`)
- `const basic & operator=` (`const basic &other`)
basic assignment operator: the other object might be of a derived class.
- `virtual basic * duplicate` () `const`
Create a clone of this object on the heap.
- `virtual ex eval` () `const`
Perform automatic non-interruptive term rewriting rules.
- `virtual ex evalf` () `const`
Evaluate object numerically.
- `virtual ex evalm` () `const`
Evaluate sums, products and integer powers of matrices.
- `virtual ex eval_integ` () `const`
Evaluate integrals, if result is known.
- `virtual ex eval_indexed` (`const basic &i`) `const`
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- `virtual void print` (`const print_context &c`, `unsigned level=0`) `const`
Output to stream.
- `virtual void dbgprint` () `const`
Little wrapper around print to be called within a debugger.
- `virtual void dbgprinttree` () `const`
Little wrapper around printtree to be called within a debugger.
- `virtual unsigned precedence` () `const`
Return relative operator precedence (for parenthezing output).
- `virtual bool info` (`unsigned inf`) `const`
Information about the object.
- `virtual size_t nops` () `const`
Number of operands/members.

- virtual `ex op` (`size_t i`) const
Return operand/member at position i.
- virtual `ex operator[]` (`const ex &index`) const
- virtual `ex operator[]` (`size_t i`) const
- virtual `ex & let_op` (`size_t i`)
Return modifiable operand/member at position i.
- virtual `ex & operator[]` (`const ex &index`)
- virtual `ex & operator[]` (`size_t i`)
- virtual `bool has` (`const ex &other`, unsigned `options=0`) const
Test for occurrence of a pattern.
- virtual `bool match` (`const ex &pattern`, `exmap &repls`) const
Check whether the expression matches a given pattern.
- virtual `ex subs` (`const exmap &m`, unsigned `options=0`) const
Substitute a set of objects by arbitrary expressions.
- virtual `ex map` (`map_function &f`) const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual `void accept` (`GiNaC::visitor &v`) const
- virtual `bool is_polynomial` (`const ex &var`) const
Check whether this is a polynomial in the given variables.
- virtual `int degree` (`const ex &s`) const
Return degree of highest power in object s.
- virtual `int ldegree` (`const ex &s`) const
Return degree of lowest power in object s.
- virtual `ex coeff` (`const ex &s`, int `n=1`) const
Return coefficient of degree n in object s.
- virtual `ex expand` (unsigned `options=0`) const
Expand expression, i.e.
- virtual `ex collect` (`const ex &s`, bool `distributed=false`) const
Sort expanded expression in terms of powers of some object(s).
- virtual `ex series` (`const relational &r`, int `order`, unsigned `options=0`) const
Default implementation of `ex::series()`.
- virtual `ex normal` (`exmap &repl`, `exmap &rev_lookup`, `lst &modifier`) const
Default implementation of `ex::normal()`.
- virtual `ex to_rational` (`exmap &repl`) const
Default implementation of `ex::to_rational()`.
- virtual `ex to_polynomial` (`exmap &repl`) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (`const numeric &xi`) const
Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- virtual `numeric max_coefficient` () const
Implementation `ex::max_coefficient()`.
- virtual `exvector get_free_indices` () const
Return a vector containing the free indices of an expression.
- virtual `ex add_indexed` (`const ex &self`, `const ex &other`) const
Add two indexed expressions.
- virtual `ex scalar_mul_indexed` (`const ex &self`, `const numeric &other`) const
Multiply an indexed expression with a scalar.
- virtual `bool contract_with` (`exvector::iterator self`, `exvector::iterator other`, `exvector &v`) const
Try to contract two indexed expressions that appear in the same product.
- virtual unsigned `return_type` () const
- virtual `return_type_t return_type_tinfo` () const

- virtual `ex conjugate ()` const
- virtual `ex real_part ()` const
- virtual `ex imag_part ()` const
- template<class T >
void `print_dispatch` (const `print_context` &c, unsigned level) const
Like `print()`, but dispatch to the specified class.
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const
Like `print()`, but dispatch to the specified class.
- virtual void `archive` (`archive_node` &n) const
Save (serialize) the object into archive node.
- virtual void `read_archive` (const `archive_node` &n, `lst` &syms)
Load (deserialize) the object from an archive node.
- `ex subs_one_level` (const `exmap` &m, unsigned `options`) const
Helper function for `subs()`.
- `ex diff` (const `symbol` &s, unsigned nth=1) const
Default interface of nth derivative `ex::diff(s, n)`.
- int `compare` (const `basic` &other) const
Compare objects syntactically to establish canonical ordering.
- bool `is_equal` (const `basic` &other) const
Test for syntactic equality.
- const `basic` & `hold` () const
Stop further evaluation.
- unsigned `gethash` () const
- const `basic` & `setflag` (unsigned f) const
Set some `status_flags`.
- const `basic` & `clearflag` (unsigned f) const
Clear some `status_flags`.

Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- unsigned int `add_reference` () noexcept
- unsigned int `remove_reference` () noexcept
- unsigned int `get_refcount` () const noexcept
- void `set_refcount` (unsigned int r) noexcept

Static Public Attributes

- static int `max_integration_level` = 15
- static `ex relative_integration_error` = 1e-8

Protected Member Functions

- `ex derivative` (const `symbol` &s) const override
Default implementation of `ex::diff()`.
- `ex series` (const `relational` &r, int `order`, unsigned `options`=0) const override
Default implementation of `ex::series()`.
- void `do_print` (const `print_context` &c, unsigned level) const
- void `do_print_latex` (const `print_latex` &c, unsigned level) const

Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match_same_type](#) (const [basic](#) &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual [ex derivative](#) (const [symbol](#) &s) const
Default implementation of [ex::diff\(\)](#).
- virtual int [compare_same_type](#) (const [basic](#) &other) const
Returns order relation between two objects of same type.
- virtual bool [is_equal_same_type](#) (const [basic](#) &other) const
Returns true if two objects of same type are equal.
- virtual unsigned [calchash](#) () const
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- void [ensure_if_modifiable](#) () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
Default output to stream.
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
Tree output to stream.
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
Python parsable output to stream.

Private Attributes

- [ex](#) x
- [ex](#) a
- [ex](#) b
- [ex](#) f

Additional Inherited Members

Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)
of type [status_flags](#)
- unsigned [hashvalue](#)
hash value

6.76.1 Detailed Description

Symbolic integral.

6.76.2 Constructor & Destructor Documentation

6.76.2.1 integral()

```
GiNaC::integral::integral (
    const ex & x_,
    const ex & a_,
    const ex & b_,
    const ex & f_ )
```

References [x](#).

6.76.3 Member Function Documentation

6.76.3.1 precedence()

```
unsigned GiNaC::integral::precedence ( ) const [inline], [override], [virtual]
```

Return relative operator precedence (for parenthezing output).

Reimplemented from [GiNaC::basic](#).

Referenced by [do_print_latex\(\)](#).

6.76.3.2 eval()

```
ex GiNaC::integral::eval ( ) const [override], [virtual]
```

Perform automatic non-interruptive term rewriting rules.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex0](#), [a](#), [b](#), [GiNaC::status_flags::evaluated](#), [f](#), [GiNaC::basic::flags](#), [GiNaC::ex::has\(\)](#), [GiNaC::haswild\(\)](#), [GiNaC::basic::hold\(\)](#), and [x](#).

6.76.3.3 evalf()

```
ex GiNaC::integral::evalf ( ) const [override], [virtual]
```

Evaluate object numerically.

Reimplemented from [GiNaC::basic](#).

References [a](#), [GiNaC::adaptivesimpson\(\)](#), [GiNaC::are_ex_trivially_equal\(\)](#), [b](#), [GiNaC::ex::evalf\(\)](#), [f](#), [GiNaC::ex::subs\(\)](#), and [x](#).

6.76.3.4 degree()

```
int GiNaC::integral::degree (
    const ex & s ) const [override], [virtual]
```

Return degree of highest power in object s.

Reimplemented from [GiNaC::basic](#).

References [a](#), [b](#), and [f](#).

6.76.3.5 ldegree()

```
int GiNaC::integral::ldegree (
    const ex & s ) const [override], [virtual]
```

Return degree of lowest power in object s.

Reimplemented from [GiNaC::basic](#).

References [a](#), [b](#), and [f](#).

6.76.3.6 eval_ncmul()

```
ex GiNaC::integral::eval_ncmul (
    const exvector & v ) const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::ex::eval_ncmul\(\)](#), and [f](#).

6.76.3.7 nops()

```
size_t GiNaC::integral::nops ( ) const [override], [virtual]
```

Number of operands/members.

Reimplemented from [GiNaC::basic](#).

6.76.3.8 op()

```
ex GiNaC::integral::op (
    size_t i ) const [override], [virtual]
```

Return operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [a](#), [b](#), [f](#), [GINAC_ASSERT](#), and [x](#).

6.76.3.9 let_op()

```
ex & GiNaC::integral::let_op (
    size_t i ) [override], [virtual]
```

Return modifiable operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [a](#), [b](#), [GiNaC::basic::ensure_if_modifiable\(\)](#), [f](#), and [x](#).

6.76.3.10 expand()

```
ex GiNaC::integral::expand (
    unsigned options = 0 ) const [override], [virtual]
```

Expand expression, i.e.

multiply it out and return the result as a new expression.

Reimplemented from [GiNaC::basic](#).

References [a](#), [GiNaC::are_ex_trivially_equal\(\)](#), [b](#), [GiNaC::basic::ex](#), [GiNaC::ex::expand\(\)](#), [expand\(\)](#), [GiNaC::status_flags::expanded](#), [f](#), [GiNaC::basic::flags](#), [GiNaC::ex::has\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), [options](#), [GiNaC::basic::setflag\(\)](#), and [x](#).

Referenced by [eval_integ\(\)](#), and [expand\(\)](#).

6.76.3.11 get_free_indices()

```
exvector GiNaC::integral::get_free_indices ( ) const [override], [virtual]
```

Return a vector containing the free indices of an expression.

Reimplemented from [GiNaC::basic](#).

References [a](#), [b](#), [f](#), and [GiNaC::ex::get_free_indices\(\)](#).

6.76.3.12 return_type()

```
unsigned GiNaC::integral::return_type ( ) const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [f](#), and [GiNaC::ex::return_type\(\)](#).

6.76.3.13 return_type_tinfo()

```
return_type_t GiNaC::integral::return_type_tinfo ( ) const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [f](#), and [GiNaC::ex::return_type_tinfo\(\)](#).

6.76.3.14 conjugate()

```
ex GiNaC::integral::conjugate ( ) const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [a](#), [GiNaC::are_ex_trivially_equal\(\)](#), [b](#), [GiNaC::ex::conjugate\(\)](#), [f](#), [GiNaC::ex::subs\(\)](#), and [x](#).

6.76.3.15 eval_integ()

```
ex GiNaC::integral::eval_integ ( ) const [override], [virtual]
```

Evaluate integrals, if result is known.

Reimplemented from [GiNaC::basic](#).

References [a](#), [b](#), [GiNaC::ex::eval_integ\(\)](#), [expand\(\)](#), [GiNaC::status_flags::expanded](#), [f](#), [GiNaC::basic::flags](#), [GiNaC::ex::has\(\)](#), [GiNaC::log\(\)](#), [GiNaC::ex::op\(\)](#), [GiNaC::ex::subs\(\)](#), and [x](#).

6.76.3.16 archive()

```
void GiNaC::integral::archive (
    archive_node & n ) const [override], [virtual]
```

Save (a.k.a.

serialize) object into archive.

Reimplemented from [GiNaC::basic](#).

References [a](#), [b](#), [f](#), [n](#), and [x](#).

6.76.3.17 read_archive()

```
void GiNaC::integral::read_archive (
    const archive_node & n,
    lst & syms ) [override], [virtual]
```

Read (a.k.a.

deserialize) object from archive.

Reimplemented from [GiNaC::basic](#).

References [a](#), [b](#), [f](#), [n](#), and [x](#).

6.76.3.18 derivative()

```
ex GiNaC::integral::derivative (
    const symbol & s ) const [override], [protected], [virtual]
```

Default implementation of [ex::diff\(\)](#).

It maps the operation on the operands (or returns 0 when the object has no operands).

See also

[ex::diff](#)

Reimplemented from [GiNaC::basic](#).

References [a](#), [b](#), [GiNaC::ex::diff\(\)](#), [f](#), [GiNaC::ex::subs\(\)](#), and [x](#).

6.76.3.19 series()

```
ex GiNaC::integral::series (
    const relational & r,
    int order,
    unsigned options = 0 ) const [override], [protected], [virtual]
```

Default implementation of [ex::series\(\)](#).

This performs Taylor expansion.

See also

[ex::series](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex1](#), [a](#), [b](#), [f](#), [GiNaC::is_order_function\(\)](#), [GiNaC::ex::nops\(\)](#), [options](#), [order](#), [r](#), [GiNaC::ex::series\(\)](#), [series\(\)](#), [GiNaC::ex::subs\(\)](#), and [x](#).

Referenced by [series\(\)](#).

6.76.3.20 do_print()

```
void GiNaC::integral::do_print (
    const print\_context & c,
    unsigned level ) const [protected]
```

References [a](#), [b](#), [c](#), [f](#), [GiNaC::ex::print\(\)](#), and [x](#).

6.76.3.21 do_print_latex()

```
void GiNaC::integral::do_print_latex (
    const print\_latex & c,
    unsigned level ) const [protected]
```

References [a](#), [b](#), [c](#), [f](#), [precedence\(\)](#), [GiNaC::ex::print\(\)](#), and [x](#).

6.76.4 Member Data Documentation

6.76.4.1 max_integration_level

```
int GiNaC::integral::max_integration_level = 15 [static]
```

Referenced by [GiNaC::adaptivesimpson\(\)](#).

6.76.4.2 relative_integration_error

```
ex GiNaC::integral::relative_integration_error = 1e-8 [static]
```

6.76.4.3 x

```
ex GiNaC::integral::x [private]
```

Referenced by [archive\(\)](#), [conjugate\(\)](#), [derivative\(\)](#), [do_print\(\)](#), [do_print_latex\(\)](#), [eval\(\)](#), [eval_integ\(\)](#), [evalf\(\)](#), [expand\(\)](#), [integral\(\)](#), [let_op\(\)](#), [op\(\)](#), [read_archive\(\)](#), and [series\(\)](#).

6.76.4.4 a

`ex` GiNaC::integral::a [private]

Referenced by [archive\(\)](#), [conjugate\(\)](#), [degree\(\)](#), [derivative\(\)](#), [do_print\(\)](#), [do_print_latex\(\)](#), [eval\(\)](#), [eval_integ\(\)](#), [evalf\(\)](#), [expand\(\)](#), [get_free_indices\(\)](#), [ldegree\(\)](#), [let_op\(\)](#), [op\(\)](#), [read_archive\(\)](#), and [series\(\)](#).

6.76.4.5 b

`ex` GiNaC::integral::b [private]

Referenced by [archive\(\)](#), [conjugate\(\)](#), [degree\(\)](#), [derivative\(\)](#), [do_print\(\)](#), [do_print_latex\(\)](#), [eval\(\)](#), [eval_integ\(\)](#), [evalf\(\)](#), [expand\(\)](#), [get_free_indices\(\)](#), [ldegree\(\)](#), [let_op\(\)](#), [op\(\)](#), [read_archive\(\)](#), and [series\(\)](#).

6.76.4.6 f

`ex` GiNaC::integral::f [private]

Referenced by [archive\(\)](#), [conjugate\(\)](#), [degree\(\)](#), [derivative\(\)](#), [do_print\(\)](#), [do_print_latex\(\)](#), [eval\(\)](#), [eval_integ\(\)](#), [eval_ncmul\(\)](#), [evalf\(\)](#), [expand\(\)](#), [get_free_indices\(\)](#), [ldegree\(\)](#), [let_op\(\)](#), [op\(\)](#), [read_archive\(\)](#), [return_type\(\)](#), [return_type_tinfo\(\)](#), and [series\(\)](#).

The documentation for this class was generated from the following files:

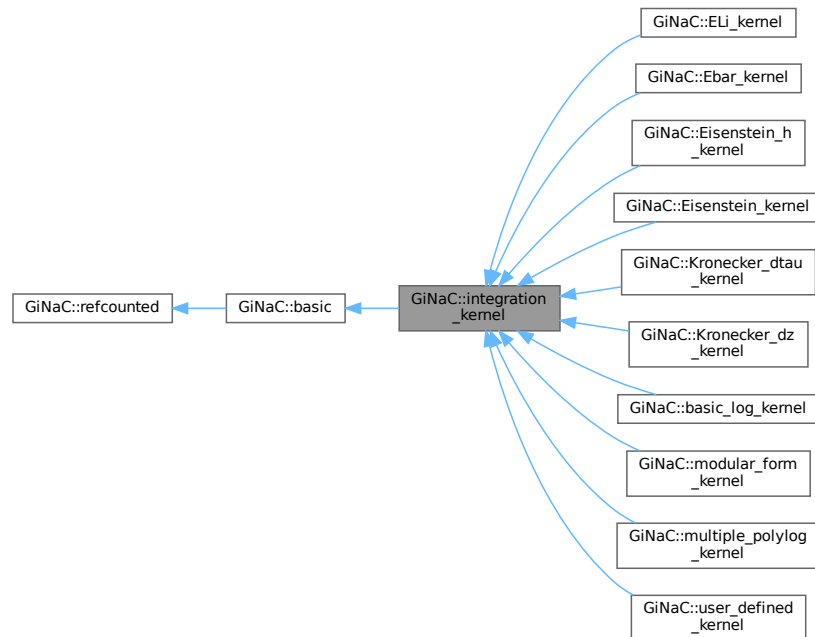
- [integral.h](#)
- [indexed.cpp](#)
- [integral.cpp](#)
- [pseries.cpp](#)

6.77 GiNaC::integration_kernel Class Reference

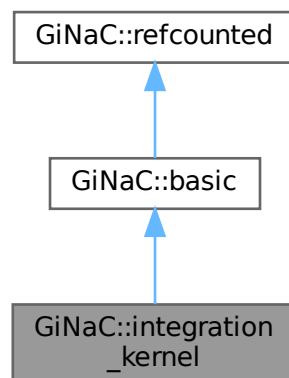
The base class for integration kernels for iterated integrals.

```
#include <integration_kernel.h>
```

Inheritance diagram for `GiNaC::integration_kernel`:



Collaboration diagram for `GiNaC::integration_kernel`:



Public Member Functions

- `ex series` (const `relational` &`r`, int `order`, unsigned `options`=0) const override
Default implementation of `ex::series()`.
- virtual bool `has_trailing_zero` (void) const
This routine returns true, if the integration kernel has a trailing zero.

- virtual bool `is_numeric` (void) const
This routine returns true, if the integration kernel can be evaluated numerically.
- virtual `ex Laurent_series` (const `ex` &x, int order) const
Returns the Laurent series, starting possibly with the pole term.
- virtual `ex get_numerical_value` (const `ex` &lambda, int N_trunc=0) const
Evaluates the integrand at lambda.
- size_t `get_cache_size` (void) const
Returns the current size of the cache.
- void `set_cache_step` (int cache_steps) const
Sets the step size by which the cache is increased.
- `ex get_series_coeff` (int i) const
Wrapper around series_coeff(i), converts cl_N to numeric.
- cln::cl_N `series_coeff` (int i) const
Subclasses have either to implement series_coeff_impl or the two methods Laurent_series and uses_Laurent_series.

Public Member Functions inherited from GiNaC::basic

- virtual `~basic` ()
basic destructor, virtual because class ex will delete objects of derived classes via a basic.*
- `basic` (const `basic` &other)
- const `basic` & `operator=` (const `basic` &other)
basic assignment operator: the other object might be of a derived class.
- virtual `basic * duplicate` () const
Create a clone of this object on the heap.
- virtual `ex eval` () const
Perform automatic non-interruptive term rewriting rules.
- virtual `ex evalf` () const
Evaluate object numerically.
- virtual `ex evalm` () const
Evaluate sums, products and integer powers of matrices.
- virtual `ex eval_integ` () const
Evaluate integrals, if result is known.
- virtual `ex eval_indexed` (const `basic` &i) const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void `print` (const `print_context` &c, unsigned level=0) const
Output to stream.
- virtual void `dbgprint` () const
Little wrapper around print to be called within a debugger.
- virtual void `dbgprinttree` () const
Little wrapper around printtree to be called within a debugger.
- virtual unsigned `precedence` () const
Return relative operator precedence (for parenthezing output).
- virtual bool `info` (unsigned inf) const
Information about the object.
- virtual size_t `nops` () const
Number of operands/members.
- virtual `ex op` (size_t i) const
Return operand/member at position i.
- virtual `ex operator[]` (const `ex` &index) const
- virtual `ex operator[]` (size_t i) const

- virtual `ex & let_op` (size_t i)
Return modifiable operand/member at position i.
- virtual `ex & operator[]` (const `ex` &index)
- virtual `ex & operator[]` (size_t i)
- virtual bool `has` (const `ex` &other, unsigned `options`=0) const
Test for occurrence of a pattern.
- virtual bool `match` (const `ex` &pattern, `exmap` &repls) const
Check whether the expression matches a given pattern.
- virtual `ex subs` (const `exmap` &m, unsigned `options`=0) const
Substitute a set of objects by arbitrary expressions.
- virtual `ex map` (`map_function` &f) const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void `accept` (`GiNaC::visitor` &v) const
- virtual bool `is_polynomial` (const `ex` &var) const
Check whether this is a polynomial in the given variables.
- virtual int `degree` (const `ex` &s) const
Return degree of highest power in object s.
- virtual int `ldegree` (const `ex` &s) const
Return degree of lowest power in object s.
- virtual `ex coeff` (const `ex` &s, int n=1) const
Return coefficient of degree n in object s.
- virtual `ex expand` (unsigned `options`=0) const
Expand expression, i.e.
- virtual `ex collect` (const `ex` &s, bool distributed=false) const
Sort expanded expression in terms of powers of some object(s).
- virtual `ex series` (const `relational` &r, int `order`, unsigned `options`=0) const
Default implementation of `ex::series()`.
- virtual `ex normal` (`exmap` &repl, `exmap` &rev_lookup, `lst` &modifier) const
Default implementation of `ex::normal()`.
- virtual `ex to_rational` (`exmap` &repl) const
Default implementation of `ex::to_rational()`.
- virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const
Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- virtual `numeric max_coefficient` () const
Implementation `ex::max_coefficient()`.
- virtual `exvector get_free_indices` () const
Return a vector containing the free indices of an expression.
- virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
Add two indexed expressions.
- virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
Multiply an indexed expression with a scalar.
- virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const
Try to contract two indexed expressions that appear in the same product.
- virtual unsigned `return_type` () const
- virtual `return_type_t return_type_tinfo` () const
- virtual `ex conjugate` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const

- template<class T >
void [print_dispatch](#) (const [print_context](#) &c, unsigned level) const
Like [print\(\)](#), but dispatch to the specified class.
- void [print_dispatch](#) (const [registered_class_info](#) &ri, const [print_context](#) &c, unsigned level) const
Like [print\(\)](#), but dispatch to the specified class.
- virtual void [archive](#) ([archive_node](#) &n) const
Save (serialize) the object into archive node.
- virtual void [read_archive](#) (const [archive_node](#) &n, [lst](#) &syms)
Load (deserialize) the object from an archive node.
- [ex subs_one_level](#) (const [exmap](#) &m, unsigned [options](#)) const
Helper function for [subs\(\)](#).
- [ex diff](#) (const [symbol](#) &s, unsigned nth=1) const
Default interface of nth derivative [ex::diff\(s, n\)](#).
- int [compare](#) (const [basic](#) &other) const
Compare objects syntactically to establish canonical ordering.
- bool [is_equal](#) (const [basic](#) &other) const
Test for syntactic equality.
- const [basic](#) & [hold](#) () const
Stop further evaluation.
- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const
Set some [status_flags](#).
- const [basic](#) & [clearflag](#) (unsigned f) const
Clear some [status_flags](#).

Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add_reference](#) () noexcept
- unsigned int [remove_reference](#) () noexcept
- unsigned int [get_refcount](#) () const noexcept
- void [set_refcount](#) (unsigned int r) noexcept

Protected Member Functions

- virtual bool [uses_Laurent_series](#) () const
Returns true, if the coefficients are computed from the Laurent series (in which case the method [Laurent_series](#) needs to be implemented).
- virtual [cln::cl_N series_coeff_impl](#) (int i) const
For $\omega = d\lambda$ only the coefficient of λ^0 is non-zero.
- [ex get_numerical_value_impl](#) (const [ex](#) &lambda, const [ex](#) &pre, int shift, int N_trunc) const
The actual implementation for computing a numerical value for the integrand.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const

Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match_same_type](#) (const [basic](#) &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual [ex derivative](#) (const [symbol](#) &s) const
Default implementation of [ex::diff\(\)](#).
- virtual int [compare_same_type](#) (const [basic](#) &other) const
Returns order relation between two objects of same type.
- virtual bool [is_equal_same_type](#) (const [basic](#) &other) const
Returns true if two objects of same type are equal.
- virtual unsigned [calchash](#) () const
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- void [ensure_if_modifiable](#) () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
Default output to stream.
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
Tree output to stream.
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
Python parsable output to stream.

Protected Attributes

- int [cache_step_size](#)
- std::vector< [cln::cl_N](#) > [series_vec](#)

Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)
of type [status_flags](#)
- unsigned [hashvalue](#)
hash value

6.77.1 Detailed Description

The base class for integration kernels for iterated integrals.

This class represents the differential one-form

$$\omega = d\lambda$$

The integration variable is a dummy variable and does not need to be specified.

6.77.2 Member Function Documentation

6.77.2.1 series()

```
ex GiNaC::integration_kernel::series (
    const relational & r,
    int order,
    unsigned options = 0 ) const [override], [virtual]
```

Default implementation of [ex::series\(\)](#).

This performs Taylor expansion.

See also

[ex::series](#)

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::Eisenstein_kernel](#), [GiNaC::Eisenstein_h_kernel](#), and [GiNaC::modular_form_kernel](#).

References [order](#), and [r](#).

6.77.2.2 has_trailing_zero()

```
bool GiNaC::integration_kernel::has_trailing_zero (
    void ) const [virtual]
```

This routine returns true, if the integration kernel has a trailing zero.

6.77.2.3 is_numeric()

```
bool GiNaC::integration_kernel::is_numeric (
    void ) const [virtual]
```

This routine returns true, if the integration kernel can be evaluated numerically.

Reimplemented in [GiNaC::multiple_polylog_kernel](#), [GiNaC::ELi_kernel](#), [GiNaC::Ebar_kernel](#), [GiNaC::Kronecker_dtau_kernel](#), [GiNaC::Kronecker_dz_kernel](#), [GiNaC::Eisenstein_kernel](#), [GiNaC::Eisenstein_h_kernel](#), [GiNaC::modular_form_kernel](#), and [GiNaC::user_defined_kernel](#).

6.77.2.4 Laurent_series()

```
ex GiNaC::integration_kernel::Laurent_series (
    const ex & x,
    int order ) const [virtual]
```

Returns the Laurent series, starting possibly with the pole term.

Neglected terms are of order $O(x^{order})$.

Reimplemented in [GiNaC::modular_form_kernel](#), [GiNaC::Eisenstein_kernel](#), [GiNaC::Eisenstein_h_kernel](#), and [GiNaC::user_defined_kernel](#).

References [n](#), [order](#), [GiNaC::pow\(\)](#), [GiNaC::ex::series\(\)](#), and [x](#).

6.77.2.5 get_numerical_value()

```
ex GiNaC::integration_kernel::get_numerical_value (
    const ex & lambda,
    int N_trunc = 0 ) const [virtual]
```

Evaluates the integrand at lambda.

Reimplemented in [GiNaC::ELi_kernel](#), [GiNaC::Ebar_kernel](#), [GiNaC::Kronecker_dtau_kernel](#), [GiNaC::Eisenstein_kernel](#), [GiNaC::Eisenstein_h_kernel](#), [GiNaC::modular_form_kernel](#), and [GiNaC::Kronecker_dz_kernel](#).

6.77.2.6 uses_Laurent_series()

```
bool GiNaC::integration_kernel::uses_Laurent_series ( ) const [protected], [virtual]
```

Returns true, if the coefficients are computed from the Laurent series (in which case the method `Laurent_series` needs to be implemented).

Returns false if this is not the case (and the class has an implementation of `series_coeff_impl`).

Reimplemented in [GiNaC::Eisenstein_kernel](#), [GiNaC::Eisenstein_h_kernel](#), [GiNaC::modular_form_kernel](#), and [GiNaC::user_defined_kernel](#).

6.77.2.7 series_coeff_impl()

```
cln::cl_N GiNaC::integration_kernel::series_coeff_impl (
    int i ) const [protected], [virtual]
```

For $\omega = d\lambda$ only the coefficient of λ^0 is non-zero.

The i -th coefficient corresponds to the power λ^{i-1} .

Reimplemented in [GiNaC::basic_log_kernel](#), [GiNaC::multiple_polylog_kernel](#), [GiNaC::ELi_kernel](#), [GiNaC::Ebar_kernel](#), [GiNaC::Kronecker_dtau_kernel](#), and [GiNaC::Kronecker_dz_kernel](#).

6.77.2.8 get_cache_size()

```
size_t GiNaC::integration_kernel::get_cache_size (
    void ) const
```

Returns the current size of the cache.

6.77.2.9 set_cache_step()

```
void GiNaC::integration_kernel::set_cache_step (
    int cache_steps ) const
```

Sets the step size by which the cache is increased.

6.77.2.10 get_series_coeff()

```
ex GiNaC::integration_kernel::get_series_coeff (
    int i ) const
```

Wrapper around `series_coeff(i)`, converts `cl_N` to numeric.

6.77.2.11 series_coeff()

```
cln::cl_N GiNaC::integration_kernel::series_coeff (
    int i ) const
```

Subclasses have either to implement `series_coeff_impl` or the two methods `Laurent_series` and `uses_Laurent_`↔`series`.

The method `series_coeff_impl` can be used, if a single coefficient can be computed independently of the others.

The method `Laurent_series` can be used, if it is more efficient to compute a Laurent series in one shot and to determine a range of coefficients from this Laurent series.

References [GiNaC::ex::coeff\(\)](#), [GiNaC::ex::evalf\(\)](#), and `x`.

6.77.2.12 `get_numerical_value_impl()`

```
ex GiNaC::integration_kernel::get_numerical_value_impl (
    const ex & lambda,
    const ex & pre,
    int shift,
    int N_trunc ) const [protected]
```

The actual implementation for computing a numerical value for the integrand.

References [GiNaC::Digits](#), [GiNaC::ex::evalf\(\)](#), and [one](#).

Referenced by [GiNaC::ELi_kernel::get_numerical_value\(\)](#), [GiNaC::Ebar_kernel::get_numerical_value\(\)](#), [GiNaC::Kronecker_dtau_kernel::get_numerical_value\(\)](#), [GiNaC::Eisenstein_kernel::get_numerical_value\(\)](#), [GiNaC::Eisenstein_h_kernel::get_numerical_value\(\)](#), [GiNaC::modular_form_kernel::get_numerical_value\(\)](#), and [GiNaC::Kronecker_dz_kernel::get_numerical_value\(\)](#).

6.77.2.13 `do_print()`

```
void GiNaC::integration_kernel::do_print (
    const print_context & c,
    unsigned level ) const [protected]
```

References [c](#).

6.77.3 Member Data Documentation

6.77.3.1 `cache_step_size`

```
int GiNaC::integration_kernel::cache_step_size [mutable], [protected]
```

6.77.3.2 `series_vec`

```
std::vector<cln::cl_N> GiNaC::integration_kernel::series_vec [mutable], [protected]
```

The documentation for this class was generated from the following files:

- [integration_kernel.h](#)
- [integration_kernel.cpp](#)

6.78 `GiNaC::is_not_a_clifford` Struct Reference

Predicate for finding non-clifford objects.

Public Member Functions

- bool [operator\(\)](#) (const [ex](#) &e)

6.78.1 Detailed Description

Predicate for finding non-clifford objects.

6.78.2 Member Function Documentation

6.78.2.1 [operator\(\)](#)

```
bool GiNaC::is_not_a_clifford::operator() (
    const ex & e ) [inline]
```

The documentation for this struct was generated from the following file:

- [clifford.cpp](#)

6.79 GiNaC::is_summation_idx Struct Reference

Public Member Functions

- bool [operator\(\)](#) (const [ex](#) &e)

6.79.1 Member Function Documentation

6.79.1.1 [operator\(\)](#)

```
bool GiNaC::is_summation_idx::operator() (
    const ex & e ) [inline]
```

References [GiNaC::is_dummy_pair\(\)](#).

The documentation for this struct was generated from the following file:

- [indexed.cpp](#)

6.80 GiNaC::iterated_integral2_SERIAL Class Reference

Complete elliptic integral of the first kind.

```
#include <inifcns.h>
```

Static Public Attributes

- static unsigned [serial](#)

6.80.1 Detailed Description

Complete elliptic integral of the first kind.

Complete elliptic integral of the second kind. Iterated integral.

6.80.2 Member Data Documentation

6.80.2.1 serial

```
unsigned GiNaC::iterated_integral2_SERIAL::serial [static]
```

Initial value:

```
=
    function::register_new(function_options("iterated_integral", 2).
        eval_func(iterated_integral2_eval).
        evalf_func(iterated_integral2_evalf).
        do_not_evalf_params().
        overloaded(2))
```

Referenced by [GiNaC::iterated_integral\(\)](#).

The documentation for this class was generated from the following files:

- [inifcns.h](#)
- [inifcns_elliptic.cpp](#)

6.81 GiNaC::iterated_integral3_SERIAL Class Reference

Iterated integral with explicit truncation.

```
#include <inifcns.h>
```

Static Public Attributes

- static unsigned [serial](#)

6.81.1 Detailed Description

Iterated integral with explicit truncation.

6.81.2 Member Data Documentation

6.81.2.1 serial

```
unsigned GiNaC::iterated_integral3_SERIAL::serial [static]
```

Initial value:

```
=
    function::register_new(function_options("iterated_integral", 3).
        eval_func(iterated_integral3_eval).
        evalf_func(iterated_integral3_evalf).
        do_not_evalf_params().
        overloaded(2))
```

Referenced by [GiNaC::iterated_integral\(\)](#).

The documentation for this class was generated from the following files:

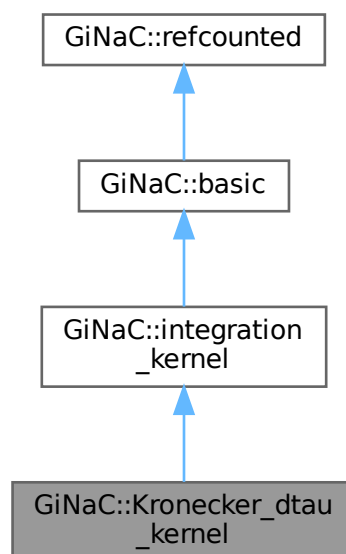
- [inifcns.h](#)
- [inifcns_elliptic.cpp](#)

6.82 GiNaC::Kronecker_dtau_kernel Class Reference

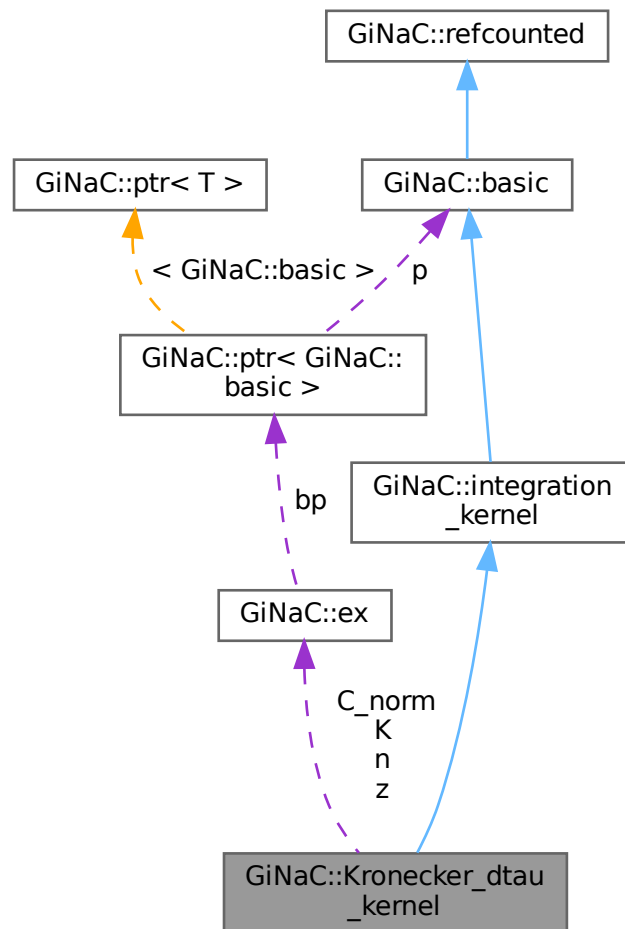
The kernel corresponding to integrating the Kronecker coefficient function $g^{(n)}(z_j, K\tau)$ in τ (or equivalently in \bar{q}).

```
#include <integration_kernel.h>
```

Inheritance diagram for GiNaC::Kronecker_dtau_kernel:



Collaboration diagram for GiNaC::Kronecker_dtau_kernel:



Public Member Functions

- `Kronecker_dtau_kernel` (const `ex` &`n`, const `ex` &`z`, const `ex` &`K=numeric(1)`, const `ex` &`C_norm=numeric(1)`)
- `size_t nops ()` const override
Number of operands/members.
- `ex op (size_t i)` const override
Return operand/member at position i.
- `ex &let_op (size_t i)` override
Return modifiable operand/member at position i.
- `bool is_numeric (void)` const override
This routine returns true, if the integration kernel can be evaluated numerically.
- `ex get_numerical_value` (const `ex` &`qbar`, int `N_trunc=0`) const override
Returns the value of the $g^{(n)}(z, K \cdot \tau)$, where τ is given by `qbar`.

Public Member Functions inherited from [GiNaC::integration_kernel](#)

- [ex series](#) (const [relational](#) &r, int [order](#), unsigned [options](#)=0) const override
Default implementation of [ex::series\(\)](#).
- virtual bool [has_trailing_zero](#) (void) const
This routine returns true, if the integration kernel has a trailing zero.
- virtual bool [is_numeric](#) (void) const
This routine returns true, if the integration kernel can be evaluated numerically.
- virtual [ex Laurent_series](#) (const [ex](#) &x, int [order](#)) const
Returns the Laurent series, starting possibly with the pole term.
- virtual [ex get_numerical_value](#) (const [ex](#) &lambda, int N_trunc=0) const
Evaluates the integrand at lambda.
- size_t [get_cache_size](#) (void) const
Returns the current size of the cache.
- void [set_cache_step](#) (int cache_steps) const
Sets the step size by which the cache is increased.
- [ex get_series_coeff](#) (int i) const
Wrapper around [series_coeff\(i\)](#), converts [cl_N](#) to numeric.
- [cln::cl_N series_coeff](#) (int i) const
Subclasses have either to implement [series_coeff_impl](#) or the two methods [Laurent_series](#) and [uses_Laurent_series](#).

Public Member Functions inherited from [GiNaC::basic](#)

- virtual [~basic](#) ()
basic destructor, virtual because class [ex](#) will delete objects of derived classes via a [basic](#).*
- [basic](#) (const [basic](#) &other)
- const [basic](#) & [operator=](#) (const [basic](#) &other)
basic assignment operator: the other object might be of a derived class.
- virtual [basic * duplicate](#) () const
Create a clone of this object on the heap.
- virtual [ex eval](#) () const
Perform automatic non-interruptive term rewriting rules.
- virtual [ex evalf](#) () const
Evaluate object numerically.
- virtual [ex evalm](#) () const
Evaluate sums, products and integer powers of matrices.
- virtual [ex eval_integ](#) () const
Evaluate integrals, if result is known.
- virtual [ex eval_indexed](#) (const [basic](#) &i) const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void [print](#) (const [print_context](#) &c, unsigned level=0) const
Output to stream.
- virtual void [dbgprint](#) () const
Little wrapper around [print](#) to be called within a debugger.
- virtual void [dbgprnttree](#) () const
Little wrapper around [prnttree](#) to be called within a debugger.
- virtual unsigned [precedence](#) () const
Return relative operator precedence (for parenthezing output).
- virtual bool [info](#) (unsigned inf) const
Information about the object.

- virtual `size_t nops ()` const
Number of operands/members.
- virtual `ex op (size_t i)` const
Return operand/member at position i.
- virtual `ex operator[] (const ex &index)` const
- virtual `ex operator[] (size_t i)` const
- virtual `ex & let_op (size_t i)`
Return modifiable operand/member at position i.
- virtual `ex & operator[] (const ex &index)`
- virtual `ex & operator[] (size_t i)`
- virtual `bool has (const ex &other, unsigned options=0)` const
Test for occurrence of a pattern.
- virtual `bool match (const ex &pattern, exmap &repls)` const
Check whether the expression matches a given pattern.
- virtual `ex subs (const exmap &m, unsigned options=0)` const
Substitute a set of objects by arbitrary expressions.
- virtual `ex map (map_function &f)` const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual `void accept (GiNaC::visitor &v)` const
- virtual `bool is_polynomial (const ex &var)` const
Check whether this is a polynomial in the given variables.
- virtual `int degree (const ex &s)` const
Return degree of highest power in object s.
- virtual `int ldegree (const ex &s)` const
Return degree of lowest power in object s.
- virtual `ex coeff (const ex &s, int n=1)` const
Return coefficient of degree n in object s.
- virtual `ex expand (unsigned options=0)` const
Expand expression, i.e.
- virtual `ex collect (const ex &s, bool distributed=false)` const
Sort expanded expression in terms of powers of some object(s).
- virtual `ex series (const relational &r, int order, unsigned options=0)` const
Default implementation of `ex::series()`.
- virtual `ex normal (exmap &repl, exmap &rev_lookup, lst &modifier)` const
Default implementation of `ex::normal()`.
- virtual `ex to_rational (exmap &repl)` const
Default implementation of `ex::to_rational()`.
- virtual `ex to_polynomial (exmap &repl)` const
- virtual `numeric integer_content ()` const
- virtual `ex smod (const numeric &xi)` const
Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- virtual `numeric max_coefficient ()` const
Implementation `ex::max_coefficient()`.
- virtual `exvector get_free_indices ()` const
Return a vector containing the free indices of an expression.
- virtual `ex add_indexed (const ex &self, const ex &other)` const
Add two indexed expressions.
- virtual `ex scalar_mul_indexed (const ex &self, const numeric &other)` const
Multiply an indexed expression with a scalar.
- virtual `bool contract_with (exvector::iterator self, exvector::iterator other, exvector &v)` const
Try to contract two indexed expressions that appear in the same product.

- virtual unsigned `return_type` () const
- virtual `return_type_t return_type_tinfo` () const
- virtual `ex conjugate` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const
- template<class T >
void `print_dispatch` (const `print_context` &c, unsigned level) const
Like `print()`, but dispatch to the specified class.
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const
Like `print()`, but dispatch to the specified class.
- virtual void `archive` (`archive_node` &n) const
Save (serialize) the object into archive node.
- virtual void `read_archive` (const `archive_node` &n, `lst` &syms)
Load (deserialize) the object from an archive node.
- `ex subs_one_level` (const `exmap` &m, unsigned `options`) const
Helper function for `subs()`.
- `ex diff` (const `symbol` &s, unsigned nth=1) const
Default interface of nth derivative `ex::diff(s, n)`.
- int `compare` (const `basic` &other) const
Compare objects syntactically to establish canonical ordering.
- bool `is_equal` (const `basic` &other) const
Test for syntactic equality.
- const `basic` & `hold` () const
Stop further evaluation.
- unsigned `gethash` () const
- const `basic` & `setflag` (unsigned f) const
Set some `status_flags`.
- const `basic` & `clearflag` (unsigned f) const
Clear some `status_flags`.

Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- unsigned int `add_reference` () noexcept
- unsigned int `remove_reference` () noexcept
- unsigned int `get_refcount` () const noexcept
- void `set_refcount` (unsigned int r) noexcept

Protected Member Functions

- `cln::cl_N series_coeff_impl` (int i) const override
For $\omega = d\lambda$ only the coefficient of λ^0 is non-zero.
- void `do_print` (const `print_context` &c, unsigned level) const

Protected Member Functions inherited from `GiNaC::integration_kernel`

- virtual bool `uses_Laurent_series` () const
Returns true, if the coefficients are computed from the Laurent series (in which case the method `Laurent_series` needs to be implemented).
- virtual `cln::cl_N series_coeff_impl` (int i) const
For $\omega = d\lambda$ only the coefficient of λ^0 is non-zero.
- `ex get_numerical_value_impl` (const `ex` &lambda, const `ex` &pre, int shift, int N_trunc) const
The actual implementation for computing a numerical value for the integrand.
- void `do_print` (const `print_context` &c, unsigned level) const

Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match_same_type](#) (const [basic](#) &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual [ex derivative](#) (const [symbol](#) &s) const
Default implementation of [ex::diff\(\)](#).
- virtual int [compare_same_type](#) (const [basic](#) &other) const
Returns order relation between two objects of same type.
- virtual bool [is_equal_same_type](#) (const [basic](#) &other) const
Returns true if two objects of same type are equal.
- virtual unsigned [calchash](#) () const
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- void [ensure_if_modifiable](#) () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
Default output to stream.
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
Tree output to stream.
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
Python parsable output to stream.

Protected Attributes

- [ex n](#)
- [ex z](#)
- [ex K](#)
- [ex C_norm](#)

Protected Attributes inherited from [GiNaC::integration_kernel](#)

- int [cache_step_size](#)
- `std::vector< cln::cl_N >` [series_vec](#)

Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)
of type [status_flags](#)
- unsigned [hashvalue](#)
hash value

6.82.1 Detailed Description

The kernel corresponding to integrating the Kronecker coefficient function $g^{(n)}(z_j, K\tau)$ in τ (or equivalently in \bar{q}).

This class represents the differential one-form

$$\omega_{n,K}^{\text{Kronecker},\tau}(z_j) = \frac{C_n K(n-1)}{(2\pi i)^n} g^{(n)}(z_j, K\tau) \frac{d\bar{q}}{\bar{q}}$$

6.82.2 Constructor & Destructor Documentation

6.82.2.1 Kronecker_dtau_kernel()

```
GiNaC::Kronecker_dtau_kernel::Kronecker_dtau_kernel (
    const ex & n,
    const ex & z,
    const ex & K = numeric\(1\),
    const ex & C_norm = numeric\(1\) )
```

6.82.3 Member Function Documentation

6.82.3.1 nops()

```
size_t GiNaC::Kronecker_dtau_kernel::nops ( ) const [override], [virtual]
```

Number of operands/members.

Reimplemented from [GiNaC::basic](#).

6.82.3.2 op()

```
ex GiNaC::Kronecker_dtau_kernel::op (
    size_t i ) const [override], [virtual]
```

Return operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [C_norm](#), [K](#), [n](#), and [z](#).

6.82.3.3 let_op()

```
ex & GiNaC::Kronecker_dtau_kernel::let_op (
    size_t i ) [override], [virtual]
```

Return modifiable operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [C_norm](#), [GiNaC::basic::ensure_if_modifiable\(\)](#), [K](#), [n](#), and [z](#).

6.82.3.4 is_numeric()

```
bool GiNaC::Kronecker_dtau_kernel::is_numeric (
    void ) const [override], [virtual]
```

This routine returns true, if the integration kernel can be evaluated numerically.

Reimplemented from [GiNaC::integration_kernel](#).

References [C_norm](#), [GiNaC::ex::evalf\(\)](#), [GiNaC::ex::info\(\)](#), [K](#), [n](#), [GiNaC::info_flags::nonnegint](#), [GiNaC::info_flags::numeric](#), [GiNaC::info_flags::posint](#), and [z](#).

6.82.3.5 get_numerical_value()

```
ex GiNaC::Kronecker_dtau_kernel::get_numerical_value (
    const ex & qbar,
    int N_trunc = 0 ) const [override], [virtual]
```

Returns the value of the $g^{(n)}(z, K \cdot \tau)$, where τ is given by $qbar$.

Reimplemented from [GiNaC::integration_kernel](#).

References [C_norm](#), [GiNaC::basic::evalf\(\)](#), [GiNaC::ex::evalf\(\)](#), [GiNaC::exp\(\)](#), [GiNaC::Ebar_kernel::get_numerical_value\(\)](#), [GiNaC::integration_kernel::get_numerical_value_impl\(\)](#), [GiNaC::l](#), [K](#), [n](#), [GiNaC::Pi](#), [GiNaC::pow\(\)](#), [qbar](#), and [z](#).

6.82.3.6 series_coeff_impl()

```
cln::cl_N GiNaC::Kronecker_dtau_kernel::series_coeff_impl (
    int i ) const [override], [protected], [virtual]
```

For $\omega = d\lambda$ only the coefficient of λ^0 is non-zero.

The i -th coefficient corresponds to the power λ^{i-1} .

Reimplemented from [GiNaC::integration_kernel](#).

References [GiNaC::bernoulli\(\)](#), [C_norm](#), [GiNaC::basic::evalf\(\)](#), [GiNaC::ex::evalf\(\)](#), [GiNaC::exp\(\)](#), [GiNaC::factorial\(\)](#), [GiNaC::l](#), [K](#), [n](#), [GiNaC::Pi](#), [GiNaC::numeric::to_cl_N\(\)](#), [GiNaC::numeric::to_int\(\)](#), and [z](#).

6.82.3.7 do_print()

```
void GiNaC::Kronecker_dtau_kernel::do_print (
    const print_context & c,
    unsigned level ) const [protected]
```

References [c](#), [C_norm](#), [K](#), [n](#), [GiNaC::ex::print\(\)](#), and [z](#).

6.82.4 Member Data Documentation

6.82.4.1 `n`

`ex` GiNaC::Kronecker_dtau_kernel::n [protected]

Referenced by [do_print\(\)](#), [get_numerical_value\(\)](#), [is_numeric\(\)](#), [let_op\(\)](#), [op\(\)](#), and [series_coeff_impl\(\)](#).

6.82.4.2 `z`

`ex` GiNaC::Kronecker_dtau_kernel::z [protected]

Referenced by [do_print\(\)](#), [get_numerical_value\(\)](#), [is_numeric\(\)](#), [let_op\(\)](#), [op\(\)](#), and [series_coeff_impl\(\)](#).

6.82.4.3 `K`

`ex` GiNaC::Kronecker_dtau_kernel::K [protected]

Referenced by [do_print\(\)](#), [get_numerical_value\(\)](#), [is_numeric\(\)](#), [let_op\(\)](#), [op\(\)](#), and [series_coeff_impl\(\)](#).

6.82.4.4 `C_norm`

`ex` GiNaC::Kronecker_dtau_kernel::C_norm [protected]

Referenced by [do_print\(\)](#), [get_numerical_value\(\)](#), [is_numeric\(\)](#), [let_op\(\)](#), [op\(\)](#), and [series_coeff_impl\(\)](#).

The documentation for this class was generated from the following files:

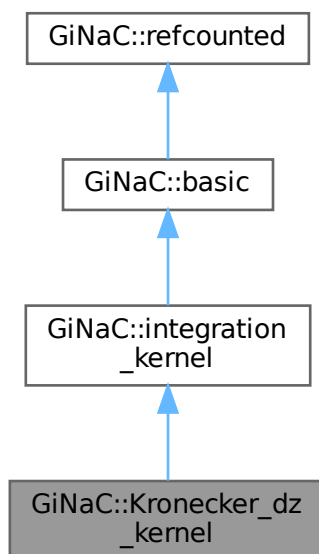
- [integration_kernel.h](#)
- [integration_kernel.cpp](#)

6.83 GiNaC::Kronecker_dz_kernel Class Reference

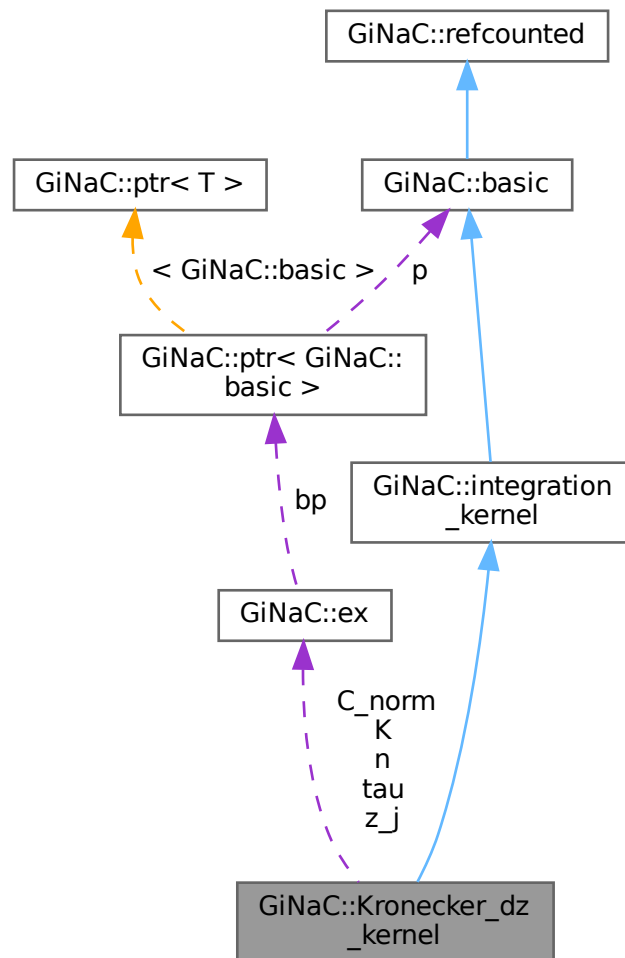
The kernel corresponding to integrating the Kronecker coefficient function $g^{(n-1)}(z - z_j, K\tau)$ in z .

```
#include <integration_kernel.h>
```

Inheritance diagram for GiNaC::Kronecker_dz_kernel:



Collaboration diagram for GiNaC::Kronecker_dz_kernel:



Public Member Functions

- `Kronecker_dz_kernel` (const `ex` &`n`, const `ex` &`z_j`, const `ex` &`tau`, const `ex` &`K=numeric(1)`, const `ex` &`C_norm=numeric(1)`)
- `size_t nops` () const override
Number of operands/members.
- `ex op` (size_t `i`) const override
Return operand/member at position i.
- `ex &let_op` (size_t `i`) override
Return modifiable operand/member at position i.
- `bool is_numeric` (void) const override
This routine returns true, if the integration kernel can be evaluated numerically.
- `ex get_numerical_value` (const `ex` &`z`, int `N_trunc=0`) const override
Returns the value of the $g^{(n-1)}(z-z_j, K\tau)$.*

Public Member Functions inherited from [GiNaC::integration_kernel](#)

- [ex series](#) (const [relational](#) &r, int [order](#), unsigned [options](#)=0) const override
Default implementation of [ex::series\(\)](#).
- virtual bool [has_trailing_zero](#) (void) const
This routine returns true, if the integration kernel has a trailing zero.
- virtual bool [is_numeric](#) (void) const
This routine returns true, if the integration kernel can be evaluated numerically.
- virtual [ex Laurent_series](#) (const [ex](#) &x, int [order](#)) const
Returns the Laurent series, starting possibly with the pole term.
- virtual [ex get_numerical_value](#) (const [ex](#) &lambda, int N_trunc=0) const
Evaluates the integrand at lambda.
- size_t [get_cache_size](#) (void) const
Returns the current size of the cache.
- void [set_cache_step](#) (int cache_steps) const
Sets the step size by which the cache is increased.
- [ex get_series_coeff](#) (int i) const
Wrapper around [series_coeff\(i\)](#), converts [cl_N](#) to numeric.
- [cln::cl_N series_coeff](#) (int i) const
Subclasses have either to implement [series_coeff_impl](#) or the two methods [Laurent_series](#) and [uses_Laurent_series](#).

Public Member Functions inherited from [GiNaC::basic](#)

- virtual [~basic](#) ()
basic destructor, virtual because class [ex](#) will delete objects of derived classes via a [basic](#).*
- [basic](#) (const [basic](#) &other)
- const [basic](#) & [operator=](#) (const [basic](#) &other)
basic assignment operator: the other object might be of a derived class.
- virtual [basic * duplicate](#) () const
Create a clone of this object on the heap.
- virtual [ex eval](#) () const
Perform automatic non-interruptive term rewriting rules.
- virtual [ex evalf](#) () const
Evaluate object numerically.
- virtual [ex evalm](#) () const
Evaluate sums, products and integer powers of matrices.
- virtual [ex eval_integ](#) () const
Evaluate integrals, if result is known.
- virtual [ex eval_indexed](#) (const [basic](#) &i) const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void [print](#) (const [print_context](#) &c, unsigned level=0) const
Output to stream.
- virtual void [dbgprint](#) () const
Little wrapper around [print](#) to be called within a debugger.
- virtual void [dbgprnttree](#) () const
Little wrapper around [prnttree](#) to be called within a debugger.
- virtual unsigned [precedence](#) () const
Return relative operator precedence (for parenthezing output).
- virtual bool [info](#) (unsigned inf) const
Information about the object.

- virtual `size_t nops ()` const
Number of operands/members.
- virtual `ex op (size_t i)` const
Return operand/member at position i.
- virtual `ex operator[] (const ex &index)` const
- virtual `ex operator[] (size_t i)` const
- virtual `ex & let_op (size_t i)`
Return modifiable operand/member at position i.
- virtual `ex & operator[] (const ex &index)`
- virtual `ex & operator[] (size_t i)`
- virtual `bool has (const ex &other, unsigned options=0)` const
Test for occurrence of a pattern.
- virtual `bool match (const ex &pattern, exmap &repls)` const
Check whether the expression matches a given pattern.
- virtual `ex subs (const exmap &m, unsigned options=0)` const
Substitute a set of objects by arbitrary expressions.
- virtual `ex map (map_function &f)` const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual `void accept (GiNaC::visitor &v)` const
- virtual `bool is_polynomial (const ex &var)` const
Check whether this is a polynomial in the given variables.
- virtual `int degree (const ex &s)` const
Return degree of highest power in object s.
- virtual `int ldegree (const ex &s)` const
Return degree of lowest power in object s.
- virtual `ex coeff (const ex &s, int n=1)` const
Return coefficient of degree n in object s.
- virtual `ex expand (unsigned options=0)` const
Expand expression, i.e.
- virtual `ex collect (const ex &s, bool distributed=false)` const
Sort expanded expression in terms of powers of some object(s).
- virtual `ex series (const relational &r, int order, unsigned options=0)` const
Default implementation of `ex::series()`.
- virtual `ex normal (exmap &repl, exmap &rev_lookup, lst &modifier)` const
Default implementation of `ex::normal()`.
- virtual `ex to_rational (exmap &repl)` const
Default implementation of `ex::to_rational()`.
- virtual `ex to_polynomial (exmap &repl)` const
- virtual `numeric integer_content ()` const
- virtual `ex smod (const numeric &xi)` const
Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- virtual `numeric max_coefficient ()` const
Implementation `ex::max_coefficient()`.
- virtual `exvector get_free_indices ()` const
Return a vector containing the free indices of an expression.
- virtual `ex add_indexed (const ex &self, const ex &other)` const
Add two indexed expressions.
- virtual `ex scalar_mul_indexed (const ex &self, const numeric &other)` const
Multiply an indexed expression with a scalar.
- virtual `bool contract_with (exvector::iterator self, exvector::iterator other, exvector &v)` const
Try to contract two indexed expressions that appear in the same product.

- virtual unsigned `return_type` () const
- virtual `return_type_t return_type_tinfo` () const
- virtual `ex conjugate` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const
- template<class T >
void `print_dispatch` (const `print_context` &c, unsigned level) const
Like `print()`, but dispatch to the specified class.
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const
Like `print()`, but dispatch to the specified class.
- virtual void `archive` (`archive_node` &n) const
Save (serialize) the object into archive node.
- virtual void `read_archive` (const `archive_node` &n, `lst` &syms)
Load (deserialize) the object from an archive node.
- `ex subs_one_level` (const `exmap` &m, unsigned `options`) const
Helper function for `subs()`.
- `ex diff` (const `symbol` &s, unsigned nth=1) const
Default interface of nth derivative `ex::diff(s, n)`.
- int `compare` (const `basic` &other) const
Compare objects syntactically to establish canonical ordering.
- bool `is_equal` (const `basic` &other) const
Test for syntactic equality.
- const `basic` & `hold` () const
Stop further evaluation.
- unsigned `gethash` () const
- const `basic` & `setflag` (unsigned f) const
Set some `status_flags`.
- const `basic` & `clearflag` (unsigned f) const
Clear some `status_flags`.

Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- unsigned int `add_reference` () noexcept
- unsigned int `remove_reference` () noexcept
- unsigned int `get_refcount` () const noexcept
- void `set_refcount` (unsigned int r) noexcept

Protected Member Functions

- `cln::cl_N series_coeff_impl` (int i) const override
For $\omega = d\lambda$ only the coefficient of λ^0 is non-zero.
- void `do_print` (const `print_context` &c, unsigned level) const

Protected Member Functions inherited from `GiNaC::integration_kernel`

- virtual bool `uses_Laurent_series` () const
Returns true, if the coefficients are computed from the Laurent series (in which case the method `Laurent_series` needs to be implemented).
- virtual `cln::cl_N series_coeff_impl` (int i) const
For $\omega = d\lambda$ only the coefficient of λ^0 is non-zero.
- `ex get_numerical_value_impl` (const `ex` &lambda, const `ex` &pre, int shift, int N_trunc) const
The actual implementation for computing a numerical value for the integrand.
- void `do_print` (const `print_context` &c, unsigned level) const

Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match_same_type](#) (const [basic](#) &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual [ex derivative](#) (const [symbol](#) &s) const
Default implementation of [ex::diff\(\)](#).
- virtual int [compare_same_type](#) (const [basic](#) &other) const
Returns order relation between two objects of same type.
- virtual bool [is_equal_same_type](#) (const [basic](#) &other) const
Returns true if two objects of same type are equal.
- virtual unsigned [calchash](#) () const
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- void [ensure_if_modifiable](#) () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
Default output to stream.
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
Tree output to stream.
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
Python parsable output to stream.

Protected Attributes

- [ex n](#)
- [ex z_j](#)
- [ex tau](#)
- [ex K](#)
- [ex C_norm](#)

Protected Attributes inherited from [GiNaC::integration_kernel](#)

- int [cache_step_size](#)
- [std::vector< cln::cl_N >](#) [series_vec](#)

Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)
of type [status_flags](#)
- unsigned [hashvalue](#)
hash value

6.83.1 Detailed Description

The kernel corresponding to integrating the Kronecker coefficient function $g^{(n-1)}(z - z_j, K\tau)$ in z .

This class represents the differential one-form

$$\omega_{n,K}^{\text{Kronecker},z}(z_j, \tau) = C_n (2\pi i)^{2-n} g^{(n-1)}(z - z_j, K\tau) dz$$

6.83.2 Constructor & Destructor Documentation

6.83.2.1 Kronecker_dz_kernel()

```
GiNaC::Kronecker_dz_kernel::Kronecker_dz_kernel (
    const ex & n,
    const ex & z_j,
    const ex & tau,
    const ex & K = numeric(1),
    const ex & C_norm = numeric(1) )
```

6.83.3 Member Function Documentation

6.83.3.1 nops()

```
size_t GiNaC::Kronecker_dz_kernel::nops ( ) const [override], [virtual]
```

Number of operands/members.

Reimplemented from [GiNaC::basic](#).

6.83.3.2 op()

```
ex GiNaC::Kronecker_dz_kernel::op (
    size_t i ) const [override], [virtual]
```

Return operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [C_norm](#), [K](#), [n](#), [tau](#), and [z_j](#).

6.83.3.3 let_op()

```
ex & GiNaC::Kronecker_dz_kernel::let_op (
    size_t i ) [override], [virtual]
```

Return modifiable operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [C_norm](#), [GiNaC::basic::ensure_if_modifiable\(\)](#), [K](#), [n](#), [tau](#), and [z_j](#).

6.83.3.4 is_numeric()

```
bool GiNaC::Kronecker_dz_kernel::is_numeric (
    void ) const [override], [virtual]
```

This routine returns true, if the integration kernel can be evaluated numerically.

Reimplemented from [GiNaC::integration_kernel](#).

References [C_norm](#), [GiNaC::ex::evalf\(\)](#), [GiNaC::ex::info\(\)](#), [K](#), [n](#), [GiNaC::info_flags::nonnegint](#), [GiNaC::info_flags::numeric](#), [GiNaC::info_flags::posint](#), [tau](#), and [z_j](#).

6.83.3.5 get_numerical_value()

```
ex GiNaC::Kronecker_dz_kernel::get_numerical_value (
    const ex & z,
    int N_trunc = 0 ) const [override], [virtual]
```

Returns the value of the $g^{(n-1)}(z-z_j, K \cdot \tau)$.

Reimplemented from [GiNaC::integration_kernel](#).

References [C_norm](#), [GiNaC::integration_kernel::get_numerical_value_impl\(\)](#), [GiNaC::l](#), [n](#), [GiNaC::Pi](#), and [GiNaC::pow\(\)](#).

6.83.3.6 series_coeff_impl()

```
cln::cl_N GiNaC::Kronecker_dz_kernel::series_coeff_impl (
    int i ) const [override], [protected], [virtual]
```

For $\omega = d\lambda$ only the coefficient of λ^0 is non-zero.

The i -th coefficient corresponds to the power λ^{i-1} .

Reimplemented from [GiNaC::integration_kernel](#).

References [GiNaC::bernoulli\(\)](#), [C_norm](#), [GiNaC::basic::evalf\(\)](#), [GiNaC::ex::evalf\(\)](#), [GiNaC::exp\(\)](#), [GiNaC::factorial\(\)](#), [GiNaC::Ebar_kernel::get_numerical_value\(\)](#), [GiNaC::l](#), [GiNaC::is_even\(\)](#), [K](#), [n](#), [GiNaC::Pi](#), [GiNaC::pow\(\)](#), [qbar](#), [tau](#), [GiNaC::numeric::to_int\(\)](#), and [z_j](#).

6.83.3.7 do_print()

```
void GiNaC::Kronecker_dz_kernel::do_print (
    const print_context & c,
    unsigned level ) const [protected]
```

References [c](#), [C_norm](#), [K](#), [n](#), [GiNaC::ex::print\(\)](#), [tau](#), and [z_j](#).

6.83.4 Member Data Documentation

6.83.4.1 `n`

`ex` `GiNaC::Kronecker_dz_kernel::n` [protected]

Referenced by [do_print\(\)](#), [get_numerical_value\(\)](#), [is_numeric\(\)](#), [let_op\(\)](#), [op\(\)](#), and [series_coeff_impl\(\)](#).

6.83.4.2 `z_j`

`ex` `GiNaC::Kronecker_dz_kernel::z_j` [protected]

Referenced by [do_print\(\)](#), [is_numeric\(\)](#), [let_op\(\)](#), [op\(\)](#), and [series_coeff_impl\(\)](#).

6.83.4.3 `tau`

`ex` `GiNaC::Kronecker_dz_kernel::tau` [protected]

Referenced by [do_print\(\)](#), [is_numeric\(\)](#), [let_op\(\)](#), [op\(\)](#), and [series_coeff_impl\(\)](#).

6.83.4.4 `K`

`ex` `GiNaC::Kronecker_dz_kernel::K` [protected]

Referenced by [do_print\(\)](#), [is_numeric\(\)](#), [let_op\(\)](#), [op\(\)](#), and [series_coeff_impl\(\)](#).

6.83.4.5 `C_norm`

`ex` `GiNaC::Kronecker_dz_kernel::C_norm` [protected]

Referenced by [do_print\(\)](#), [get_numerical_value\(\)](#), [is_numeric\(\)](#), [let_op\(\)](#), [op\(\)](#), and [series_coeff_impl\(\)](#).

The documentation for this class was generated from the following files:

- [integration_kernel.h](#)
- [integration_kernel.cpp](#)

6.84 GiNaC::lanczos_coeffs Class Reference

Public Member Functions

- [lanczos_coeffs](#) ()
- bool [sufficiently_accurate](#) (int digits)
- int [get_order](#) () const
- cln::cl_N [calc_lanczos_A](#) (const cln::cl_N &) const

Private Attributes

- std::vector< cln::cl_N > * [current_vector](#)

Static Private Attributes

- static std::vector< cln::cl_N > * [coeffs](#) = nullptr

6.84.1 Constructor & Destructor Documentation

6.84.1.1 lanczos_coeffs()

GiNaC::lanczos_coeffs::lanczos_coeffs ()

References [coeffs](#).

6.84.2 Member Function Documentation

6.84.2.1 sufficiently_accurate()

```
bool GiNaC::lanczos_coeffs::sufficiently_accurate (
    int digits )
```

References [coeffs](#), and [current_vector](#).

Referenced by [GiNaC::lgamma\(\)](#), and [GiNaC::tgamma\(\)](#).

6.84.2.2 `get_order()`

```
int GiNaC::lanczos_coeffs::get_order ( ) const [inline]
```

References [current_vector](#).

Referenced by [GiNaC::lgamma\(\)](#), and [GiNaC::tgamma\(\)](#).

6.84.2.3 `calc_lanczos_A()`

```
cln::cl_N GiNaC::lanczos_coeffs::calc_lanczos_A (
    const cln::cl_N & x ) const
```

References [current_vector](#), and [x](#).

Referenced by [GiNaC::lgamma\(\)](#), and [GiNaC::tgamma\(\)](#).

6.84.3 Member Data Documentation

6.84.3.1 `coeffs`

```
std::vector< cln::cl_N > * GiNaC::lanczos_coeffs::coeffs = nullptr [static], [private]
```

Referenced by [lanczos_coeffs\(\)](#), and [sufficiently_accurate\(\)](#).

6.84.3.2 `current_vector`

```
std::vector<cln::cl_N>* GiNaC::lanczos_coeffs::current_vector [private]
```

Referenced by [calc_lanczos_A\(\)](#), [get_order\(\)](#), and [sufficiently_accurate\(\)](#).

The documentation for this class was generated from the following file:

- [numeric.cpp](#)

6.85 `std::less< GiNaC::ptr< T > >` Struct Template Reference

Specialization of `std::less` for `ptr<T>` to enable ordering of `ptr<T>` objects (e.g.

```
#include <ptr.h>
```

Public Member Functions

- `bool operator()` (const `GiNaC::ptr< T >` &lhs, const `GiNaC::ptr< T >` &rhs) const

6.85.1 Detailed Description

```
template<class T>
struct std::less< GiNaC::ptr< T > >
```

Specialization of `std::less` for `ptr<T>` to enable ordering of `ptr<T>` objects (e.g.

for the use as `std::map` keys).

6.85.2 Member Function Documentation

6.85.2.1 operator()

```
template<class T >
bool std::less< GiNaC::ptr< T > >::operator() (
    const GiNaC::ptr< T > & lhs,
    const GiNaC::ptr< T > & rhs ) const [inline]
```

The documentation for this struct was generated from the following file:

- [ptr.h](#)

6.86 GiNaC::library_init Class Reference

Helper class to initialize the library.

```
#include <ex.h>
```

Public Member Functions

- `library_init()`
Ctor of static initialization helpers.
- `~library_init()`
Dtor of static initialization helpers.

Static Private Member Functions

- static void `init_unarchivers()`

Static Private Attributes

- static int [count](#) = 0

How many static objects were created? Only the first one must create the static flyweights on the heap.

6.86.1 Detailed Description

Helper class to initialize the library.

There must be one static object of this class in every object file that makes use of our flyweights in order to guarantee proper initialization. Hence we put it into this file which is included by every relevant file anyways. This is modeled after section [jos::Init] of the C++ standard, where cout and friends are set up.

See also

[utils.cpp](#)

6.86.2 Constructor & Destructor Documentation

6.86.2.1 library_init()

```
GiNaC::library_init::library_init ( )
```

Ctor of static initialization helpers.

The first call to this is going to initialize the library, the others do nothing.

References [GiNaC::_ex0](#), [GiNaC::_ex1](#), [GiNaC::_ex10](#), [GiNaC::_ex11](#), [GiNaC::_ex12](#), [GiNaC::_ex120](#), [GiNaC::_ex15](#), [GiNaC::_ex18](#), [GiNaC::_ex1_2](#), [GiNaC::_ex1_3](#), [GiNaC::_ex1_4](#), [GiNaC::_ex2](#), [GiNaC::_ex20](#), [GiNaC::_ex24](#), [GiNaC::_ex25](#), [GiNaC::_ex3](#), [GiNaC::_ex30](#), [GiNaC::_ex4](#), [GiNaC::_ex48](#), [GiNaC::_ex5](#), [GiNaC::_ex6](#), [GiNaC::_ex60](#), [GiNaC::_ex7](#), [GiNaC::_ex8](#), [GiNaC::_ex9](#), [GiNaC::_ex_1](#), [GiNaC::_ex_10](#), [GiNaC::_ex_11](#), [GiNaC::_ex_12](#), [GiNaC::_ex_120](#), [GiNaC::_ex_15](#), [GiNaC::_ex_18](#), [GiNaC::_ex_1_2](#), [GiNaC::_ex_1_3](#), [GiNaC::_ex_1_4](#), [GiNaC::_ex_2](#), [GiNaC::_ex_20](#), [GiNaC::_ex_24](#), [GiNaC::_ex_25](#), [GiNaC::_ex_3](#), [GiNaC::_ex_30](#), [GiNaC::_ex_4](#), [GiNaC::_ex_48](#), [GiNaC::_ex_5](#), [GiNaC::_ex_6](#), [GiNaC::_ex_60](#), [GiNaC::_ex_7](#), [GiNaC::_ex_8](#), [GiNaC::_ex_9](#), [GiNaC::_num0_bp](#), [GiNaC::_num0_p](#), [GiNaC::_num10_p](#), [GiNaC::_num11_p](#), [GiNaC::_num120_p](#), [GiNaC::_num12_p](#), [GiNaC::_num15_p](#), [GiNaC::_num18_p](#), [GiNaC::_num1_2_p](#), [GiNaC::_num1_3_p](#), [GiNaC::_num1_4_p](#), [GiNaC::_num1_p](#), [GiNaC::_num20_p](#), [GiNaC::_num24_p](#), [GiNaC::_num25_p](#), [GiNaC::_num2_p](#), [GiNaC::_num30_p](#), [GiNaC::_num3_p](#), [GiNaC::_num48_p](#), [GiNaC::_num4_p](#), [GiNaC::_num5_p](#), [GiNaC::_num60_p](#), [GiNaC::_num6_p](#), [GiNaC::_num7_p](#), [GiNaC::_num8_p](#), [GiNaC::_num9_p](#), [GiNaC::_num_10_p](#), [GiNaC::_num_11_p](#), [GiNaC::_num_120_p](#), [GiNaC::_num_12_p](#), [GiNaC::_num_15_p](#), [GiNaC::_num_18_p](#), [GiNaC::_num_1_2_p](#), [GiNaC::_num_1_3_p](#), [GiNaC::_num_1_4_p](#), [GiNaC::_num_1_p](#), [GiNaC::_num_20_p](#), [GiNaC::_num_24_p](#), [GiNaC::_num_25_p](#), [GiNaC::_num_2_p](#), [GiNaC::_num_30_p](#), [GiNaC::_num_3_p](#), [GiNaC::_num_48_p](#), [GiNaC::_num_4_p](#), [GiNaC::_num_5_p](#), [GiNaC::_num_60_p](#), [GiNaC::_num_6_p](#), [GiNaC::_num_7_p](#), [GiNaC::_num_8_p](#), [GiNaC::_num_9_p](#), and [count](#).

6.86.2.2 ~library_init()

```
GiNaC::library_init::~~library_init ( )
```

Dtor of static initialization helpers.

The last call to this is going to shut down the library, the others do nothing.

References [GiNaC::_ex0](#), [GiNaC::_ex1](#), [GiNaC::_ex10](#), [GiNaC::_ex11](#), [GiNaC::_ex12](#), [GiNaC::_ex120](#), [GiNaC::_ex15](#), [GiNaC::_ex18](#), [GiNaC::_ex1_2](#), [GiNaC::_ex1_3](#), [GiNaC::_ex1_4](#), [GiNaC::_ex2](#), [GiNaC::_ex20](#), [GiNaC::_ex24](#), [GiNaC::_ex25](#), [GiNaC::_ex3](#), [GiNaC::_ex30](#), [GiNaC::_ex4](#), [GiNaC::_ex48](#), [GiNaC::_ex5](#), [GiNaC::_ex6](#), [GiNaC::_ex60](#), [GiNaC::_ex7](#), [GiNaC::_ex8](#), [GiNaC::_ex9](#), [GiNaC::_ex_1](#), [GiNaC::_ex_10](#), [GiNaC::_ex_11](#), [GiNaC::_ex_12](#), [GiNaC::_ex_120](#), [GiNaC::_ex_15](#), [GiNaC::_ex_18](#), [GiNaC::_ex_1_2](#), [GiNaC::_ex_1_3](#), [GiNaC::_ex_1_4](#), [GiNaC::_ex_2](#), [GiNaC::_ex_20](#), [GiNaC::_ex_24](#), [GiNaC::_ex_25](#), [GiNaC::_ex_3](#), [GiNaC::_ex_30](#), [GiNaC::_ex_4](#), [GiNaC::_ex_48](#), [GiNaC::_ex_5](#), [GiNaC::_ex_6](#), [GiNaC::_ex_60](#), [GiNaC::_ex_7](#), [GiNaC::_ex_8](#), [GiNaC::_ex_9](#), and [count](#).

6.86.3 Member Function Documentation

6.86.3.1 init_unarchivers()

```
void GiNaC::library_init::init_unarchivers ( ) [static], [private]
```

6.86.4 Member Data Documentation

6.86.4.1 count

```
int GiNaC::library_init::count = 0 [static], [private]
```

How many static objects were created? Only the first one must create the static flyweights on the heap.

Referenced by [library_init\(\)](#), and [~library_init\(\)](#).

The documentation for this class was generated from the following files:

- [ex.h](#)
- [utils.cpp](#)

6.87 GiNaC::make_flat_inserter Class Reference

Class to handle the renaming of dummy indices.

```
#include <expairseq.h>
```

Public Member Functions

- [make_flat_inserter](#) (const [epvector](#) &epv, bool b)
- [make_flat_inserter](#) (const [exvector](#) &v, bool b)
- [ex_handle_factor](#) (const [ex](#) &x, const [ex](#) &coeff)

Private Member Functions

- void [combine_indices](#) (const [exvector](#) &dummies_of_factor)

Private Attributes

- bool [do_renaming](#)
- [exvector](#) [used_indices](#)

6.87.1 Detailed Description

Class to handle the renaming of dummy indices.

It holds a vector of indices that are being used in the expression so far. If the same index occurs again as a dummy index in a factor, it is to be renamed. Unless dummy index renaming was switched off, of course ;-)

6.87.2 Constructor & Destructor Documentation

6.87.2.1 [make_flat_inserter\(\)](#) [1/2]

```
GiNaC::make_flat_inserter::make_flat_inserter (
    const epvector & epv,
    bool b ) [inline]
```

References [GiNaC::are_ex_trivially_equal\(\)](#), [combine_indices\(\)](#), and [do_renaming](#).

6.87.2.2 [make_flat_inserter\(\)](#) [2/2]

```
GiNaC::make_flat_inserter::make_flat_inserter (
    const exvector & v,
    bool b ) [inline]
```

References [combine_indices\(\)](#), and [do_renaming](#).

6.87.3 Member Function Documentation

6.87.3.1 handle_factor()

```
ex GiNaC::make_flat_inserter::handle_factor (
    const ex & x,
    const ex & coeff ) [inline]
```

References [GiNaC::coeff\(\)](#), [combine_indices\(\)](#), [do_renaming](#), [GiNaC::get_all_dummy_indices_safely\(\)](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::rename_dummy_indices_uniquely\(\)](#), [used_indices](#), and [x](#).

Referenced by [GiNaC::ncmul::eval\(\)](#), and [GiNaC::expairseq::make_flat\(\)](#).

6.87.3.2 combine_indices()

```
void GiNaC::make_flat_inserter::combine_indices (
    const exvector & dummies_of_factor ) [inline], [private]
```

References [used_indices](#).

Referenced by [handle_factor\(\)](#), and [make_flat_inserter\(\)](#).

6.87.4 Member Data Documentation

6.87.4.1 do_renaming

```
bool GiNaC::make_flat_inserter::do_renaming [private]
```

Referenced by [handle_factor\(\)](#), and [make_flat_inserter\(\)](#).

6.87.4.2 used_indices

```
exvector GiNaC::make_flat_inserter::used_indices [private]
```

Referenced by [combine_indices\(\)](#), and [handle_factor\(\)](#).

The documentation for this class was generated from the following file:

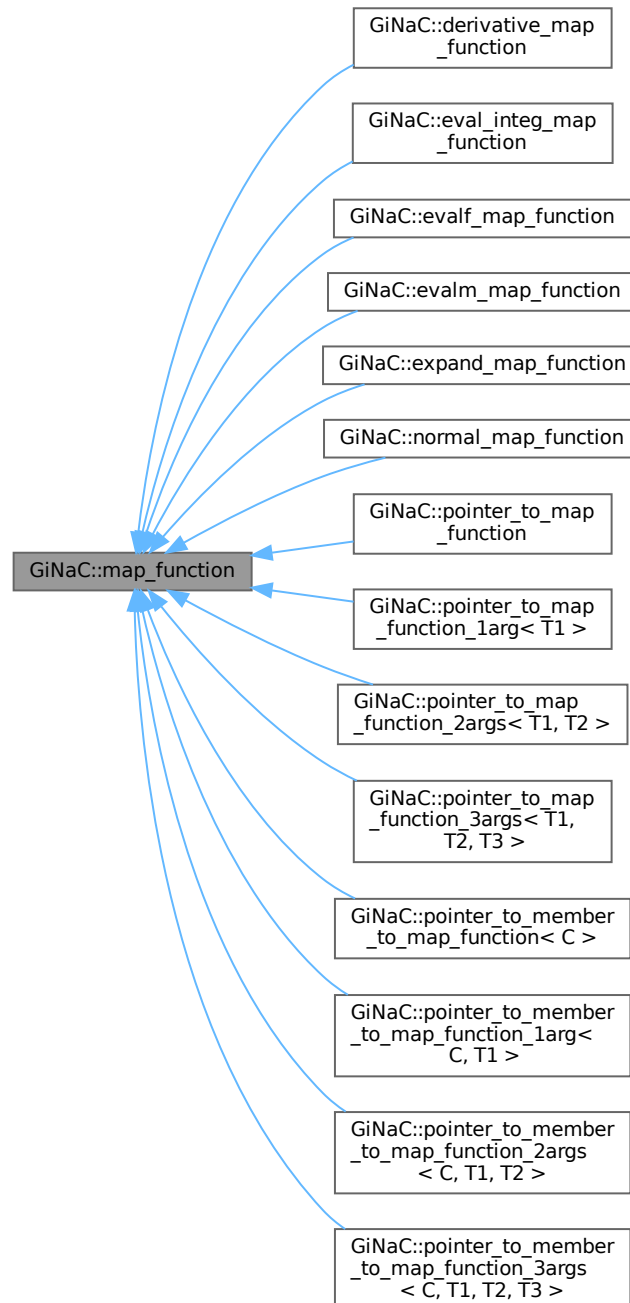
- [expairseq.h](#)

6.88 GiNaC::map_function Struct Reference

Function object for map().

```
#include <basic.h>
```

Inheritance diagram for GiNaC::map_function:



Public Types

- typedef const [ex](#) & [argument_type](#)
- typedef [ex](#) [result_type](#)

Public Member Functions

- virtual [~map_function](#) ()
- virtual [ex operator\(\)](#) (const [ex](#) &*e*)=0

6.88.1 Detailed Description

Function object for `map()`.

6.88.2 Member Typedef Documentation

6.88.2.1 `argument_type`

```
typedef const ex& GiNaC::map\_function::argument\_type
```

6.88.2.2 `result_type`

```
typedef ex GiNaC::map\_function::result\_type
```

6.88.3 Constructor & Destructor Documentation

6.88.3.1 `~map_function()`

```
virtual GiNaC::map\_function::~~map\_function ( ) [inline], [virtual]
```

6.88.4 Member Function Documentation

6.88.4.1 operator()

```
virtual ex GiNaC::map_function::operator() (
    const ex & e ) [pure virtual]
```

Implemented in [GiNaC::evalf_map_function](#), [GiNaC::evalm_map_function](#), [GiNaC::eval_integ_map_function](#), [GiNaC::derivative_map_function](#), [GiNaC::expand_map_function](#), [GiNaC::pointer_to_map_function](#), [GiNaC::pointer_to_map_function](#), [GiNaC::pointer_to_map_function_2args< T1, T2 >](#), [GiNaC::pointer_to_map_function_3args< T1, T2, T3 >](#), [GiNaC::pointer_to_member_to_map_function< C >](#), [GiNaC::pointer_to_member_to_map_function_1arg< C, T1 >](#), [GiNaC::pointer_to_member_to_map_function_2args< C, T1, T2 >](#), [GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2 >](#) and [GiNaC::normal_map_function](#).

The documentation for this struct was generated from the following file:

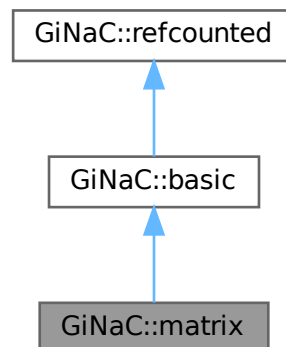
- [basic.h](#)

6.89 GiNaC::matrix Class Reference

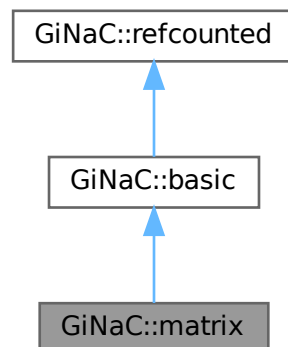
Symbolic matrices.

```
#include <matrix.h>
```

Inheritance diagram for GiNaC::matrix:



Collaboration diagram for GiNaC::matrix:



Public Member Functions

- `matrix` (unsigned `r`, unsigned `c`)
Very common ctor.
- `matrix` (unsigned `r`, unsigned `c`, const `lst` &`l`)
Construct matrix from (flat) list of elements.
- `matrix` (std::initializer_list< std::initializer_list< `ex` > > `l`)
Construct a matrix from an 2 dimensional initializer list.
- `size_t nops` () const override
nops is defined to be rows x columns.
- `ex op` (size_t `i`) const override
returns matrix entry at position (i/col, icol).
- `ex & let_op` (size_t `i`) override
returns writable matrix entry at position (i/col, icol).
- `ex evalm` () const override
Evaluate sums, products and integer powers of matrices.
- `ex subs` (const `exmap` &`m`, unsigned `options`=0) const override
Substitute a set of objects by arbitrary expressions.
- `ex eval_indexed` (const `basic` &`i`) const override
Automatic symbolic evaluation of an indexed matrix.
- `ex add_indexed` (const `ex` &`self`, const `ex` &`other`) const override
Sum of two indexed matrices.
- `ex scalar_mul_indexed` (const `ex` &`self`, const `numeric` &`other`) const override
Product of an indexed matrix with a number.
- bool `contract_with` (exvector::iterator `self`, exvector::iterator `other`, `exvector` &`v`) const override
Contraction of an indexed matrix with something else.
- `ex conjugate` () const override
Complex conjugate every matrix entry.
- `ex real_part` () const override
- `ex imag_part` () const override
- void `archive` (`archive_node` &`n`) const override

- *Save (a.k.a.*
 - void `read_archive` (const `archive_node` &n, `lst` &`syms`) override
- *Read (a.k.a.*
 - unsigned `rows` () const
- *Get number of rows.*
 - unsigned `cols` () const
- *Get number of columns.*
 - `matrix add` (const `matrix` &other) const
- *Sum of matrices.*
 - `matrix sub` (const `matrix` &other) const
- *Difference of matrices.*
 - `matrix mul` (const `matrix` &other) const
- *Product of matrices.*
 - `matrix mul` (const `numeric` &other) const
- *Product of matrix and scalar.*
 - `matrix mul_scalar` (const `ex` &other) const
- *Product of matrix and scalar expression.*
 - `matrix pow` (const `ex` &expn) const
- *Power of a matrix.*
 - const `ex` & `operator()` (unsigned ro, unsigned co) const
- *operator() to access elements for reading.*
 - `ex` & `operator()` (unsigned ro, unsigned co)
- *operator() to access elements for writing.*
 - `matrix` & `set` (unsigned ro, unsigned co, const `ex` &value)
- `matrix transpose` () const
- *Transposed of an $m \times n$ matrix, producing a new $n \times m$ matrix object that represents the transposed.*
 - `ex determinant` (unsigned algo=`determinant_algo::automatic`) const
- *Determinant of square matrix.*
 - `ex trace` () const
- *Trace of a matrix.*
 - `ex charpoly` (const `ex` &lambda) const
- *Characteristic Polynomial.*
 - `matrix inverse` () const
- *Inverse of this matrix, with automatic algorithm selection.*
 - `matrix inverse` (unsigned algo) const
- *Inverse of this matrix.*
 - `matrix solve` (const `matrix` &vars, const `matrix` &rhs, unsigned algo=`solve_algo::automatic`) const
- *Solve a linear system consisting of a $m \times n$ matrix and a $m \times p$ right hand side by applying an elimination scheme to the augmented matrix.*
 - unsigned `rank` () const
- *Compute the rank of this matrix.*
 - unsigned `rank` (unsigned `solve_algo`) const
- *Compute the rank of this matrix using the given algorithm, which should be a member of enum `solve_algo`.*
 - bool `is_zero_matrix` () const
- *Function to check that all elements of the matrix are zero.*

Public Member Functions inherited from [GiNaC::basic](#)

- virtual [~basic](#) ()
basic destructor, virtual because class ex will delete objects of derived classes via a basic.*
- [basic](#) (const [basic](#) &other)
- const [basic](#) & [operator=](#) (const [basic](#) &other)
basic assignment operator: the other object might be of a derived class.
- virtual [basic](#) * [duplicate](#) () const
Create a clone of this object on the heap.
- virtual [ex eval](#) () const
Perform automatic non-interruptive term rewriting rules.
- virtual [ex evalf](#) () const
Evaluate object numerically.
- virtual [ex evalm](#) () const
Evaluate sums, products and integer powers of matrices.
- virtual [ex eval_integ](#) () const
Evaluate integrals, if result is known.
- virtual [ex eval_indexed](#) (const [basic](#) &i) const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void [print](#) (const [print_context](#) &c, unsigned level=0) const
Output to stream.
- virtual void [dbgprint](#) () const
Little wrapper around print to be called within a debugger.
- virtual void [dbgprinttree](#) () const
Little wrapper around printtree to be called within a debugger.
- virtual unsigned [precedence](#) () const
Return relative operator precedence (for parenthezing output).
- virtual bool [info](#) (unsigned inf) const
Information about the object.
- virtual size_t [nops](#) () const
Number of operands/members.
- virtual [ex op](#) (size_t i) const
Return operand/member at position i.
- virtual [ex operator\[\]](#) (const [ex](#) &index) const
- virtual [ex operator\[\]](#) (size_t i) const
- virtual [ex](#) & [let_op](#) (size_t i)
Return modifiable operand/member at position i.
- virtual [ex](#) & [operator\[\]](#) (const [ex](#) &index)
- virtual [ex](#) & [operator\[\]](#) (size_t i)
- virtual bool [has](#) (const [ex](#) &other, unsigned [options](#)=0) const
Test for occurrence of a pattern.
- virtual bool [match](#) (const [ex](#) &pattern, [exmap](#) &repls) const
Check whether the expression matches a given pattern.
- virtual [ex subs](#) (const [exmap](#) &m, unsigned [options](#)=0) const
Substitute a set of objects by arbitrary expressions.
- virtual [ex map](#) ([map_function](#) &f) const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void [accept](#) ([GiNaC::visitor](#) &v) const
- virtual bool [is_polynomial](#) (const [ex](#) &var) const
Check whether this is a polynomial in the given variables.
- virtual int [degree](#) (const [ex](#) &s) const

- Return degree of highest power in object s.*

 - virtual int `ldegree` (const `ex` &s) const
- Return degree of lowest power in object s.*

 - virtual `ex coeff` (const `ex` &s, int `n`=1) const
- Return coefficient of degree n in object s.*

 - virtual `ex expand` (unsigned `options`=0) const
- Expand expression, i.e.*

 - virtual `ex collect` (const `ex` &s, bool `distributed`=false) const
- Sort expanded expression in terms of powers of some object(s).*

 - virtual `ex series` (const `relational` &r, int `order`, unsigned `options`=0) const
- Default implementation of `ex::series()`.*

 - virtual `ex normal` (`exmap` &repl, `exmap` &rev_lookup, `lst` &modifier) const
- Default implementation of `ex::normal()`.*

 - virtual `ex to_rational` (`exmap` &repl) const
- Default implementation of `ex::to_rational()`.*

 - virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const
- Apply symmetric modular homomorphism to an expanded multivariate polynomial.*

 - virtual `numeric max_coefficient` () const
- Implementation `ex::max_coefficient()`.*

 - virtual `exvector get_free_indices` () const
- Return a vector containing the free indices of an expression.*

 - virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
- Add two indexed expressions.*

 - virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
- Multiply an indexed expression with a scalar.*

 - virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const
- Try to contract two indexed expressions that appear in the same product.*

 - virtual unsigned `return_type` () const
 - virtual `return_type_t return_type_tinfo` () const
 - virtual `ex conjugate` () const
 - virtual `ex real_part` () const
 - virtual `ex imag_part` () const
- template<class T >

 - void `print_dispatch` (const `print_context` &c, unsigned `level`) const
- Like `print()`, but dispatch to the specified class.*

 - void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned `level`) const
- Like `print()`, but dispatch to the specified class.*

 - virtual void `archive` (`archive_node` &n) const
- Save (serialize) the object into archive node.*

 - virtual void `read_archive` (const `archive_node` &n, `lst` &syms)
- Load (deserialize) the object from an archive node.*

 - `ex subs_one_level` (const `exmap` &m, unsigned `options`) const
- Helper function for `subs()`.*

 - `ex diff` (const `symbol` &s, unsigned `nth`=1) const
- Default interface of nth derivative `ex::diff(s, n)`.*

 - int `compare` (const `basic` &other) const
- Compare objects syntactically to establish canonical ordering.*

 - bool `is_equal` (const `basic` &other) const
- Test for syntactic equality.*

- const [basic](#) & [hold](#) () const
Stop further evaluation.
- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const
Set some [status_flags](#).
- const [basic](#) & [clearflag](#) (unsigned f) const
Clear some [status_flags](#).

Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add_reference](#) () noexcept
- unsigned int [remove_reference](#) () noexcept
- unsigned int [get_refcount](#) () const noexcept
- void [set_refcount](#) (unsigned int r) noexcept

Protected Member Functions

- [matrix](#) (unsigned r, unsigned c, const [exvector](#) &m2)
Ctor from representation, for internal use only.
- [matrix](#) (unsigned r, unsigned c, [exvector](#) &&m2)
- bool [match_same_type](#) (const [basic](#) &other) const override
Returns true if the attributes of two objects are similar enough for a match.
- unsigned [return_type](#) () const override
- [ex_determinant_minor](#) () const
Recursive determinant for small matrices having at least one symbolic entry.
- std::vector< unsigned > [echelon_form](#) (unsigned algo, int n)
- int [gauss_elimination](#) (const bool det=false)
Perform the steps of an ordinary Gaussian elimination to bring the m x n matrix into an upper echelon form.
- int [division_free_elimination](#) (const bool det=false)
Perform the steps of division free elimination to bring the m x n matrix into an upper echelon form.
- int [fraction_free_elimination](#) (const bool det=false)
Perform the steps of Bareiss' one-step fraction free elimination to bring the matrix into an upper echelon form.
- std::vector< unsigned > [markowitz_elimination](#) (unsigned n)
- int [pivot](#) (unsigned ro, unsigned co, bool symbolic=true)
Partial pivoting method for matrix elimination schemes.
- void [print_elements](#) (const [print_context](#) &c, const char *row_start, const char *row_end, const char *row←
_sep, const char *col_sep) const
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
- void [do_print_latex](#) (const [print_latex](#) &c, unsigned level) const
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const

Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match_same_type](#) (const [basic](#) &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual [ex derivative](#) (const [symbol](#) &s) const
Default implementation of [ex::diff\(\)](#).
- virtual int [compare_same_type](#) (const [basic](#) &other) const
Returns order relation between two objects of same type.
- virtual bool [is_equal_same_type](#) (const [basic](#) &other) const
Returns true if two objects of same type are equal.
- virtual unsigned [calchash](#) () const
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- void [ensure_if_modifiable](#) () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
Default output to stream.
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
Tree output to stream.
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
Python parsable output to stream.

Protected Attributes

- unsigned [row](#)
number of rows
- unsigned [col](#)
number of columns
- [exvector](#) m
representation (cols indexed first)

Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)
of type [status_flags](#)
- unsigned [hashvalue](#)
hash value

6.89.1 Detailed Description

Symbolic matrices.

6.89.2 Constructor & Destructor Documentation

6.89.2.1 matrix() [1/5]

```
GiNaC::matrix::matrix (
    unsigned r,
    unsigned c )
```

Very common ctor.

Initializes to r x c-dimensional zero-matrix.

Parameters

<i>r</i>	number of rows
<i>c</i>	number of cols

References [GiNaC::_ex0](#), [GiNaC::status_flags::not_shareable](#), and [GiNaC::basic::setflag\(\)](#).

6.89.2.2 matrix() [2/5]

```
GiNaC::matrix::matrix (
    unsigned r,
    unsigned c,
    const lst & l )
```

Construct matrix from (flat) list of elements.

If the list has fewer elements than the matrix, the remaining matrix elements are set to zero. If the list has more elements than the matrix, the excessive elements are thrown away.

References [c](#), [m](#), [GiNaC::status_flags::not_shareable](#), [r](#), [GiNaC::basic::setflag\(\)](#), and [x](#).

6.89.2.3 matrix() [3/5]

```
GiNaC::matrix::matrix (
    std::initializer_list< std::initializer_list< ex > > l )
```

Construct a matrix from an 2 dimensional initializer list.

Throws an exception if some row has a different length than all the others.

References [c](#), [col](#), [m](#), [GiNaC::status_flags::not_shareable](#), [r](#), [row](#), and [GiNaC::basic::setflag\(\)](#).

6.89.2.4 matrix() [4/5]

```
GiNaC::matrix::matrix (
    unsigned r,
    unsigned c,
    const exvector & m2 ) [protected]
```

Ctor from representation, for internal use only.

References [GiNaC::status_flags::not_shareable](#), and [GiNaC::basic::setflag\(\)](#).

6.89.2.5 matrix() [5/5]

```
GiNaC::matrix::matrix (
    unsigned r,
    unsigned c,
    exvector && m2 ) [protected]
```

References [GiNaC::status_flags::not_shareable](#), and [GiNaC::basic::setflag\(\)](#).

6.89.3 Member Function Documentation

6.89.3.1 nops()

```
size_t GiNaC::matrix::nops ( ) const [override], [virtual]
```

nops is defined to be rows x columns.

Reimplemented from [GiNaC::basic](#).

References [col](#), and [row](#).

Referenced by [let_op\(\)](#), and [op\(\)](#).

6.89.3.2 op()

```
ex GiNaC::matrix::op (
    size_t i ) const [override], [virtual]
```

returns matrix entry at position (i/col, icol).

Reimplemented from [GiNaC::basic](#).

References [GINAC_ASSERT](#), [m](#), and [nops\(\)](#).

Referenced by [contract_with\(\)](#).

6.89.3.3 let_op()

```
ex & GiNaC::matrix::let_op (
    size_t i ) [override], [virtual]
```

returns writable matrix entry at position (i/col, icol).

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ensure_if_modifiable\(\)](#), [GINAC_ASSERT](#), [m](#), and [nops\(\)](#).

6.89.3.4 evalm()

```
ex GiNaC::matrix::evalm ( ) const [inline], [override], [virtual]
```

Evaluate sums, products and integer powers of matrices.

Reimplemented from [GiNaC::basic](#).

6.89.3.5 subs()

```
ex GiNaC::matrix::subs (
    const exmap & m,
    unsigned options = 0 ) const [override], [virtual]
```

Substitute a set of objects by arbitrary expressions.

The ex returned will already be evaluated.

Reimplemented from [GiNaC::basic](#).

References [c](#), [col](#), [m](#), [options](#), [r](#), [row](#), [subs\(\)](#), and [GiNaC::basic::subs_one_level\(\)](#).

Referenced by [fraction_free_elimination\(\)](#), and [subs\(\)](#).

6.89.3.6 eval_indexed()

```
ex GiNaC::matrix::eval_indexed (
    const basic & i ) const [override], [virtual]
```

Automatic symbolic evaluation of an indexed matrix.

Reimplemented from [GiNaC::basic](#).

References [col](#), [GiNaC::idx::get_dim\(\)](#), [GiNaC::idx::get_value\(\)](#), [GINAC_ASSERT](#), [GiNaC::basic::hold\(\)](#), [GiNaC::is_dummy_pair\(\)](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::info_flags::nonnegint](#), [GiNaC::basic::nops\(\)](#), [GiNaC::basic::op\(\)](#), [row](#), and [trace\(\)](#).

6.89.3.7 add_indexed()

```
ex GiNaC::matrix::add_indexed (
    const ex & self,
    const ex & other ) const [override], [virtual]
```

Sum of two indexed matrices.

Reimplemented from [GiNaC::basic](#).

References [add\(\)](#), [col](#), [GINAC_ASSERT](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), [row](#), and [transpose\(\)](#).

6.89.3.8 scalar_mul_indexed()

```
ex GiNaC::matrix::scalar_mul_indexed (
    const ex & self,
    const numeric & other ) const [override], [virtual]
```

Product of an indexed matrix with a number.

Reimplemented from [GiNaC::basic](#).

References [GINAC_ASSERT](#), [mul\(\)](#), [GiNaC::ex::nops\(\)](#), and [GiNaC::ex::op\(\)](#).

6.89.3.9 contract_with()

```
bool GiNaC::matrix::contract_with (
    exvector::iterator self,
    exvector::iterator other,
    exvector & v ) const [override], [virtual]
```

Contraction of an indexed matrix with something else.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex1](#), [col](#), [GINAC_ASSERT](#), [GiNaC::is_dummy_pair\(\)](#), [mul\(\)](#), [GiNaC::ex::op\(\)](#), [op\(\)](#), [row](#), and [transpose\(\)](#).

6.89.3.10 conjugate()

```
ex GiNaC::matrix::conjugate ( ) const [override], [virtual]
```

Complex conjugate every matrix entry.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::are_ex_trivially_equal\(\)](#), [col](#), [m](#), [row](#), and [x](#).

6.89.3.11 real_part()

```
ex GiNaC::matrix::real_part ( ) const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [col](#), [m](#), and [row](#).

6.89.3.12 imag_part()

```
ex GiNaC::matrix::imag_part ( ) const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [col](#), [m](#), and [row](#).

6.89.3.13 archive()

```
void GiNaC::matrix::archive (
    archive_node & n ) const [override], [virtual]
```

Save (a.k.a.

serialize) object into archive.

Reimplemented from [GiNaC::basic](#).

References [col](#), [m](#), [n](#), and [row](#).

6.89.3.14 read_archive()

```
void GiNaC::matrix::read_archive (
    const archive_node & n,
    lst & syms ) [override], [virtual]
```

Read (a.k.a.

deserialize) object from archive.

Reimplemented from [GiNaC::basic](#).

References [col](#), [m](#), [n](#), and [row](#).

6.89.3.15 match_same_type()

```
bool GiNaC::matrix::match_same_type (
    const basic & other ) const [override], [protected], [virtual]
```

Returns true if the attributes of two objects are similar enough for a match.

This function must not match subexpressions (this is already done by [basic::match\(\)](#)). Only attributes not accessible by [op\(\)](#) should be compared. This is also the reason why this function doesn't take the wildcard replacement list from [match\(\)](#) as an argument: only subexpressions are subject to wildcard matches. Also, this function only needs to be implemented for container classes because [is_equal_same_type\(\)](#) is automatically used instead of [match_same_type\(\)](#) if [nops\(\)](#) == 0.

See also

[basic::match](#)

Reimplemented from [GiNaC::basic](#).

References [col](#), [cols\(\)](#), [GINAC_ASSERT](#), [row](#), and [rows\(\)](#).

6.89.3.16 return_type()

```
unsigned GiNaC::matrix::return_type ( ) const [inline], [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::return_types::noncommutative](#).

6.89.3.17 rows()

```
unsigned GiNaC::matrix::rows ( ) const [inline]
```

Get number of rows.

References [row](#).

Referenced by [division_free_elimination\(\)](#), [fraction_free_elimination\(\)](#), [gauss_elimination\(\)](#), [GiNaC::lsolve\(\)](#), [match_same_type\(\)](#), [mul\(\)](#), [solve\(\)](#), and [transpose\(\)](#).

6.89.3.18 cols()

```
unsigned GiNaC::matrix::cols ( ) const [inline]
```

Get number of columns.

References [col](#).

Referenced by [determinant_minor\(\)](#), [division_free_elimination\(\)](#), [fraction_free_elimination\(\)](#), [gauss_elimination\(\)](#), [GiNaC::lsolve\(\)](#), [match_same_type\(\)](#), [mul\(\)](#), [solve\(\)](#), and [transpose\(\)](#).

6.89.3.19 add()

```
matrix GiNaC::matrix::add (
    const matrix & other ) const
```

Sum of matrices.

Exceptions

<i>logic_error</i>	(incompatible matrices)
--------------------	-------------------------

References [col](#), [m](#), and [row](#).

Referenced by [add_indexed\(\)](#), and [GiNaC::add::evalm\(\)](#).

6.89.3.20 sub()

```
matrix GiNaC::matrix::sub (
    const matrix & other ) const
```

Difference of matrices.

Exceptions

<i>logic_error</i>	(incompatible matrices)
--------------------	-------------------------

References [col](#), [m](#), and [row](#).

6.89.3.21 mul() [1/2]

```
matrix GiNaC::matrix::mul (
    const matrix & other ) const
```

Product of matrices.

Exceptions

<i>logic_error</i>	(incompatible matrices)
--------------------	-------------------------

References [c](#), [col](#), [cols\(\)](#), [GiNaC::is_zero\(\)](#), [m](#), [row](#), and [rows\(\)](#).

Referenced by [charpoly\(\)](#), [contract_with\(\)](#), [GiNaC::ncmul::evalm\(\)](#), [pow\(\)](#), and [scalar_mul_indexed\(\)](#).

6.89.3.22 mul() [2/2]

```
matrix GiNaC::matrix::mul (
    const numeric & other ) const
```

Product of matrix and scalar.

References [c](#), [col](#), [m](#), [r](#), and [row](#).

6.89.3.23 mul_scalar()

```
matrix GiNaC::matrix::mul_scalar (
    const ex & other ) const
```

Product of matrix and scalar expression.

References [c](#), [col](#), [GiNaC::return_types::commutative](#), [m](#), [r](#), [GiNaC::ex::return_type\(\)](#), and [row](#).

6.89.3.24 pow()

```
matrix GiNaC::matrix::pow (
    const ex & expn ) const
```

Power of a matrix.

Currently handles integer exponents only.

References [GiNaC::_ex1](#), [GiNaC::_num1_p](#), [GiNaC::_num2_p](#), [col](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::integer](#), [inverse\(\)](#), [GiNaC::numeric::is_odd\(\)](#), [GiNaC::numeric::is_zero\(\)](#), [mul\(\)](#), [GiNaC::info_flags::negative](#), [r](#), and [row](#).

6.89.3.25 operator>() [1/2]

```
const ex & GiNaC::matrix::operator() (
    unsigned ro,
    unsigned co ) const
```

`operator()` to access elements for reading.

Parameters

<i>ro</i>	row of element
<i>co</i>	column of element

Exceptions

<i>range_error</i>	(index out of range)
--------------------	----------------------

References [col](#), [m](#), and [row](#).

6.89.3.26 operator>() [2/2]

```
ex & GiNaC::matrix::operator() (
    unsigned ro,
    unsigned co )
```

`operator()` to access elements for writing.

Parameters

<i>ro</i>	row of element
<i>co</i>	column of element

Exceptions

<code>range_error</code>	(index out of range)
--------------------------	----------------------

References [col](#), [GiNaC::basic::ensure_if_modifiable\(\)](#), [m](#), and [row](#).

6.89.3.27 set()

```
matrix & GiNaC::matrix::set (
    unsigned ro,
    unsigned co,
    const ex & value ) [inline]
```

References [value](#).

6.89.3.28 transpose()

```
matrix GiNaC::matrix::transpose ( ) const
```

Transposed of an m x n matrix, producing a new n x m matrix object that represents the transposed.

References [c](#), [cols\(\)](#), [m](#), [r](#), and [rows\(\)](#).

Referenced by [add_indexed\(\)](#), and [contract_with\(\)](#).

6.89.3.29 determinant()

```
ex GiNaC::matrix::determinant (
    unsigned algo = determinant_algo::automatic ) const
```

Determinant of square matrix.

This routine doesn't actually calculate the determinant, it only implements some heuristics about which algorithm to run. If all the elements of the matrix are elements of an integral domain the determinant is also in that integral domain and the result is expanded only. If one or more elements are from a quotient field the determinant is usually also in that quotient field and the result is normalized before it is returned. This implies that the determinant of the symbolic 2x2 matrix $\begin{bmatrix} a/(a-b) & 1 \\ b/(a-b) & 1 \end{bmatrix}$ is returned as unity. (In this respect, it behaves like MapleV and unlike Mathematica.)

Parameters

<code>algo</code>	allows to chose an algorithm
-------------------	------------------------------

Returns

the determinant as a new expression

Exceptions

<i>logic_error</i>	(matrix not square)
--------------------	---------------------

See also

[determinant_algo](#)

References [GiNaC::_ex0](#), [GiNaC::determinant_algo::automatic](#), [GiNaC::determinant_algo::bareiss](#), [c](#), [col](#), [GiNaC::info_flags::crational_polynomial](#), [determinant_minor\(\)](#), [GiNaC::determinant_algo::divfree](#), [division_free_elimination\(\)](#), [fraction_free_elimination\(\)](#), [GiNaC::determinant_algo::gauss](#), [gauss_elimination\(\)](#), [GINAC_ASSERT](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is_zero\(\)](#), [GiNaC::is_zero\(\)](#), [GiNaC::determinant_algo::laplace](#), [m](#), [GiNaC::ex::normal\(\)](#), [GiNaC::info_flags::numeric](#), [GiNaC::permutation_sign\(\)](#), [r](#), [GiNaC::info_flags::rational_function](#), and [row](#).

Referenced by [charpoly\(\)](#), and [GiNaC::tensepsilon::contract_with\(\)](#).

6.89.3.30 trace()

```
ex GiNaC::matrix::trace ( ) const
```

Trace of a matrix.

The result is normalized if it is in some quotient field and expanded only otherwise. This implies that the trace of the symbolic 2x2 matrix $\begin{bmatrix} a/(a-b), x \\ y, b/(b-a) \end{bmatrix}$ is recognized to be unity.

Returns

the sum of diagonal elements

Exceptions

<i>logic_error</i>	(matrix not square)
--------------------	---------------------

References [col](#), [GiNaC::info_flags::crational_polynomial](#), [GiNaC::ex::expand\(\)](#), [GiNaC::ex::info\(\)](#), [m](#), [GiNaC::ex::normal\(\)](#), [r](#), [GiNaC::info_flags::rational_function](#), and [row](#).

Referenced by [charpoly\(\)](#), and [eval_indexed\(\)](#).

6.89.3.31 charpoly()

```
ex GiNaC::matrix::charpoly (
    const ex & lambda ) const
```

Characteristic Polynomial.

Following mathematica notation the characteristic polynomial of a matrix M is defined as the determinant of $(M - \lambda * 1)$ where 1 stands for the unit matrix of the same dimension as M . Note that some CASs define it with a sign inside the determinant which gives rise to an overall sign if the dimension is odd. This method returns the characteristic polynomial collected in powers of λ as a new expression.

Returns

characteristic polynomial as new expression

Exceptions

<i>logic_error</i>	(matrix not square)
--------------------	---------------------

See also

[matrix::determinant\(\)](#)

References [c](#), [col](#), [GiNaC::ex::collect\(\)](#), [determinant\(\)](#), [GiNaC::basic::ex](#), [m](#), [mul\(\)](#), [GiNaC::info_flags::numeric](#), [poly](#), [r](#), [row](#), and [trace\(\)](#).

6.89.3.32 `inverse()` [1/2]

```
matrix GiNaC::matrix::inverse ( ) const
```

Inverse of this matrix, with automatic algorithm selection.

References [GiNaC::solve_algo::automatic](#), and [inverse\(\)](#).

Referenced by [inverse\(\)](#), and [pow\(\)](#).

6.89.3.33 `inverse()` [2/2]

```
matrix GiNaC::matrix::inverse (
    unsigned algo ) const
```

Inverse of this matrix.

Parameters

<i>algo</i>	selects the algorithm (one of solve_algo)
-------------	--

Returns

the inverted matrix

Exceptions

<i>logic_error</i>	(matrix not square)
<i>runtime_error</i>	(singular matrix)

References [GiNaC::_ex1](#), [c](#), [col](#), [r](#), [row](#), and [solve\(\)](#).

6.89.3.34 solve()

```
matrix GiNaC::matrix::solve (
    const matrix & vars,
    const matrix & rhs,
    unsigned algo = solve_algo::automatic ) const
```

Solve a linear system consisting of a $m \times n$ matrix and a $m \times p$ right hand side by applying an elimination scheme to the augmented matrix.

Parameters

<i>vars</i>	$n \times p$ matrix, all elements must be symbols
<i>rhs</i>	$m \times p$ matrix
<i>algo</i>	selects the solving algorithm

Returns

$n \times p$ solution matrix

Exceptions

<i>logic_error</i>	(incompatible matrices)
<i>invalid_argument</i>	(1st argument must be matrix of symbols)
<i>runtime_error</i>	(inconsistent linear system)

See also

[solve_algo](#)

References [c](#), [cols\(\)](#), [echelon_form\(\)](#), [GiNaC::basic::info\(\)](#), [m](#), [n](#), [GiNaC::basic::normal\(\)](#), [r](#), [GiNaC::rhs\(\)](#), [rows\(\)](#), and [GiNaC::info_flags::symbol](#).

Referenced by [inverse\(\)](#), [GiNaC::lsolve\(\)](#), and [GiNaC::sqrfree_parfrac\(\)](#).

6.89.3.35 rank() [1/2]

```
unsigned GiNaC::matrix::rank ( ) const
```

Compute the rank of this matrix.

References [GiNaC::solve_algo::automatic](#), and [rank\(\)](#).

Referenced by [rank\(\)](#).

6.89.3.36 rank() [2/2]

```
unsigned GiNaC::matrix::rank (
    unsigned solve_algo ) const
```

Compute the rank of this matrix using the given algorithm, which should be a member of enum [solve_algo](#).

References [col](#), [echelon_form\(\)](#), [GINAC_ASSERT](#), [m](#), [r](#), and [row](#).

6.89.3.37 is_zero_matrix()

```
bool GiNaC::matrix::is_zero_matrix ( ) const
```

Function to check that all elements of the matrix are zero.

References [m](#).

6.89.3.38 determinant_minor()

```
ex GiNaC::matrix::determinant_minor ( ) const [protected]
```

Recursive determinant for small matrices having at least one symbolic entry.

The basic algorithm, known as Laplace-expansion, is enhanced by some bookkeeping to avoid calculation of the same submatrices ("minors") more than once. According to W.M.Gentleman and S.C.Johnson this algorithm is better than elimination schemes for matrices of sparse multivariate polynomials and also for matrices of dense univariate polynomials if the matrix' dimension is larger than 7.

Returns

the determinant as a new expression (in expanded form)

See also

[matrix::determinant\(\)](#)

References [GiNaC::_ex0](#), [GiNaC::_ex1](#), [c](#), [cols\(\)](#), [GiNaC::ex::expand\(\)](#), [GiNaC::ex::is_zero\(\)](#), [GiNaC::is_zero\(\)](#), [m](#), [n](#), and [r](#).

Referenced by [determinant\(\)](#).

6.89.3.39 echelon_form()

```
std::vector< unsigned > GiNaC::matrix::echelon_form (
    unsigned algo,
    int n ) [protected]
```

References [GiNaC::solve_algo::automatic](#), [GiNaC::solve_algo::bareiss](#), [c](#), [col](#), [GiNaC::solve_algo::divfree](#), [division_free_elimination\(\)](#), [fraction_free_elimination\(\)](#), [GiNaC::solve_algo::gauss](#), [gauss_elimination\(\)](#), [m](#), [GiNaC::solve_algo::markowitz](#), [markowitz_elimination\(\)](#), [n](#), [GiNaC::info_flags::numeric](#), [r](#), and [row](#).

Referenced by [rank\(\)](#), and [solve\(\)](#).

6.89.3.40 gauss_elimination()

```
int GiNaC::matrix::gauss_elimination (
    const bool det = false ) [protected]
```

Perform the steps of an ordinary Gaussian elimination to bring the m x n matrix into an upper echelon form.

The algorithm is ok for matrices with numeric coefficients but quite unsuited for symbolic matrices.

Parameters

<i>det</i>	may be set to true to save a lot of space if one is only interested in the diagonal elements (i.e. for calculating determinants). The others are set to zero in this case.
------------	--

Returns

sign is 1 if an even number of rows was swapped, -1 if an odd number of rows was swapped and 0 if the matrix is singular.

References [GiNaC::ex0](#), [c](#), [cols\(\)](#), [GiNaC::basic::ensure_if_modifiable\(\)](#), [GINAC_ASSERT](#), [GiNaC::basic::info\(\)](#), [GiNaC::is_zero\(\)](#), [m](#), [n](#), [GiNaC::ex::normal\(\)](#), [GiNaC::info_flags::numeric](#), [pivot\(\)](#), [r](#), and [rows\(\)](#).

Referenced by [determinant\(\)](#), and [echelon_form\(\)](#).

6.89.3.41 division_free_elimination()

```
int GiNaC::matrix::division_free_elimination (
    const bool det = false ) [protected]
```

Perform the steps of division free elimination to bring the m x n matrix into an upper echelon form.

Parameters

<i>det</i>	may be set to true to save a lot of space if one is only interested in the diagonal elements (i.e. for calculating determinants). The others are set to zero in this case.
------------	--

Returns

sign is 1 if an even number of rows was swapped, -1 if an odd number of rows was swapped and 0 if the matrix is singular.

References [GiNaC::_ex0](#), [c](#), [cols\(\)](#), [GiNaC::basic::ensure_if_modifiable\(\)](#), [GINAC_ASSERT](#), [m](#), [n](#), [pivot\(\)](#), [r](#), and [rows\(\)](#).

Referenced by [determinant\(\)](#), and [echelon_form\(\)](#).

6.89.3.42 fraction_free_elimination()

```
int GiNaC::matrix::fraction_free_elimination (
    const bool det = false ) [protected]
```

Perform the steps of Bareiss' one-step fraction free elimination to bring the matrix into an upper echelon form.

Fraction free elimination means that divide is used straightforwardly, without computing GCDs first. This is possible, since we know the divisor at each step.

Parameters

<i>det</i>	may be set to true to save a lot of space if one is only interested in the last element (i.e. for calculating determinants). The others are set to zero in this case.
------------	---

Returns

sign is 1 if an even number of rows was swapped, -1 if an odd number of rows was swapped and 0 if the matrix is singular.

References [GiNaC::_ex0](#), [GiNaC::_ex1](#), [c](#), [cols\(\)](#), [GiNaC::divide\(\)](#), [GiNaC::basic::ensure_if_modifiable\(\)](#), [GiNaC::basic::expand\(\)](#), [GINAC_ASSERT](#), [GiNaC::is_zero\(\)](#), [m](#), [n](#), [GiNaC::subs_options::no_pattern](#), [GiNaC::ex::normal\(\)](#), [GiNaC::ex::numer_denom\(\)](#), [GiNaC::ex::op\(\)](#), [r](#), [rows\(\)](#), [subs\(\)](#), and [GiNaC::ex::to_rational\(\)](#).

Referenced by [determinant\(\)](#), and [echelon_form\(\)](#).

6.89.3.43 markowitz_elimination()

```
std::vector< unsigned > GiNaC::matrix::markowitz_elimination (
    unsigned n ) [protected]
```

References [GiNaC::_ex0](#), [c](#), [col](#), [GINAC_ASSERT](#), [GiNaC::ex::is_zero\(\)](#), [GiNaC::is_zero\(\)](#), [k](#), [m](#), [n](#), [GiNaC::basic::normal\(\)](#), [r](#), [row](#), and [std::swap\(\)](#).

Referenced by [echelon_form\(\)](#).

6.89.3.44 pivot()

```
int GiNaC::matrix::pivot (
    unsigned ro,
    unsigned co,
    bool symbolic = true ) [protected]
```

Partial pivoting method for matrix elimination schemes.

Usual pivoting (`symbolic==false`) returns the index to the element with the largest absolute value in column `ro` and swaps the current row with the one where the element was found. With (`symbolic==true`) it does the same thing with the first non-zero element.

Parameters

<i>ro</i>	is the row from where to begin
<i>co</i>	is the column to be inspected
<i>symbolic</i>	signal if we want the first non-zero element to be pivoted (true) or the one with the largest absolute value (false).

Returns

0 if no interchange occurred, -1 if all are zero (usually signaling a degeneracy) and positive integer `k` means that rows `ro` and `k` were swapped.

References [GiNaC::abs\(\)](#), [c](#), [col](#), [GiNaC::basic::ensure_if_modifiable\(\)](#), [GiNaC::basic::expand\(\)](#), [GINAC_ASSERT](#), [GiNaC::numeric::is_zero\(\)](#), [GiNaC::is_zero\(\)](#), [k](#), [m](#), [row](#), and [GiNaC::swap\(\)](#).

Referenced by [division_free_elimination\(\)](#), and [gauss_elimination\(\)](#).

6.89.3.45 print_elements()

```
void GiNaC::matrix::print_elements (
    const print_context & c,
    const char * row_start,
    const char * row_end,
    const char * row_sep,
    const char * col_sep ) const [protected]
```

References [c](#), [col](#), [m](#), and [row](#).

Referenced by [do_print\(\)](#), [do_print_latex\(\)](#), and [do_print_python_repr\(\)](#).

6.89.3.46 do_print()

```
void GiNaC::matrix::do_print (
    const print_context & c,
    unsigned level ) const [protected]
```

References [c](#), and [print_elements\(\)](#).

6.89.3.47 do_print_latex()

```
void GiNaC::matrix::do_print_latex (
    const print\_latex & c,
    unsigned level ) const [protected]
```

References [c](#), [col](#), and [print_elements\(\)](#).

6.89.3.48 do_print_python_repr()

```
void GiNaC::matrix::do_print_python_repr (
    const print\_python\_repr & c,
    unsigned level ) const [protected]
```

References [c](#), and [print_elements\(\)](#).

6.89.4 Member Data Documentation

6.89.4.1 row

```
unsigned GiNaC::matrix::row [protected]
```

number of rows

Referenced by [add\(\)](#), [add_indexed\(\)](#), [archive\(\)](#), [charpoly\(\)](#), [conjugate\(\)](#), [contract_with\(\)](#), [determinant\(\)](#), [echelon_form\(\)](#), [eval_indexed\(\)](#), [imag_part\(\)](#), [inverse\(\)](#), [markowitz_elimination\(\)](#), [match_same_type\(\)](#), [matrix\(\)](#), [mul\(\)](#), [mul_scalar\(\)](#), [nops\(\)](#), [operator\(\)\(\)](#), [pivot\(\)](#), [pow\(\)](#), [print_elements\(\)](#), [rank\(\)](#), [read_archive\(\)](#), [real_part\(\)](#), [rows\(\)](#), [sub\(\)](#), [subs\(\)](#), and [trace\(\)](#).

6.89.4.2 col

```
unsigned GiNaC::matrix::col [protected]
```

number of columns

Referenced by [add\(\)](#), [add_indexed\(\)](#), [archive\(\)](#), [charpoly\(\)](#), [cols\(\)](#), [conjugate\(\)](#), [contract_with\(\)](#), [determinant\(\)](#), [do_print_latex\(\)](#), [echelon_form\(\)](#), [eval_indexed\(\)](#), [imag_part\(\)](#), [inverse\(\)](#), [markowitz_elimination\(\)](#), [match_same_type\(\)](#), [matrix\(\)](#), [mul\(\)](#), [mul_scalar\(\)](#), [nops\(\)](#), [operator\(\)\(\)](#), [pivot\(\)](#), [pow\(\)](#), [print_elements\(\)](#), [rank\(\)](#), [read_archive\(\)](#), [real_part\(\)](#), [sub\(\)](#), [subs\(\)](#), and [trace\(\)](#).

6.89.4.3 m

`exvector` GiNaC::matrix::m [protected]

representation (cols indexed first)

Referenced by [add\(\)](#), [archive\(\)](#), [charpoly\(\)](#), [conjugate\(\)](#), [determinant\(\)](#), [determinant_minor\(\)](#), [division_free_elimination\(\)](#), [echelon_form\(\)](#), [fraction_free_elimination\(\)](#), [gauss_elimination\(\)](#), [imag_part\(\)](#), [is_zero_matrix\(\)](#), [let_op\(\)](#), [markowitz_elimination\(\)](#), [matrix\(\)](#), [mul\(\)](#), [mul_scalar\(\)](#), [op\(\)](#), [operator\(\)](#), [pivot\(\)](#), [print_elements\(\)](#), [rank\(\)](#), [read_archive\(\)](#), [real_part\(\)](#), [solve\(\)](#), [sub\(\)](#), [subs\(\)](#), [trace\(\)](#), and [transpose\(\)](#).

The documentation for this class was generated from the following files:

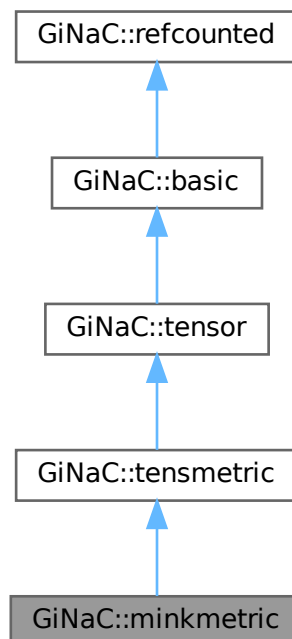
- [matrix.h](#)
- [matrix.cpp](#)

6.90 GiNaC::minkmetric Class Reference

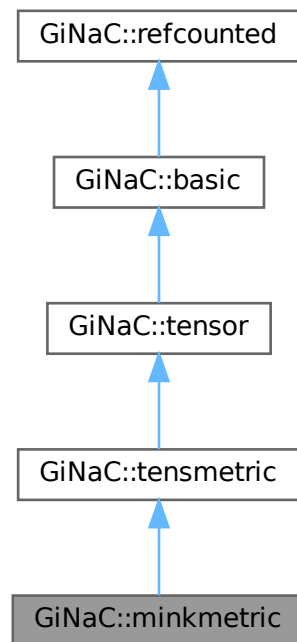
This class represents a Minkowski metric tensor.

```
#include <tensor.h>
```

Inheritance diagram for GiNaC::minkmetric:



Collaboration diagram for `GiNaC::minkmetric`:



Public Member Functions

- `minkmetric` (bool `pos_sig`)
Construct Lorentz metric tensor with given signature.
- bool `info` (unsigned int) const override
Information about the object.
- `ex eval_indexed` (const `basic` &i) const override
Automatic symbolic evaluation of an indexed Lorentz metric tensor.
- void `archive` (`archive_node` &n) const override
Save (a.k.a.
- void `read_archive` (const `archive_node` &n, list &syms) override
Read (a.k.a.

Public Member Functions inherited from `GiNaC::tensmetric`

- bool `info` (unsigned int) const override
Information about the object.
- `ex eval_indexed` (const `basic` &i) const override
Automatic symbolic evaluation of an indexed metric tensor.
- bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const override
Contraction of an indexed metric tensor with something else.

Public Member Functions inherited from [GiNaC::tensor](#)

- bool [replace_contr_index](#) (exvector::iterator self, exvector::iterator other) const
Replace dummy index in contracted-with object by the contracting object's second index (used internally for delta and metric tensor contractions).

Public Member Functions inherited from [GiNaC::basic](#)

- virtual [~basic](#) ()
basic destructor, virtual because class ex will delete objects of derived classes via a basic.*
- [basic](#) (const [basic](#) &other)
- const [basic](#) & [operator=](#) (const [basic](#) &other)
basic assignment operator: the other object might be of a derived class.
- virtual [basic](#) * [duplicate](#) () const
Create a clone of this object on the heap.
- virtual [ex eval](#) () const
Perform automatic non-interruptive term rewriting rules.
- virtual [ex evalf](#) () const
Evaluate object numerically.
- virtual [ex evalm](#) () const
Evaluate sums, products and integer powers of matrices.
- virtual [ex eval_integ](#) () const
Evaluate integrals, if result is known.
- virtual [ex eval_indexed](#) (const [basic](#) &i) const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void [print](#) (const [print_context](#) &c, unsigned level=0) const
Output to stream.
- virtual void [dbgprint](#) () const
Little wrapper around print to be called within a debugger.
- virtual void [dbgprinttree](#) () const
Little wrapper around printtree to be called within a debugger.
- virtual unsigned [precedence](#) () const
Return relative operator precedence (for parenthezing output).
- virtual bool [info](#) (unsigned inf) const
Information about the object.
- virtual size_t [nops](#) () const
Number of operands/members.
- virtual [ex op](#) (size_t i) const
Return operand/member at position i.
- virtual [ex operator\[\]](#) (const [ex](#) &index) const
- virtual [ex operator\[\]](#) (size_t i) const
- virtual [ex](#) & [let_op](#) (size_t i)
Return modifiable operand/member at position i.
- virtual [ex](#) & [operator\[\]](#) (const [ex](#) &index)
- virtual [ex](#) & [operator\[\]](#) (size_t i)
- virtual bool [has](#) (const [ex](#) &other, unsigned [options](#)=0) const
Test for occurrence of a pattern.
- virtual bool [match](#) (const [ex](#) &pattern, [exmap](#) &repls) const
Check whether the expression matches a given pattern.
- virtual [ex subs](#) (const [exmap](#) &m, unsigned [options](#)=0) const
Substitute a set of objects by arbitrary expressions.

- virtual `ex map` (`map_function` &f) const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void `accept` (`GiNaC::visitor` &v) const
- virtual bool `is_polynomial` (const `ex` &var) const
Check whether this is a polynomial in the given variables.
- virtual int `degree` (const `ex` &s) const
Return degree of highest power in object s.
- virtual int `ldegree` (const `ex` &s) const
Return degree of lowest power in object s.
- virtual `ex coeff` (const `ex` &s, int n=1) const
Return coefficient of degree n in object s.
- virtual `ex expand` (unsigned `options`=0) const
Expand expression, i.e.
- virtual `ex collect` (const `ex` &s, bool distributed=false) const
Sort expanded expression in terms of powers of some object(s).
- virtual `ex series` (const `relational` &r, int `order`, unsigned `options`=0) const
Default implementation of `ex::series()`.
- virtual `ex normal` (`exmap` &repl, `exmap` &rev_lookup, `lst` &modifier) const
Default implementation of `ex::normal()`.
- virtual `ex to_rational` (`exmap` &repl) const
Default implementation of `ex::to_rational()`.
- virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const
Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- virtual `numeric max_coefficient` () const
Implementation `ex::max_coefficient()`.
- virtual `exvector get_free_indices` () const
Return a vector containing the free indices of an expression.
- virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
Add two indexed expressions.
- virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
Multiply an indexed expression with a scalar.
- virtual bool `contract_with` (`exvector::iterator` self, `exvector::iterator` other, `exvector` &v) const
Try to contract two indexed expressions that appear in the same product.
- virtual unsigned `return_type` () const
- virtual `return_type_t return_type_tinfo` () const
- virtual `ex conjugate` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const
- template<class T >
void `print_dispatch` (const `print_context` &c, unsigned level) const
Like `print()`, but dispatch to the specified class.
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const
Like `print()`, but dispatch to the specified class.
- virtual void `archive` (`archive_node` &n) const
Save (serialize) the object into archive node.
- virtual void `read_archive` (const `archive_node` &n, `lst` &syms)
Load (deserialize) the object from an archive node.
- `ex subs_one_level` (const `exmap` &m, unsigned `options`) const
Helper function for `subs()`.

- `ex diff` (const `symbol` &s, unsigned nth=1) const
Default interface of nth derivative `ex::diff(s, n)`.
- int `compare` (const `basic` &other) const
Compare objects syntactically to establish canonical ordering.
- bool `is_equal` (const `basic` &other) const
Test for syntactic equality.
- const `basic` & `hold` () const
Stop further evaluation.
- unsigned `gethash` () const
- const `basic` & `setflag` (unsigned f) const
Set some `status_flags`.
- const `basic` & `clearflag` (unsigned f) const
Clear some `status_flags`.

Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- unsigned int `add_reference` () noexcept
- unsigned int `remove_reference` () noexcept
- unsigned int `get_refcount` () const noexcept
- void `set_refcount` (unsigned int r) noexcept

Protected Member Functions

- unsigned `return_type` () const override
- void `do_print` (const `print_context` &c, unsigned level) const
- void `do_print_latex` (const `print_latex` &c, unsigned level) const

Protected Member Functions inherited from `GiNaC::tensmetric`

- unsigned `return_type` () const override
- void `do_print` (const `print_context` &c, unsigned level) const
- unsigned `return_type` () const override

Protected Member Functions inherited from `GiNaC::basic`

- `basic` ()
- virtual `ex eval_ncmul` (const `exvector` &v) const
- virtual bool `match_same_type` (const `basic` &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual `ex derivative` (const `symbol` &s) const
Default implementation of `ex::diff()`.
- virtual int `compare_same_type` (const `basic` &other) const
Returns order relation between two objects of same type.
- virtual bool `is_equal_same_type` (const `basic` &other) const
Returns true if two objects of same type are equal.
- virtual unsigned `calchash` () const
Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.

- void `ensure_if_modifiable` () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void `do_print` (const `print_context` &c, unsigned level) const
Default output to stream.
- void `do_print_tree` (const `print_tree` &c, unsigned level) const
Tree output to stream.
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const
Python parsable output to stream.

Private Attributes

- bool `pos_sig`
If true, the metric is $\text{diag}(-1, 1, 1, \dots)$.

Additional Inherited Members

Protected Attributes inherited from `GiNaC::basic`

- unsigned `flags`
of type `status_flags`
- unsigned `hashvalue`
hash value

6.90.1 Detailed Description

This class represents a Minkowski metric tensor.

It has all the properties of a metric tensor and is (as a matrix) equal to $\text{diag}(1, -1, -1, \dots)$ or $\text{diag}(-1, 1, 1, \dots)$.

6.90.2 Constructor & Destructor Documentation

6.90.2.1 `minkmetric()`

```
GiNaC::minkmetric::minkmetric (
    bool pos_sig )
```

Construct Lorentz metric tensor with given signature.

6.90.3 Member Function Documentation

6.90.3.1 info()

```
bool GiNaC::minkmetric::info (
    unsigned inf ) const [override], [virtual]
```

Information about the object.

See also

class [info_flags](#)

Reimplemented from [GiNaC::tensmetric](#).

References [GiNaC::info_flags::real](#).

6.90.3.2 eval_indexed()

```
ex GiNaC::minkmetric::eval_indexed (
    const basic & i ) const [override], [virtual]
```

Automatic symbolic evaluation of an indexed Lorentz metric tensor.

Reimplemented from [GiNaC::tensmetric](#).

References [GiNaC::_ex0](#), [GiNaC::_ex1](#), [GiNaC::_ex_1](#), [GiNaC::idx::get_value\(\)](#), [GINAC_ASSERT](#), [GiNaC::info_flags::nonnegint](#), [GiNaC::basic::nops\(\)](#), [GiNaC::basic::op\(\)](#), and [pos_sig](#).

6.90.3.3 archive()

```
void GiNaC::minkmetric::archive (
    archive\_node & n ) const [override], [virtual]
```

Save (a.k.a.

serialize) object into archive.

Reimplemented from [GiNaC::basic](#).

References [n](#), and [pos_sig](#).

6.90.3.4 read_archive()

```
void GiNaC::minkmetric::read_archive (
    const archive_node & n,
    lst & syms ) [override], [virtual]
```

Read (a.k.a.

deserialize) object from archive.

Reimplemented from [GiNaC::basic](#).

References [n](#), and [pos_sig](#).

6.90.3.5 return_type()

```
unsigned GiNaC::minkmetric::return_type ( ) const [inline], [override], [protected], [virtual]
```

Reimplemented from [GiNaC::tensmetric](#).

References [GiNaC::return_types::commutative](#).

6.90.3.6 do_print()

```
void GiNaC::minkmetric::do_print (
    const print_context & c,
    unsigned level ) const [protected]
```

6.90.3.7 do_print_latex()

```
void GiNaC::minkmetric::do_print_latex (
    const print_latex & c,
    unsigned level ) const [protected]
```

6.90.4 Member Data Documentation

6.90.4.1 pos_sig

```
bool GiNaC::minkmetric::pos_sig [private]
```

If true, the metric is $\text{diag}(-1, 1, 1, \dots)$.

Otherwise it is $\text{diag}(1, -1, -1, \dots)$.

Referenced by [archive\(\)](#), [eval_indexed\(\)](#), and [read_archive\(\)](#).

The documentation for this class was generated from the following files:

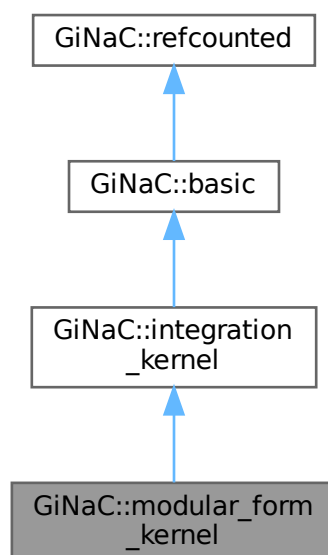
- [tensor.h](#)
- [tensor.cpp](#)

6.91 GiNaC::modular_form_kernel Class Reference

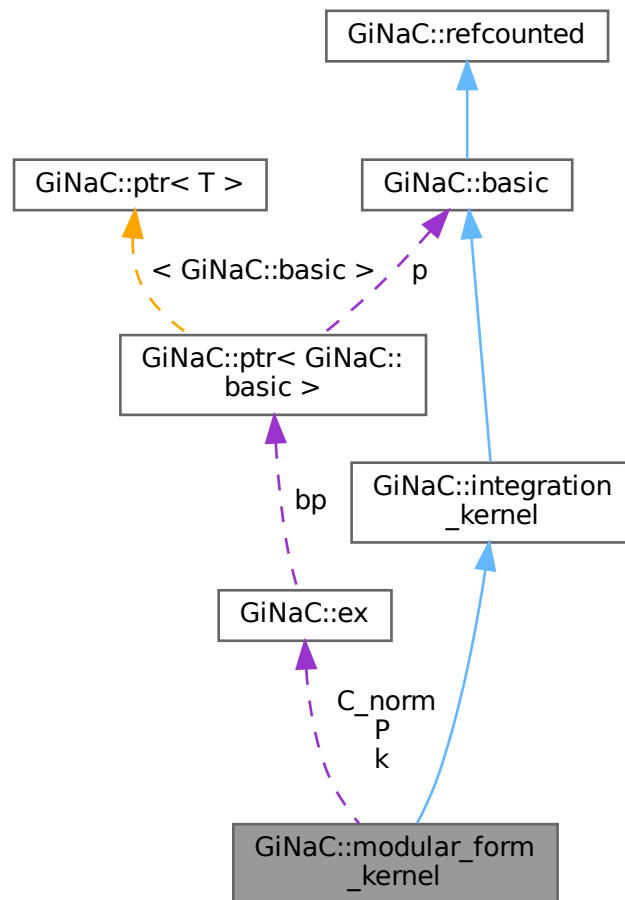
A kernel corresponding to a polynomial in Eisenstein series.

```
#include <integration_kernel.h>
```

Inheritance diagram for GiNaC::modular_form_kernel:



Collaboration diagram for GiNaC::modular_form_kernel:



Public Member Functions

- `modular_form_kernel` (const `ex` &`k`, const `ex` &`P`, const `ex` &`C_norm`=`numeric`(1))
- `ex series` (const `relational` &`r`, int `order`, unsigned `options`=0) const override
The series method for this class returns the qbar-expansion of the modular form, without an additional factor of C_norm/qbar.
- `size_t nops` () const override
Number of operands/members.
- `ex op` (size_t `i`) const override
Return operand/member at position i.
- `ex & let_op` (size_t `i`) override
Return modifiable operand/member at position i.
- `bool is_numeric` (void) const override
This routine returns true, if the integration kernel can be evaluated numerically.
- `ex Laurent_series` (const `ex` &`qbar`, int `order`) const override
Returns the Laurent series, starting possibly with the pole term.

- `ex get_numerical_value` (const `ex` &`qbar`, int `N_trunc`=0) const override
Returns the value of the modular form.
- `ex q_expansion_modular_form` (const `ex` &`q`, int `order`) const

Public Member Functions inherited from `GiNaC::integration_kernel`

- `ex series` (const `relational` &`r`, int `order`, unsigned `options`=0) const override
Default implementation of `ex::series()`.
- virtual bool `has_trailing_zero` (void) const
This routine returns true, if the integration kernel has a trailing zero.
- virtual bool `is_numeric` (void) const
This routine returns true, if the integration kernel can be evaluated numerically.
- virtual `ex Laurent_series` (const `ex` &`x`, int `order`) const
Returns the Laurent series, starting possibly with the pole term.
- virtual `ex get_numerical_value` (const `ex` &`lambda`, int `N_trunc`=0) const
Evaluates the integrand at `lambda`.
- size_t `get_cache_size` (void) const
Returns the current size of the cache.
- void `set_cache_step` (int `cache_steps`) const
Sets the step size by which the cache is increased.
- `ex get_series_coeff` (int `i`) const
Wrapper around `series_coeff(i)`, converts `cl_N` to numeric.
- `cln::cl_N series_coeff` (int `i`) const
Subclasses have either to implement `series_coeff_impl` or the two methods `Laurent_series` and `uses_Laurent_series`.

Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()
basic destructor, virtual because class `ex` will delete objects of derived classes via a `basic`.*
- `basic` (const `basic` &`other`)
- const `basic` & `operator=` (const `basic` &`other`)
basic assignment operator: the other object might be of a derived class.
- virtual `basic * duplicate` () const
Create a clone of this object on the heap.
- virtual `ex eval` () const
Perform automatic non-interruptive term rewriting rules.
- virtual `ex evalf` () const
Evaluate object numerically.
- virtual `ex evalm` () const
Evaluate sums, products and integer powers of matrices.
- virtual `ex eval_integ` () const
Evaluate integrals, if result is known.
- virtual `ex eval_indexed` (const `basic` &`i`) const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void `print` (const `print_context` &`c`, unsigned `level`=0) const
Output to stream.
- virtual void `dbgprint` () const
Little wrapper around `print` to be called within a debugger.
- virtual void `dbgprinttree` () const
Little wrapper around `printtree` to be called within a debugger.

- virtual unsigned `precedence` () const
Return relative operator precedence (for parenthezing output).
- virtual bool `info` (unsigned inf) const
Information about the object.
- virtual size_t `nops` () const
Number of operands/members.
- virtual `ex op` (size_t i) const
Return operand/member at position i.
- virtual `ex operator[]` (const `ex` &index) const
- virtual `ex operator[]` (size_t i) const
- virtual `ex & let_op` (size_t i)
Return modifiable operand/member at position i.
- virtual `ex & operator[]` (const `ex` &index)
- virtual `ex & operator[]` (size_t i)
- virtual bool `has` (const `ex` &other, unsigned `options`=0) const
Test for occurrence of a pattern.
- virtual bool `match` (const `ex` &pattern, `exmap` &repls) const
Check whether the expression matches a given pattern.
- virtual `ex subs` (const `exmap` &m, unsigned `options`=0) const
Substitute a set of objects by arbitrary expressions.
- virtual `ex map` (`map_function` &f) const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void `accept` (`GiNaC::visitor` &v) const
- virtual bool `is_polynomial` (const `ex` &var) const
Check whether this is a polynomial in the given variables.
- virtual int `degree` (const `ex` &s) const
Return degree of highest power in object s.
- virtual int `ldegree` (const `ex` &s) const
Return degree of lowest power in object s.
- virtual `ex coeff` (const `ex` &s, int n=1) const
Return coefficient of degree n in object s.
- virtual `ex expand` (unsigned `options`=0) const
Expand expression, i.e.
- virtual `ex collect` (const `ex` &s, bool distributed=false) const
Sort expanded expression in terms of powers of some object(s).
- virtual `ex series` (const `relational` &r, int `order`, unsigned `options`=0) const
Default implementation of `ex::series()`.
- virtual `ex normal` (`exmap` &repl, `exmap` &rev_lookup, `lst` &modifier) const
Default implementation of `ex::normal()`.
- virtual `ex to_rational` (`exmap` &repl) const
Default implementation of `ex::to_rational()`.
- virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const
Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- virtual `numeric max_coefficient` () const
Implementation `ex::max_coefficient()`.
- virtual `exvector get_free_indices` () const
Return a vector containing the free indices of an expression.
- virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
Add two indexed expressions.

- virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
Multiply an indexed expression with a scalar.
- virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const
Try to contract two indexed expressions that appear in the same product.
- virtual unsigned `return_type` () const
- virtual `return_type_t` `return_type_tinfo` () const
- virtual `ex conjugate` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const
- template<class T >
void `print_dispatch` (const `print_context` &c, unsigned level) const
Like `print()`, but dispatch to the specified class.
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const
Like `print()`, but dispatch to the specified class.
- virtual void `archive` (`archive_node` &n) const
Save (serialize) the object into archive node.
- virtual void `read_archive` (const `archive_node` &n, `lst` &syms)
Load (deserialize) the object from an archive node.
- `ex subs_one_level` (const `exmap` &m, unsigned `options`) const
Helper function for `subs()`.
- `ex diff` (const `symbol` &s, unsigned nth=1) const
Default interface of nth derivative `ex::diff(s, n)`.
- int `compare` (const `basic` &other) const
Compare objects syntactically to establish canonical ordering.
- bool `is_equal` (const `basic` &other) const
Test for syntactic equality.
- const `basic` & `hold` () const
Stop further evaluation.
- unsigned `gethash` () const
- const `basic` & `setflag` (unsigned f) const
Set some `status_flags`.
- const `basic` & `clearflag` (unsigned f) const
Clear some `status_flags`.

Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- unsigned int `add_reference` () noexcept
- unsigned int `remove_reference` () noexcept
- unsigned int `get_refcount` () const noexcept
- void `set_refcount` (unsigned int r) noexcept

Protected Member Functions

- bool `uses_Laurent_series` () const override
Returns true, if the coefficients are computed from the Laurent series (in which case the method `Laurent_series` needs to be implemented).
- void `do_print` (const `print_context` &c, unsigned level) const

Protected Member Functions inherited from [GiNaC::integration_kernel](#)

- virtual bool [uses_Laurent_series](#) () const
Returns true, if the coefficients are computed from the Laurent series (in which case the method [Laurent_series](#) needs to be implemented).
- virtual [cln::cl_N](#) [series_coeff_impl](#) (int i) const
For $\omega = d\lambda$ only the coefficient of λ^0 is non-zero.
- [ex](#) [get_numerical_value_impl](#) (const [ex](#) &lambda, const [ex](#) &pre, int shift, int N_trunc) const
The actual implementation for computing a numerical value for the integrand.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const

Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex](#) [eval_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match_same_type](#) (const [basic](#) &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual [ex](#) [derivative](#) (const [symbol](#) &s) const
Default implementation of [ex::diff\(\)](#).
- virtual int [compare_same_type](#) (const [basic](#) &other) const
Returns order relation between two objects of same type.
- virtual bool [is_equal_same_type](#) (const [basic](#) &other) const
Returns true if two objects of same type are equal.
- virtual unsigned [calchash](#) () const
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- void [ensure_if_modifiable](#) () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
Default output to stream.
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
Tree output to stream.
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
Python parsable output to stream.

Protected Attributes

- [ex](#) k
- [ex](#) P
- [ex](#) C_norm

Protected Attributes inherited from [GiNaC::integration_kernel](#)

- int [cache_step_size](#)
- [std::vector](#)< [cln::cl_N](#) > [series_vec](#)

Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)
of type [status_flags](#)
- unsigned [hashvalue](#)
hash value

6.91.1 Detailed Description

A kernel corresponding to a polynomial in Eisenstein series.

This class represents the differential one-form

$$\omega^{\text{modular}}(P_k(\eta_{k_1}^{(1)}, \dots, \eta_{k_r}^{(r)})) = C_k P_k(\eta_{k_1}^{(1)}, \dots, \eta_{k_r}^{(r)}) \frac{d\bar{q}_N}{\bar{q}_N}.$$

6.91.2 Constructor & Destructor Documentation

6.91.2.1 modular_form_kernel()

```
GiNaC::modular_form_kernel::modular_form_kernel (
    const ex & k,
    const ex & P,
    const ex & C_norm = numeric(1) )
```

6.91.3 Member Function Documentation

6.91.3.1 series()

```
ex GiNaC::modular_form_kernel::series (
    const relational & r,
    int order,
    unsigned options = 0 ) const \[override\], \[virtual\]
```

The series method for this class returns the qbar-expansion of the modular form, without an additional factor of C_norm/qbar.

Reimplemented from [GiNaC::integration_kernel](#).

References [order](#), [P](#), [GiNaC::pow\(\)](#), [qbar](#), [r](#), and [GiNaC::ex::series\(\)](#).

Referenced by [q_expansion_modular_form\(\)](#).

6.91.3.2 nops()

```
size_t GiNaC::modular_form_kernel::nops ( ) const \[override\], \[virtual\]
```

Number of operands/members.

Reimplemented from [GiNaC::basic](#).

6.91.3.3 op()

```
ex GiNaC::modular_form_kernel::op (
    size_t i ) const [override], [virtual]
```

Return operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [C_norm](#), [k](#), and [P](#).

6.91.3.4 let_op()

```
ex & GiNaC::modular_form_kernel::let_op (
    size_t i ) [override], [virtual]
```

Return modifiable operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [C_norm](#), [GiNaC::basic::ensure_if_modifiable\(\)](#), [k](#), and [P](#).

6.91.3.5 is_numeric()

```
bool GiNaC::modular_form_kernel::is_numeric (
    void ) const [override], [virtual]
```

This routine returns true, if the integration kernel can be evaluated numerically.

Reimplemented from [GiNaC::integration_kernel](#).

References [C_norm](#), [GiNaC::ex::evalf\(\)](#), [GiNaC::ex::info\(\)](#), [k](#), [GiNaC::info_flags::nonnegint](#), [GiNaC::info_flags::numeric](#), [q_expansion_modular_form\(\)](#), [qbar](#), [GiNaC::series_to_poly\(\)](#), and [GiNaC::ex::subs\(\)](#).

6.91.3.6 Laurent_series()

```
ex GiNaC::modular_form_kernel::Laurent_series (
    const ex & x,
    int order ) const [override], [virtual]
```

Returns the Laurent series, starting possibly with the pole term.

Neglected terms are of order $O(x^{order})$.

Reimplemented from [GiNaC::integration_kernel](#).

References [C_norm](#), [order](#), [q_expansion_modular_form\(\)](#), [qbar](#), [GiNaC::ex::series\(\)](#), and [GiNaC::series_to_poly\(\)](#).

6.91.3.7 get_numerical_value()

```
ex GiNaC::modular_form_kernel::get_numerical_value (
    const ex & qbar,
    int N_trunc = 0 ) const [override], [virtual]
```

Returns the value of the modular form.

Reimplemented from [GiNaC::integration_kernel](#).

References [C_norm](#), [GiNaC::integration_kernel::get_numerical_value_impl\(\)](#), and [qbar](#).

6.91.3.8 uses_Laurent_series()

```
bool GiNaC::modular_form_kernel::uses_Laurent_series ( ) const [override], [protected], [virtual]
```

Returns true, if the coefficients are computed from the Laurent series (in which case the method `Laurent_series` needs to be implemented).

Returns false if this is not the case (and the class has an implementation of `series_coeff_impl`).

Reimplemented from [GiNaC::integration_kernel](#).

6.91.3.9 q_expansion_modular_form()

```
ex GiNaC::modular_form_kernel::q_expansion_modular_form (
    const ex & q,
    int order ) const
```

References [series\(\)](#).

Referenced by [is_numeric\(\)](#), and [Laurent_series\(\)](#).

6.91.3.10 do_print()

```
void GiNaC::modular_form_kernel::do_print (
    const print_context & c,
    unsigned level ) const [protected]
```

References [c](#), [C_norm](#), [k](#), [P](#), and [GiNaC::ex::print\(\)](#).

6.91.4 Member Data Documentation

6.91.4.1 **k**

`ex GiNaC::modular_form_kernel::k` [protected]

Referenced by [do_print\(\)](#), [is_numeric\(\)](#), [let_op\(\)](#), and [op\(\)](#).

6.91.4.2 **P**

`ex GiNaC::modular_form_kernel::P` [protected]

Referenced by [do_print\(\)](#), [let_op\(\)](#), [op\(\)](#), and [series\(\)](#).

6.91.4.3 **C_norm**

`ex GiNaC::modular_form_kernel::C_norm` [protected]

Referenced by [do_print\(\)](#), [get_numerical_value\(\)](#), [is_numeric\(\)](#), [Laurent_series\(\)](#), [let_op\(\)](#), and [op\(\)](#).

The documentation for this class was generated from the following files:

- [integration_kernel.h](#)
- [integration_kernel.cpp](#)

6.92 GiNaC::basic_partition_generator::mpartition2 Struct Reference

```
#include <utils.h>
```

Public Member Functions

- [mpartition2](#) (unsigned n_, unsigned m_)
- bool [next_partition](#) ()

Public Attributes

- `std::vector< unsigned >` [x](#)
- unsigned [n](#)
- unsigned [m](#)

6.92.1 Constructor & Destructor Documentation

6.92.1.1 mpartition2()

```
GiNaC::basic_partition_generator::mpartition2::mpartition2 (
    unsigned n_,
    unsigned m_ ) [inline]
```

References [k](#), [m](#), [n](#), and [x](#).

6.92.2 Member Function Documentation

6.92.2.1 next_partition()

```
bool GiNaC::basic_partition_generator::mpartition2::next_partition ( ) [inline]
```

References [k](#), [m](#), and [x](#).

Referenced by [GiNaC::partition_with_zero_parts_generator::next\(\)](#), and [GiNaC::partition_generator::next\(\)](#).

6.92.3 Member Data Documentation

6.92.3.1 x

```
std::vector<unsigned> GiNaC::basic_partition_generator::mpartition2::x
```

Referenced by [GiNaC::partition_with_zero_parts_generator::get\(\)](#), [GiNaC::partition_generator::get\(\)](#), [mpartition2\(\)](#), and [next_partition\(\)](#).

6.92.3.2 n

```
unsigned GiNaC::basic_partition_generator::mpartition2::n
```

Referenced by [mpartition2\(\)](#), and [GiNaC::partition_with_zero_parts_generator::next\(\)](#).

6.92.3.3 m

```
unsigned GiNaC::basic_partition_generator::mpartition2::m
```

Referenced by [GiNaC::partition_with_zero_parts_generator::get\(\)](#), [GiNaC::partition_generator::get\(\)](#), [mpartition2\(\)](#), [GiNaC::partition_with_zero_parts_generator::next\(\)](#), and [next_partition\(\)](#).

The documentation for this struct was generated from the following file:

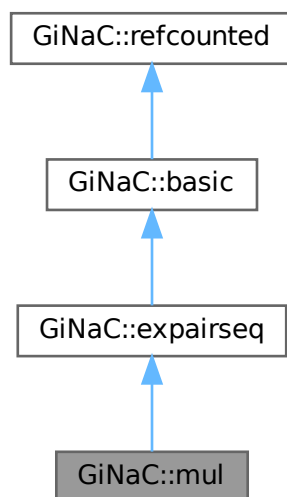
- [utils.h](#)

6.93 GiNaC::mul Class Reference

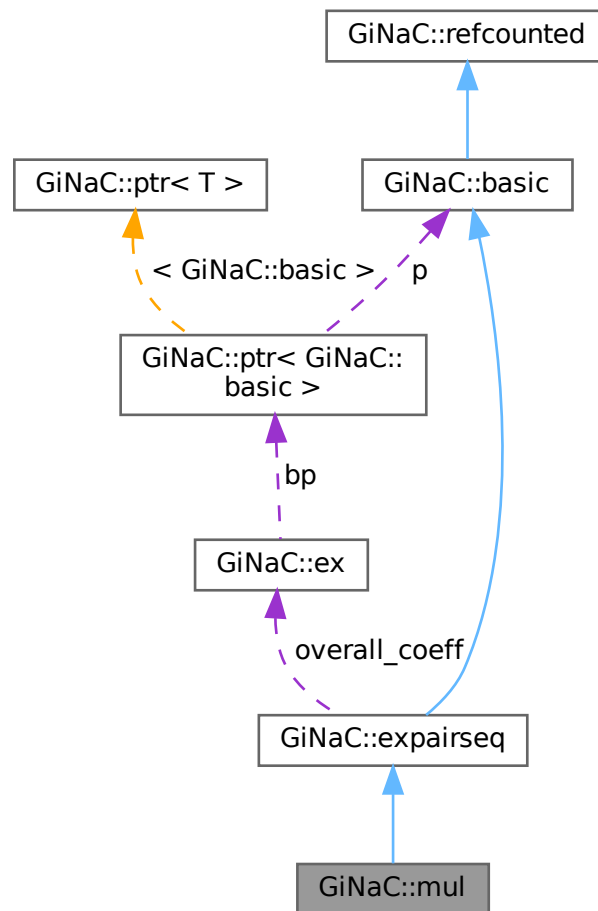
Product of expressions.

```
#include <mul.h>
```

Inheritance diagram for GiNaC::mul:



Collaboration diagram for GiNaC::mul:



Public Member Functions

- `mul` (const `ex` &lh, const `ex` &rh)
- `mul` (const `exvector` &v)
- `mul` (const `epvector` &v)
- `mul` (const `epvector` &v, const `ex` &oc, bool do_index_renaming=false)
- `mul` (`epvector` &&vp)
- `mul` (`epvector` &&vp, const `ex` &oc, bool do_index_renaming=false)
- `mul` (const `ex` &lh, const `ex` &mh, const `ex` &rh)
- unsigned `precedence` () const override
Return relative operator precedence (for parenthesizing output).
- bool `info` (unsigned inf) const override
Information about the object.
- bool `is_polynomial` (const `ex` &var) const override
Check whether this is a polynomial in the given variables.
- int `degree` (const `ex` &s) const override

- *Return degree of highest power in object s.*
- `int ldegree (const ex &s) const` override
- *Return degree of lowest power in object s.*
- `ex coeff (const ex &s, int n=1) const` override
- *Return coefficient of degree n in object s.*
- `bool has (const ex &other, unsigned options=0) const` override
- *Test for occurrence of a pattern.*
- `ex eval ()` const override
- *Perform automatic term rewriting rules in this class.*
- `ex evalf ()` const override
- *Evaluate object numerically.*
- `ex real_part ()` const override
- `ex imag_part ()` const override
- `ex evalm ()` const override
- *Evaluate sums, products and integer powers of matrices.*
- `ex series (const relational &s, int order, unsigned options=0) const` override
- *Implementation of `ex::series()` for product.*
- `ex normal (exmap &repl, exmap &rev_lookup, lst &modifier) const` override
- *Implementation of `ex::normal()` for a product.*
- `numeric integer_content ()` const override
- `ex smod (const numeric &xi) const` override
- *Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- `numeric max_coefficient ()` const override
- *Implementation `ex::max_coefficient()`.*
- `exvector get_free_indices ()` const override
- *Return a vector containing the free indices of an expression.*
- `ex conjugate ()` const override
- `ex algebraic_subs_mul (const exmap &m, unsigned options) const`

Public Member Functions inherited from `GiNaC::expairseq`

- `expairseq (const ex &lh, const ex &rh)`
- `expairseq (const exvector &v)`
- `expairseq (const epvector &v, const ex &oc, bool do_index_renaming=false)`
- `expairseq (epvector &&vp, const ex &oc, bool do_index_renaming=false)`
- `unsigned precedence ()` const override
- *Return relative operator precedence (for parenthezing output).*
- `bool info (unsigned inf) const` override
- *Information about the object.*
- `size_t nops ()` const override
- *Number of operands/members.*
- `ex op (size_t i) const` override
- *Return operand/member at position i.*
- `ex map (map_function &f) const` override
- *Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- `ex eval ()` const override
- *Perform coefficient-wise automatic term rewriting rules in this class.*
- `ex to_rational (exmap &repl) const` override
- *Implementation of `ex::to_rational()` for expairseqs.*
- `ex to_polynomial (exmap &repl) const` override
- *Implementation of `ex::to_polynomial()` for expairseqs.*

- bool **match** (const **ex** &pattern, **exmap** &repl_lst) const override
Check whether the expression matches a given pattern.
- **ex subs** (const **exmap** &m, unsigned **options**=0) const override
Substitute a set of objects by arbitrary expressions.
- **ex conjugate** () const override
- void **archive** (**archive_node** &n) const override
Save (serialize) the object into archive node.
- void **read_archive** (const **archive_node** &n, **lst** &syms) override
Load (deserialize) the object from an archive node.

Public Member Functions inherited from **GiNaC::basic**

- virtual **~basic** ()
basic destructor, virtual because class ex will delete objects of derived classes via a basic.*
- **basic** (const **basic** &other)
- const **basic** & **operator=** (const **basic** &other)
basic assignment operator: the other object might be of a derived class.
- virtual **basic** * **duplicate** () const
Create a clone of this object on the heap.
- virtual **ex eval** () const
Perform automatic non-interruptive term rewriting rules.
- virtual **ex evalf** () const
Evaluate object numerically.
- virtual **ex evalm** () const
Evaluate sums, products and integer powers of matrices.
- virtual **ex eval_integ** () const
Evaluate integrals, if result is known.
- virtual **ex eval_indexed** (const **basic** &i) const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void **print** (const **print_context** &c, unsigned level=0) const
Output to stream.
- virtual void **dbgprint** () const
Little wrapper around print to be called within a debugger.
- virtual void **dbgprinttree** () const
Little wrapper around printtree to be called within a debugger.
- virtual unsigned **precedence** () const
Return relative operator precedence (for parenthezing output).
- virtual bool **info** (unsigned inf) const
Information about the object.
- virtual size_t **nops** () const
Number of operands/members.
- virtual **ex op** (size_t i) const
Return operand/member at position i.
- virtual **ex operator[]** (const **ex** &index) const
- virtual **ex operator[]** (size_t i) const
- virtual **ex** & **let_op** (size_t i)
Return modifiable operand/member at position i.
- virtual **ex** & **operator[]** (const **ex** &index)
- virtual **ex** & **operator[]** (size_t i)
- virtual bool **has** (const **ex** &other, unsigned **options**=0) const

- Test for occurrence of a pattern.*

 - virtual bool `match` (const `ex` &pattern, `exmap` &repls) const
- Check whether the expression matches a given pattern.*

 - virtual `ex subs` (const `exmap` &m, unsigned `options`=0) const
- Substitute a set of objects by arbitrary expressions.*

 - virtual `ex map` (`map_function` &f) const
- Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*

 - virtual void `accept` (`GiNaC::visitor` &v) const
 - virtual bool `is_polynomial` (const `ex` &var) const
- Check whether this is a polynomial in the given variables.*

 - virtual int `degree` (const `ex` &s) const
- Return degree of highest power in object s.*

 - virtual int `ldegree` (const `ex` &s) const
- Return degree of lowest power in object s.*

 - virtual `ex coeff` (const `ex` &s, int `n`=1) const
- Return coefficient of degree n in object s.*

 - virtual `ex expand` (unsigned `options`=0) const
- Expand expression, i.e.*

 - virtual `ex collect` (const `ex` &s, bool `distributed`=false) const
- Sort expanded expression in terms of powers of some object(s).*

 - virtual `ex series` (const `relational` &r, int `order`, unsigned `options`=0) const
- Default implementation of `ex::series()`.*

 - virtual `ex normal` (`exmap` &repl, `exmap` &rev_lookup, `lst` &modifier) const
- Default implementation of `ex::normal()`.*

 - virtual `ex to_rational` (`exmap` &repl) const
- Default implementation of `ex::to_rational()`.*

 - virtual `ex to_polynomial` (`exmap` &repl) const
 - virtual `numeric integer_content` () const
 - virtual `ex smod` (const `numeric` &xi) const
- Apply symmetric modular homomorphism to an expanded multivariate polynomial.*

 - virtual `numeric max_coefficient` () const
- Implementation `ex::max_coefficient()`.*

 - virtual `exvector get_free_indices` () const
- Return a vector containing the free indices of an expression.*

 - virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
- Add two indexed expressions.*

 - virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
- Multiply an indexed expression with a scalar.*

 - virtual bool `contract_with` (`exvector::iterator` self, `exvector::iterator` other, `exvector` &v) const
- Try to contract two indexed expressions that appear in the same product.*

 - virtual unsigned `return_type` () const
 - virtual `return_type_t return_type_tinfo` () const
 - virtual `ex conjugate` () const
 - virtual `ex real_part` () const
 - virtual `ex imag_part` () const
- template<class T >

 - void `print_dispatch` (const `print_context` &c, unsigned level) const
- Like `print()`, but dispatch to the specified class.*

 - void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const
- Like `print()`, but dispatch to the specified class.*

 - virtual void `archive` (`archive_node` &n) const

- *Save (serialize) the object into archive node.*
- virtual void `read_archive` (const `archive_node` &n, `lst` &syms)
- *Load (deserialize) the object from an archive node.*
- `ex subs_one_level` (const `exmap` &m, unsigned `options`) const
- *Helper function for `subs()`.*
- `ex diff` (const `symbol` &s, unsigned `nth`=1) const
- *Default interface of `nth` derivative `ex::diff(s, n)`.*
- int `compare` (const `basic` &other) const
- *Compare objects syntactically to establish canonical ordering.*
- bool `is_equal` (const `basic` &other) const
- *Test for syntactic equality.*
- const `basic` & `hold` () const
- *Stop further evaluation.*
- unsigned `gethash` () const
- const `basic` & `setflag` (unsigned `f`) const
- *Set some `status_flags`.*
- const `basic` & `clearflag` (unsigned `f`) const
- *Clear some `status_flags`.*

Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- unsigned int `add_reference` () noexcept
- unsigned int `remove_reference` () noexcept
- unsigned int `get_refcount` () const noexcept
- void `set_refcount` (unsigned int `r`) noexcept

Protected Member Functions

- `ex derivative` (const `symbol` &s) const override
- *Implementation of `ex::diff()` for a product.*
- `ex eval_ncmul` (const `exvector` &v) const override
- unsigned `return_type` () const override
- `return_type_t return_type_tinfo` () const override
- `ex thisexpairseq` (const `epvector` &v, const `ex` &oc, bool `do_index_renaming`=false) const override
- *Create an object of this type.*
- `ex thisexpairseq` (`epvector` &&vp, const `ex` &oc, bool `do_index_renaming`=false) const override
- `expair split_ex_to_pair` (const `ex` &e) const override
- *Form an expair from an ex, using the corresponding semantics.*
- `expair combine_ex_with_coeff_to_pair` (const `ex` &e, const `ex` &c) const override
- `expair combine_pair_with_coeff_to_pair` (const `expair` &p, const `ex` &c) const override
- `ex recombine_pair_to_ex` (const `expair` &p) const override
- *Form an ex out of an expair, using the corresponding semantics.*
- bool `expair_needs_further_processing` (`epp` it) override
- `ex default_overall_coeff` () const override
- void `combine_overall_coeff` (const `ex` &c) override
- void `combine_overall_coeff` (const `ex` &c1, const `ex` &c2) override
- bool `can_make_flat` (const `expair` &p) const override
- `ex expand` (unsigned `options`=0) const override
- *Expand expression, i.e.*
- void `find_real_imag` (`ex` &, `ex` &) const

- void `print_overall_coeff` (const `print_context` &c, const char *mul_sym) const
- void `do_print` (const `print_context` &c, unsigned level) const
- void `do_print_latex` (const `print_latex` &c, unsigned level) const
- void `do_print_csrc` (const `print_csrc` &c, unsigned level) const
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const
- `epvector` `expandchildren` (unsigned `options`) const

Member-wise expand the expires representing this sequence.

Protected Member Functions inherited from `GiNaC::expairseq`

- bool `is_equal_same_type` (const `basic` &other) const override
Returns true if two objects of same type are equal.
- unsigned `return_type` () const override
- unsigned `calchash` () const override
Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.
- `ex` `expand` (unsigned `options`=0) const override
Expand expression, i.e.
- virtual `ex` `thisexpairseq` (const `epvector` &v, const `ex` &oc, bool do_index_renaming=false) const
Create an object of this type.
- virtual `ex` `thisexpairseq` (`epvector` &&vp, const `ex` &oc, bool do_index_renaming=false) const
- virtual void `printseq` (const `print_context` &c, char delim, unsigned this_precedence, unsigned upper_precedence) const
- virtual void `printpair` (const `print_context` &c, const `expair` &p, unsigned upper_precedence) const
- virtual `expair` `split_ex_to_pair` (const `ex` &e) const
Form an expair from an ex, using the corresponding semantics.
- virtual `expair` `combine_ex_with_coeff_to_pair` (const `ex` &e, const `ex` &c) const
- virtual `expair` `combine_pair_with_coeff_to_pair` (const `expair` &p, const `ex` &c) const
- virtual `ex` `recombine_pair_to_ex` (const `expair` &p) const
Form an ex out of an expair, using the corresponding semantics.
- virtual bool `expair_needs_further_processing` (`epp` it)
- virtual `ex` `default_overall_coeff` () const
- virtual void `combine_overall_coeff` (const `ex` &c)
- virtual void `combine_overall_coeff` (const `ex` &c1, const `ex` &c2)
- virtual bool `can_make_flat` (const `expair` &p) const
- void `do_print` (const `print_context` &c, unsigned level) const
- void `do_print_tree` (const `print_tree` &c, unsigned level) const
- void `construct_from_2_ex` (const `ex` &lh, const `ex` &rh)
- void `construct_from_2_expairseq` (const `expairseq` &s1, const `expairseq` &s2)
- void `construct_from_expairseq_ex` (const `expairseq` &s, const `ex` &e)
- void `construct_from_exvector` (const `exvector` &v)
- void `construct_from_epvector` (const `epvector` &v, bool do_index_renaming=false)
- void `construct_from_epvector` (`epvector` &&v, bool do_index_renaming=false)
- void `make_flat` (const `exvector` &v)
Combine this expairseq with argument exvector.
- void `make_flat` (const `epvector` &v, bool do_index_renaming=false)
Combine this expairseq with argument epvector.
- void `canonicalize` ()
Brings this expairseq into a sorted (canonical) form.
- void `combine_same_terms_sorted_seq` ()
Compact a presorted expairseq by combining all matching expires to one each.
- bool `is_canonical` () const
Check if this expairseq is in sorted (canonical) form.

- [epvector expandchildren](#) (unsigned [options](#)) const
Member-wise expand the expires in this sequence.
- [epvector evalchildren](#) () const
Member-wise evaluate the expires in this sequence.
- [epvector subschildren](#) (const [exmap](#) &m, unsigned [options](#)=0) const
Member-wise substitute in this sequence.

Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match_same_type](#) (const [basic](#) &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual [ex derivative](#) (const [symbol](#) &s) const
Default implementation of [ex::diff\(\)](#).
- virtual int [compare_same_type](#) (const [basic](#) &other) const
Returns order relation between two objects of same type.
- virtual bool [is_equal_same_type](#) (const [basic](#) &other) const
Returns true if two objects of same type are equal.
- virtual unsigned [calchash](#) () const
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- void [ensure_if_modifiable](#) () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
Default output to stream.
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
Tree output to stream.
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
Python parsable output to stream.

Static Protected Member Functions

- static bool [can_be_further_expanded](#) (const [ex](#) &e)

Friends

- class [add](#)
- class [ncmul](#)
- class [power](#)

Additional Inherited Members

Protected Attributes inherited from [GiNaC::expairseq](#)

- [epvector seq](#)
- [ex overall_coeff](#)

Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)
of type [status_flags](#)
- unsigned [hashvalue](#)
hash value

6.93.1 Detailed Description

Product of expressions.

6.93.2 Constructor & Destructor Documentation

6.93.2.1 `mul()` [1/7]

```
GiNaC::mul::mul (
    const ex & lh,
    const ex & rh )
```

References [GiNaC::_ex1](#), [GiNaC::expairseq::construct_from_2_ex\(\)](#), [GINAC_ASSERT](#), [GiNaC::expairseq::is_canonical\(\)](#), and [GiNaC::expairseq::overall_coeff](#).

6.93.2.2 `mul()` [2/7]

```
GiNaC::mul::mul (
    const exvector & v )
```

References [GiNaC::_ex1](#), [GiNaC::expairseq::construct_from_exvector\(\)](#), [GINAC_ASSERT](#), [GiNaC::expairseq::is_canonical\(\)](#), and [GiNaC::expairseq::overall_coeff](#).

6.93.2.3 `mul()` [3/7]

```
GiNaC::mul::mul (
    const epvector & v )
```

References [GiNaC::_ex1](#), [GiNaC::expairseq::construct_from_epvector\(\)](#), [GINAC_ASSERT](#), [GiNaC::expairseq::is_canonical\(\)](#), and [GiNaC::expairseq::overall_coeff](#).

6.93.2.4 mul() [4/7]

```
GiNaC::mul::mul (
    const epvector & v,
    const ex & oc,
    bool do_index_renaming = false )
```

References [GiNaC::expairseq::construct_from_epvector\(\)](#), [GINAC_ASSERT](#), [GiNaC::expairseq::is_canonical\(\)](#), and [GiNaC::expairseq::overall_coeff](#).

6.93.2.5 mul() [5/7]

```
GiNaC::mul::mul (
    epvector && vp )
```

References [GiNaC::_ex1](#), [GiNaC::expairseq::construct_from_epvector\(\)](#), [GINAC_ASSERT](#), [GiNaC::expairseq::is_canonical\(\)](#), and [GiNaC::expairseq::overall_coeff](#).

6.93.2.6 mul() [6/7]

```
GiNaC::mul::mul (
    epvector && vp,
    const ex & oc,
    bool do_index_renaming = false )
```

References [GiNaC::expairseq::construct_from_epvector\(\)](#), [GINAC_ASSERT](#), [GiNaC::expairseq::is_canonical\(\)](#), and [GiNaC::expairseq::overall_coeff](#).

6.93.2.7 mul() [7/7]

```
GiNaC::mul::mul (
    const ex & lh,
    const ex & mh,
    const ex & rh )
```

References [GiNaC::_ex1](#), [GiNaC::expairseq::construct_from_exvector\(\)](#), [factors](#), [GINAC_ASSERT](#), [GiNaC::expairseq::is_canonical\(\)](#), and [GiNaC::expairseq::overall_coeff](#).

6.93.3 Member Function Documentation

6.93.3.1 precedence()

```
unsigned GiNaC::mul::precedence ( ) const [inline], [override], [virtual]
```

Return relative operator precedence (for parenthezing output).

Reimplemented from [GiNaC::expairseq](#).

Referenced by [do_print\(\)](#), [do_print_csrc\(\)](#), [do_print_latex\(\)](#), and [print_overall_coeff\(\)](#).

6.93.3.2 info()

```
bool GiNaC::mul::info (
    unsigned inf ) const [override], [virtual]
```

Information about the object.

See also

class [info_flags](#)

Reimplemented from [GiNaC::expairseq](#).

References [GiNaC::_num1_p](#), [GiNaC::info_flags::cinteger](#), [GiNaC::info_flags::cinteger_polynomial](#), [GiNaC::info_flags::crational](#), [GiNaC::info_flags::crational_polynomial](#), [GiNaC::info_flags::even](#), [GiNaC::factor\(\)](#), [GiNaC::basic::flags](#), [GiNaC::info_flags::indefinite](#), [GiNaC::ex::info\(\)](#), [info\(\)](#), [GiNaC::info_flags::integer](#), [GiNaC::info_flags::integer_polynomial](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::status_flags::is_negative](#), [GiNaC::status_flags::is_positive](#), [GiNaC::info_flags::negative](#), [GiNaC::info_flags::negint](#), [GiNaC::info_flags::nonnegative](#), [GiNaC::info_flags::nonnegint](#), [GiNaC::expairseq::overall_coeff](#), [GiNaC::info_flags::polynomial](#), [GiNaC::info_flags::posint](#), [GiNaC::info_flags::positive](#), [GiNaC::status_flags::purely_indefinite](#), [GiNaC::info_flags::rational](#), [GiNaC::info_flags::rational_function](#), [GiNaC::info_flags::rational_polynomial](#), [GiNaC::info_flags::real](#), [recombine_pair_to_ex\(\)](#), [GiNaC::expairseq::seq](#), and [GiNaC::basic::setflag\(\)](#).

Referenced by [expand\(\)](#), and [info\(\)](#).

6.93.3.3 is_polynomial()

```
bool GiNaC::mul::is_polynomial (
    const ex & var ) const [override], [virtual]
```

Check whether this is a polynomial in the given variables.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::info_flags::nonnegint](#), and [GiNaC::expairseq::seq](#).

6.93.3.4 degree()

```
int GiNaC::mul::degree (
    const ex & s ) const [override], [virtual]
```

Return degree of highest power in object s.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::ex::degree\(\)](#), [recombine_pair_to_ex\(\)](#), and [GiNaC::expairseq::seq](#).

6.93.3.5 ldegree()

```
int GiNaC::mul::ldegree (
    const ex & s ) const [override], [virtual]
```

Return degree of lowest power in object s.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::ex::ldegree\(\)](#), [recombine_pair_to_ex\(\)](#), and [GiNaC::expairseq::seq](#).

6.93.3.6 coeff()

```
ex GiNaC::mul::coeff (
    const ex & s,
    int n = 1 ) const [override], [virtual]
```

Return coefficient of degree n in object s.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex0](#), [c](#), [GiNaC::ex::coeff\(\)](#), [coeff\(\)](#), [n](#), [GiNaC::expairseq::overall_coeff](#), [recombine_pair_to_ex\(\)](#), and [GiNaC::expairseq::seq](#).

Referenced by [coeff\(\)](#), and [print_overall_coeff\(\)](#).

6.93.3.7 has()

```
bool GiNaC::mul::has (
    const ex & pattern,
    unsigned options = 0 ) const [override], [virtual]
```

Test for occurrence of a pattern.

An object 'has' a pattern if it matches the pattern itself or one of the children 'has' it. As a consequence (according to the definition of children) given $e=x+y+z$, $e.has(x)$ is true but $e.has(x+y)$ is false.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::has_options::algebraic](#), [GiNaC::algebraic_match_mul_with_mul\(\)](#), [GiNaC::basic::has\(\)](#), [GiNaC::expairseq::nops\(\)](#), and [options](#).

6.93.3.8 eval()

```
ex GiNaC::mul::eval ( ) const [override], [virtual]
```

Perform automatic term rewriting rules in this class.

In the following x , x_1 , x_2 ,... stand for a symbolic variables of type `ex` and c , c_1 , c_2 ... stand for such expressions that contain a plain number.

- $*(...,x;0) \rightarrow 0$
- $*(+(x_1,x_2,...);c) \rightarrow *(*(x_1,c),*(x_2,c),...)$
- $*(x;1) \rightarrow x$
- $*(;c) \rightarrow c$

Reimplemented from [GiNaC::expairseq](#).

References [GiNaC::_ex0](#), [GiNaC::_ex1](#), [GiNaC::_num1_p](#), [GiNaC::_num_1_p](#), [c](#), [GiNaC::basic::clearflag\(\)](#), [GiNaC::ex::coeff\(\)](#), [GiNaC::add::combine_pair_with_coeff_to_pair\(\)](#), [GiNaC::numeric::div\(\)](#), [GiNaC::expairseq::evalchildren\(\)](#), [GiNaC::status_flags::evaluated](#), [GiNaC::status_flags::expanded](#), [GiNaC::basic::flags](#), [GINAC_ASSERT](#), [GiNaC::status_flags::hash_c](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::numeric::is_integer\(\)](#), [GiNaC::numeric::is_pos_integer\(\)](#), [GiNaC::ex::is_zero\(\)](#), [last](#), [likely](#), [GiNaC::numeric::mul\(\)](#), [GiNaC::expairseq::overall_coeff](#), [recombine_pair_to_ex\(\)](#), [GiNaC::expairseq::seq](#), and [unlikely](#).

Referenced by [do_print_latex\(\)](#).

6.93.3.9 evalf()

```
ex GiNaC::mul::evalf ( ) const [override], [virtual]
```

Evaluate object numerically.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::ex::evalf\(\)](#), [GiNaC::expairseq::overall_coeff](#), and [GiNaC::expairseq::seq](#).

6.93.3.10 real_part()

```
ex GiNaC::mul::real_part ( ) const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [find_real_imag\(\)](#).

6.93.3.11 imag_part()

```
ex GiNaC::mul::imag_part ( ) const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [find_real_imag\(\)](#).

6.93.3.12 evalm()

```
ex GiNaC::mul::evalm ( ) const [override], [virtual]
```

Evaluate sums, products and integer powers of matrices.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex1](#), [GiNaC::ex::end\(\)](#), [GiNaC::ex::evalm\(\)](#), [m](#), [GiNaC::expairseq::overall_coeff](#), [recombine_pair_to_ex\(\)](#), [GiNaC::expairseq::seq](#), and [split_ex_to_pair\(\)](#).

6.93.3.13 series()

```
ex GiNaC::mul::series (
    const relational & r,
    int order,
    unsigned options = 0 ) const [override], [virtual]
```

Implementation of [ex::series\(\)](#) for product.

This performs series multiplication when multiplying series.

See also

[ex::series](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex1](#), [GiNaC::ex::coeff\(\)](#), [GiNaC::ex::expand\(\)](#), [GiNaC::factor\(\)](#), [GINAC_ASSERT](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::integer](#), [GiNaC::ex::lddegree\(\)](#), [GiNaC::pseries::mul_const\(\)](#), [GiNaC::pseries::mul_series\(\)](#), [GiNaC::expairseq::op\(\)](#), [options](#), [order](#), [GiNaC::expairseq::overall_coeff](#), [r](#), [recombine_pair_to_ex\(\)](#), [GiNaC::expairseq::seq](#), and [GiNaC::ex::series\(\)](#).

6.93.3.14 normal()

```
ex GiNaC::mul::normal (
    exmap & repl,
    exmap & rev_lookup,
    lst & modifier ) const [override], [virtual]
```

Implementation of [ex::normal\(\)](#) for a product.

It cancels common factors from fractions.

See also

[ex::normal\(\)](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::frac_cancel\(\)](#), [n](#), [GiNaC::subs_options::no_pattern](#), [GiNaC::container< C >::nops\(\)](#), [GiNaC::container< C >::op\(\)](#), [GiNaC::expairseq::overall_coeff](#), [recombine_pair_to_ex\(\)](#), and [GiNaC::expairseq::seq](#).

6.93.3.15 integer_content()

```
numeric GiNaC::mul::integer_content ( ) const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::abs\(\)](#), [GINAC_ASSERT](#), [GiNaC::expairseq::overall_coeff](#), [recombine_pair_to_ex\(\)](#), and [GiNaC::expairseq::seq](#).

6.93.3.16 smod()

```
ex GiNaC::mul::smod (
    const numeric & xi ) const [override], [virtual]
```

Apply symmetric modular homomorphism to an expanded multivariate polynomial.

This function is usually used internally by [heur_gcd\(\)](#).

Parameters

xi	modulus
------	---------

Returns

mapped polynomial

See also

[heur_gcd](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::clearflag\(\)](#), [GiNaC::status_flags::evaluated](#), [GINAC_ASSERT](#), [GiNaC::status_flags::hash_calculated](#), [GiNaC::expairseq::overall_coeff](#), [recombine_pair_to_ex\(\)](#), [GiNaC::expairseq::seq](#), and [GiNaC::smod\(\)](#).

6.93.3.17 max_coefficient()

```
numeric GiNaC::mul::max_coefficient ( ) const [override], [virtual]
```

Implementation [ex::max_coefficient\(\)](#).

See also

[heur_gcd](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::abs\(\)](#), [GINAC_ASSERT](#), [GiNaC::expairseq::overall_coeff](#), [recombine_pair_to_ex\(\)](#), and [GiNaC::expairseq::seq](#).

6.93.3.18 get_free_indices()

```
exvector GiNaC::mul::get_free_indices ( ) const [override], [virtual]
```

Return a vector containing the free indices of an expression.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::find_free_and_dummy\(\)](#), [GiNaC::ex::get_free_indices\(\)](#), [GiNaC::expairseq::nops\(\)](#), and [GiNaC::expairseq::op\(\)](#).

6.93.3.19 conjugate()

```
ex GiNaC::mul::conjugate ( ) const [override], [virtual]
```

Reimplemented from [GiNaC::expairseq](#).

References [GiNaC::are_ex_trivially_equal\(\)](#), [c](#), [GiNaC::ex::conjugate\(\)](#), [GiNaC::expairseq::overall_coeff](#), [recombine_pair_to_ex\(\)](#), [GiNaC::expairseq::seq](#), [split_ex_to_pair\(\)](#), [thisexpairseq\(\)](#), and [x](#).

6.93.3.20 derivative()

```
ex GiNaC::mul::derivative (
    const symbol & s ) const [override], [protected], [virtual]
```

Implementation of [ex::diff\(\)](#) for a product.

It applies the product rule.

See also

[ex::diff](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex1](#), [GiNaC::ex::coeff\(\)](#), [GiNaC::basic::diff\(\)](#), [GiNaC::expairseq::overall_coeff](#), [GiNaC::pow\(\)](#), [GiNaC::expairseq::seq](#), [split_ex_to_pair\(\)](#), and [GiNaC::expair::swap\(\)](#).

6.93.3.21 eval_ncmul()

```
ex GiNaC::mul::eval_ncmul (
    const exvector & v ) const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::return_types::noncommutative](#), and [GiNaC::expairseq::seq](#).

6.93.3.22 return_type()

```
unsigned GiNaC::mul::return_type ( ) const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::expairseq](#).

References [GiNaC::return_types::commutative](#), [GiNaC::return_types::noncommutative](#), [GiNaC::return_types::noncommutative_comp](#) and [GiNaC::expairseq::seq](#).

6.93.3.23 return_type_tinfo()

```
return\_type\_t GiNaC::mul::return_type_tinfo ( ) const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::return_types::noncommutative](#), and [GiNaC::expairseq::seq](#).

6.93.3.24 thisexpairseq() [1/2]

```
ex GiNaC::mul::thisexpairseq (
    const epvector & v,
    const ex & oc,
    bool do_index_renaming = false ) const [override], [protected], [virtual]
```

Create an object of this type.

This method works similar to a constructor. It is useful because expairseq has (at least) two possible different semantics but we want to inherit methods thus avoiding code duplication. Sometimes a method in expairseq has to create a new one of the same semantics, which cannot be done by a ctor because the name (add, mul,...) is unknown on the expairseq level. In order for this trick to work a derived class must of course override this definition.

Reimplemented from [GiNaC::expairseq](#).

Referenced by [conjugate\(\)](#).

6.93.3.25 thisexpairseq() [2/2]

```
ex GiNaC::mul::thisexpairseq (
    epvector && vp,
    const ex & oc,
    bool do_index_renaming = false ) const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::expairseq](#).

6.93.3.26 split_ex_to_pair()

```
expair GiNaC::mul::split_ex_to_pair (
    const ex & e ) const [override], [protected], [virtual]
```

Form an expair from an ex, using the corresponding semantics.

See also

[expairseq::recombine_pair_to_ex\(\)](#)

Reimplemented from [GiNaC::expairseq](#).

References [GiNaC::_ex1](#), [GiNaC::power::basis](#), and [GiNaC::power::exponent](#).

Referenced by [combine_ex_with_coeff_to_pair\(\)](#), [combine_pair_with_coeff_to_pair\(\)](#), [conjugate\(\)](#), [derivative\(\)](#), [evalm\(\)](#), [expair_needs_further_processing\(\)](#), [expand\(\)](#), and [expandchildren\(\)](#).

6.93.3.27 combine_ex_with_coeff_to_pair()

```

expair GiNaC::mul::combine_ex_with_coeff_to_pair (
    const ex & e,
    const ex & c ) const [override], [protected], [virtual]

```

Reimplemented from [GiNaC::expairseq](#).

References [GiNaC::_ex1](#), [c](#), [GINAC_ASSERT](#), [GiNaC::pow\(\)](#), and [split_ex_to_pair\(\)](#).

6.93.3.28 combine_pair_with_coeff_to_pair()

```

expair GiNaC::mul::combine_pair_with_coeff_to_pair (
    const expair & p,
    const ex & c ) const [override], [protected], [virtual]

```

Reimplemented from [GiNaC::expairseq](#).

References [GiNaC::_ex1](#), [c](#), [GiNaC::expair::coeff](#), [GINAC_ASSERT](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::pow\(\)](#), [recombine_pair_to_ex\(\)](#), [GiNaC::expair::rest](#), and [split_ex_to_pair\(\)](#).

6.93.3.29 recombine_pair_to_ex()

```

ex GiNaC::mul::recombine_pair_to_ex (
    const expair & p ) const [override], [protected], [virtual]

```

Form an ex out of an expair, using the corresponding semantics.

See also

[expairseq::split_ex_to_pair\(\)](#)

Reimplemented from [GiNaC::expairseq](#).

References [GiNaC::_ex1](#), [GiNaC::expair::coeff](#), [GiNaC::ex::is_equal\(\)](#), and [GiNaC::expair::rest](#).

Referenced by [coeff\(\)](#), [combine_pair_with_coeff_to_pair\(\)](#), [conjugate\(\)](#), [degree\(\)](#), [do_print\(\)](#), [do_print_latex\(\)](#), [eval\(\)](#), [evalm\(\)](#), [expair_needs_further_processing\(\)](#), [expandchildren\(\)](#), [find_real_imag\(\)](#), [info\(\)](#), [integer_content\(\)](#), [ldegree\(\)](#), [max_coefficient\(\)](#), [normal\(\)](#), [series\(\)](#), and [smod\(\)](#).

6.93.3.30 expair_needs_further_processing()

```

bool GiNaC::mul::expair_needs_further_processing (
    epp it ) [override], [protected], [virtual]

```

Reimplemented from [GiNaC::expairseq](#).

References [GiNaC::_ex1](#), [GiNaC::expair::is_equal\(\)](#), [recombine_pair_to_ex\(\)](#), and [split_ex_to_pair\(\)](#).

6.93.3.31 default_overall_coeff()

```
ex GiNaC::mul::default_overall_coeff ( ) const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::expairseq](#).

References [GiNaC::_ex1](#).

6.93.3.32 combine_overall_coeff() [1/2]

```
void GiNaC::mul::combine_overall_coeff (
    const ex & c ) [override], [protected], [virtual]
```

Reimplemented from [GiNaC::expairseq](#).

References [c](#), [GINAC_ASSERT](#), and [GiNaC::expairseq::overall_coeff](#).

6.93.3.33 combine_overall_coeff() [2/2]

```
void GiNaC::mul::combine_overall_coeff (
    const ex & c1,
    const ex & c2 ) [override], [protected], [virtual]
```

Reimplemented from [GiNaC::expairseq](#).

References [GINAC_ASSERT](#), [GiNaC::expairseq::overall_coeff](#), and [power](#).

6.93.3.34 can_make_flat()

```
bool GiNaC::mul::can_make_flat (
    const expair & p ) const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::expairseq](#).

References [GiNaC::expair::coeff](#), [GINAC_ASSERT](#), [GiNaC::ex::info\(\)](#), and [GiNaC::info_flags::integer](#).

6.93.3.35 expand()

```
ex GiNaC::mul::expand (
    unsigned options = 0 ) const [override], [protected], [virtual]
```

Expand expression, i.e.

multiply it out and return the result as a new expression.

Reimplemented from [GiNaC::expairseq](#).

References [GiNaC::_ex1](#), [GiNaC::_num0_p](#), [can_be_further_expanded\(\)](#), [GiNaC::ex::expand\(\)](#), [GiNaC::expand_options::expand_ren](#), [expandchildren\(\)](#), [GiNaC::status_flags::expanded](#), [factors](#), [GiNaC::get_all_dummy_indices_safely\(\)](#), [GiNaC::info_flags::has_indices](#), [info\(\)](#), [GiNaC::info_flags::integer](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::ex::is_zero\(\)](#), [GiNaC::numeric::mul\(\)](#), [n](#), [GiNaC::subs_options::no_pattern](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), [GiNaC::container< C >::op\(\)](#), [options](#), [GiNaC::expairseq::overall_coeff](#), [GiNaC::rename_dummy_indices_uniquely\(\)](#), [GiNaC::expairseq::seq](#), [GiNaC::basic::setflag\(\)](#), and [split_ex_to_pair\(\)](#).

6.93.3.36 algebraic_subs_mul()

```
ex GiNaC::mul::algebraic_subs_mul (
    const exmap & m,
    unsigned options ) const
```

References [GiNaC::subs_options::algebraic](#), [GiNaC::algebraic_match_mul_with_mul\(\)](#), [m](#), [GiNaC::subs_options::no_pattern](#), [GiNaC::expairseq::nops\(\)](#), [GiNaC::expairseq::op\(\)](#), [options](#), [GiNaC::pow\(\)](#), [GiNaC::ex::subs\(\)](#), [GiNaC::basic::subs_one_level\(\)](#), and [GiNaC::tryfactsubs\(\)](#).

6.93.3.37 find_real_imag()

```
void GiNaC::mul::find_real_imag (
    ex & rp,
    ex & ip ) const [protected]
```

References [GiNaC::ex::expand\(\)](#), [GiNaC::factor\(\)](#), [GiNaC::ex::imag_part\(\)](#), [GiNaC::ex::is_zero\(\)](#), [GiNaC::expairseq::overall_coeff](#), [GiNaC::ex::real_part\(\)](#), [recombine_pair_to_ex\(\)](#), and [GiNaC::expairseq::seq](#).

Referenced by [imag_part\(\)](#), and [real_part\(\)](#).

6.93.3.38 print_overall_coeff()

```
void GiNaC::mul::print_overall_coeff (
    const print_context & c,
    const char * mul_sym ) const [protected]
```

References [GiNaC::_num1_p](#), [GiNaC::_num_1_p](#), [c](#), [coeff\(\)](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::expairseq::overall_coeff](#), [precedence\(\)](#), [GiNaC::basic::print\(\)](#), and [GiNaC::ex::print\(\)](#).

Referenced by [do_print\(\)](#), and [do_print_latex\(\)](#).

6.93.3.39 do_print()

```
void GiNaC::mul::do_print (
    const print\_context & c,
    unsigned level ) const [protected]
```

References [c](#), [precedence\(\)](#), [GiNaC::ex::print\(\)](#), [print_overall_coeff\(\)](#), [recombine_pair_to_ex\(\)](#), and [GiNaC::expairseq::seq](#).

6.93.3.40 do_print_latex()

```
void GiNaC::mul::do_print_latex (
    const print\_latex & c,
    unsigned level ) const [protected]
```

References [c](#), [eval\(\)](#), [GINAC_ASSERT](#), [precedence\(\)](#), [GiNaC::ex::print\(\)](#), [print_overall_coeff\(\)](#), [recombine_pair_to_ex\(\)](#), and [GiNaC::expairseq::seq](#).

6.93.3.41 do_print_csrc()

```
void GiNaC::mul::do_print_csrc (
    const print\_csrc & c,
    unsigned level ) const [protected]
```

References [GiNaC::_ex1](#), [GiNaC::_ex_1](#), [c](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::info_flags::negint](#), [GiNaC::expairseq::overall_coeff](#), [power](#), [precedence\(\)](#), [GiNaC::ex::print\(\)](#), and [GiNaC::expairseq::seq](#).

6.93.3.42 do_print_python_repr()

```
void GiNaC::mul::do_print_python_repr (
    const print\_python\_repr & c,
    unsigned level ) const [protected]
```

References [c](#), [GiNaC::expairseq::nops\(\)](#), [GiNaC::expairseq::op\(\)](#), and [GiNaC::ex::print\(\)](#).

6.93.3.43 can_be_further_expanded()

```
bool GiNaC::mul::can_be_further_expanded (
    const ex & e ) [static], [protected]
```

References [GiNaC::ex::info\(\)](#), [GiNaC::ex::op\(\)](#), [GiNaC::info_flags::posint](#), and [GiNaC::expairseq::seq](#).

Referenced by [expand\(\)](#).

6.93.3.44 `expandchildren()`

```
epvector GiNaC::mul::expandchildren (
    unsigned options ) const [protected]
```

Member-wise expand the expairs representing this sequence.

This must be overridden from [expairseq::expandchildren\(\)](#) and done iteratively in order to allow for early cancellations and thus save memory.

See also

[mul::expand\(\)](#)

Returns

epvector containing expanded pairs, empty if no members had to be changed.

References [GiNaC::are_ex_trivially_equal\(\)](#), [GiNaC::ex::expand\(\)](#), [GiNaC::factor\(\)](#), [last](#), [options](#), [recombine_pair_to_ex\(\)](#), [GiNaC::expairseq::seq](#), and [split_ex_to_pair\(\)](#).

Referenced by [expand\(\)](#).

6.93.4 Friends And Related Function Documentation

6.93.4.1 `add`

```
friend class add [friend]
```

6.93.4.2 `ncmul`

```
friend class ncmul [friend]
```

6.93.4.3 `power`

```
friend class power [friend]
```

Referenced by [combine_overall_coeff\(\)](#), and [do_print_csrc\(\)](#).

The documentation for this class was generated from the following files:

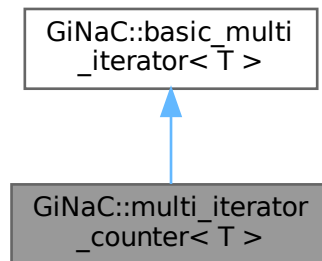
- [mul.h](#)
- [indexed.cpp](#)
- [mul.cpp](#)
- [normal.cpp](#)
- [pseries.cpp](#)

6.94 GiNaC::multi_iterator_counter< T > Class Template Reference

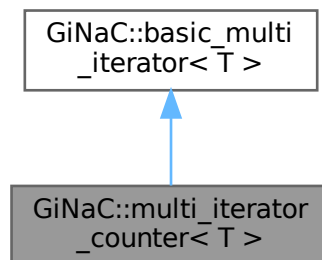
The class `multi_iterator_counter` defines a `multi_iterator` (i_1, i_2, \dots, i_k) , such that.

```
#include <utils_multi_iterator.h>
```

Inheritance diagram for `GiNaC::multi_iterator_counter< T >`:



Collaboration diagram for `GiNaC::multi_iterator_counter< T >`:



Public Member Functions

- `multi_iterator_counter` (void)
Default constructor.
- `multi_iterator_counter` (T B, T N, size_t k)
Construct a multi_iterator with upper limit N and size k.
- `multi_iterator_counter` (T B, T N, const std::vector< T > &vv)
Construct from a vector.
- `basic_multi_iterator< T > & init` (void)
Initialize the multi-index to.
- `basic_multi_iterator< T > & operator++` (int)
The postfix increment operator allows to write for a multi-index n++, which will update n to the next configuration.

Public Member Functions inherited from [GiNaC::basic_multi_iterator< T >](#)

- [basic_multi_iterator](#) (void)
Default constructor.
- [basic_multi_iterator](#) (T [B](#), T [N](#), size_t [k](#))
Construct a multi_iterator with upper limit N, lower limit B and size k .
- [basic_multi_iterator](#) (T [B](#), T [N](#), const std::vector< T > &vv)
Construct from a vector.
- virtual [~basic_multi_iterator](#) ()
Destructor.
- size_t [size](#) (void) const
Returns the size of a multi_iterator.
- bool [overflow](#) (void) const
Return the overflow flag.
- const std::vector< T > & [get_vector](#) (void) const
Returns a reference to the vector v.
- T [operator\[\]](#) (size_t i) const
Subscription via [].
- T & [operator\[\]](#) (size_t i)
Subscription via [].
- T [operator\(\)](#) (size_t i) const
Subscription via ().
- T & [operator\(\)](#) (size_t i)
Subscription via ().
- virtual [basic_multi_iterator](#)< T > & [init](#) (void)
Initialize the multi-index to.
- virtual [basic_multi_iterator](#)< T > & [operator++](#) (int)
No effect for basic_multi_iterator.

Friends

- template<class TT >
std::ostream & [operator<<](#) (std::ostream &os, const [multi_iterator_counter](#)< TT > &v)

Additional Inherited Members

Protected Attributes inherited from [GiNaC::basic_multi_iterator< T >](#)

- T [N](#)
- T [B](#)
- std::vector< T > [v](#)
- bool [flag_overflow](#)

6.94.1 Detailed Description

```
template<class T>
class GiNaC::multi_iterator_counter< T >
```

The class [multi_iterator_counter](#) defines a multi_iterator (i_1, i_2, \dots, i_k) , such that.

$$B \leq i_j < N$$

6.94.2 Constructor & Destructor Documentation

6.94.2.1 multi_iterator_counter() [1/3]

```
template<class T >
GiNaC::multi_iterator_counter< T >::multi_iterator_counter (
    void ) [inline]
```

Default constructor.

6.94.2.2 multi_iterator_counter() [2/3]

```
template<class T >
GiNaC::multi_iterator_counter< T >::multi_iterator_counter (
    T B,
    T N,
    size_t k ) [inline], [explicit]
```

Construct a multi_iterator with upper limit N and size k .

6.94.2.3 multi_iterator_counter() [3/3]

```
template<class T >
GiNaC::multi_iterator_counter< T >::multi_iterator_counter (
    T B,
    T N,
    const std::vector< T > & vv ) [inline], [explicit]
```

Construct from a vector.

6.94.3 Member Function Documentation

6.94.3.1 init()

```
template<class T >
basic_multi_iterator< T > & GiNaC::multi_iterator_counter< T >::init (
    void ) [inline], [virtual]
```

Initialize the multi-index to.

$$(n_1, n_2, n_3, \dots, n_k) = (B, B, \dots, B)$$

Reimplemented from [GiNaC::basic_multi_iterator< T >](#).

6.94.3.2 operator++()

```
template<class T >
basic_multi_iterator< T > & GiNaC::multi_iterator_counter< T >::operator++ (
    int ) [inline], [virtual]
```

The postfix increment operator allows to write for a multi-index $n++$, which will update n to the next configuration.

If n is in the last configuration and the increment operator $++$ is applied to n , the overflow flag will be raised.

Reimplemented from [GiNaC::basic_multi_iterator< T >](#).

References [k](#).

6.94.4 Friends And Related Function Documentation

6.94.4.1 operator<<

```
template<class T >
template<class TT >
std::ostream & operator<< (
    std::ostream & os,
    const multi_iterator_counter< TT > & v ) [friend]
```

The documentation for this class was generated from the following file:

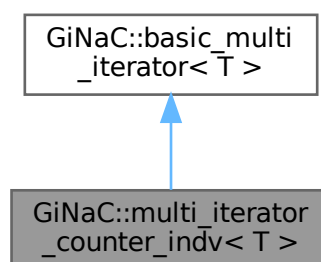
- [utils_multi_iterator.h](#)

6.95 GiNaC::multi_iterator_counter_indv< T > Class Template Reference

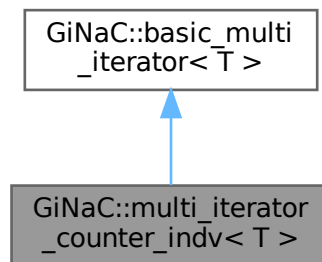
The class [multi_iterator_counter_indv](#) defines a multi_iterator (i_1, i_2, \dots, i_k) , such that.

```
#include <utils_multi_iterator.h>
```

Inheritance diagram for [GiNaC::multi_iterator_counter_indv< T >](#):



Collaboration diagram for GiNaC::multi_iterator_counter_indv< T >:



Public Member Functions

- `multi_iterator_counter_indv` (void)
Default constructor.
- `multi_iterator_counter_indv` (T B, const std::vector< T > &Nv, size_t k)
Construct a multi_iterator with upper limit N and size k .
- `multi_iterator_counter_indv` (T B, const std::vector< T > &Nv, const std::vector< T > &vv)
Construct from a vector.
- `basic_multi_iterator< T > &init` (void)
Initialize the multi-index to.
- `basic_multi_iterator< T > &operator++` (int)
The postfix increment operator allows to write for a multi-index n++, which will update n to the next configuration.

Public Member Functions inherited from `GiNaC::basic_multi_iterator< T >`

- `basic_multi_iterator` (void)
Default constructor.
- `basic_multi_iterator` (T B, T N, size_t k)
Construct a multi_iterator with upper limit N, lower limit B and size k .
- `basic_multi_iterator` (T B, T N, const std::vector< T > &vv)
Construct from a vector.
- virtual `~basic_multi_iterator` ()
Destructor.
- `size_t size` (void) const
Returns the size of a multi_iterator.
- `bool overflow` (void) const
Return the overflow flag.
- `const std::vector< T > &get_vector` (void) const
Returns a reference to the vector v.
- `T operator[]` (size_t i) const
Subscription via [].
- `T &operator[]` (size_t i)
Subscription via [].

- `T operator() (size_t i) const`
Subscription via ()
- `T & operator() (size_t i)`
Subscription via ()
- virtual `basic_multi_iterator< T > & init (void)`
Initialize the multi-index to.
- virtual `basic_multi_iterator< T > & operator++ (int)`
No effect for `basic_multi_iterator`.

Protected Attributes

- `std::vector< T > Nv`

Protected Attributes inherited from `GiNaC::basic_multi_iterator< T >`

- `T N`
- `T B`
- `std::vector< T > v`
- `bool flag_overflow`

Friends

- `template<class TT >`
`std::ostream & operator<< (std::ostream &os, const multi_iterator_counter_indv< TT > &v)`

6.95.1 Detailed Description

```
template<class T>
class GiNaC::multi_iterator_counter_indv< T >
```

The class `multi_iterator_counter_indv` defines a `multi_iterator` (i_1, i_2, \dots, i_k) , such that.

$$B \leq i_j < N_j$$

6.95.2 Constructor & Destructor Documentation

6.95.2.1 `multi_iterator_counter_indv()` [1/3]

```
template<class T >
GiNaC::multi_iterator_counter_indv< T >::multi_iterator_counter_indv (
    void ) [inline]
```

Default constructor.

6.95.2.2 multi_iterator_counter_indv() [2/3]

```
template<class T >
GiNaC::multi_iterator_counter_indv< T >::multi_iterator_counter_indv (
    T B,
    const std::vector< T > & Nv,
    size_t k ) [inline], [explicit]
```

Construct a multi_iterator with upper limit N and size k .

6.95.2.3 multi_iterator_counter_indv() [3/3]

```
template<class T >
GiNaC::multi_iterator_counter_indv< T >::multi_iterator_counter_indv (
    T B,
    const std::vector< T > & Nv,
    const std::vector< T > & vv ) [inline], [explicit]
```

Construct from a vector.

6.95.3 Member Function Documentation**6.95.3.1 init()**

```
template<class T >
basic_multi_iterator< T > & GiNaC::multi_iterator_counter_indv< T >::init (
    void ) [inline], [virtual]
```

Initialize the multi-index to.

$$(n_1, n_2, n_3, \dots, n_k) = (B, B, \dots, B)$$

Reimplemented from [GiNaC::basic_multi_iterator< T >](#).

6.95.3.2 operator++()

```
template<class T >
basic_multi_iterator< T > & GiNaC::multi_iterator_counter_indv< T >::operator++ (
    int ) [inline], [virtual]
```

The postfix increment operator allows to write for a multi-index n++, which will update n to the next configuration.

If n is in the last configuration and the increment operator ++ is applied to n, the overflow flag will be raised.

Reimplemented from [GiNaC::basic_multi_iterator< T >](#).

References [k](#).

6.95.4 Friends And Related Function Documentation

6.95.4.1 operator<<

```
template<class T >
template<class TT >
std::ostream & operator<< (
    std::ostream & os,
    const multi_iterator_counter_indv< TT > & v ) [friend]
```

6.95.5 Member Data Documentation

6.95.5.1 Nv

```
template<class T >
std::vector<T> GiNaC::multi_iterator_counter_indv< T >::Nv [protected]
```

The documentation for this class was generated from the following file:

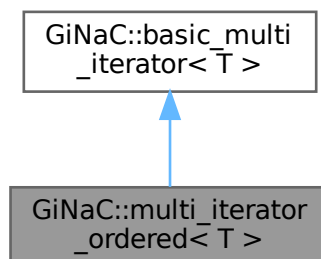
- [utils_multi_iterator.h](#)

6.96 GiNaC::multi_iterator_ordered< T > Class Template Reference

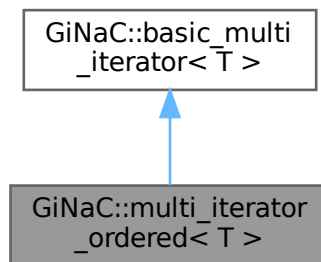
The class [multi_iterator_ordered](#) defines a multi_iterator (i_1, i_2, \dots, i_k) , such that.

```
#include <utils_multi_iterator.h>
```

Inheritance diagram for GiNaC::multi_iterator_ordered< T >:



Collaboration diagram for GiNaC::multi_iterator_ordered< T >:



Public Member Functions

- `multi_iterator_ordered` (void)
Default constructor.
- `multi_iterator_ordered` (T B, T N, size_t k)
Construct a multi_iterator with upper limit N and size k.
- `multi_iterator_ordered` (T B, T N, const std::vector< T > &vv)
Construct from a vector.
- `basic_multi_iterator< T > &init` (void)
Initialize the multi-index to.
- `basic_multi_iterator< T > &operator++` (int)
The postfix increment operator allows to write for a multi-index n++, which will update n to the next configuration.

Public Member Functions inherited from `GiNaC::basic_multi_iterator< T >`

- `basic_multi_iterator` (void)
Default constructor.
- `basic_multi_iterator` (T B, T N, size_t k)
Construct a multi_iterator with upper limit N, lower limit B and size k.
- `basic_multi_iterator` (T B, T N, const std::vector< T > &vv)
Construct from a vector.
- virtual `~basic_multi_iterator` ()
Destructor.
- size_t `size` (void) const
Returns the size of a multi_iterator.
- bool `overflow` (void) const
Return the overflow flag.
- const std::vector< T > &`get_vector` (void) const
Returns a reference to the vector v.
- T `operator[]` (size_t i) const
Subscription via [].
- T &`operator[]` (size_t i)
Subscription via [].

- `T operator() (size_t i) const`
Subscription via ()
- `T & operator() (size_t i)`
Subscription via ()
- virtual `basic_multi_iterator< T > & init (void)`
Initialize the multi-index to.
- virtual `basic_multi_iterator< T > & operator++ (int)`
No effect for `basic_multi_iterator`.

Friends

- `template<class TT >`
`std::ostream & operator<< (std::ostream &os, const multi_iterator_ordered< TT > &v)`

Additional Inherited Members

Protected Attributes inherited from `GiNaC::basic_multi_iterator< T >`

- `T N`
- `T B`
- `std::vector< T > v`
- `bool flag_overflow`

6.96.1 Detailed Description

```
template<class T>
class GiNaC::multi_iterator_ordered< T >
```

The class `multi_iterator_ordered` defines a `multi_iterator` (i_1, i_2, \dots, i_k) , such that.

$$B \leq i_j < N$$

and

$$i_j < i_{j+1}.$$

It is assumed that $k > 0$ and $N - B \geq k$.

6.96.2 Constructor & Destructor Documentation

6.96.2.1 `multi_iterator_ordered()` [1/3]

```
template<class T >
GiNaC::multi_iterator_ordered< T >::multi_iterator_ordered (
    void ) [inline]
```

Default constructor.

6.96.2.2 multi_iterator_ordered() [2/3]

```
template<class T >
GiNaC::multi_iterator_ordered< T >::multi_iterator_ordered (
    T B,
    T N,
    size_t k ) [inline], [explicit]
```

Construct a multi_iterator with upper limit N and size k .

6.96.2.3 multi_iterator_ordered() [3/3]

```
template<class T >
GiNaC::multi_iterator_ordered< T >::multi_iterator_ordered (
    T B,
    T N,
    const std::vector< T > & vv ) [inline], [explicit]
```

Construct from a vector.

6.96.3 Member Function Documentation**6.96.3.1 init()**

```
template<class T >
basic_multi_iterator< T > & GiNaC::multi_iterator_ordered< T >::init (
    void ) [inline], [virtual]
```

Initialize the multi-index to.

$$(n_1, n_2, n_3, \dots, n_k) = (B + 0, B + 1, B + 2, \dots, B + k - 1)$$

Reimplemented from [GiNaC::basic_multi_iterator< T >](#).

6.96.3.2 operator++()

```
template<class T >
basic_multi_iterator< T > & GiNaC::multi_iterator_ordered< T >::operator++ (
    int ) [inline], [virtual]
```

The postfix increment operator allows to write for a multi-index n++, which will update n to the next configuration.

If n is in the last configuration and the increment operator ++ is applied to n, the overflow flag will be raised.

Reimplemented from [GiNaC::basic_multi_iterator< T >](#).

References [k](#).

6.96.4 Friends And Related Function Documentation

6.96.4.1 `operator<<`

```
template<class T >
template<class TT >
std::ostream & operator<< (
    std::ostream & os,
    const multi_iterator_ordered< TT > & v ) [friend]
```

The documentation for this class was generated from the following file:

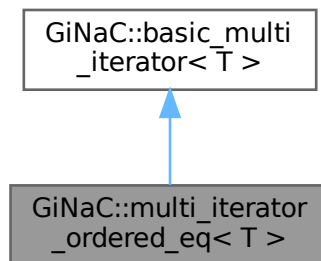
- [utils_multi_iterator.h](#)

6.97 GiNaC::multi_iterator_ordered_eq< T > Class Template Reference

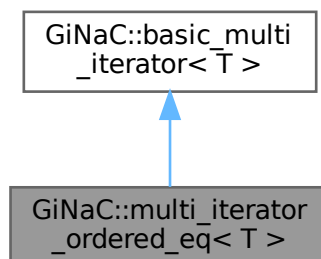
The class `multi_iterator_ordered_eq` defines a multi_iterator (i_1, i_2, \dots, i_k) , such that.

```
#include <utils_multi_iterator.h>
```

Inheritance diagram for GiNaC::multi_iterator_ordered_eq< T >:



Collaboration diagram for GiNaC::multi_iterator_ordered_eq< T >:



Public Member Functions

- [multi_iterator_ordered_eq](#) (void)
Default constructor.
- [multi_iterator_ordered_eq](#) (T B, T N, size_t k)
Construct a multi_iterator with upper limit N and size k.
- [multi_iterator_ordered_eq](#) (T B, T N, const std::vector< T > &vv)
Construct from a vector.
- [basic_multi_iterator](#)< T > & [init](#) (void)
Initialize the multi-index to.
- [basic_multi_iterator](#)< T > & [operator++](#) (int)
The postfix increment operator allows to write for a multi-index n++, which will update n to the next configuration.

Public Member Functions inherited from [GiNaC::basic_multi_iterator](#)< T >

- [basic_multi_iterator](#) (void)
Default constructor.
- [basic_multi_iterator](#) (T B, T N, size_t k)
Construct a multi_iterator with upper limit N, lower limit B and size k.
- [basic_multi_iterator](#) (T B, T N, const std::vector< T > &vv)
Construct from a vector.
- virtual [~basic_multi_iterator](#) ()
Destructor.
- size_t [size](#) (void) const
Returns the size of a multi_iterator.
- bool [overflow](#) (void) const
Return the overflow flag.
- const std::vector< T > & [get_vector](#) (void) const
Returns a reference to the vector v.
- T [operator\[\]](#) (size_t i) const
Subscription via [].
- T & [operator\[\]](#) (size_t i)
Subscription via [].
- T [operator\(\)](#) (size_t i) const
Subscription via ().
- T & [operator\(\)](#) (size_t i)
Subscription via ().
- virtual [basic_multi_iterator](#)< T > & [init](#) (void)
Initialize the multi-index to.
- virtual [basic_multi_iterator](#)< T > & [operator++](#) (int)
No effect for [basic_multi_iterator](#).

Friends

- template<class TT >
std::ostream & [operator<<](#) (std::ostream &os, const [multi_iterator_ordered_eq](#)< TT > &v)

Additional Inherited Members

Protected Attributes inherited from [GiNaC::basic_multi_iterator< T >](#)

- [T N](#)
- [T B](#)
- `std::vector< T > v`
- `bool flag_overflow`

6.97.1 Detailed Description

```
template<class T>
class GiNaC::multi_iterator_ordered_eq< T >
```

The class [multi_iterator_ordered_eq](#) defines a `multi_iterator` (i_1, i_2, \dots, i_k) , such that.

$$B \leq i_j < N$$

and

$$i_j \leq i_{j+1}.$$

It is assumed that $k > 0$.

6.97.2 Constructor & Destructor Documentation

6.97.2.1 `multi_iterator_ordered_eq()` [1/3]

```
template<class T >
GiNaC::multi_iterator_ordered_eq< T >::multi_iterator_ordered_eq (
    void ) [inline]
```

Default constructor.

6.97.2.2 `multi_iterator_ordered_eq()` [2/3]

```
template<class T >
GiNaC::multi_iterator_ordered_eq< T >::multi_iterator_ordered_eq (
    T B,
    T N,
    size_t k ) [inline], [explicit]
```

Construct a `multi_iterator` with upper limit N and size k .

6.97.2.3 multi_iterator_ordered_eq() [3/3]

```
template<class T >
GiNaC::multi_iterator_ordered_eq< T >::multi_iterator_ordered_eq (
    T B,
    T N,
    const std::vector< T > & vv ) [inline], [explicit]
```

Construct from a vector.

6.97.3 Member Function Documentation**6.97.3.1 init()**

```
template<class T >
basic_multi_iterator< T > & GiNaC::multi_iterator_ordered_eq< T >::init (
    void ) [inline], [virtual]
```

Initialize the multi-index to.

$$(n_1, n_2, \dots, n_k) = (B, B, \dots, B)$$

Reimplemented from [GiNaC::basic_multi_iterator< T >](#).

6.97.3.2 operator++()

```
template<class T >
basic_multi_iterator< T > & GiNaC::multi_iterator_ordered_eq< T >::operator++ (
    int ) [inline], [virtual]
```

The postfix increment operator allows to write for a multi-index $n++$, which will update n to the next configuration.

If n is in the last configuration and the increment operator $++$ is applied to n , the overflow flag will be raised.

Reimplemented from [GiNaC::basic_multi_iterator< T >](#).

References [k](#).

6.97.4 Friends And Related Function Documentation

6.97.4.1 operator<<

```
template<class T >
template<class TT >
std::ostream & operator<< (
    std::ostream & os,
    const multi_iterator_ordered_eq< TT > & v ) [friend]
```

The documentation for this class was generated from the following file:

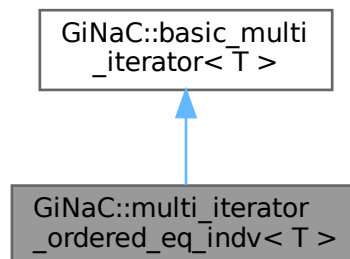
- [utils_multi_iterator.h](#)

6.98 GiNaC::multi_iterator_ordered_eq_indv< T > Class Template Reference

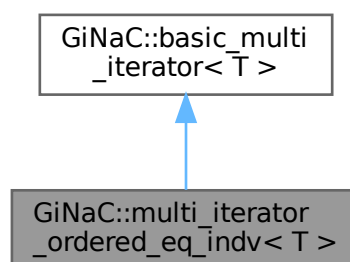
The class [multi_iterator_ordered_eq_indv](#) defines a multi_iterator (i_1, i_2, \dots, i_k) , such that.

```
#include <utils_multi_iterator.h>
```

Inheritance diagram for GiNaC::multi_iterator_ordered_eq_indv< T >:



Collaboration diagram for GiNaC::multi_iterator_ordered_eq_indv< T >:



Public Member Functions

- [multi_iterator_ordered_eq_indv](#) (void)
Default constructor.
- [multi_iterator_ordered_eq_indv](#) (T B, const std::vector< T > &Nv, size_t k)
Construct a multi_iterator with upper limit N and size k .
- [multi_iterator_ordered_eq_indv](#) (T B, const std::vector< T > &Nv, const std::vector< T > &vv)
Construct from a vector.
- [basic_multi_iterator](#)< T > &init (void)
Initialize the multi-index to.
- [basic_multi_iterator](#)< T > &operator++ (int)
The postfix increment operator allows to write for a multi-index n++, which will update n to the next configuration.

Public Member Functions inherited from [GiNaC::basic_multi_iterator< T >](#)

- [basic_multi_iterator](#) (void)
Default constructor.
- [basic_multi_iterator](#) (T B, T N, size_t k)
Construct a multi_iterator with upper limit N, lower limit B and size k .
- [basic_multi_iterator](#) (T B, T N, const std::vector< T > &vv)
Construct from a vector.
- virtual [~basic_multi_iterator](#) ()
Destructor.
- size_t [size](#) (void) const
Returns the size of a multi_iterator.
- bool [overflow](#) (void) const
Return the overflow flag.
- const std::vector< T > &[get_vector](#) (void) const
Returns a reference to the vector v.
- T [operator\[\]](#) (size_t i) const
Subscription via [].
- T &[operator\[\]](#) (size_t i)
Subscription via [].
- T [operator\(\)](#) (size_t i) const
Subscription via ().
- T &[operator\(\)](#) (size_t i)
Subscription via ().
- virtual [basic_multi_iterator](#)< T > &init (void)
Initialize the multi-index to.
- virtual [basic_multi_iterator](#)< T > &operator++ (int)
No effect for basic_multi_iterator.

Protected Attributes

- std::vector< T > Nv

Protected Attributes inherited from [GiNaC::basic_multi_iterator< T >](#)

- T N
- T B
- std::vector< T > v
- bool [flag_overflow](#)

Friends

- `template<class TT >`
`std::ostream & operator<< (std::ostream &os, const multi_iterator_ordered_eq_indv< TT > &v)`

6.98.1 Detailed Description

```
template<class T>
class GiNaC::multi_iterator_ordered_eq_indv< T >
```

The class `multi_iterator_ordered_eq_indv` defines a `multi_iterator` (i_1, i_2, \dots, i_k) , such that.

$$B \leq i_j < N_j$$

and

$$i_j \leq i_{j+1}.$$

6.98.2 Constructor & Destructor Documentation

6.98.2.1 multi_iterator_ordered_eq_indv() [1/3]

```
template<class T >
GiNaC::multi_iterator_ordered_eq_indv< T >::multi_iterator_ordered_eq_indv (
    void ) [inline]
```

Default constructor.

6.98.2.2 multi_iterator_ordered_eq_indv() [2/3]

```
template<class T >
GiNaC::multi_iterator_ordered_eq_indv< T >::multi_iterator_ordered_eq_indv (
    T B,
    const std::vector< T > & Nv,
    size_t k ) [inline], [explicit]
```

Construct a `multi_iterator` with upper limit N and size k .

6.98.2.3 multi_iterator_ordered_eq_indv() [3/3]

```
template<class T >
GiNaC::multi_iterator_ordered_eq_indv< T >::multi_iterator_ordered_eq_indv (
    T B,
    const std::vector< T > & Nv,
    const std::vector< T > & vv ) [inline], [explicit]
```

Construct from a vector.

6.98.3 Member Function Documentation

6.98.3.1 init()

```
template<class T >
basic_multi_iterator< T > & GiNaC::multi_iterator_ordered_eq_indv< T >::init (
    void ) [inline], [virtual]
```

Initialize the multi-index to.

$$(n_1, n_2, n_3, \dots, n_k) = (B, B, B, \dots, B)$$

Reimplemented from [GiNaC::basic_multi_iterator< T >](#).

6.98.3.2 operator++()

```
template<class T >
basic_multi_iterator< T > & GiNaC::multi_iterator_ordered_eq_indv< T >::operator++ (
    int ) [inline], [virtual]
```

The postfix increment operator allows to write for a multi-index $n++$, which will update n to the next configuration.

If n is in the last configuration and the increment operator $++$ is applied to n , the overflow flag will be raised.

Reimplemented from [GiNaC::basic_multi_iterator< T >](#).

References [k](#).

6.98.4 Friends And Related Function Documentation

6.98.4.1 operator<<

```
template<class T >
template<class TT >
std::ostream & operator<< (
    std::ostream & os,
    const multi_iterator_ordered_eq_indv< TT > & v ) [friend]
```

6.98.5 Member Data Documentation

6.98.5.1 Nv

```
template<class T >
std::vector<T> GiNaC::multi_iterator_ordered_eq_indv< T >::Nv [protected]
```

The documentation for this class was generated from the following file:

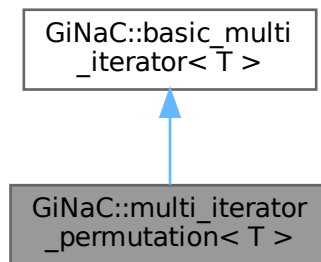
- [utils_multi_iterator.h](#)

6.99 GiNaC::multi_iterator_permutation< T > Class Template Reference

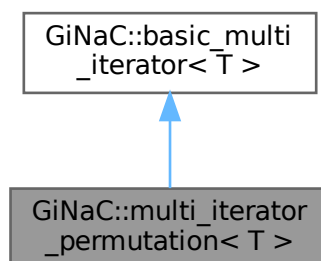
The class [multi_iterator_permutation](#) defines a multi_iterator (i_1, i_2, \dots, i_k) , for which.

```
#include <utils_multi_iterator.h>
```

Inheritance diagram for GiNaC::multi_iterator_permutation< T >:



Collaboration diagram for GiNaC::multi_iterator_permutation< T >:



Public Member Functions

- [multi_iterator_permutation](#) (void)
Default constructor.
- [multi_iterator_permutation](#) (T B, T N, size_t k)
Construct a multi_iterator with upper limit N and size k .
- [multi_iterator_permutation](#) (T B, T N, const std::vector< T > &vv)
Construct from a vector.
- [basic_multi_iterator](#)< T > & [init](#) (void)
Initialize the multi-index to.
- [basic_multi_iterator](#)< T > & [operator++](#) (int)
The postfix increment operator allows to write for a multi-index n++, which will update n to the next configuration.
- int [get_sign](#) (void) const
Returns the sign of the permutation, defined by.

Public Member Functions inherited from [GiNaC::basic_multi_iterator< T >](#)

- [basic_multi_iterator](#) (void)
Default constructor.
- [basic_multi_iterator](#) (T B, T N, size_t k)
Construct a multi_iterator with upper limit N, lower limit B and size k .
- [basic_multi_iterator](#) (T B, T N, const std::vector< T > &vv)
Construct from a vector.
- virtual [~basic_multi_iterator](#) ()
Destructor.
- size_t [size](#) (void) const
Returns the size of a multi_iterator.
- bool [overflow](#) (void) const
Return the overflow flag.
- const std::vector< T > & [get_vector](#) (void) const
Returns a reference to the vector v.
- T [operator\[\]](#) (size_t i) const
Subscription via [].
- T & [operator\[\]](#) (size_t i)
Subscription via [].
- T [operator\(\)](#) (size_t i) const
Subscription via ().
- T & [operator\(\)](#) (size_t i)
Subscription via ().
- virtual [basic_multi_iterator](#)< T > & [init](#) (void)
Initialize the multi-index to.
- virtual [basic_multi_iterator](#)< T > & [operator++](#) (int)
No effect for [basic_multi_iterator](#).

Friends

- template<class TT >
std::ostream & [operator<<](#) (std::ostream &os, const [multi_iterator_permutation](#)< TT > &v)

Additional Inherited Members

Protected Attributes inherited from [GiNaC::basic_multi_iterator< T >](#)

- [T N](#)
- [T B](#)
- `std::vector< T > v`
- `bool flag_overflow`

6.99.1 Detailed Description

```
template<class T>
class GiNaC::multi_iterator_permutation< T >
```

The class [multi_iterator_permutation](#) defines a multi_iterator (i_1, i_2, \dots, i_k) , for which.

$$B \leq i_j < N$$

and

$$i_i \neq i_j$$

In particular, if $N - B = k$, [multi_iterator_permutation](#) loops over all permutations of k elements.

6.99.2 Constructor & Destructor Documentation

6.99.2.1 multi_iterator_permutation() [1/3]

```
template<class T >
GiNaC::multi\_iterator\_permutation< T >::multi_iterator_permutation (
    void ) [inline]
```

Default constructor.

6.99.2.2 multi_iterator_permutation() [2/3]

```
template<class T >
GiNaC::multi\_iterator\_permutation< T >::multi_iterator_permutation (
    T B,
    T N,
    size_t k ) [inline], [explicit]
```

Construct a multi_iterator with upper limit N and size k .

6.99.2.3 multi_iterator_permutation() [3/3]

```
template<class T >
GiNaC::multi_iterator_permutation< T >::multi_iterator_permutation (
    T B,
    T N,
    const std::vector< T > & vv ) [inline], [explicit]
```

Construct from a vector.

6.99.3 Member Function Documentation**6.99.3.1 init()**

```
template<class T >
basic_multi_iterator< T > & GiNaC::multi_iterator_permutation< T >::init (
    void ) [inline], [virtual]
```

Initialize the multi-index to.

$$(n_1, n_2, n_3, \dots, n_k) = (B + 0, B + 1, B + 2, \dots, B + k - 1)$$

Reimplemented from [GiNaC::basic_multi_iterator< T >](#).

6.99.3.2 operator++()

```
template<class T >
basic_multi_iterator< T > & GiNaC::multi_iterator_permutation< T >::operator++ (
    int ) [inline], [virtual]
```

The postfix increment operator allows to write for a multi-index `n++`, which will update `n` to the next configuration.

If `n` is in the last configuration and the increment operator `++` is applied to `n`, the overflow flag will be raised.

Reimplemented from [GiNaC::basic_multi_iterator< T >](#).

References [k](#).

6.99.3.3 get_sign()

```
template<class T >
int GiNaC::multi_iterator_permutation< T >::get_sign (
    void ) const [inline]
```

Returns the sign of the permutation, defined by.

$$(-1)^{n_{inv}},$$

where n_{inv} is the number of inversions, e.g. the number of pairs $i < j$ for which

$$n_i > n_j.$$

References [k](#).

6.99.4 Friends And Related Function Documentation

6.99.4.1 operator<<

```
template<class T >
template<class TT >
std::ostream & operator<< (
    std::ostream & os,
    const multi_iterator_permutation< TT > & v ) [friend]
```

The documentation for this class was generated from the following file:

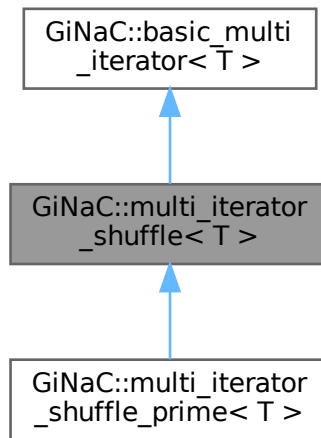
- [utils_multi_iterator.h](#)

6.100 GiNaC::multi_iterator_shuffle< T > Class Template Reference

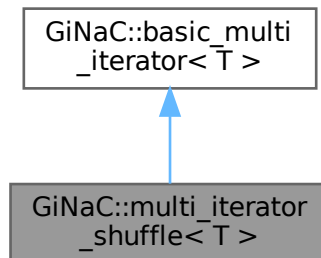
The class [multi_iterator_shuffle](#) defines a multi_iterator, which runs over all shuffles of a and b.

```
#include <utils_multi_iterator.h>
```

Inheritance diagram for GiNaC::multi_iterator_shuffle< T >:



Collaboration diagram for GiNaC::multi_iterator_shuffle< T >:



Public Member Functions

- `multi_iterator_shuffle` (void)
Default constructor.
- `multi_iterator_shuffle` (const std::vector< T > &a, const std::vector< T > &b)
Construct from a vector.
- `basic_multi_iterator< T > &init` (void)
Initialize the multi-index to the first shuffle.
- `basic_multi_iterator< T > &operator++` (int)
The postfix increment operator allows to write for a multi-index `n++`, which will update `n` to the next configuration.

Public Member Functions inherited from [GiNaC::basic_multi_iterator< T >](#)

- [basic_multi_iterator](#) (void)
Default constructor.
- [basic_multi_iterator](#) (T [B](#), T [N](#), size_t [k](#))
Construct a multi_iterator with upper limit N, lower limit B and size k.
- [basic_multi_iterator](#) (T [B](#), T [N](#), const std::vector< T > &vv)
Construct from a vector.
- virtual [~basic_multi_iterator](#) ()
Destructor.
- size_t [size](#) (void) const
Returns the size of a multi_iterator.
- bool [overflow](#) (void) const
Return the overflow flag.
- const std::vector< T > & [get_vector](#) (void) const
Returns a reference to the vector v.
- T [operator\[\]](#) (size_t i) const
Subscription via [].
- T & [operator\[\]](#) (size_t i)
Subscription via [].
- T [operator\(\)](#) (size_t i) const
Subscription via ().
- T & [operator\(\)](#) (size_t i)
Subscription via ().
- virtual [basic_multi_iterator](#)< T > & [init](#) (void)
Initialize the multi-index to.
- virtual [basic_multi_iterator](#)< T > & [operator++](#) (int)
No effect for basic_multi_iterator.

Protected Attributes

- size_t [N_internal](#)
- std::vector< size_t > [v_internal](#)
- std::vector< T > [v_orig](#)

Protected Attributes inherited from [GiNaC::basic_multi_iterator< T >](#)

- T [N](#)
- T [B](#)
- std::vector< T > [v](#)
- bool [flag_overflow](#)

Friends

- template<class TT >
std::ostream & [operator<<](#) (std::ostream &os, const [multi_iterator_shuffle](#)< TT > &v)

6.100.1 Detailed Description

```
template<class T>
class GiNaC::multi_iterator_shuffle< T >
```

The class [multi_iterator_shuffle](#) defines a multi_iterator, which runs over all shuffles of a and b.

6.100.2 Constructor & Destructor Documentation

6.100.2.1 multi_iterator_shuffle() [1/2]

```
template<class T >
GiNaC::multi_iterator_shuffle< T >::multi_iterator_shuffle (
    void ) [inline]
```

Default constructor.

6.100.2.2 multi_iterator_shuffle() [2/2]

```
template<class T >
GiNaC::multi_iterator_shuffle< T >::multi_iterator_shuffle (
    const std::vector< T > & a,
    const std::vector< T > & b ) [inline], [explicit]
```

Construct from a vector.

References [GiNaC::basic_multi_iterator< T >::B](#), [GiNaC::multi_iterator_shuffle< T >::N_internal](#), [GiNaC::basic_multi_iterator< T >::v_internal](#), and [GiNaC::multi_iterator_shuffle< T >::v_orig](#).

6.100.3 Member Function Documentation

6.100.3.1 init()

```
template<class T >
basic_multi_iterator< T > & GiNaC::multi_iterator_shuffle< T >::init (
    void ) [inline], [virtual]
```

Initialize the multi-index to the first shuffle.

Reimplemented from [GiNaC::basic_multi_iterator< T >](#).

Reimplemented in [GiNaC::multi_iterator_shuffle_prime< T >](#).

6.100.3.2 operator++()

```
template<class T >
basic_multi_iterator< T > & GiNaC::multi_iterator_shuffle< T >::operator++ (
    int ) [inline], [virtual]
```

The postfix increment operator allows to write for a multi-index `n++`, which will update `n` to the next configuration.

If `n` is in the last configuration and the increment operator `++` is applied to `n`, the overflow flag will be raised.

Reimplemented from [GiNaC::basic_multi_iterator< T >](#).

References [k](#).

6.100.4 Friends And Related Function Documentation

6.100.4.1 operator<<

```
template<class T >
template<class TT >
std::ostream & operator<< (
    std::ostream & os,
    const multi_iterator_shuffle< TT > & v ) [friend]
```

6.100.5 Member Data Documentation

6.100.5.1 N_internal

```
template<class T >
size_t GiNaC::multi_iterator_shuffle< T >::N_internal [protected]
```

Referenced by [GiNaC::multi_iterator_shuffle< T >::multi_iterator_shuffle\(\)](#).

6.100.5.2 v_internal

```
template<class T >
std::vector<size_t> GiNaC::multi_iterator_shuffle< T >::v_internal [protected]
```

Referenced by [GiNaC::multi_iterator_shuffle< T >::multi_iterator_shuffle\(\)](#).

6.100.5.3 v_orig

```
template<class T >
std::vector<T> GiNaC::multi_iterator_shuffle< T >::v_orig [protected]
```

Referenced by [GiNaC::multi_iterator_shuffle< T >::multi_iterator_shuffle\(\)](#).

The documentation for this class was generated from the following file:

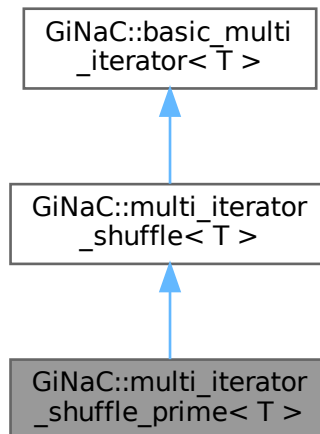
- [utils_multi_iterator.h](#)

6.101 GiNaC::multi_iterator_shuffle_prime< T > Class Template Reference

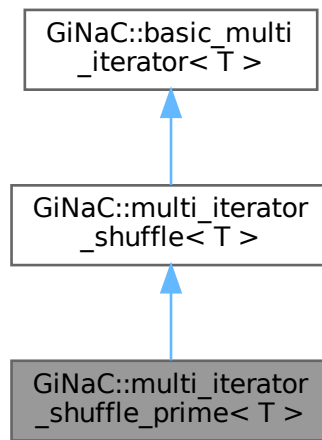
The class [multi_iterator_shuffle_prime](#) defines a multi_iterator, which runs over all shuffles of a and b, excluding the first one (a,b).

```
#include <utils_multi_iterator.h>
```

Inheritance diagram for GiNaC::multi_iterator_shuffle_prime< T >:



Collaboration diagram for `GiNaC::multi_iterator_shuffle_prime< T >`:



Public Member Functions

- `multi_iterator_shuffle_prime` (void)
Default constructor.
- `multi_iterator_shuffle_prime` (const std::vector< T > &a, const std::vector< T > &b)
Construct from a vector.
- `basic_multi_iterator< T > &init` (void)
Initialize the multi-index to the first shuffle.

Public Member Functions inherited from `GiNaC::multi_iterator_shuffle< T >`

- `multi_iterator_shuffle` (void)
Default constructor.
- `multi_iterator_shuffle` (const std::vector< T > &a, const std::vector< T > &b)
Construct from a vector.
- `basic_multi_iterator< T > &init` (void)
Initialize the multi-index to the first shuffle.
- `basic_multi_iterator< T > &operator++` (int)
The postfix increment operator allows to write for a multi-index `n++`, which will update `n` to the next configuration.

Public Member Functions inherited from `GiNaC::basic_multi_iterator< T >`

- `basic_multi_iterator` (void)
Default constructor.
- `basic_multi_iterator` (T B, T N, size_t k)
Construct a multi_iterator with upper limit N, lower limit B and size k.
- `basic_multi_iterator` (T B, T N, const std::vector< T > &vv)
Construct from a vector.

- virtual `~basic_multi_iterator()`
Destructor.
- `size_t size()` const
Returns the size of a multi_iterator.
- `bool overflow()` const
Return the overflow flag.
- `const std::vector< T > & get_vector()` const
Returns a reference to the vector v.
- `T operator[] (size_t i)` const
Subscription via [].
- `T & operator[] (size_t i)`
Subscription via [].
- `T operator() (size_t i)` const
Subscription via ().
- `T & operator() (size_t i)`
Subscription via ().
- virtual `basic_multi_iterator< T > & init()` (void)
Initialize the multi-index to.
- virtual `basic_multi_iterator< T > & operator++` (int)
No effect for basic_multi_iterator.

Friends

- `template<class TT >`
`std::ostream & operator<< (std::ostream &os, const multi_iterator_shuffle_prime< TT > &v)`

Additional Inherited Members

Protected Attributes inherited from `GiNaC::multi_iterator_shuffle< T >`

- `size_t N_internal`
- `std::vector< size_t > v_internal`
- `std::vector< T > v_orig`

Protected Attributes inherited from `GiNaC::basic_multi_iterator< T >`

- `T N`
- `T B`
- `std::vector< T > v`
- `bool flag_overflow`

6.101.1 Detailed Description

```
template<class T>
class GiNaC::multi_iterator_shuffle_prime< T >
```

The class `multi_iterator_shuffle_prime` defines a multi_iterator, which runs over all shuffles of a and b, excluding the first one (a,b).

6.101.2 Constructor & Destructor Documentation

6.101.2.1 multi_iterator_shuffle_prime() [1/2]

```
template<class T >
GiNaC::multi_iterator_shuffle_prime< T >::multi_iterator_shuffle_prime (
    void ) [inline]
```

Default constructor.

6.101.2.2 multi_iterator_shuffle_prime() [2/2]

```
template<class T >
GiNaC::multi_iterator_shuffle_prime< T >::multi_iterator_shuffle_prime (
    const std::vector< T > & a,
    const std::vector< T > & b ) [inline], [explicit]
```

Construct from a vector.

6.101.3 Member Function Documentation

6.101.3.1 init()

```
template<class T >
basic_multi_iterator< T > & GiNaC::multi_iterator_shuffle_prime< T >::init (
    void ) [inline], [virtual]
```

Initialize the multi-index to the first shuffle.

Reimplemented from [GiNaC::multi_iterator_shuffle< T >](#).

6.101.4 Friends And Related Function Documentation

6.101.4.1 operator<<

```
template<class T >
template<class TT >
std::ostream & operator<< (
    std::ostream & os,
    const multi_iterator_shuffle_prime< TT > & v ) [friend]
```

The documentation for this class was generated from the following file:

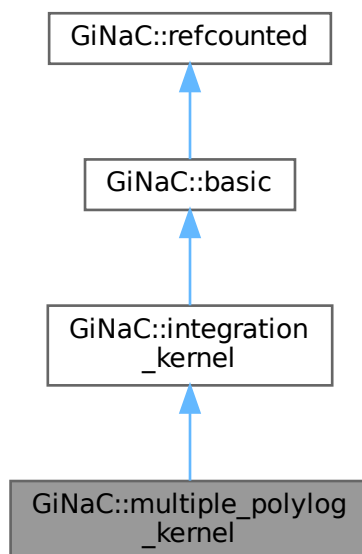
- [utils_multi_iterator.h](#)

6.102 GiNaC::multiple_polylog_kernel Class Reference

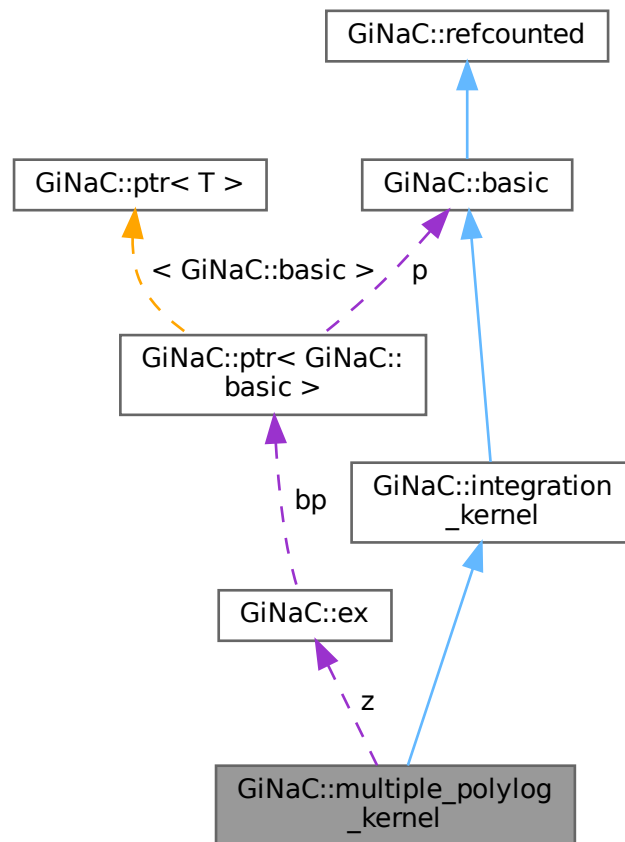
The integration kernel for multiple polylogarithms.

```
#include <integration_kernel.h>
```

Inheritance diagram for GiNaC::multiple_polylog_kernel:



Collaboration diagram for `GiNaC::multiple_polylog_kernel`:



Public Member Functions

- `multiple_polylog_kernel` (const `ex` &`z`)
- `size_t nops` () const override
Number of operands/members.
- `ex op` (size_t `i`) const override
Return operand/member at position `i`.
- `ex` & `let_op` (size_t `i`) override
Return modifiable operand/member at position `i`.
- bool `is_numeric` (void) const override
This routine returns true, if the integration kernel can be evaluated numerically.

Public Member Functions inherited from `GiNaC::integration_kernel`

- `ex series` (const `relational` &`r`, int `order`, unsigned `options`=0) const override
Default implementation of `ex::series()`.
- virtual bool `has_trailing_zero` (void) const

- *This routine returns true, if the integration kernel has a trailing zero.*
- virtual bool `is_numeric` (void) const
- *This routine returns true, if the integration kernel can be evaluated numerically.*
- virtual `ex Laurent_series` (const `ex &x`, int `order`) const
- *Returns the Laurent series, starting possibly with the pole term.*
- virtual `ex get_numerical_value` (const `ex &lambda`, int `N_trunc=0`) const
- *Evaluates the integrand at lambda.*
- size_t `get_cache_size` (void) const
- *Returns the current size of the cache.*
- void `set_cache_step` (int `cache_steps`) const
- *Sets the step size by which the cache is increased.*
- `ex get_series_coeff` (int `i`) const
- *Wrapper around series_coeff(i), converts cl_N to numeric.*
- `cln::cl_N series_coeff` (int `i`) const
- *Subclasses have either to implement series_coeff_impl or the two methods Laurent_series and uses_Laurent_series.*

Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()
- *basic destructor, virtual because class ex will delete objects of derived classes via a basic*.*
- `basic` (const `basic &other`)
- const `basic & operator=` (const `basic &other`)
- *basic assignment operator: the other object might be of a derived class.*
- virtual `basic * duplicate` () const
- *Create a clone of this object on the heap.*
- virtual `ex eval` () const
- *Perform automatic non-interruptive term rewriting rules.*
- virtual `ex evalf` () const
- *Evaluate object numerically.*
- virtual `ex evalm` () const
- *Evaluate sums, products and integer powers of matrices.*
- virtual `ex eval_integ` () const
- *Evaluate integrals, if result is known.*
- virtual `ex eval_indexed` (const `basic &i`) const
- *Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual void `print` (const `print_context &c`, unsigned `level=0`) const
- *Output to stream.*
- virtual void `dbgprint` () const
- *Little wrapper around print to be called within a debugger.*
- virtual void `dbgprinttree` () const
- *Little wrapper around printtree to be called within a debugger.*
- virtual unsigned `precedence` () const
- *Return relative operator precedence (for parenthezing output).*
- virtual bool `info` (unsigned `inf`) const
- *Information about the object.*
- virtual size_t `nops` () const
- *Number of operands/members.*
- virtual `ex op` (size_t `i`) const
- *Return operand/member at position i.*
- virtual `ex operator[]` (const `ex &index`) const

- virtual `ex operator[]` (size_t i) const
- virtual `ex & let_op` (size_t i)
 - Return modifiable operand/member at position i.*
- virtual `ex & operator[]` (const `ex` &index)
- virtual `ex & operator[]` (size_t i)
- virtual bool `has` (const `ex` &other, unsigned `options`=0) const
 - Test for occurrence of a pattern.*
- virtual bool `match` (const `ex` &pattern, `exmap` &repls) const
 - Check whether the expression matches a given pattern.*
- virtual `ex subs` (const `exmap` &m, unsigned `options`=0) const
 - Substitute a set of objects by arbitrary expressions.*
- virtual `ex map` (`map_function` &f) const
 - Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual void `accept` (`GiNaC::visitor` &v) const
- virtual bool `is_polynomial` (const `ex` &var) const
 - Check whether this is a polynomial in the given variables.*
- virtual int `degree` (const `ex` &s) const
 - Return degree of highest power in object s.*
- virtual int `ldegree` (const `ex` &s) const
 - Return degree of lowest power in object s.*
- virtual `ex coeff` (const `ex` &s, int n=1) const
 - Return coefficient of degree n in object s.*
- virtual `ex expand` (unsigned `options`=0) const
 - Expand expression, i.e.*
- virtual `ex collect` (const `ex` &s, bool distributed=false) const
 - Sort expanded expression in terms of powers of some object(s).*
- virtual `ex series` (const `relational` &r, int `order`, unsigned `options`=0) const
 - Default implementation of `ex::series()`.*
- virtual `ex normal` (`exmap` &repl, `exmap` &rev_lookup, `lst` &modifier) const
 - Default implementation of `ex::normal()`.*
- virtual `ex to_rational` (`exmap` &repl) const
 - Default implementation of `ex::to_rational()`.*
- virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const
 - Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- virtual `numeric max_coefficient` () const
 - Implementation `ex::max_coefficient()`.*
- virtual `exvector get_free_indices` () const
 - Return a vector containing the free indices of an expression.*
- virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
 - Add two indexed expressions.*
- virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
 - Multiply an indexed expression with a scalar.*
- virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const
 - Try to contract two indexed expressions that appear in the same product.*
- virtual unsigned `return_type` () const
- virtual `return_type_t return_type_tinfo` () const
- virtual `ex conjugate` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const

- template<class T >
void [print_dispatch](#) (const [print_context](#) &c, unsigned level) const
Like [print\(\)](#), but dispatch to the specified class.
- void [print_dispatch](#) (const [registered_class_info](#) &ri, const [print_context](#) &c, unsigned level) const
Like [print\(\)](#), but dispatch to the specified class.
- virtual void [archive](#) ([archive_node](#) &n) const
Save (serialize) the object into archive node.
- virtual void [read_archive](#) (const [archive_node](#) &n, [lst](#) &syms)
Load (deserialize) the object from an archive node.
- [ex subs_one_level](#) (const [exmap](#) &m, unsigned [options](#)) const
Helper function for [subs\(\)](#).
- [ex diff](#) (const [symbol](#) &s, unsigned nth=1) const
Default interface of nth derivative [ex::diff\(s, n\)](#).
- int [compare](#) (const [basic](#) &other) const
Compare objects syntactically to establish canonical ordering.
- bool [is_equal](#) (const [basic](#) &other) const
Test for syntactic equality.
- const [basic](#) & [hold](#) () const
Stop further evaluation.
- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const
Set some [status_flags](#).
- const [basic](#) & [clearflag](#) (unsigned f) const
Clear some [status_flags](#).

Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add_reference](#) () noexcept
- unsigned int [remove_reference](#) () noexcept
- unsigned int [get_refcount](#) () const noexcept
- void [set_refcount](#) (unsigned int r) noexcept

Protected Member Functions

- [cln::cl_N_series_coeff_impl](#) (int i) const override
For $\omega = d\lambda$ only the coefficient of λ^0 is non-zero.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const

Protected Member Functions inherited from [GiNaC::integration_kernel](#)

- virtual bool [uses_Laurent_series](#) () const
Returns true, if the coefficients are computed from the Laurent series (in which case the method [Laurent_series](#) needs to be implemented).
- virtual [cln::cl_N_series_coeff_impl](#) (int i) const
For $\omega = d\lambda$ only the coefficient of λ^0 is non-zero.
- [ex get_numerical_value_impl](#) (const [ex](#) &lambda, const [ex](#) &pre, int shift, int N_trunc) const
The actual implementation for computing a numerical value for the integrand.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const

Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match_same_type](#) (const [basic](#) &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual [ex derivative](#) (const [symbol](#) &s) const
Default implementation of [ex::diff\(\)](#).
- virtual int [compare_same_type](#) (const [basic](#) &other) const
Returns order relation between two objects of same type.
- virtual bool [is_equal_same_type](#) (const [basic](#) &other) const
Returns true if two objects of same type are equal.
- virtual unsigned [calchash](#) () const
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- void [ensure_if_modifiable](#) () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
Default output to stream.
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
Tree output to stream.
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
Python parsable output to stream.

Protected Attributes

- [ex](#) z

Protected Attributes inherited from [GiNaC::integration_kernel](#)

- int [cache_step_size](#)
- std::vector< [cln::cl_N](#) > [series_vec](#)

Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)
of type [status_flags](#)
- unsigned [hashvalue](#)
hash value

6.102.1 Detailed Description

The integration kernel for multiple polylogarithms.

This class represents the differential one-form

$$\omega^{\text{mpl}}(z) = \frac{d\lambda}{\lambda - z}$$

For the case $z = 0$ the class [basic_log_kernel](#) should be used.

6.102.2 Constructor & Destructor Documentation

6.102.2.1 multiple_polylog_kernel()

```
GiNaC::multiple_polylog_kernel::multiple_polylog_kernel (
    const ex & z )
```

6.102.3 Member Function Documentation

6.102.3.1 nops()

```
size_t GiNaC::multiple_polylog_kernel::nops ( ) const [override], [virtual]
```

Number of operands/members.

Reimplemented from [GiNaC::basic](#).

6.102.3.2 op()

```
ex GiNaC::multiple_polylog_kernel::op (
    size_t i ) const [override], [virtual]
```

Return operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [z](#).

6.102.3.3 let_op()

```
ex & GiNaC::multiple_polylog_kernel::let_op (
    size_t i ) [override], [virtual]
```

Return modifiable operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ensure_if_modifiable\(\)](#), and [z](#).

6.102.3.4 `is_numeric()`

```
bool GiNaC::multiple_polylog_kernel::is_numeric (
    void ) const [override], [virtual]
```

This routine returns true, if the integration kernel can be evaluated numerically.

Reimplemented from [GiNaC::integration_kernel](#).

References [GiNaC::ex::evalf\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::numeric](#), and [z](#).

6.102.3.5 `series_coeff_impl()`

```
cln::cl_N GiNaC::multiple_polylog_kernel::series_coeff_impl (
    int i ) const [override], [protected], [virtual]
```

For $\omega = d\lambda$ only the coefficient of λ^0 is non-zero.

The i -th coefficient corresponds to the power λ^{i-1} .

Reimplemented from [GiNaC::integration_kernel](#).

References [GiNaC::ex::evalf\(\)](#), and [z](#).

6.102.3.6 `do_print()`

```
void GiNaC::multiple_polylog_kernel::do_print (
    const print_context & c,
    unsigned level ) const [protected]
```

References [c](#), [GiNaC::ex::print\(\)](#), and [z](#).

6.102.4 Member Data Documentation

6.102.4.1 `z`

```
ex GiNaC::multiple_polylog_kernel::z [protected]
```

Referenced by [do_print\(\)](#), [is_numeric\(\)](#), [let_op\(\)](#), [op\(\)](#), and [series_coeff_impl\(\)](#).

The documentation for this class was generated from the following files:

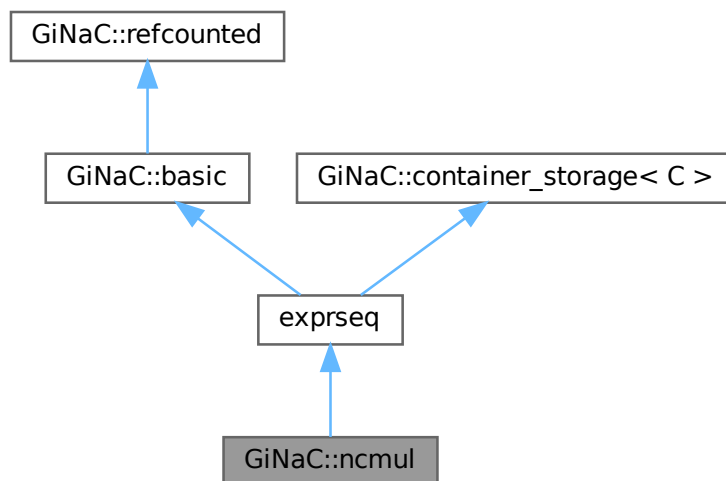
- [integration_kernel.h](#)
- [integration_kernel.cpp](#)

6.103 GiNaC::ncmul Class Reference

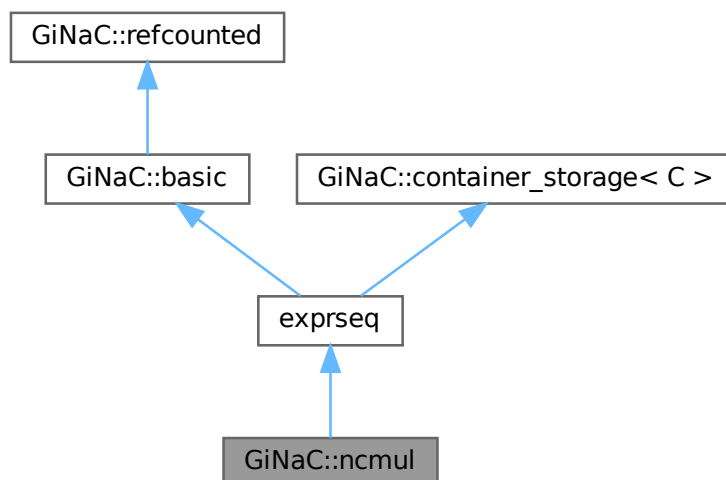
Non-commutative product of expressions.

```
#include <ncmul.h>
```

Inheritance diagram for GiNaC::ncmul:



Collaboration diagram for GiNaC::ncmul:



Public Member Functions

- `ncmul` (const `ex` &lh, const `ex` &rh)
- `ncmul` (const `ex` &f1, const `ex` &f2, const `ex` &f3)
- `ncmul` (const `ex` &f1, const `ex` &f2, const `ex` &f3, const `ex` &f4)
- `ncmul` (const `ex` &f1, const `ex` &f2, const `ex` &f3, const `ex` &f4, const `ex` &f5)
- `ncmul` (const `ex` &f1, const `ex` &f2, const `ex` &f3, const `ex` &f4, const `ex` &f5, const `ex` &f6)
- `ncmul` (const `exvector` &v)
- `ncmul` (`exvector` &&v)
- unsigned `precedence` () const override
Return relative operator precedence (for parenthezing output).
- bool `info` (unsigned inf) const override
Information about the object.
- int `degree` (const `ex` &s) const override
Return degree of highest power in object s.
- int `ldegree` (const `ex` &s) const override
Return degree of lowest power in object s.
- `ex expand` (unsigned `options`=0) const override
Expand expression, i.e.
- `ex coeff` (const `ex` &s, int `n`=1) const override
Return coefficient of degree n in object s.
- `ex eval` () const override
Perform automatic term rewriting rules in this class.
- `ex evalm` () const override
Evaluate sums, products and integer powers of matrices.
- `exvector get_free_indices` () const override
Return a vector containing the free indices of an expression.
- `ex thiscontainer` (const `exvector` &v) const override
- `ex thiscontainer` (`exvector` &&v) const override
- `ex conjugate` () const override
- `ex real_part` () const override
- `ex imag_part` () const override
- const `exvector` & `get_factors` () const

Public Member Functions inherited from `GiNaC::container< C >`

- `container` (STLT const &s)
- `container` (STLT &&v)
- `container` (`exvector::const_iterator` b, `exvector::const_iterator` e)
- `container` (std::initializer_list< `ex` > il)
- bool `info` (unsigned inf) const override
Information about the object.
- unsigned `precedence` () const override
Return relative operator precedence (for parenthezing output).
- size_t `nops` () const override
Number of operands/members.
- `ex op` (size_t i) const override
Return operand/member at position i.
- `ex & let_op` (size_t i) override
Return modifiable operand/member at position i.
- `ex subs` (const `exmap` &m, unsigned `options`=0) const override
Substitute a set of objects by arbitrary expressions.

- void `read_archive` (const `archive_node` &n, `lst` &sym_lst) override
Load (deserialize) the object from an archive node.
- void `archive` (`archive_node` &n) const override
Archive the object.
- `container` & `prepend` (const `ex` &b)
Add element at front.
- `container` & `append` (const `ex` &b)
Add element at back.
- `container` & `remove_first` ()
Remove first element.
- `container` & `remove_last` ()
Remove last element.
- `container` & `remove_all` ()
Remove all elements.
- `container` & `sort` ()
Sort elements.
- `container` & `unique` ()
Remove adjacent duplicate elements.
- `const_iterator` `begin` () const
- `const_iterator` `end` () const
- `const_reverse_iterator` `rbegin` () const
- `const_reverse_iterator` `rend` () const

Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()
basic destructor, virtual because class `ex` will delete objects of derived classes via a `basic`.*
- `basic` (const `basic` &other)
- const `basic` & `operator=` (const `basic` &other)
basic assignment operator: the other object might be of a derived class.
- virtual `basic` * `duplicate` () const
Create a clone of this object on the heap.
- virtual `ex` `eval` () const
Perform automatic non-interruptive term rewriting rules.
- virtual `ex` `evalf` () const
Evaluate object numerically.
- virtual `ex` `evalm` () const
Evaluate sums, products and integer powers of matrices.
- virtual `ex` `eval_integ` () const
Evaluate integrals, if result is known.
- virtual `ex` `eval_indexed` (const `basic` &i) const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void `print` (const `print_context` &c, unsigned level=0) const
Output to stream.
- virtual void `dbgprint` () const
Little wrapper around `print` to be called within a debugger.
- virtual void `dbgprinttree` () const
Little wrapper around `printtree` to be called within a debugger.
- virtual unsigned `precedence` () const
Return relative operator precedence (for parenthezing output).

- virtual bool [info](#) (unsigned inf) const
Information about the object.
- virtual size_t [nops](#) () const
Number of operands/members.
- virtual [ex op](#) (size_t i) const
Return operand/member at position i.
- virtual [ex operator\[\]](#) (const [ex](#) &index) const
- virtual [ex operator\[\]](#) (size_t i) const
- virtual [ex & let_op](#) (size_t i)
Return modifiable operand/member at position i.
- virtual [ex & operator\[\]](#) (const [ex](#) &index)
- virtual [ex & operator\[\]](#) (size_t i)
- virtual bool [has](#) (const [ex](#) &other, unsigned [options](#)=0) const
Test for occurrence of a pattern.
- virtual bool [match](#) (const [ex](#) &pattern, [exmap](#) &repls) const
Check whether the expression matches a given pattern.
- virtual [ex subs](#) (const [exmap](#) &m, unsigned [options](#)=0) const
Substitute a set of objects by arbitrary expressions.
- virtual [ex map](#) ([map_function](#) &f) const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void [accept](#) ([GiNaC::visitor](#) &v) const
- virtual bool [is_polynomial](#) (const [ex](#) &var) const
Check whether this is a polynomial in the given variables.
- virtual int [degree](#) (const [ex](#) &s) const
Return degree of highest power in object s.
- virtual int [ldegree](#) (const [ex](#) &s) const
Return degree of lowest power in object s.
- virtual [ex coeff](#) (const [ex](#) &s, int n=1) const
Return coefficient of degree n in object s.
- virtual [ex expand](#) (unsigned [options](#)=0) const
Expand expression, i.e.
- virtual [ex collect](#) (const [ex](#) &s, bool distributed=false) const
Sort expanded expression in terms of powers of some object(s).
- virtual [ex series](#) (const [relational](#) &r, int [order](#), unsigned [options](#)=0) const
Default implementation of [ex::series\(\)](#).
- virtual [ex normal](#) ([exmap](#) &repl, [exmap](#) &rev_lookup, [lst](#) &modifier) const
Default implementation of [ex::normal\(\)](#).
- virtual [ex to_rational](#) ([exmap](#) &repl) const
Default implementation of [ex::to_rational\(\)](#).
- virtual [ex to_polynomial](#) ([exmap](#) &repl) const
- virtual [numeric integer_content](#) () const
- virtual [ex smod](#) (const [numeric](#) &xi) const
Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- virtual [numeric max_coefficient](#) () const
Implementation [ex::max_coefficient\(\)](#).
- virtual [exvector get_free_indices](#) () const
Return a vector containing the free indices of an expression.
- virtual [ex add_indexed](#) (const [ex](#) &self, const [ex](#) &other) const
Add two indexed expressions.
- virtual [ex scalar_mul_indexed](#) (const [ex](#) &self, const [numeric](#) &other) const
Multiply an indexed expression with a scalar.

- virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const
Try to contract two indexed expressions that appear in the same product.
- virtual unsigned `return_type` () const
- virtual `return_type_t return_type_tinfo` () const
- virtual `ex conjugate` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const
- template<class T >
void `print_dispatch` (const `print_context` &c, unsigned level) const
Like `print()`, but dispatch to the specified class.
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const
Like `print()`, but dispatch to the specified class.
- virtual void `archive` (`archive_node` &n) const
Save (serialize) the object into archive node.
- virtual void `read_archive` (const `archive_node` &n, `lst` &syms)
Load (deserialize) the object from an archive node.
- `ex subs_one_level` (const `exmap` &m, unsigned `options`) const
Helper function for `subs()`.
- `ex diff` (const `symbol` &s, unsigned nth=1) const
Default interface of nth derivative `ex::diff(s, n)`.
- int `compare` (const `basic` &other) const
Compare objects syntactically to establish canonical ordering.
- bool `is_equal` (const `basic` &other) const
Test for syntactic equality.
- const `basic` & `hold` () const
Stop further evaluation.
- unsigned `gethash` () const
- const `basic` & `setflag` (unsigned f) const
Set some `status_flags`.
- const `basic` & `clearflag` (unsigned f) const
Clear some `status_flags`.

Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- unsigned int `add_reference` () noexcept
- unsigned int `remove_reference` () noexcept
- unsigned int `get_refcount` () const noexcept
- void `set_refcount` (unsigned int r) noexcept

Protected Member Functions

- `ex derivative` (const `symbol` &s) const override
Implementation of `ex::diff()` for a non-commutative product.
- unsigned `return_type` () const override
- `return_type_t return_type_tinfo` () const override
- void `do_print` (const `print_context` &c, unsigned level) const
- void `do_print_csrc` (const `print_context` &c, unsigned level) const
- size_t `count_factors` (const `ex` &e) const
- void `append_factors` (`exvector` &v, const `ex` &e) const
- `exvector expandchildren` (unsigned `options`) const

Protected Member Functions inherited from [GiNaC::container< C >](#)

- [ex conjugate](#) () const override
- [ex real_part](#) () const override
- [ex imag_part](#) () const override
- bool [is_equal_same_type](#) (const [basic](#) &other) const override
Returns true if two objects of same type are equal.
- virtual [ex thiscontainer](#) (const [STLT](#) &v) const
Similar to [duplicate\(\)](#), but with a preset sequence.
- virtual [ex thiscontainer](#) ([STLT](#) &&v) const
Similar to [duplicate\(\)](#), but with a preset sequence (which gets pilfered).
- virtual void [printseq](#) (const [print_context](#) &c, char openbracket, char delim, char closebracket, unsigned this↔_precedence, unsigned upper_precedence=0) const
Print sequence of contained elements.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
- void [do_print_python](#) (const [print_python](#) &c, unsigned level) const
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
- [STLT](#) [subchildren](#) (const [exmap](#) &m, unsigned [options](#)=0) const

Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match_same_type](#) (const [basic](#) &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual [ex derivative](#) (const [symbol](#) &s) const
Default implementation of [ex::diff\(\)](#).
- virtual int [compare_same_type](#) (const [basic](#) &other) const
Returns order relation between two objects of same type.
- virtual bool [is_equal_same_type](#) (const [basic](#) &other) const
Returns true if two objects of same type are equal.
- virtual unsigned [calchash](#) () const
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- void [ensure_if_modifiable](#) () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
Default output to stream.
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
Tree output to stream.
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
Python parsable output to stream.

Protected Member Functions inherited from [GiNaC::container_storage< C >](#)

- [container_storage](#) ()
- [container_storage](#) (size_t n, const [ex](#) &e)
- [container_storage](#) (std::initializer_list< [ex](#) > il)
- template<class In >
 [container_storage](#) (In b, In e)
- void [reserve](#) (size_t)
- [~container_storage](#) ()
- void [reserve](#) (size_t n)
- void [reserve](#) (std::vector< [ex](#) > &v, size_t n)

Friends

- class [power](#)
- [ex reeval_ncmul](#) (const [exvector](#) &v)
- [ex hold_ncmul](#) (const [exvector](#) &v)

Additional Inherited Members

Public Types inherited from [GiNaC::container< C >](#)

- typedef [STLT::const_iterator](#) [const_iterator](#)
- typedef [STLT::const_reverse_iterator](#) [const_reverse_iterator](#)

Protected Types inherited from [GiNaC::container< C >](#)

- typedef [container_storage< C >::STLT](#) [STLT](#)

Protected Types inherited from [GiNaC::container_storage< C >](#)

- typedef [C< ex >](#) [STLT](#)

Static Protected Member Functions inherited from [GiNaC::container< C >](#)

- static unsigned [get_default_flags](#) ()
Specialization of [container::get_default_flags\(\)](#) for [lst](#).
- static char [get_open_delim](#) ()
Specialization of [container::get_open_delim\(\)](#) for [lst](#).
- static char [get_close_delim](#) ()
Specialization of [container::get_close_delim\(\)](#) for [lst](#).

Static Protected Member Functions inherited from [GiNaC::container_storage< C >](#)

- static void [reserve](#) ([STLT](#) &, [size_t](#))

Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)
of type [status_flags](#)
- unsigned [hashvalue](#)
hash value

Protected Attributes inherited from [GiNaC::container_storage< C >](#)

- [STLT seq](#)

6.103.1 Detailed Description

Non-commutative product of expressions.

6.103.2 Constructor & Destructor Documentation

6.103.2.1 `ncmul()` [1/7]

```
GiNaC::ncmul::ncmul (
    const ex & lh,
    const ex & rh )
```

6.103.2.2 `ncmul()` [2/7]

```
GiNaC::ncmul::ncmul (
    const ex & f1,
    const ex & f2,
    const ex & f3 )
```

6.103.2.3 `ncmul()` [3/7]

```
GiNaC::ncmul::ncmul (
    const ex & f1,
    const ex & f2,
    const ex & f3,
    const ex & f4 )
```

6.103.2.4 `ncmul()` [4/7]

```
GiNaC::ncmul::ncmul (
    const ex & f1,
    const ex & f2,
    const ex & f3,
    const ex & f4,
    const ex & f5 )
```

6.103.2.5 ncmul() [5/7]

```
GiNaC::ncmul::ncmul (
    const ex & f1,
    const ex & f2,
    const ex & f3,
    const ex & f4,
    const ex & f5,
    const ex & f6 )
```

6.103.2.6 ncmul() [6/7]

```
GiNaC::ncmul::ncmul (
    const exvector & v )
```

6.103.2.7 ncmul() [7/7]

```
GiNaC::ncmul::ncmul (
    exvector && v )
```

6.103.3 Member Function Documentation**6.103.3.1 precedence()**

```
unsigned GiNaC::ncmul::precedence ( ) const [inline], [override], [virtual]
```

Return relative operator precedence (for parenthezing output).

Reimplemented from [GiNaC::container< C >](#).

Referenced by [do_print\(\)](#), and [do_print_csrc\(\)](#).

6.103.3.2 info()

```
bool GiNaC::ncmul::info (
    unsigned inf ) const [override], [virtual]
```

Information about the object.

See also

class [info_flags](#)

Reimplemented from [GiNaC::container< C >](#).

6.103.3.3 degree()

```
int GiNaC::ncmul::degree (
    const ex & s ) const [override], [virtual]
```

Return degree of highest power in object s.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::is_equal\(\)](#), and [GiNaC::container_storage< C >::seq](#).

6.103.3.4 ldegree()

```
int GiNaC::ncmul::ldegree (
    const ex & s ) const [override], [virtual]
```

Return degree of lowest power in object s.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::is_equal\(\)](#), and [GiNaC::container_storage< C >::seq](#).

6.103.3.5 expand()

```
ex GiNaC::ncmul::expand (
    unsigned options = 0 ) const [override], [virtual]
```

Expand expression, i.e.

multiply it out and return the result as a new expression.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex1](#), [expandchildren\(\)](#), [GiNaC::status_flags::expanded](#), [k](#), [GiNaC::container< C >::op\(\)](#), [options](#), [GiNaC::rename_dummy_indices_uniquely\(\)](#), [GiNaC::container_storage< C >::seq](#), and [GiNaC::basic::setflag\(\)](#).

6.103.3.6 coeff()

```
ex GiNaC::ncmul::coeff (
    const ex & s,
    int n = 1 ) const [override], [virtual]
```

Return coefficient of degree n in object s.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex0](#), [GiNaC::_ex1](#), [c](#), [GiNaC::basic::is_equal\(\)](#), [n](#), and [GiNaC::container_storage< C >::seq](#).

Referenced by [GiNaC::add::coeff\(\)](#).

6.103.3.7 eval()

```
ex GiNaC::ncmul::eval ( ) const [override], [virtual]
```

Perform automatic term rewriting rules in this class.

In the following x, x_1, x_2, \dots stand for a symbolic variables of type `ex` and c, c_1, c_2, \dots stand for such expressions that contain a plain number.

- $\text{ncmul}(\dots, *(x_1, x_2), \dots, \text{ncmul}(x_3, x_4), \dots) \rightarrow \text{ncmul}(\dots, x_1, x_2, \dots, x_3, x_4, \dots)$ (associativity)
- $\text{ncmul}(x) \rightarrow x$
- $\text{ncmul}() \rightarrow 1$
- $\text{ncmul}(\dots, c_1, \dots, c_2, \dots) \rightarrow *(c_1, c_2, \text{ncmul}(\dots))$ (pull out commutative elements)
- $\text{ncmul}(x_1, y_1, x_2, y_2) \rightarrow *(\text{ncmul}(x_1, x_2), \text{ncmul}(y_1, y_2))$ (collect elements of same type)
- $\text{ncmul}(x_1, x_2, x_3, \dots) \rightarrow x::\text{eval_ncmul}(x_1, x_2, x_3, \dots)$

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex1](#), [append_factors\(\)](#), [GiNaC::return_types::commutative](#), [count_factors\(\)](#), [GiNaC::status_flags::evaluated](#), [GiNaC::factor\(\)](#), [factors](#), [GiNaC::basic::flags](#), [GINAC_ASSERT](#), [GiNaC::make_flat_inserter::handle_factor\(\)](#), [GiNaC::return_types::noncommutative](#), [GiNaC::return_types::noncommutative_composite](#), [GiNaC::container_storage< C >::reserve](#) and [GiNaC::container_storage< C >::seq](#).

6.103.3.8 evalm()

```
ex GiNaC::ncmul::evalm ( ) const [override], [virtual]
```

Evaluate sums, products and integer powers of matrices.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::ex::begin\(\)](#), [GiNaC::matrix::mul\(\)](#), and [GiNaC::container_storage< C >::seq](#).

6.103.3.9 get_free_indices()

```
exvector GiNaC::ncmul::get_free_indices ( ) const [override], [virtual]
```

Return a vector containing the free indices of an expression.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::find_free_and_dummy\(\)](#), [GiNaC::ex::get_free_indices\(\)](#), [GiNaC::container< C >::nops\(\)](#), and [GiNaC::container< C >::op\(\)](#).

6.103.3.10 thiscontainer() [1/2]

```
ex GiNaC::ncmul::thiscontainer (
    const exvector & v ) const [override]
```

6.103.3.11 thiscontainer() [2/2]

```
ex GiNaC::ncmul::thiscontainer (
    exvector && v ) const [override]
```

6.103.3.12 conjugate()

```
ex GiNaC::ncmul::conjugate ( ) const [override], [virtual]
```

Reimplemented from [GiNaC::container< C >](#).

References [GiNaC::container< C >::begin\(\)](#), [GiNaC::container< C >::conjugate\(\)](#), [GiNaC::container< C >::end\(\)](#), [GiNaC::is_clifford_tinfo\(\)](#), [GiNaC::return_types::noncommutative](#), [GiNaC::container< C >::nops\(\)](#), [return_type\(\)](#), and [return_type_tinfo\(\)](#).

6.103.3.13 real_part()

```
ex GiNaC::ncmul::real_part ( ) const [override], [virtual]
```

Reimplemented from [GiNaC::container< C >](#).

References [GiNaC::basic::real_part\(\)](#).

6.103.3.14 imag_part()

```
ex GiNaC::ncmul::imag_part ( ) const [override], [virtual]
```

Reimplemented from [GiNaC::container< C >](#).

References [GiNaC::basic::imag_part\(\)](#).

6.103.3.15 derivative()

```
ex GiNaC::ncmul::derivative (
    const symbol & s ) const [override], [protected], [virtual]
```

Implementation of [ex::diff\(\)](#) for a non-commutative product.

It applies the product rule.

See also

[ex::diff](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::container_storage< C >::seq](#), and [GiNaC::ex::swap\(\)](#).

6.103.3.16 return_type()

```
unsigned GiNaC::ncmul::return_type ( ) const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::return_types::commutative](#), [GiNaC::container< C >::end\(\)](#), [GINAC_ASSERT](#), [GiNaC::return_types::noncommutative](#), [GiNaC::return_types::noncommutative_composite](#), and [GiNaC::container_storage< C >::seq](#).

Referenced by [conjugate\(\)](#).

6.103.3.17 return_type_tinfo()

```
return\_type\_t GiNaC::ncmul::return_type_tinfo ( ) const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::return_types::noncommutative](#), and [GiNaC::container_storage< C >::seq](#).

Referenced by [conjugate\(\)](#).

6.103.3.18 do_print()

```
void GiNaC::ncmul::do_print (
    const print\_context & c,
    unsigned level ) const [protected]
```

References [c](#), [precedence\(\)](#), and [GiNaC::container< C >::printseq\(\)](#).

6.103.3.19 do_print_csrc()

```
void GiNaC::ncmul::do_print_csrc (
    const print\_context & c,
    unsigned level ) const [protected]
```

References [c](#), [precedence\(\)](#), and [GiNaC::container< C >::printseq\(\)](#).

6.103.3.20 count_factors()

```
size_t GiNaC::ncmul::count_factors (
    const ex & e ) const [protected]
```

References [GiNaC::return_types::commutative](#), [count_factors\(\)](#), [factors](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), and [GiNaC::ex::return_type\(\)](#).

Referenced by [count_factors\(\)](#), and [eval\(\)](#).

6.103.3.21 append_factors()

```
void GiNaC::ncmul::append_factors (
    exvector & v,
    const ex & e ) const [protected]
```

References [append_factors\(\)](#), [GiNaC::return_types::commutative](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), and [GiNaC::ex::return_type\(\)](#).

Referenced by [append_factors\(\)](#), and [eval\(\)](#).

6.103.3.22 expandchildren()

```
exvector GiNaC::ncmul::expandchildren (
    unsigned options ) const [protected]
```

References [GiNaC::are_ex_trivially_equal\(\)](#), [GiNaC::container< C >::end\(\)](#), [GiNaC::ex::expand\(\)](#), [options](#), and [GiNaC::container_storage< C >::seq](#).

Referenced by [expand\(\)](#).

6.103.3.23 get_factors()

```
const exvector & GiNaC::ncmul::get_factors ( ) const
```

References [GiNaC::container_storage< C >::seq](#).

6.103.4 Friends And Related Function Documentation

6.103.4.1 power

```
friend class power [friend]
```

6.103.4.2 reeval_ncmul

```
ex reeval_ncmul (
    const exvector & v ) [friend]
```

6.103.4.3 hold_ncmul

```
ex hold_ncmul (
    const exvector & v ) [friend]
```

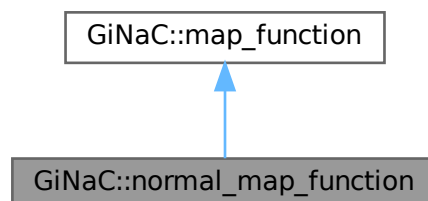
The documentation for this class was generated from the following files:

- [ncmul.h](#)
- [indexed.cpp](#)
- [ncmul.cpp](#)

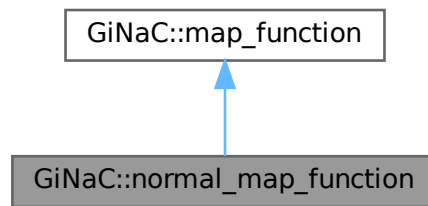
6.104 GiNaC::normal_map_function Struct Reference

Function object to be applied by [basic::normal\(\)](#).

Inheritance diagram for GiNaC::normal_map_function:



Collaboration diagram for `GiNaC::normal_map_function`:



Public Member Functions

- `ex operator()` (const `ex` &`e`) override

Public Member Functions inherited from `GiNaC::map_function`

- virtual `~map_function()`
- virtual `ex operator()` (const `ex` &`e`)=0

Additional Inherited Members

Public Types inherited from `GiNaC::map_function`

- typedef const `ex` & `argument_type`
- typedef `ex` `result_type`

6.104.1 Detailed Description

Function object to be applied by `basic::normal()`.

6.104.2 Member Function Documentation

6.104.2.1 `operator()()`

```

ex GiNaC::normal_map_function::operator() (
    const ex & e ) [inline], [override], [virtual]
  
```

Implements `GiNaC::map_function`.

References `GiNaC::normal()`.

The documentation for this struct was generated from the following file:

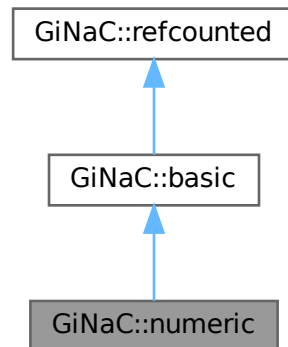
- `normal.cpp`

6.105 GiNaC::numeric Class Reference

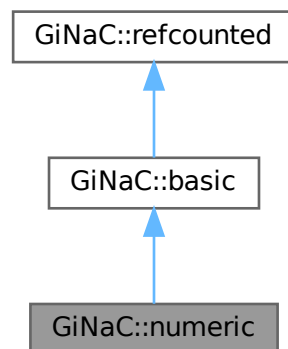
This class is a wrapper around CLN-numbers within the [GiNaC](#) class hierarchy.

```
#include <numeric.h>
```

Inheritance diagram for GiNaC::numeric:



Collaboration diagram for GiNaC::numeric:



Public Member Functions

- [numeric](#) (int i)
- [numeric](#) (unsigned int i)
- [numeric](#) (long i)
- [numeric](#) (unsigned long i)

- `numeric` (long long i)
- `numeric` (unsigned long long i)
- `numeric` (long `numer`, long `denom`)
Constructor for rational numerics a/b.
- `numeric` (double d)
- `numeric` (const char *)
ctor from C-style string.
- unsigned `precedence` () const override
Return relative operator precedence (for parenthezing output).
- bool `info` (unsigned inf) const override
Information about the object.
- bool `is_polynomial` (const `ex` &var) const override
Check whether this is a polynomial in the given variables.
- int `degree` (const `ex` &s) const override
Return degree of highest power in object s.
- int `ldegree` (const `ex` &s) const override
Return degree of lowest power in object s.
- `ex` `coeff` (const `ex` &s, int `n`=1) const override
Return coefficient of degree n in object s.
- bool `has` (const `ex` &other, unsigned `options`=0) const override
Disassemble real part and imaginary part to scan for the occurrence of a single number.
- `ex` `eval` () const override
Evaluation of numbers doesn't do anything at all.
- `ex` `evalf` () const override
Cast numeric into a floating-point object.
- `ex` `subs` (const `exmap` &`m`, unsigned `options`=0) const override
Substitute a set of objects by arbitrary expressions.
- `ex` `normal` (`exmap` &`repl`, `exmap` &`rev_lookup`, `lst` &`modifier`) const override
Implementation of `ex::normal()` for a numeric.
- `ex` `to_rational` (`exmap` &`repl`) const override
Implementation of `ex::to_rational()` for a numeric.
- `ex` `to_polynomial` (`exmap` &`repl`) const override
Implementation of `ex::to_polynomial()` for a numeric.
- `numeric` `integer_content` () const override
- `ex` `smod` (const `numeric` &`xi`) const override
Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- `numeric` `max_coefficient` () const override
Implementation `ex::max_coefficient()`.
- `ex` `conjugate` () const override
- `ex` `real_part` () const override
- `ex` `imag_part` () const override
- void `archive` (`archive_node` &`n`) const override
Save (a.k.a.
- void `read_archive` (const `archive_node` &`n`, `lst` &`syms`) override
Read (a.k.a.
- const `numeric` `add` (const `numeric` &`other`) const
Numerical addition method.
- const `numeric` `sub` (const `numeric` &`other`) const
Numerical subtraction method.
- const `numeric` `mul` (const `numeric` &`other`) const
Numerical multiplication method.

- const [numeric div](#) (const [numeric](#) &other) const
Numerical division method.
- const [numeric power](#) (const [numeric](#) &other) const
Numerical exponentiation.
- const [numeric & add_dyn](#) (const [numeric](#) &other) const
Numerical addition method.
- const [numeric & sub_dyn](#) (const [numeric](#) &other) const
Numerical subtraction method.
- const [numeric & mul_dyn](#) (const [numeric](#) &other) const
Numerical multiplication method.
- const [numeric & div_dyn](#) (const [numeric](#) &other) const
Numerical division method.
- const [numeric & power_dyn](#) (const [numeric](#) &other) const
Numerical exponentiation.
- const [numeric & operator=](#) (int i)
- const [numeric & operator=](#) (unsigned int i)
- const [numeric & operator=](#) (long i)
- const [numeric & operator=](#) (unsigned long i)
- const [numeric & operator=](#) (double d)
- const [numeric & operator=](#) (const char *s)
- const [numeric inverse](#) () const
Inverse of a number.
- [numeric step](#) () const
Return the step function of a numeric.
- int [csgn](#) () const
Return the complex half-plane (left or right) in which the number lies.
- int [compare](#) (const [numeric](#) &other) const
This method establishes a canonical order on all numbers.
- bool [is_equal](#) (const [numeric](#) &other) const
- bool [is_zero](#) () const
True if object is zero.
- bool [is_positive](#) () const
True if object is not complex and greater than zero.
- bool [is_negative](#) () const
True if object is not complex and less than zero.
- bool [is_integer](#) () const
True if object is a non-complex integer.
- bool [is_pos_integer](#) () const
True if object is an exact integer greater than zero.
- bool [is_nonneg_integer](#) () const
True if object is an exact integer greater or equal zero.
- bool [is_even](#) () const
True if object is an exact even integer.
- bool [is_odd](#) () const
True if object is an exact odd integer.
- bool [is_prime](#) () const
Probabilistic primality test.
- bool [is_rational](#) () const
True if object is an exact rational number, may even be complex (denominator may be unity).
- bool [is_real](#) () const
True if object is a real integer, rational or float (but not complex).

- bool `is_cinteger` () const
True if object is element of the domain of integers extended by I, i.e.
- bool `is_crational` () const
True if object is an exact rational number, may even be complex (denominator may be unity).
- bool `operator==` (const `numeric` &other) const
- bool `operator!=` (const `numeric` &other) const
- bool `operator<` (const `numeric` &other) const
Numerical comparison: less.
- bool `operator<=` (const `numeric` &other) const
Numerical comparison: less or equal.
- bool `operator>` (const `numeric` &other) const
Numerical comparison: greater.
- bool `operator>=` (const `numeric` &other) const
Numerical comparison: greater or equal.
- int `to_int` () const
Converts numeric types to machine's int.
- long `to_long` () const
Converts numeric types to machine's long.
- double `to_double` () const
Converts numeric types to machine's double.
- `cln::cl_N to_cl_N` () const
*Returns a new CLN object of type cl_N, representing the value of *this.*
- const `numeric real` () const
Real part of a number.
- const `numeric imag` () const
Imaginary part of a number.
- const `numeric numer` () const
Numerator.
- const `numeric denom` () const
Denominator.
- int `int_length` () const
Size in binary notation.
- `numeric` (const `cln::cl_N` &z)
Ctor from CLN types.

Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()
basic destructor, virtual because class ex will delete objects of derived classes via a basic.*
- `basic` (const `basic` &other)
- const `basic` & `operator=` (const `basic` &other)
basic assignment operator: the other object might be of a derived class.
- virtual `basic * duplicate` () const
Create a clone of this object on the heap.
- virtual `ex eval` () const
Perform automatic non-interruptive term rewriting rules.
- virtual `ex evalf` () const
Evaluate object numerically.
- virtual `ex evalm` () const
Evaluate sums, products and integer powers of matrices.

- virtual `ex eval_integ ()` const
Evaluate integrals, if result is known.
- virtual `ex eval_indexed (const basic &i)` const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void `print (const print_context &c, unsigned level=0)` const
Output to stream.
- virtual void `dbgprint ()` const
Little wrapper around print to be called within a debugger.
- virtual void `dbgprinttree ()` const
Little wrapper around printtree to be called within a debugger.
- virtual unsigned `precedence ()` const
Return relative operator precedence (for parenthezing output).
- virtual bool `info (unsigned inf)` const
Information about the object.
- virtual size_t `nops ()` const
Number of operands/members.
- virtual `ex op (size_t i)` const
Return operand/member at position i.
- virtual `ex operator[] (const ex &index)` const
- virtual `ex operator[] (size_t i)` const
- virtual `ex &let_op (size_t i)`
Return modifiable operand/member at position i.
- virtual `ex &operator[] (const ex &index)`
- virtual `ex &operator[] (size_t i)`
- virtual bool `has (const ex &other, unsigned options=0)` const
Test for occurrence of a pattern.
- virtual bool `match (const ex &pattern, exmap &repls)` const
Check whether the expression matches a given pattern.
- virtual `ex subs (const exmap &m, unsigned options=0)` const
Substitute a set of objects by arbitrary expressions.
- virtual `ex map (map_function &f)` const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void `accept (GiNaC::visitor &v)` const
- virtual bool `is_polynomial (const ex &var)` const
Check whether this is a polynomial in the given variables.
- virtual int `degree (const ex &s)` const
Return degree of highest power in object s.
- virtual int `ldegree (const ex &s)` const
Return degree of lowest power in object s.
- virtual `ex coeff (const ex &s, int n=1)` const
Return coefficient of degree n in object s.
- virtual `ex expand (unsigned options=0)` const
Expand expression, i.e.
- virtual `ex collect (const ex &s, bool distributed=false)` const
Sort expanded expression in terms of powers of some object(s).
- virtual `ex series (const relational &r, int order, unsigned options=0)` const
Default implementation of `ex::series()`.
- virtual `ex normal (exmap &repl, exmap &rev_lookup, lst &modifier)` const
Default implementation of `ex::normal()`.
- virtual `ex to_rational (exmap &repl)` const
Default implementation of `ex::to_rational()`.

- virtual [ex to_polynomial](#) ([exmap](#) &repl) const
- virtual [numeric integer_content](#) () const
- virtual [ex smod](#) (const [numeric](#) &xi) const
Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- virtual [numeric max_coefficient](#) () const
Implementation [ex::max_coefficient\(\)](#).
- virtual [exvector get_free_indices](#) () const
Return a vector containing the free indices of an expression.
- virtual [ex add_indexed](#) (const [ex](#) &self, const [ex](#) &other) const
Add two indexed expressions.
- virtual [ex scalar_mul_indexed](#) (const [ex](#) &self, const [numeric](#) &other) const
Multiply an indexed expression with a scalar.
- virtual bool [contract_with](#) (exvector::iterator self, exvector::iterator other, [exvector](#) &v) const
Try to contract two indexed expressions that appear in the same product.
- virtual unsigned [return_type](#) () const
- virtual [return_type_t](#) [return_type_tinfo](#) () const
- virtual [ex conjugate](#) () const
- virtual [ex real_part](#) () const
- virtual [ex imag_part](#) () const
- template<class T >
void [print_dispatch](#) (const [print_context](#) &c, unsigned level) const
Like [print\(\)](#), but dispatch to the specified class.
- void [print_dispatch](#) (const [registered_class_info](#) &ri, const [print_context](#) &c, unsigned level) const
Like [print\(\)](#), but dispatch to the specified class.
- virtual void [archive](#) ([archive_node](#) &n) const
Save (serialize) the object into archive node.
- virtual void [read_archive](#) (const [archive_node](#) &n, [lst](#) &syms)
Load (deserialize) the object from an archive node.
- [ex subs_one_level](#) (const [exmap](#) &m, unsigned [options](#)) const
Helper function for [subs\(\)](#).
- [ex diff](#) (const [symbol](#) &s, unsigned nth=1) const
Default interface of nth derivative [ex::diff\(s, n\)](#).
- int [compare](#) (const [basic](#) &other) const
Compare objects syntactically to establish canonical ordering.
- bool [is_equal](#) (const [basic](#) &other) const
Test for syntactic equality.
- const [basic](#) & [hold](#) () const
Stop further evaluation.
- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const
Set some [status_flags](#).
- const [basic](#) & [clearflag](#) (unsigned f) const
Clear some [status_flags](#).

Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add_reference](#) () noexcept
- unsigned int [remove_reference](#) () noexcept
- unsigned int [get_refcount](#) () const noexcept
- void [set_refcount](#) (unsigned int r) noexcept

Protected Member Functions

- `ex derivative` (const `symbol` &s) const override
Implementation of `ex::diff` for a numeric always returns 0.
- bool `is_equal_same_type` (const `basic` &other) const override
Returns true if two objects of same type are equal.
- unsigned `calchash` () const override
Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.
- void `print_numeric` (const `print_context` &c, const char *par_open, const char *par_close, const char *imag←_sym, const char *mul_sym, unsigned level) const
- void `do_print` (const `print_context` &c, unsigned level) const
- void `do_print_latex` (const `print_latex` &c, unsigned level) const
- void `do_print_csrc` (const `print_csrc` &c, unsigned level) const
- void `do_print_csrc_cl_N` (const `print_csrc_cl_N` &c, unsigned level) const
- void `do_print_tree` (const `print_tree` &c, unsigned level) const
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const

Protected Member Functions inherited from `GiNaC::basic`

- `basic` ()
- virtual `ex eval_ncmul` (const `exvector` &v) const
- virtual bool `match_same_type` (const `basic` &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual `ex derivative` (const `symbol` &s) const
Default implementation of `ex::diff()`.
- virtual int `compare_same_type` (const `basic` &other) const
Returns order relation between two objects of same type.
- virtual bool `is_equal_same_type` (const `basic` &other) const
Returns true if two objects of same type are equal.
- virtual unsigned `calchash` () const
Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.
- void `ensure_if_modifiable` () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void `do_print` (const `print_context` &c, unsigned level) const
Default output to stream.
- void `do_print_tree` (const `print_tree` &c, unsigned level) const
Tree output to stream.
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const
Python parsable output to stream.

Protected Attributes

- `cln::cl_N` value

Protected Attributes inherited from `GiNaC::basic`

- unsigned `flags`
of type `status_flags`
- unsigned `hashvalue`
hash value

6.105.1 Detailed Description

This class is a wrapper around CLN-numbers within the [GiNaC](#) class hierarchy.

Objects of this type may directly be created by the user.

6.105.2 Constructor & Destructor Documentation

6.105.2.1 `numeric()` [1/10]

```
GiNaC::numeric::numeric (  
    int i )
```

References [GiNaC::status_flags::evaluated](#), [GiNaC::status_flags::expanded](#), [GiNaC::basic::setflag\(\)](#), and [value](#).

6.105.2.2 `numeric()` [2/10]

```
GiNaC::numeric::numeric (  
    unsigned int i )
```

References [GiNaC::status_flags::evaluated](#), [GiNaC::status_flags::expanded](#), [GiNaC::basic::setflag\(\)](#), and [value](#).

6.105.2.3 `numeric()` [3/10]

```
GiNaC::numeric::numeric (  
    long i )
```

References [GiNaC::status_flags::evaluated](#), [GiNaC::status_flags::expanded](#), [GiNaC::basic::setflag\(\)](#), and [value](#).

6.105.2.4 `numeric()` [4/10]

```
GiNaC::numeric::numeric (  
    unsigned long i )
```

References [GiNaC::status_flags::evaluated](#), [GiNaC::status_flags::expanded](#), [GiNaC::basic::setflag\(\)](#), and [value](#).

6.105.2.5 numeric() [5/10]

```
GiNaC::numeric::numeric (
    long long i )
```

References [GiNaC::status_flags::evaluated](#), [GiNaC::status_flags::expanded](#), [GiNaC::basic::setflag\(\)](#), and [value](#).

6.105.2.6 numeric() [6/10]

```
GiNaC::numeric::numeric (
    unsigned long long i )
```

References [GiNaC::status_flags::evaluated](#), [GiNaC::status_flags::expanded](#), [GiNaC::basic::setflag\(\)](#), and [value](#).

6.105.2.7 numeric() [7/10]

```
GiNaC::numeric::numeric (
    long numer,
    long denom )
```

Constructor for rational numerics a/b.

Exceptions

<code>overflow_error</code>	(division by zero)
-----------------------------	--------------------

References [denom\(\)](#), [GiNaC::status_flags::evaluated](#), [GiNaC::status_flags::expanded](#), [numer\(\)](#), [GiNaC::basic::setflag\(\)](#), and [value](#).

6.105.2.8 numeric() [8/10]

```
GiNaC::numeric::numeric (
    double d )
```

References [GiNaC::status_flags::evaluated](#), [GiNaC::status_flags::expanded](#), [GiNaC::basic::setflag\(\)](#), and [value](#).

6.105.2.9 `numeric()` [9/10]

```
GiNaC::numeric::numeric (
    const char * s )
```

ctor from C-style string.

It also accepts complex numbers in [GiNaC](#) notation like "2+5*I".

References [GiNaC::Digits](#), [GiNaC::status_flags::evaluated](#), [GiNaC::status_flags::expanded](#), [GiNaC::basic::setflag\(\)](#), and [value](#).

6.105.2.10 `numeric()` [10/10]

```
GiNaC::numeric::numeric (
    const cln::cl_N & z ) [explicit]
```

Ctor from CLN types.

This is for the initiated user or internal use only.

References [GiNaC::status_flags::evaluated](#), [GiNaC::status_flags::expanded](#), [GiNaC::basic::setflag\(\)](#), and [value](#).

6.105.3 Member Function Documentation

6.105.3.1 `precedence()`

```
unsigned GiNaC::numeric::precedence ( ) const [inline], [override], [virtual]
```

Return relative operator precedence (for parenthezing output).

Reimplemented from [GiNaC::basic](#).

Referenced by [print_numeric\(\)](#).

6.105.3.2 info()

```
bool GiNaC::numeric::info (
    unsigned int ) const [override], [virtual]
```

Information about the object.

See also

class [info_flags](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::info_flags::cinteger](#), [GiNaC::info_flags::cinteger_polynomial](#), [GiNaC::info_flags::crational](#), [GiNaC::info_flags::crational_polynomial](#), [GiNaC::info_flags::even](#), [GiNaC::info_flags::expanded](#), [GiNaC::info_flags::integer](#), [GiNaC::info_flags::integer_polynomial](#), [is_cinteger\(\)](#), [is_crational\(\)](#), [is_even\(\)](#), [is_integer\(\)](#), [is_negative\(\)](#), [is_nonneg_integer\(\)](#), [is_odd\(\)](#), [is_pos_integer\(\)](#), [is_positive\(\)](#), [is_prime\(\)](#), [is_rational\(\)](#), [is_real\(\)](#), [is_zero\(\)](#), [GiNaC::info_flags::negative](#), [GiNaC::info_flags::negint](#), [GiNaC::info_flags::nonnegative](#), [GiNaC::info_flags::nonnegint](#), [GiNaC::info_flags::numeric](#), [GiNaC::info_flags::odd](#), [GiNaC::info_flags::polynomial](#), [GiNaC::info_flags::posint](#), [GiNaC::info_flags::positive](#), [GiNaC::info_flags::prime](#), [GiNaC::info_flags::rational](#), [GiNaC::info_flags::rational_function](#), [GiNaC::info_flags::rational_polynomial](#), and [GiNaC::info_flags::real](#).

Referenced by [GiNaC::abs_power\(\)](#), [GiNaC::csgn_power\(\)](#), and [GiNaC::zeta1_eval\(\)](#).

6.105.3.3 is_polynomial()

```
bool GiNaC::numeric::is_polynomial (
    const ex & var ) const [override], [virtual]
```

Check whether this is a polynomial in the given variables.

Reimplemented from [GiNaC::basic](#).

6.105.3.4 degree()

```
int GiNaC::numeric::degree (
    const ex & s ) const [override], [virtual]
```

Return degree of highest power in object s.

Reimplemented from [GiNaC::basic](#).

6.105.3.5 ldegree()

```
int GiNaC::numeric::ldegree (
    const ex & s ) const [override], [virtual]
```

Return degree of lowest power in object s.

Reimplemented from [GiNaC::basic](#).

6.105.3.6 coeff()

```
ex GiNaC::numeric::coeff (
    const ex & s,
    int n = 1 ) const [override], [virtual]
```

Return coefficient of degree n in object s.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex0](#), and [n](#).

Referenced by [GiNaC::pseries::mul_const\(\)](#).

6.105.3.7 has()

```
bool GiNaC::numeric::has (
    const ex & other,
    unsigned options = 0 ) const [override], [virtual]
```

Disassemble real part and imaginary part to scan for the occurrence of a single number.

Also handles the imaginary unit. It ignores the sign on both this and the argument, which may lead to what might appear as funny results: $(2+i).has(-2) \rightarrow true$. But this is consistent, since we also would like to have $(-2+i).has(2) \rightarrow true$ and we want to think about the sign as a multiplicative factor.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_num0_p](#), [GiNaC::i](#), [imag\(\)](#), [is_equal\(\)](#), [is_real\(\)](#), [is_zero\(\)](#), and [real\(\)](#).

6.105.3.8 eval()

```
ex GiNaC::numeric::eval ( ) const [override], [virtual]
```

Evaluation of numbers doesn't do anything at all.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::hold\(\)](#).

6.105.3.9 evalf()

```
ex GiNaC::numeric::evalf ( ) const [override], [virtual]
```

Cast numeric into a floating-point object.

For example `exact numeric(1)` is returned as a `1.000000000000000000000000` and so on according to how `Digits` is currently set. In case the object already was a floating point number the precision is trimmed to match the currently set default.

Returns

an ex-handle to a numeric.

Reimplemented from [GiNaC::basic](#).

References [value](#).

6.105.3.10 subs()

```
ex GiNaC::numeric::subs (
    const exmap & m,
    unsigned options = 0 ) const [inline], [override], [virtual]
```

Substitute a set of objects by arbitrary expressions.

The ex returned will already be evaluated.

Reimplemented from [GiNaC::basic](#).

References [m](#), [options](#), and [GiNaC::basic::subs_one_level\(\)](#).

6.105.3.11 normal()

```
ex GiNaC::numeric::normal (
    exmap & repl,
    exmap & rev_lookup,
    lst & modifier ) const [override], [virtual]
```

Implementation of [ex::normal\(\)](#) for a numeric.

It splits complex numbers into `re+I*im` and replaces `I` and non-rational real numbers with a temporary symbol.

See also

[ex::normal](#)

Reimplemented from [GiNaC::basic](#).

References [denom\(\)](#), [GiNaC::I](#), [imag\(\)](#), [is_integer\(\)](#), [is_rational\(\)](#), [is_real\(\)](#), [numer\(\)](#), [real\(\)](#), and [GiNaC::replace_with_symbol\(\)](#).

6.105.3.12 to_rational()

```
ex GiNaC::numeric::to_rational (
    exmap & repl ) const [override], [virtual]
```

Implementation of [ex::to_rational\(\)](#) for a numeric.

It splits complex numbers into $re+I*im$ and replaces I and non-rational real numbers with a temporary symbol.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::I](#), [imag\(\)](#), [is_rational\(\)](#), [is_real\(\)](#), [real\(\)](#), and [GiNaC::replace_with_symbol\(\)](#).

6.105.3.13 to_polynomial()

```
ex GiNaC::numeric::to_polynomial (
    exmap & repl ) const [override], [virtual]
```

Implementation of [ex::to_polynomial\(\)](#) for a numeric.

It splits complex numbers into $re+I*im$ and replaces I and non-integer real numbers with a temporary symbol.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::I](#), [imag\(\)](#), [is_integer\(\)](#), [is_real\(\)](#), [real\(\)](#), and [GiNaC::replace_with_symbol\(\)](#).

6.105.3.14 integer_content()

```
numeric GiNaC::numeric::integer_content ( ) const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::abs\(\)](#).

6.105.3.15 smod()

```
ex GiNaC::numeric::smod (
    const numeric & xi ) const [override], [virtual]
```

Apply symmetric modular homomorphism to an expanded multivariate polynomial.

This function is usually used internally by [heur_gcd\(\)](#).

Parameters

xi	modulus
------	---------

Returns

mapped polynomial

See also

[heur_gcd](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::smod\(\)](#).

6.105.3.16 max_coefficient()

```
numeric GiNaC::numeric::max_coefficient ( ) const [override], [virtual]
```

Implementation [ex::max_coefficient\(\)](#).

See also

[heur_gcd](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::abs\(\)](#).

6.105.3.17 conjugate()

```
ex GiNaC::numeric::conjugate ( ) const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [is_real\(\)](#), and [value](#).

6.105.3.18 real_part()

```
ex GiNaC::numeric::real_part ( ) const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [value](#).

6.105.3.19 imag_part()

`ex` `GiNaC::numeric::imag_part () const [override], [virtual]`

Reimplemented from [GiNaC::basic](#).

References [value](#).

6.105.3.20 archive()

```
void GiNaC::numeric::archive (
    archive_node & n ) const [override], [virtual]
```

Save (a.k.a.

serialize) object into archive.

Reimplemented from [GiNaC::basic](#).

References [n](#), [value](#), and [GiNaC::write_real_float\(\)](#).

6.105.3.21 read_archive()

```
void GiNaC::numeric::read_archive (
    const archive_node & n,
    lst & syms ) [override], [virtual]
```

Read (a.k.a.

deserialize) object from archive.

Reimplemented from [GiNaC::basic](#).

References [c](#), [GiNaC::status_flags::evaluated](#), [GiNaC::status_flags::expanded](#), [n](#), [GiNaC::read_real_float\(\)](#), [GiNaC::basic::setflag\(\)](#), and [value](#).

6.105.3.22 derivative()

```
ex GiNaC::numeric::derivative (
    const symbol & s ) const [inline], [override], [protected], [virtual]
```

Implementation of [ex::diff](#) for a numeric always returns 0.

See also

[ex::diff](#)

Reimplemented from [GiNaC::basic](#).

6.105.3.23 is_equal_same_type()

```
bool GiNaC::numeric::is_equal_same_type (
    const basic & other ) const [override], [protected], [virtual]
```

Returns true if two objects of same type are equal.

Normally needs not be reimplemented as long as it wasn't overwritten by some parent class, since it just calls [compare_same_type\(\)](#). The reason why this function exists is that sometimes it is easier to determine equality than an order relation and then it can be overridden.

Reimplemented from [GiNaC::basic](#).

References [GINAC_ASSERT](#), and [is_equal\(\)](#).

6.105.3.24 calchash()

```
unsigned GiNaC::numeric::calchash ( ) const [override], [protected], [virtual]
```

Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.

The method inherited from class basic computes a hash value based on the type and hash values of possible members. For this reason it is well suited for container classes but atomic classes should override this implementation because otherwise they would all end up with the same hashvalue.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::golden_ratio_hash\(\)](#), [GiNaC::status_flags::hash_calculated](#), [GiNaC::basic::hashvalue](#), [GiNaC::basic::setflag\(\)](#), and [value](#).

6.105.3.25 add()

```
const numeric GiNaC::numeric::add (
    const numeric & other ) const
```

Numerical addition method.

Adds argument to *this and returns result as a numeric object.

References [value](#).

Referenced by [GiNaC::operator+\(\)](#), [GiNaC::operator++\(\)](#), [GiNaC::operator+=\(\)](#), and [GiNaC::operator--\(\)](#).

6.105.3.26 sub()

```
const numeric GiNaC::numeric::sub (
    const numeric & other ) const
```

Numerical subtraction method.

Subtracts argument from *this and returns result as a numeric object.

References [value](#).

Referenced by [GiNaC::operator-\(\)](#), and [GiNaC::operator-=\(\)](#).

6.105.3.27 mul()

```
const numeric GiNaC::numeric::mul (
    const numeric & other ) const
```

Numerical multiplication method.

Multiplies *this and argument and returns result as a numeric object.

References [value](#).

Referenced by [GiNaC::mul::eval\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::mul::expand\(\)](#), [GiNaC::power::expand_add_2\(\)](#), [GiNaC::lcm\(\)](#), [GiNaC::operator*\(\)](#), [GiNaC::operator*=\(\)](#), and [GiNaC::operator-\(\)](#).

6.105.3.28 div()

```
const numeric GiNaC::numeric::div (
    const numeric & other ) const
```

Numerical division method.

Divides *this by argument and returns result as a numeric object.

Exceptions

overflow_error	(division by zero)
--------------------------------	--------------------

References [value](#).

Referenced by [GiNaC::mul::eval\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::multinomial_coefficient\(\)](#), [GiNaC::operator/\(\)](#), [GiNaC::operator/=\(\)](#), [GiNaC::basic::series\(\)](#), and [GiNaC::tgamma_eval\(\)](#).

6.105.3.29 power()

```
const numeric GiNaC::numeric::power (
    const numeric & other ) const
```

Numerical exponentiation.

Raises *this to the power given as argument and returns result as a numeric object.

References [GiNaC::_num0_p](#), [GiNaC::_num1_p](#), and [value](#).

Referenced by [GiNaC::binomial\(\)](#), and [GiNaC::power::eval\(\)](#).

6.105.3.30 add_dyn()

```
const numeric & GiNaC::numeric::add_dyn (
    const numeric & other ) const
```

Numerical addition method.

Adds argument to *this and returns result as a numeric object on the heap. Use internally only for direct wrapping into an ex object, where the result would end up on the heap anyways.

References [GiNaC::_num0_p](#), and [value](#).

6.105.3.31 sub_dyn()

```
const numeric & GiNaC::numeric::sub_dyn (
    const numeric & other ) const
```

Numerical subtraction method.

Subtracts argument from *this and returns result as a numeric object on the heap. Use internally only for direct wrapping into an ex object, where the result would end up on the heap anyways.

References [GiNaC::_num0_p](#), and [value](#).

6.105.3.32 mul_dyn()

```
const numeric & GiNaC::numeric::mul_dyn (
    const numeric & other ) const
```

Numerical multiplication method.

Multiplies *this and argument and returns result as a numeric object on the heap. Use internally only for direct wrapping into an ex object, where the result would end up on the heap anyways.

References [GiNaC::_num1_p](#), and [value](#).

Referenced by [GiNaC::power::expand_add_2\(\)](#).

6.105.3.33 div_dyn()

```
const numeric & GiNaC::numeric::div_dyn (
    const numeric & other ) const
```

Numerical division method.

Divides *this by argument and returns result as a numeric object on the heap. Use internally only for direct wrapping into an ex object, where the result would end up on the heap anyways.

Exceptions

<code>overflow_error</code>	(division by zero)
-----------------------------	--------------------

References [GiNaC::_num1_p](#), and [value](#).

6.105.3.34 power_dyn()

```
const numeric & GiNaC::numeric::power_dyn (
    const numeric & other ) const
```

Numerical exponentiation.

Raises *this to the power given as argument and returns result as a numeric object on the heap. Use internally only for direct wrapping into an ex object, where the result would end up on the heap anyways.

References [GiNaC::_num0_p](#), [GiNaC::_num1_p](#), and [value](#).

6.105.3.35 operator=() [1/6]

```
const numeric & GiNaC::numeric::operator= (
    int i )
```

References [operator=\(\)](#).

Referenced by [operator=\(\)](#).

6.105.3.36 operator=() [2/6]

```
const numeric & GiNaC::numeric::operator= (
    unsigned int i )
```

References [operator=\(\)](#).

6.105.3.37 operator=() [3/6]

```
const numeric & GiNaC::numeric::operator= (
    long i )
```

References [operator=\(\)](#).

6.105.3.38 operator=() [4/6]

```
const numeric & GiNaC::numeric::operator= (
    unsigned long i )
```

References [operator=\(\)](#).

6.105.3.39 operator=() [5/6]

```
const numeric & GiNaC::numeric::operator= (
    double d )
```

References [operator=\(\)](#).

6.105.3.40 operator=() [6/6]

```
const numeric & GiNaC::numeric::operator= (
    const char * s )
```

References [operator=\(\)](#).

6.105.3.41 inverse()

```
const numeric GiNaC::numeric::inverse ( ) const
```

Inverse of a number.

References [value](#).

Referenced by [GiNaC::divide_in_z\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::heur_gcd_z\(\)](#), [GiNaC::interpolate\(\)](#), and [GiNaC::psi1_eval\(\)](#).

6.105.3.42 step()

```
numeric GiNaC::numeric::step ( ) const
```

Return the step function of a numeric.

The imaginary part of it is ignored because the step function is generally considered real but a numeric may develop a small imaginary part due to rounding errors.

References [r](#), and [value](#).

6.105.3.43 csgn()

```
int GiNaC::numeric::csgn ( ) const
```

Return the complex half-plane (left or right) in which the number lies.

$\text{csgn}(x) == 0$ for $x == 0$, $\text{csgn}(x) == 1$ for $\text{Re}(x) > 0$ or $\text{Re}(x) = 0$ and $\text{Im}(x) > 0$, $\text{csgn}(x) == -1$ for $\text{Re}(x) < 0$ or $\text{Re}(x) = 0$ and $\text{Im}(x) < 0$.

See also

`numeric::compare(const numeric &other)`

References [r](#), and [value](#).

6.105.3.44 compare()

```
int GiNaC::numeric::compare (
    const numeric & other ) const
```

This method establishes a canonical order on all numbers.

For complex numbers this is not possible in a mathematically consistent way but we need to establish some order and it ought to be fast. So we simply define it to be compatible with our method `csgn`.

Returns

`csgn(*this-other)`

See also

[numeric::csgn\(\)](#)

References [value](#).

Referenced by [GiNaC::power::eval\(\)](#).

6.105.3.45 is_equal()

```
bool GiNaC::numeric::is_equal (
    const numeric & other ) const
```

References [value](#).

Referenced by [GiNaC::atan\(\)](#), [GiNaC::cos_eval\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::exp_eval\(\)](#), [has\(\)](#), [is_equal_same_type\(\)](#), [GiNaC::psi2_eval\(\)](#), [GiNaC::sin_eval\(\)](#), [GiNaC::tan_eval\(\)](#), and [GiNaC::zeta1_eval\(\)](#).

6.105.3.46 is_zero()

```
bool GiNaC::numeric::is_zero ( ) const
```

True if object is zero.

References [value](#).

Referenced by [GiNaC::asinh_conjugate\(\)](#), [GiNaC::atan\(\)](#), [GiNaC::atan_conjugate\(\)](#), [GiNaC::expairseq::construct_from_2_expairseq\(\)](#), [GiNaC::expairseq::construct_from_expairseq_ex\(\)](#), [GiNaC::csgn_eval\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::fsolve\(\)](#), [GiNaC::gcd\(\)](#), [has\(\)](#), [info\(\)](#), [GiNaC::iquo\(\)](#), [GiNaC::irem\(\)](#), [GiNaC::matrix::pivot\(\)](#), [GiNaC::matrix::pow\(\)](#), [GiNaC::pseries::power_const\(\)](#), [GiNaC::step_eval\(\)](#), and [GiNaC::zeta1_eval\(\)](#).

6.105.3.47 is_positive()

```
bool GiNaC::numeric::is_positive ( ) const
```

True if object is not complex and greater than zero.

References [value](#).

Referenced by [GiNaC::power::eval\(\)](#), [info\(\)](#), [GiNaC::psi1_eval\(\)](#), [GiNaC::psi2_eval\(\)](#), and [GiNaC::tgamma_eval\(\)](#).

6.105.3.48 is_negative()

```
bool GiNaC::numeric::is_negative ( ) const
```

True if object is not complex and less than zero.

References [value](#).

Referenced by [GiNaC::bernoulli\(\)](#), [GiNaC::beta_eval\(\)](#), [GiNaC::eta_eval\(\)](#), [GiNaC::eta_evalf\(\)](#), [info\(\)](#), and [GiNaC::pseries::power_const\(\)](#).

6.105.3.49 is_integer()

```
bool GiNaC::numeric::is_integer ( ) const
```

True if object is a non-complex integer.

References [value](#).

Referenced by [GiNaC::bernoulli\(\)](#), [GiNaC::beta_eval\(\)](#), [GiNaC::binomial_sym\(\)](#), [GiNaC::mul::eval\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::gcd\(\)](#), [info\(\)](#), [GiNaC::iquo\(\)](#), [GiNaC::irem\(\)](#), [GiNaC::lcm\(\)](#), [GiNaC::mod\(\)](#), [normal\(\)](#), [GiNaC::psi1_eval\(\)](#), [GiNaC::psi2_eval\(\)](#), [GiNaC::smod\(\)](#), [GiNaC::tgamma_eval\(\)](#), [to_int\(\)](#), [to_long\(\)](#), [to_polynomial\(\)](#), and [GiNaC::zeta1_eval\(\)](#).

6.105.3.50 `is_pos_integer()`

```
bool GiNaC::numeric::is_pos_integer ( ) const
```

True if object is an exact integer greater than zero.

References [value](#).

Referenced by [GiNaC::mul::eval\(\)](#), [GiNaC::power::eval\(\)](#), [info\(\)](#), and [GiNaC::pseries::power_const\(\)](#).

6.105.3.51 `is_nonneg_integer()`

```
bool GiNaC::numeric::is_nonneg_integer ( ) const
```

True if object is an exact integer greater or equal zero.

References [value](#).

Referenced by [GiNaC::binomial_sym\(\)](#), [info\(\)](#), and [print_numeric\(\)](#).

6.105.3.52 `is_even()`

```
bool GiNaC::numeric::is_even ( ) const
```

True if object is an exact even integer.

References [value](#).

Referenced by [info\(\)](#), [GiNaC::kronecker_symbol\(\)](#), and [GiNaC::tgamma_eval\(\)](#).

6.105.3.53 `is_odd()`

```
bool GiNaC::numeric::is_odd ( ) const
```

True if object is an exact odd integer.

References [value](#).

Referenced by [info\(\)](#), [GiNaC::is_discriminant_of_quadratic_number_field\(\)](#), and [GiNaC::matrix::pow\(\)](#).

6.105.3.54 is_prime()

```
bool GiNaC::numeric::is_prime ( ) const
```

Probabilistic primality test.

Returns

true if object is exact integer and prime.

References [value](#).

Referenced by [info\(\)](#).

6.105.3.55 is_rational()

```
bool GiNaC::numeric::is_rational ( ) const
```

True if object is an exact rational number, may even be complex (denominator may be unity).

References [value](#).

Referenced by [GiNaC::power::eval\(\)](#), [info\(\)](#), [GiNaC::multiply_lcm\(\)](#), [normal\(\)](#), and [to_rational\(\)](#).

6.105.3.56 is_real()

```
bool GiNaC::numeric::is_real ( ) const
```

True if object is a real integer, rational or float (but not complex).

References [value](#).

Referenced by [GiNaC::atan\(\)](#), [GiNaC::beta_eval\(\)](#), [conjugate\(\)](#), [GiNaC::csgn_eval\(\)](#), [denom\(\)](#), [do_print_csrc\(\)](#), [do_print_csrc_cl_N\(\)](#), [GiNaC::eta_eval\(\)](#), [GiNaC::eta_evalf\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::fsolve\(\)](#), [has\(\)](#), [info\(\)](#), [is_cinteger\(\)](#), [is_crational\(\)](#), [normal\(\)](#), [numer\(\)](#), [operator<\(\)](#), [operator<=\(\)](#), [operator>\(\)](#), [operator>=\(\)](#), [GiNaC::step_eval\(\)](#), [to_double\(\)](#), [to_polynomial\(\)](#), and [to_rational\(\)](#).

6.105.3.57 is_cinteger()

```
bool GiNaC::numeric::is_cinteger ( ) const
```

True if object is element of the domain of integers extended by i , i.e.

is of the form $a+bi$, where a and b are integers.

References [is_real\(\)](#), and [value](#).

Referenced by [info\(\)](#).

6.105.3.58 is_crational()

```
bool GiNaC::numeric::is_crational ( ) const
```

True if object is an exact rational number, may even be complex (denominator may be unity).

References [is_real\(\)](#), and [value](#).

Referenced by [GiNaC::power::eval\(\)](#), and [info\(\)](#).

6.105.3.59 operator==()

```
bool GiNaC::numeric::operator== (
    const numeric & other ) const
```

References [value](#).

6.105.3.60 operator"!="()

```
bool GiNaC::numeric::operator!= (
    const numeric & other ) const
```

References [value](#).

6.105.3.61 operator<()

```
bool GiNaC::numeric::operator< (
    const numeric & other ) const
```

Numerical comparison: less.

Exceptions

<i>invalid_argument</i>	(complex inequality)
-------------------------	----------------------

References [is_real\(\)](#), and [value](#).

6.105.3.62 operator<=()

```
bool GiNaC::numeric::operator<= (
    const numeric & other ) const
```

Numerical comparison: less or equal.

Exceptions

<i>invalid_argument</i>	(complex inequality)
-------------------------	----------------------

References [is_real\(\)](#), and [value](#).

6.105.3.63 operator>()

```
bool GiNaC::numeric::operator> (
    const numeric & other ) const
```

Numerical comparison: greater.

Exceptions

<i>invalid_argument</i>	(complex inequality)
-------------------------	----------------------

References [is_real\(\)](#), and [value](#).

6.105.3.64 operator>=()

```
bool GiNaC::numeric::operator>= (
    const numeric & other ) const
```

Numerical comparison: greater or equal.

Exceptions

<i>invalid_argument</i>	(complex inequality)
-------------------------	----------------------

References [is_real\(\)](#), and [value](#).

6.105.3.65 to_int()

```
int GiNaC::numeric::to_int ( ) const
```

Converts numeric types to machine's int.

You should check with [is_integer\(\)](#) if the number is really an integer before calling this method. You may also consider checking the range first.

References [GINAC_ASSERT](#), [is_integer\(\)](#), and [value](#).

Referenced by [GiNaC::bernoulli\(\)](#), [GiNaC::binomial_sym\(\)](#), [GiNaC::power::do_print_csrc\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::power::expand\(\)](#), [GiNaC::Li_eval\(\)](#), [GiNaC::Kronecker_dtau_kernel::series_coeff_impl\(\)](#), and [GiNaC::Kronecker_dz_kernel::s](#)

6.105.3.66 to_long()

```
long GiNaC::numeric::to_long ( ) const
```

Converts numeric types to machine's long.

You should check with [is_integer\(\)](#) if the number is really an integer before calling this method. You may also consider checking the range first.

References [GINAC_ASSERT](#), [is_integer\(\)](#), and [value](#).

Referenced by [GiNaC::power::expand\(\)](#), and [GiNaC::power::expand_add\(\)](#).

6.105.3.67 to_double()

```
double GiNaC::numeric::to_double ( ) const
```

Converts numeric types to machine's double.

You should check with [is_real\(\)](#) if the number is really not complex before calling this method.

References [GINAC_ASSERT](#), [is_real\(\)](#), and [value](#).

6.105.3.68 to_cl_N()

```
cln::cl_N GiNaC::numeric::to_cl_N ( ) const
```

Returns a new CLN object of type `cl_N`, representing the value of `*this`.

This method may be used when mixing [GiNaC](#) and CLN in one project.

References [value](#).

Referenced by [GiNaC::atan\(\)](#), [GiNaC::gcd\(\)](#), [GiNaC::iquo\(\)](#), [GiNaC::irem\(\)](#), [GiNaC::lcm\(\)](#), [GiNaC::mod\(\)](#), [GiNaC::Kronecker_dtau_kernel::series_coeff_impl\(\)](#), and [GiNaC::smod\(\)](#).

6.105.3.69 real()

```
const numeric GiNaC::numeric::real ( ) const
```

Real part of a number.

References [value](#).

Referenced by [GiNaC::csgn_eval\(\)](#), [GiNaC::power::eval\(\)](#), [has\(\)](#), [normal\(\)](#), [GiNaC::pseries::power_const\(\)](#), [GiNaC::step_eval\(\)](#), [to_polynomial\(\)](#), and [to_rational\(\)](#).

6.105.3.70 imag()

```
const numeric GiNaC::numeric::imag ( ) const
```

Imaginary part of a number.

References [value](#).

Referenced by [GiNaC::csgn_eval\(\)](#), [has\(\)](#), [normal\(\)](#), [GiNaC::step_eval\(\)](#), [to_polynomial\(\)](#), and [to_rational\(\)](#).

6.105.3.71 numer()

```
const numeric GiNaC::numeric::numer ( ) const
```

Numerator.

Computes the numerator of rational numbers, rationalized numerator of complex if real and imaginary part are both rational numbers (i.e `numer(4/3+5/6*I) == 8+5*I`), the number carrying the sign in all other cases.

References [is_real\(\)](#), [r](#), and [value](#).

Referenced by [GiNaC::power::eval\(\)](#), [GiNaC::frac_cancel\(\)](#), [normal\(\)](#), and [numeric\(\)](#).

6.105.3.72 denom()

```
const numeric GiNaC::numeric::denom ( ) const
```

Denominator.

Computes the denominator of rational numbers, common integer denominator of complex if real and imaginary part are both rational numbers (i.e `denom(4/3+5/6*I) == 6`), one in all other cases.

References [GiNaC::_num1_p](#), [is_real\(\)](#), [r](#), and [value](#).

Referenced by [GiNaC::power::eval\(\)](#), [GiNaC::frac_cancel\(\)](#), [normal\(\)](#), and [numeric\(\)](#).

6.105.3.73 int_length()

```
int GiNaC::numeric::int_length ( ) const
```

Size in binary notation.

For integers, this is the smallest $n \geq 0$ such that $-2^n \leq x < 2^n$. If $x > 0$, this is the unique $n > 0$ such that $2^{n-1} \leq x < 2^n$.

Returns

number of bits (excluding sign) needed to represent that number in two's complement if it is an integer, 0 otherwise.

References [value](#).

Referenced by [GiNaC::heur_gcd_z\(\)](#).

6.105.3.74 print_numeric()

```
void GiNaC::numeric::print_numeric (
    const print_context & c,
    const char * par_open,
    const char * par_close,
    const char * imag_sym,
    const char * mul_sym,
    unsigned level ) const [protected]
```

References [c](#), [is_nonneg_integer\(\)](#), [precedence\(\)](#), [GiNaC::print_real_number\(\)](#), [r](#), [GiNaC::print_context::s](#), and [value](#).

Referenced by [do_print\(\)](#), [do_print_latex\(\)](#), and [do_print_python_repr\(\)](#).

6.105.3.75 do_print()

```
void GiNaC::numeric::do_print (
    const print_context & c,
    unsigned level ) const [protected]
```

References [c](#), and [print_numeric\(\)](#).

6.105.3.76 do_print_latex()

```
void GiNaC::numeric::do_print_latex (
    const print_latex & c,
    unsigned level ) const [protected]
```

References [c](#), and [print_numeric\(\)](#).

6.105.3.77 do_print_csrc()

```
void GiNaC::numeric::do_print_csrc (
    const print_csrc & c,
    unsigned level ) const [protected]
```

References [c](#), [is_real\(\)](#), [GiNaC::print_real_csrc\(\)](#), and [value](#).

6.105.3.78 do_print_csrc_cl_N()

```
void GiNaC::numeric::do_print_csrc_cl_N (
    const print\_csrc\_cl\_N & c,
    unsigned level ) const [protected]
```

References [c](#), [is_real\(\)](#), [GiNaC::print_real_cl_N\(\)](#), and [value](#).

6.105.3.79 do_print_tree()

```
void GiNaC::numeric::do_print_tree (
    const print\_tree & c,
    unsigned level ) const [protected]
```

References [c](#), [GiNaC::basic::flags](#), [GiNaC::basic::hashvalue](#), and [value](#).

6.105.3.80 do_print_python_repr()

```
void GiNaC::numeric::do_print_python_repr (
    const print\_python\_repr & c,
    unsigned level ) const [protected]
```

References [c](#), and [print_numeric\(\)](#).

6.105.4 Member Data Documentation**6.105.4.1 value**

```
cln::cl_N GiNaC::numeric::value [protected]
```

Referenced by [add\(\)](#), [add_dyn\(\)](#), [archive\(\)](#), [calchash\(\)](#), [compare\(\)](#), [conjugate\(\)](#), [csgn\(\)](#), [denom\(\)](#), [div\(\)](#), [div_dyn\(\)](#), [do_print_csrc\(\)](#), [do_print_csrc_cl_N\(\)](#), [do_print_tree\(\)](#), [evalf\(\)](#), [GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT\(\)](#), [imag\(\)](#), [imag_part\(\)](#), [int_length\(\)](#), [inverse\(\)](#), [is_cinteger\(\)](#), [is_crational\(\)](#), [is_equal\(\)](#), [is_even\(\)](#), [is_integer\(\)](#), [is_negative\(\)](#), [is_nonneg_integer\(\)](#), [is_odd\(\)](#), [is_pos_integer\(\)](#), [is_positive\(\)](#), [is_prime\(\)](#), [is_rational\(\)](#), [is_real\(\)](#), [is_zero\(\)](#), [mul\(\)](#), [mul_dyn\(\)](#), [numer\(\)](#), [numeric\(\)](#), [operator!=\(\)](#), [operator<\(\)](#), [operator<=\(\)](#), [operator==\(\)](#), [operator>\(\)](#), [operator>=\(\)](#), [power\(\)](#), [power_dyn\(\)](#), [print_numeric\(\)](#), [read_archive\(\)](#), [real\(\)](#), [real_part\(\)](#), [step\(\)](#), [sub\(\)](#), [sub_dyn\(\)](#), [to_cl_N\(\)](#), [to_double\(\)](#), [to_int\(\)](#), and [to_long\(\)](#).

The documentation for this class was generated from the following files:

- [numeric.h](#)
- [normal.cpp](#)
- [numeric.cpp](#)

6.106 GiNaC::op0_is_equal Struct Reference

```
#include <ex.h>
```

Public Member Functions

- `bool operator() (const ex &lh, const ex &rh) const`

6.106.1 Member Function Documentation

6.106.1.1 operator()()

```
bool GiNaC::op0_is_equal::operator() (
    const ex & lh,
    const ex & rh ) const [inline]
```

References [GiNaC::ex::is_equal\(\)](#), and [GiNaC::ex::op\(\)](#).

The documentation for this struct was generated from the following file:

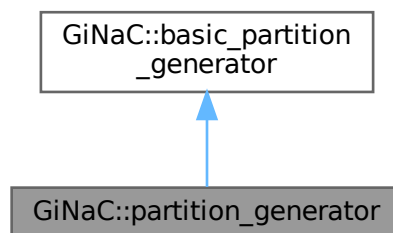
- [ex.h](#)

6.107 GiNaC::partition_generator Class Reference

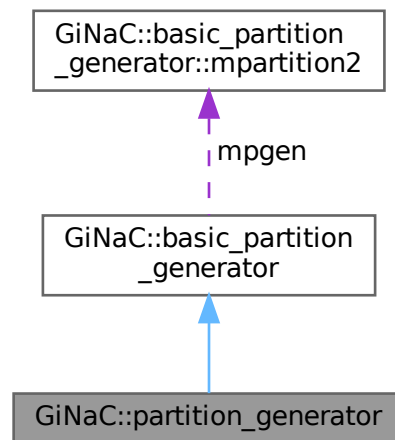
Generate all bounded combinatorial partitions of an integer n with exactly m parts (not including zero parts) in non-decreasing order.

```
#include <utils.h>
```

Inheritance diagram for `GiNaC::partition_generator`:



Collaboration diagram for `GiNaC::partition_generator`:



Public Member Functions

- [partition_generator](#) (unsigned n_, unsigned m_)
- const std::vector< unsigned > & [get](#) () const
- bool [next](#) ()

Private Attributes

- std::vector< unsigned > [partition](#)
- bool [current_updated](#)

Additional Inherited Members

Protected Member Functions inherited from [GiNaC::basic_partition_generator](#)

- [basic_partition_generator](#) (unsigned n_, unsigned m_)

Protected Attributes inherited from [GiNaC::basic_partition_generator](#)

- [mpartition2](#) [mpgen](#)

6.107.1 Detailed Description

Generate all bounded combinatorial partitions of an integer n with exactly m parts (not including zero parts) in non-decreasing order.

6.107.2 Constructor & Destructor Documentation

6.107.2.1 partition_generator()

```
GiNaC::partition_generator::partition_generator (
    unsigned n_,
    unsigned m_ ) [inline]
```

6.107.3 Member Function Documentation

6.107.3.1 get()

```
const std::vector< unsigned > & GiNaC::partition_generator::get ( ) const [inline]
```

References [current_updated](#), [GiNaC::basic_partition_generator::mpartition2::m](#), [GiNaC::basic_partition_generator::mpgen](#), [partition](#), and [GiNaC::basic_partition_generator::mpartition2::x](#).

6.107.3.2 next()

```
bool GiNaC::partition_generator::next ( ) [inline]
```

References [current_updated](#), [GiNaC::basic_partition_generator::mpgen](#), and [GiNaC::basic_partition_generator::mpartition2::next_pa](#)

6.107.4 Member Data Documentation

6.107.4.1 partition

```
std::vector<unsigned> GiNaC::partition_generator::partition [mutable], [private]
```

Referenced by [get\(\)](#).

6.107.4.2 `current_updated`

```
bool GiNaC::partition_generator::current_updated [mutable], [private]
```

Referenced by [get\(\)](#), and [next\(\)](#).

The documentation for this class was generated from the following file:

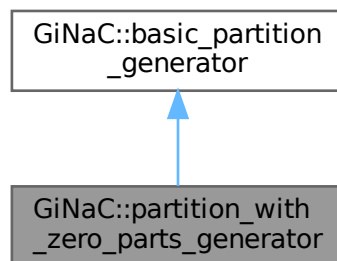
- [utils.h](#)

6.108 `GiNaC::partition_with_zero_parts_generator` Class Reference

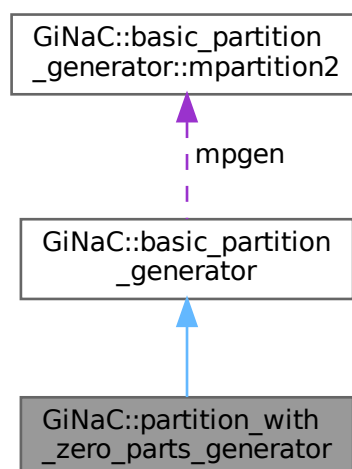
Generate all bounded combinatorial partitions of an integer n with exactly m parts (including zero parts) in non-decreasing order.

```
#include <utils.h>
```

Inheritance diagram for `GiNaC::partition_with_zero_parts_generator`:



Collaboration diagram for `GiNaC::partition_with_zero_parts_generator`:



Public Member Functions

- [partition_with_zero_parts_generator](#) (unsigned *n_*, unsigned *m_*)
- const std::vector< unsigned > & [get](#) () const
- bool [next](#) ()

Private Attributes

- unsigned [m](#)
- std::vector< unsigned > [partition](#)
- bool [current_updated](#)

Additional Inherited Members

Protected Member Functions inherited from [GiNaC::basic_partition_generator](#)

- [basic_partition_generator](#) (unsigned *n_*, unsigned *m_*)

Protected Attributes inherited from [GiNaC::basic_partition_generator](#)

- [mpartition2](#) [mpgen](#)

6.108.1 Detailed Description

Generate all bounded combinatorial partitions of an integer *n* with exactly *m* parts (including zero parts) in non-decreasing order.

6.108.2 Constructor & Destructor Documentation

6.108.2.1 [partition_with_zero_parts_generator](#)()

```
GiNaC::partition_with_zero_parts_generator::partition_with_zero_parts_generator (
    unsigned n_,
    unsigned m_ ) [inline]
```

6.108.3 Member Function Documentation

6.108.3.1 `get()`

```
const std::vector< unsigned > & GiNaC::partition_with_zero_parts_generator::get ( ) const  
[inline]
```

References [current_updated](#), [GiNaC::basic_partition_generator::mpartition2::m](#), [m](#), [GiNaC::basic_partition_generator::mpgen](#), [partition](#), and [GiNaC::basic_partition_generator::mpartition2::x](#).

Referenced by [GiNaC::power::expand_add\(\)](#).

6.108.3.2 `next()`

```
bool GiNaC::partition_with_zero_parts_generator::next ( ) [inline]
```

References [current_updated](#), [GiNaC::basic_partition_generator::mpartition2::m](#), [m](#), [GiNaC::basic_partition_generator::mpgen](#), [GiNaC::basic_partition_generator::mpartition2::n](#), and [GiNaC::basic_partition_generator::mpartition2::next_partition\(\)](#).

Referenced by [GiNaC::power::expand_add\(\)](#).

6.108.4 Member Data Documentation

6.108.4.1 `m`

```
unsigned GiNaC::partition_with_zero_parts_generator::m [private]
```

Referenced by [get\(\)](#), and [next\(\)](#).

6.108.4.2 `partition`

```
std::vector<unsigned> GiNaC::partition_with_zero_parts_generator::partition [mutable], [private]
```

Referenced by [get\(\)](#).

6.108.4.3 `current_updated`

```
bool GiNaC::partition_with_zero_parts_generator::current_updated [mutable], [private]
```

Referenced by [get\(\)](#), and [next\(\)](#).

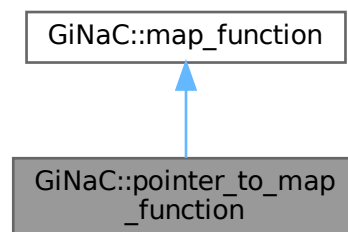
The documentation for this class was generated from the following file:

- [utils.h](#)

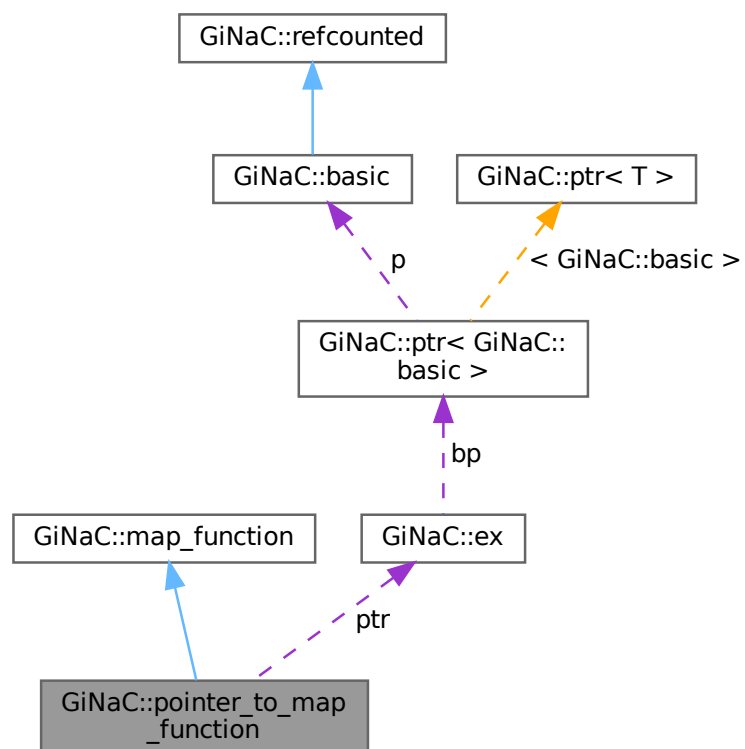
6.109 GiNaC::pointer_to_map_function Class Reference

```
#include <ex.h>
```

Inheritance diagram for GiNaC::pointer_to_map_function:



Collaboration diagram for GiNaC::pointer_to_map_function:



Public Member Functions

- [pointer_to_map_function](#) ([ex](#) x(const [ex](#) &))
- [ex operator\(\)](#) (const [ex](#) &e) override

Public Member Functions inherited from [GiNaC::map_function](#)

- virtual [~map_function](#) ()
- virtual [ex operator\(\)](#) (const [ex](#) &e)=0

Protected Attributes

- [ex](#)(* [ptr](#))(const [ex](#) &)

Additional Inherited Members

Public Types inherited from [GiNaC::map_function](#)

- typedef const [ex](#) & [argument_type](#)
- typedef [ex](#) [result_type](#)

6.109.1 Constructor & Destructor Documentation

6.109.1.1 [pointer_to_map_function\(\)](#)

```
GiNaC::pointer_to_map_function::pointer_to_map_function (
    ex xconst ex & ) [inline], [explicit]
```

6.109.2 Member Function Documentation

6.109.2.1 [operator>\(\)\(\)](#)

```
ex GiNaC::pointer_to_map_function::operator() (
    const ex & e ) [inline], [override], [virtual]
```

Implements [GiNaC::map_function](#).

References [ptr](#).

6.109.3 Member Data Documentation

6.109.3.1 ptr

```
ex(* GiNaC::pointer_to_map_function::ptr) (const ex &) [protected]
```

Referenced by [operator\(\)\(\)](#).

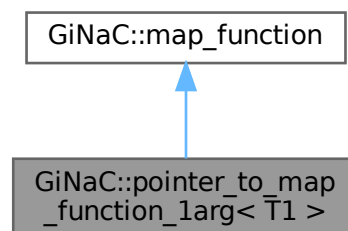
The documentation for this class was generated from the following file:

- [ex.h](#)

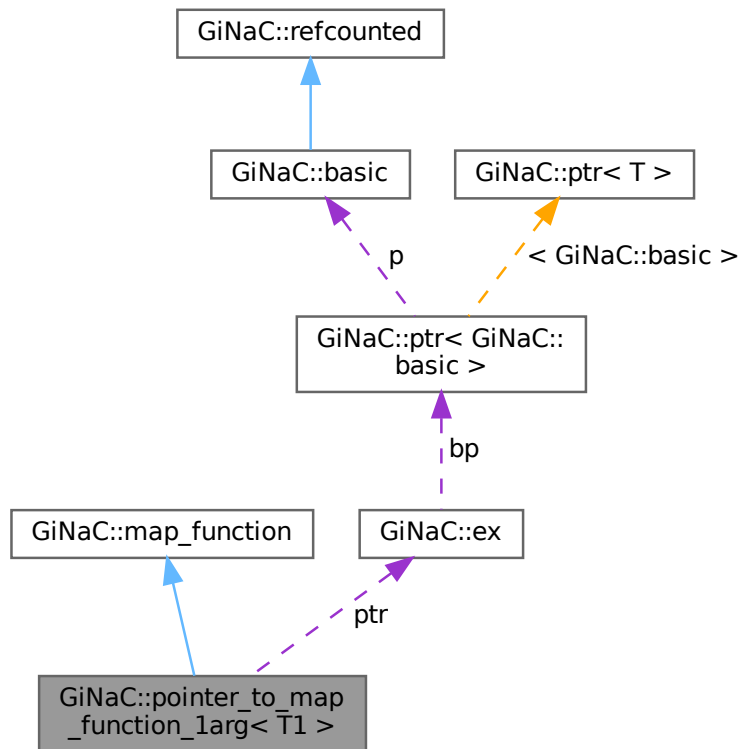
6.110 GiNaC::pointer_to_map_function_1arg< T1 > Class Template Reference

```
#include <ex.h>
```

Inheritance diagram for GiNaC::pointer_to_map_function_1arg< T1 >:



Collaboration diagram for `GiNaC::pointer_to_map_function_1arg< T1 >`:



Public Member Functions

- `pointer_to_map_function_1arg` (`ex` x(const `ex` &, T1), T1 a1)
- `ex operator()` (const `ex` &e) override

Public Member Functions inherited from `GiNaC::map_function`

- virtual `~map_function` ()
- virtual `ex operator()` (const `ex` &e)=0

Protected Attributes

- `ex(* ptr)`(const `ex` &, T1)
- T1 `arg1`

Additional Inherited Members

Public Types inherited from `GiNaC::map_function`

- typedef const `ex` & `argument_type`
- typedef `ex` `result_type`

6.110.1 Constructor & Destructor Documentation

6.110.1.1 pointer_to_map_function_1arg()

```
template<class T1 >
GiNaC::pointer_to_map_function_1arg< T1 >::pointer_to_map_function_1arg (
    ex xconst ex &, T1,
    T1 a1 ) [inline], [explicit]
```

6.110.2 Member Function Documentation

6.110.2.1 operator>()

```
template<class T1 >
ex GiNaC::pointer_to_map_function_1arg< T1 >::operator() (
    const ex & e ) [inline], [override], [virtual]
```

Implements [GiNaC::map_function](#).

References [GiNaC::pointer_to_map_function_1arg< T1 >::arg1](#), and [GiNaC::pointer_to_map_function_1arg< T1 >::ptr](#).

6.110.3 Member Data Documentation

6.110.3.1 ptr

```
template<class T1 >
ex(* GiNaC::pointer_to_map_function_1arg< T1 >::ptr) (const ex &, T1) [protected]
```

Referenced by [GiNaC::pointer_to_map_function_1arg< T1 >::operator>\(\)](#).

6.110.3.2 arg1

```
template<class T1 >
T1 GiNaC::pointer_to_map_function_1arg< T1 >::arg1 [protected]
```

Referenced by [GiNaC::pointer_to_map_function_1arg< T1 >::operator>\(\)](#).

The documentation for this class was generated from the following file:

- [ex.h](#)

Public Member Functions

- [pointer_to_map_function_2args](#) ([ex](#) x(const [ex](#) &, T1, T2), T1 a1, T2 a2)
- [ex operator\(\)](#) (const [ex](#) &e) override

Public Member Functions inherited from [GiNaC::map_function](#)

- virtual [~map_function](#) ()
- virtual [ex operator\(\)](#) (const [ex](#) &e)=0

Protected Attributes

- [ex](#)(* [ptr](#))(const [ex](#) &, T1, T2)
- T1 [arg1](#)
- T2 [arg2](#)

Additional Inherited Members

Public Types inherited from [GiNaC::map_function](#)

- typedef const [ex](#) & [argument_type](#)
- typedef [ex](#) [result_type](#)

6.111.1 Constructor & Destructor Documentation

6.111.1.1 [pointer_to_map_function_2args\(\)](#)

```
template<class T1 , class T2 >
GiNaC::pointer_to_map_function_2args< T1, T2 >::pointer_to_map_function_2args (
    ex xconst ex &, T1, T2,
    T1 a1,
    T2 a2 ) [inline], [explicit]
```

6.111.2 Member Function Documentation

6.111.2.1 [operator\(\)](#)()

```
template<class T1 , class T2 >
ex GiNaC::pointer_to_map_function_2args< T1, T2 >::operator() (
    const ex & e ) [inline], [override], [virtual]
```

Implements [GiNaC::map_function](#).

References [GiNaC::pointer_to_map_function_2args< T1, T2 >::arg1](#), [GiNaC::pointer_to_map_function_2args< T1, T2 >::arg2](#), and [GiNaC::pointer_to_map_function_2args< T1, T2 >::ptr](#).

6.111.3 Member Data Documentation

6.111.3.1 ptr

```
template<class T1 , class T2 >
ex(* GiNaC::pointer_to_map_function_2args< T1, T2 >::ptr) (const ex &, T1, T2) [protected]
```

Referenced by [GiNaC::pointer_to_map_function_2args< T1, T2 >::operator\(\)\(\)](#).

6.111.3.2 arg1

```
template<class T1 , class T2 >
T1 GiNaC::pointer_to_map_function_2args< T1, T2 >::arg1 [protected]
```

Referenced by [GiNaC::pointer_to_map_function_2args< T1, T2 >::operator\(\)\(\)](#).

6.111.3.3 arg2

```
template<class T1 , class T2 >
T2 GiNaC::pointer_to_map_function_2args< T1, T2 >::arg2 [protected]
```

Referenced by [GiNaC::pointer_to_map_function_2args< T1, T2 >::operator\(\)\(\)](#).

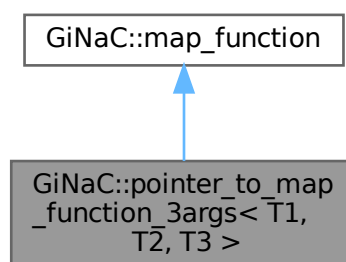
The documentation for this class was generated from the following file:

- [ex.h](#)

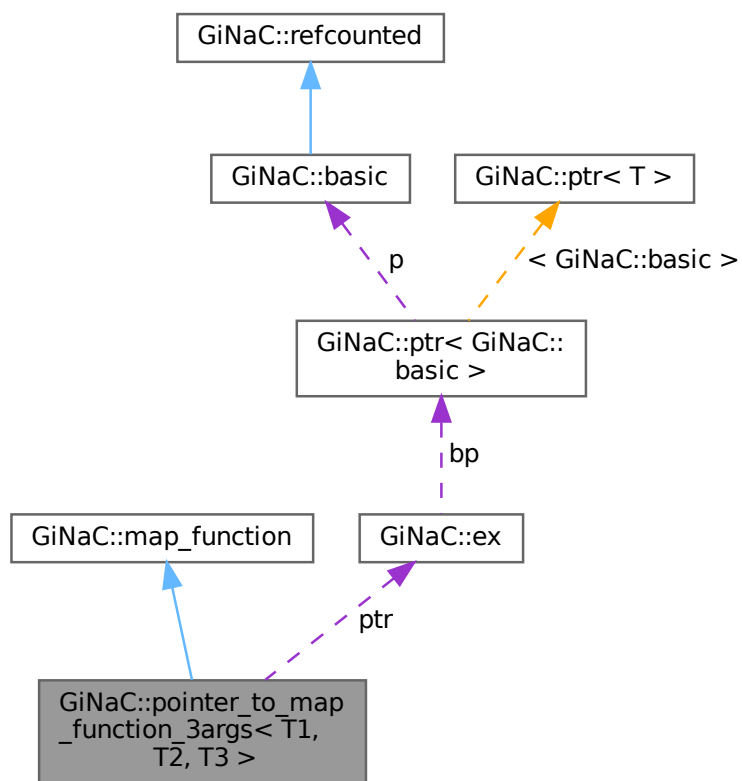
6.112 GiNaC::pointer_to_map_function_3args< T1, T2, T3 > Class Template Reference

```
#include <ex.h>
```

Inheritance diagram for `GiNaC::pointer_to_map_function_3args< T1, T2, T3 >`:



Collaboration diagram for GiNaC::pointer_to_map_function_3args< T1, T2, T3 >:



Public Member Functions

- `pointer_to_map_function_3args` (`ex x(const ex &, T1, T2, T3), T1 a1, T2 a2, T3 a3`)
- `ex operator()` (`const ex &e`) override

Public Member Functions inherited from GiNaC::map_function

- virtual `~map_function()`
- virtual `ex operator()` (`const ex &e`)=0

Protected Attributes

- `ex(* ptr)(const ex &, T1, T2, T3)`
- `T1 arg1`
- `T2 arg2`
- `T3 arg3`

Additional Inherited Members

Public Types inherited from [GiNaC::map_function](#)

- typedef const [ex](#) & [argument_type](#)
- typedef [ex](#) [result_type](#)

6.112.1 Constructor & Destructor Documentation

6.112.1.1 [pointer_to_map_function_3args\(\)](#)

```
template<class T1 , class T2 , class T3 >
GiNaC::pointer_to_map_function_3args< T1, T2, T3 >::pointer_to_map_function_3args (
    ex xconst ex &, T1, T2, T3,
    T1 a1,
    T2 a2,
    T3 a3 ) [inline], [explicit]
```

6.112.2 Member Function Documentation

6.112.2.1 [operator>\(\)\(\)](#)

```
template<class T1 , class T2 , class T3 >
ex GiNaC::pointer_to_map_function_3args< T1, T2, T3 >::operator() (
    const ex & e ) [inline], [override], [virtual]
```

Implements [GiNaC::map_function](#).

References [GiNaC::pointer_to_map_function_3args< T1, T2, T3 >::arg1](#), [GiNaC::pointer_to_map_function_3args< T1, T2, T3 >::a](#), [GiNaC::pointer_to_map_function_3args< T1, T2, T3 >::arg3](#), and [GiNaC::pointer_to_map_function_3args< T1, T2, T3 >::ptr](#).

6.112.3 Member Data Documentation

6.112.3.1 [ptr](#)

```
template<class T1 , class T2 , class T3 >
ex(* GiNaC::pointer\_to\_map\_function\_3args< T1, T2, T3 >::ptr) (const ex &, T1, T2, T3) [protected]
```

Referenced by [GiNaC::pointer_to_map_function_3args< T1, T2, T3 >::operator>\(\)\(\)](#).

6.112.3.2 arg1

```
template<class T1 , class T2 , class T3 >
T1 GiNaC::pointer_to_map_function_3args< T1, T2, T3 >::arg1 [protected]
```

Referenced by [GiNaC::pointer_to_map_function_3args< T1, T2, T3 >::operator\(\)](#).

6.112.3.3 arg2

```
template<class T1 , class T2 , class T3 >
T2 GiNaC::pointer_to_map_function_3args< T1, T2, T3 >::arg2 [protected]
```

Referenced by [GiNaC::pointer_to_map_function_3args< T1, T2, T3 >::operator\(\)](#).

6.112.3.4 arg3

```
template<class T1 , class T2 , class T3 >
T3 GiNaC::pointer_to_map_function_3args< T1, T2, T3 >::arg3 [protected]
```

Referenced by [GiNaC::pointer_to_map_function_3args< T1, T2, T3 >::operator\(\)](#).

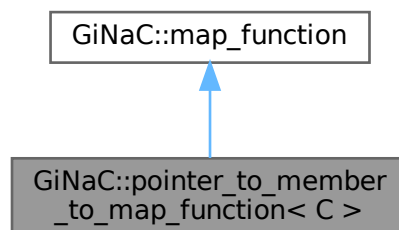
The documentation for this class was generated from the following file:

- [ex.h](#)

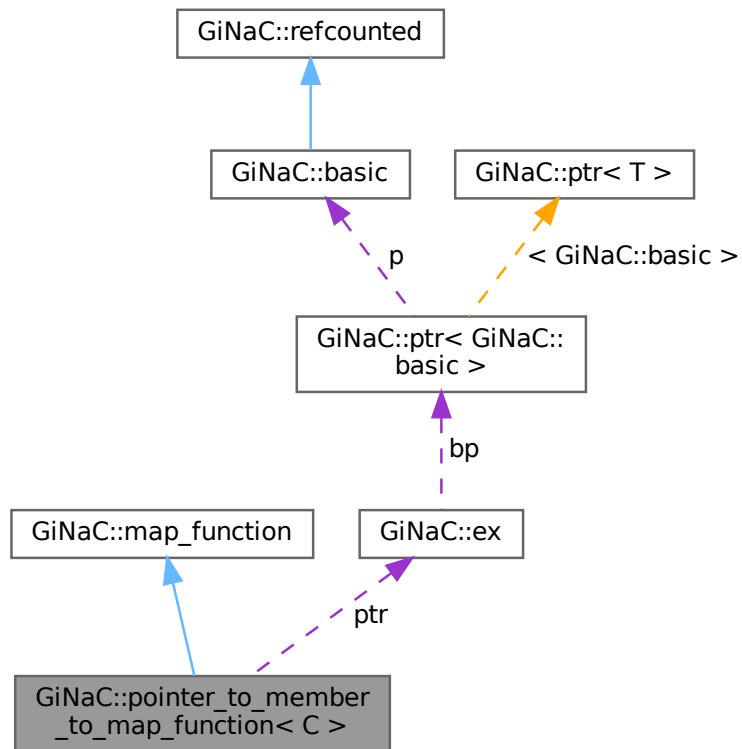
6.113 GiNaC::pointer_to_member_to_map_function< C > Class Template Reference

```
#include <ex.h>
```

Inheritance diagram for GiNaC::pointer_to_member_to_map_function< C >:



Collaboration diagram for `GiNaC::pointer_to_member_to_map_function< C >`:



Public Member Functions

- `pointer_to_member_to_map_function` (`ex(C::*member)(const ex &), C &obj`)
- `ex operator()` (`const ex &e`) override

Public Member Functions inherited from `GiNaC::map_function`

- virtual `~map_function` ()
- virtual `ex operator()` (`const ex &e`)=0

Protected Attributes

- `ex(C::* ptr)` (`const ex &`)
- `C & c`

Additional Inherited Members

Public Types inherited from `GiNaC::map_function`

- typedef `const ex & argument_type`
- typedef `ex result_type`

6.113.1 Constructor & Destructor Documentation

6.113.1.1 pointer_to_member_to_map_function()

```
template<class C >
GiNaC::pointer_to_member_to_map_function< C >::pointer_to_member_to_map_function (
    ex(C::*)(const ex &) member,
    C & obj ) [inline], [explicit]
```

6.113.2 Member Function Documentation

6.113.2.1 operator>()()

```
template<class C >
ex GiNaC::pointer_to_member_to_map_function< C >::operator() (
    const ex & e ) [inline], [override], [virtual]
```

Implements [GiNaC::map_function](#).

References [GiNaC::pointer_to_member_to_map_function< C >::c](#).

6.113.3 Member Data Documentation

6.113.3.1 ptr

```
template<class C >
ex(C::* GiNaC::pointer_to_member_to_map_function< C >::ptr) (const ex &) [protected]
```

6.113.3.2 c

```
template<class C >
C& GiNaC::pointer_to_member_to_map_function< C >::c [protected]
```

Referenced by [GiNaC::pointer_to_member_to_map_function< C >::operator>\(\)\(\)](#).

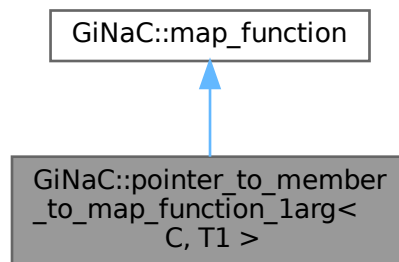
The documentation for this class was generated from the following file:

- [ex.h](#)

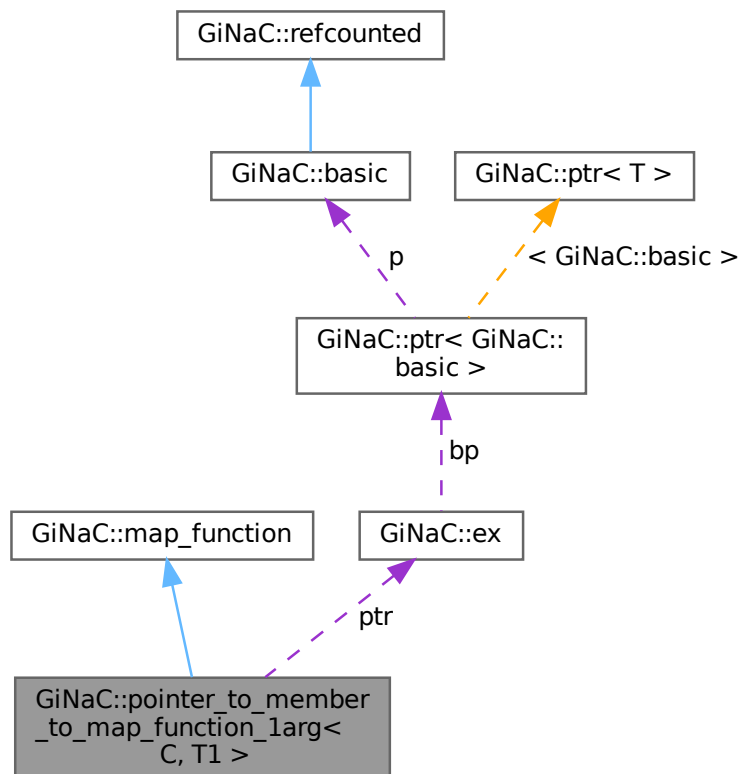
6.114 GiNaC::pointer_to_member_to_map_function_1arg< C, T1 > Class Template Reference

```
#include <ex.h>
```

Inheritance diagram for GiNaC::pointer_to_member_to_map_function_1arg< C, T1 >:



Collaboration diagram for GiNaC::pointer_to_member_to_map_function_1arg< C, T1 >:



Public Member Functions

- [pointer_to_member_to_map_function_1arg](#) ([ex](#)(C::*[member](#))(const [ex](#) &, T1), C &[obj](#), T1 [a1](#))
- [ex operator\(\)](#) (const [ex](#) &[e](#)) override

Public Member Functions inherited from [GiNaC::map_function](#)

- virtual [~map_function](#) ()
- virtual [ex operator\(\)](#) (const [ex](#) &[e](#))=0

Protected Attributes

- [ex](#)(C::* [ptr](#))(const [ex](#) &, T1)
- C & [c](#)
- T1 [arg1](#)

Additional Inherited Members

Public Types inherited from [GiNaC::map_function](#)

- typedef const [ex](#) & [argument_type](#)
- typedef [ex](#) [result_type](#)

6.114.1 Constructor & Destructor Documentation

6.114.1.1 [pointer_to_member_to_map_function_1arg\(\)](#)

```
template<class C , class T1 >
GiNaC::pointer_to_member_to_map_function_1arg< C, T1 >::pointer_to_member_to_map_function_1arg
(
    ex(C::*)(const ex &, T1) member,
    C & obj,
    T1 a1 ) [inline], [explicit]
```

6.114.2 Member Function Documentation

6.114.2.1 [operator\(\)](#)()

```
template<class C , class T1 >
ex GiNaC::pointer_to_member_to_map_function_1arg< C, T1 >::operator() (
    const ex & e ) [inline], [override], [virtual]
```

Implements [GiNaC::map_function](#).

References [GiNaC::pointer_to_member_to_map_function_1arg< C, T1 >::arg1](#), and [GiNaC::pointer_to_member_to_map_function_1arg](#).

6.114.3 Member Data Documentation

6.114.3.1 ptr

```
template<class C , class T1 >
ex(C::* GiNaC::pointer_to_member_to_map_function_1arg< C, T1 >::ptr) (const ex &, T1) [protected]
```

6.114.3.2 c

```
template<class C , class T1 >
C& GiNaC::pointer_to_member_to_map_function_1arg< C, T1 >::c [protected]
```

Referenced by [GiNaC::pointer_to_member_to_map_function_1arg< C, T1 >::operator\(\)\(\)](#).

6.114.3.3 arg1

```
template<class C , class T1 >
T1 GiNaC::pointer_to_member_to_map_function_1arg< C, T1 >::arg1 [protected]
```

Referenced by [GiNaC::pointer_to_member_to_map_function_1arg< C, T1 >::operator\(\)\(\)](#).

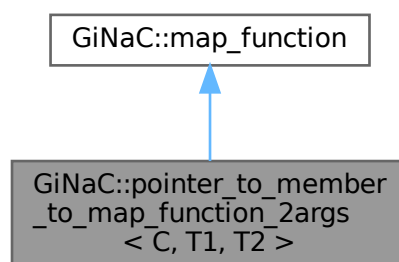
The documentation for this class was generated from the following file:

- [ex.h](#)

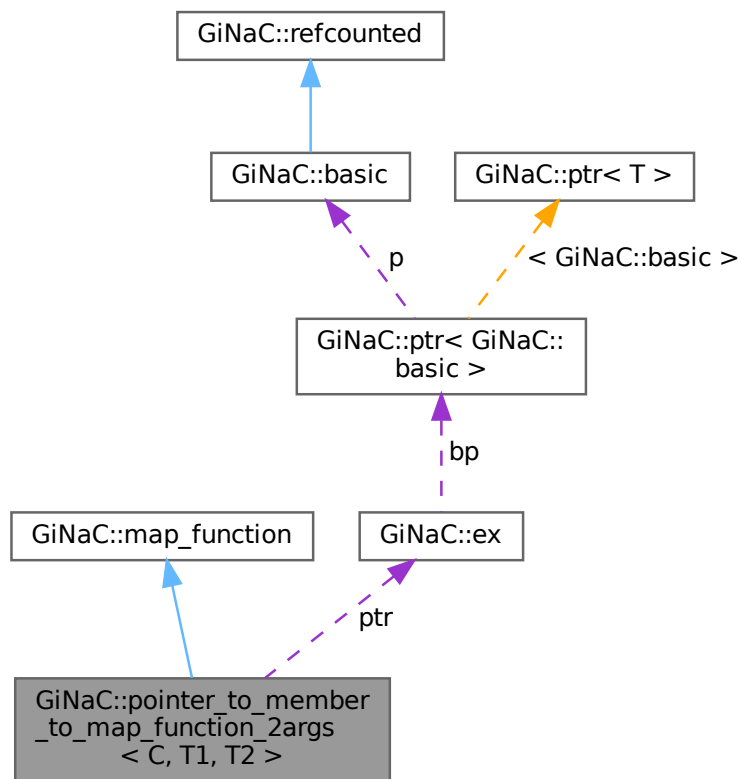
6.115 GiNaC::pointer_to_member_to_map_function_2args< C, T1, T2 > Class Template Reference

```
#include <ex.h>
```

Inheritance diagram for [GiNaC::pointer_to_member_to_map_function_2args< C, T1, T2 >](#):



Collaboration diagram for GiNaC::pointer_to_member_to_map_function_2args< C, T1, T2 >:



Public Member Functions

- `pointer_to_member_to_map_function_2args` (`ex(C::*member)(const ex &, T1, T2), C &obj, T1 a1, T2 a2`)
- `ex operator()` (`const ex &e`) override

Public Member Functions inherited from GiNaC::map_function

- virtual `~map_function()`
- virtual `ex operator()` (`const ex &e`)=0

Protected Attributes

- `ex(C::* ptr)` (`const ex &, T1, T2`)
- `C & c`
- `T1 arg1`
- `T2 arg2`

Additional Inherited Members

Public Types inherited from [GiNaC::map_function](#)

- typedef const [ex](#) & [argument_type](#)
- typedef [ex](#) [result_type](#)

6.115.1 Constructor & Destructor Documentation

6.115.1.1 `pointer_to_member_to_map_function_2args()`

```
template<class C , class T1 , class T2 >
GiNaC::pointer\_to\_member\_to\_map\_function\_2args< C, T1, T2 >::pointer_to_member_to_map_function_2args (
    ex(C::*)(const ex &, T1, T2) member,
    C & obj,
    T1 a1,
    T2 a2 ) [inline], [explicit]
```

6.115.2 Member Function Documentation

6.115.2.1 `operator>()()`

```
template<class C , class T1 , class T2 >
ex GiNaC::pointer\_to\_member\_to\_map\_function\_2args< C, T1, T2 >::operator() (
    const ex & e ) [inline], [override], [virtual]
```

Implements [GiNaC::map_function](#).

References [GiNaC::pointer_to_member_to_map_function_2args< C, T1, T2 >::arg1](#), [GiNaC::pointer_to_member_to_map_function_2args< C, T1, T2 >::c](#), and [GiNaC::pointer_to_member_to_map_function_2args< C, T1, T2 >::c](#).

6.115.3 Member Data Documentation

6.115.3.1 `ptr`

```
template<class C , class T1 , class T2 >
ex(C::* GiNaC::pointer\_to\_member\_to\_map\_function\_2args< C, T1, T2 >::ptr) (const ex &, T1, T2)
[protected]
```

6.115.3.2 c

```
template<class C , class T1 , class T2 >
C& GiNaC::pointer_to_member_to_map_function_2args< C, T1, T2 >::c [protected]
```

Referenced by [GiNaC::pointer_to_member_to_map_function_2args< C, T1, T2 >::operator\(\)\(\)](#).

6.115.3.3 arg1

```
template<class C , class T1 , class T2 >
T1 GiNaC::pointer_to_member_to_map_function_2args< C, T1, T2 >::arg1 [protected]
```

Referenced by [GiNaC::pointer_to_member_to_map_function_2args< C, T1, T2 >::operator\(\)\(\)](#).

6.115.3.4 arg2

```
template<class C , class T1 , class T2 >
T2 GiNaC::pointer_to_member_to_map_function_2args< C, T1, T2 >::arg2 [protected]
```

Referenced by [GiNaC::pointer_to_member_to_map_function_2args< C, T1, T2 >::operator\(\)\(\)](#).

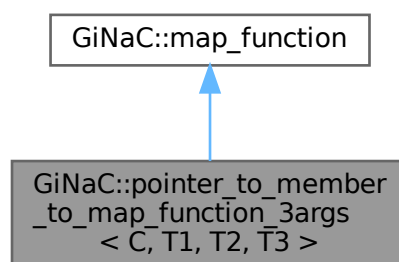
The documentation for this class was generated from the following file:

- [ex.h](#)

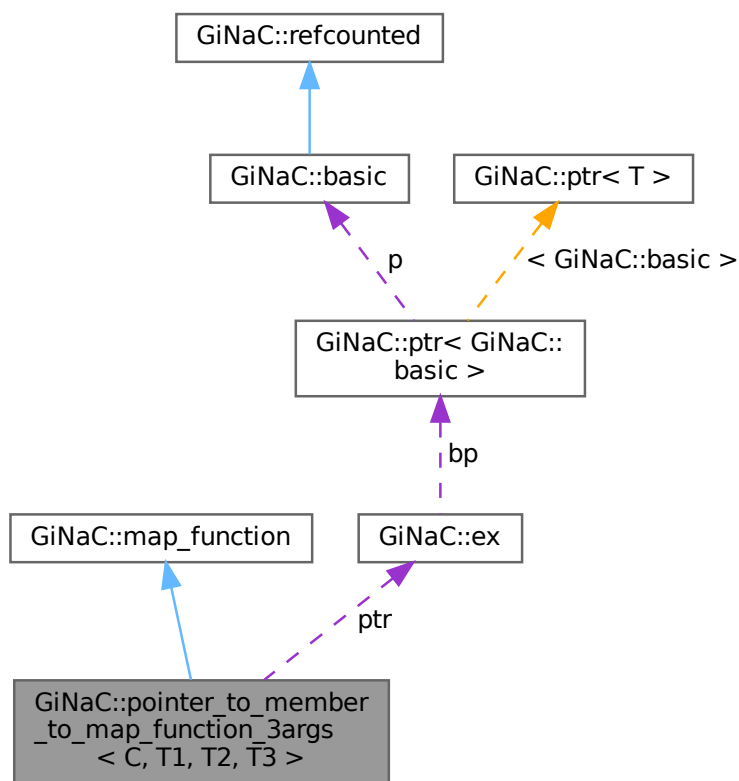
6.116 GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2, T3 > Class Template Reference

```
#include <ex.h>
```

Inheritance diagram for GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2, T3 >:



Collaboration diagram for `GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2, T3 >`:



Public Member Functions

- `pointer_to_member_to_map_function_3args` (`ex(C::*member)(const ex &, T1, T2, T3), C &obj, T1 a1, T2 a2, T3 a3)`
- `ex operator()` (`const ex &e`) override

Public Member Functions inherited from `GiNaC::map_function`

- virtual `~map_function()`
- virtual `ex operator()` (`const ex &e`)=0

Protected Attributes

- `ex(C::* ptr)` (`const ex &, T1, T2, T3`)
- `C & c`
- `T1 arg1`
- `T2 arg2`
- `T3 arg3`

Additional Inherited Members

Public Types inherited from [GiNaC::map_function](#)

- typedef const [ex](#) & [argument_type](#)
- typedef [ex](#) [result_type](#)

6.116.1 Constructor & Destructor Documentation

6.116.1.1 pointer_to_member_to_map_function_3args()

```
template<class C , class T1 , class T2 , class T3 >
GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2, T3 >::pointer_to_member_to_map_↵
function_3args (
    ex(C::*)(const ex &, T1, T2, T3) member,
    C & obj,
    T1 a1,
    T2 a2,
    T3 a3 ) [inline], [explicit]
```

6.116.2 Member Function Documentation

6.116.2.1 operator>()()

```
template<class C , class T1 , class T2 , class T3 >
ex GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2, T3 >::operator() (
    const ex & e ) [inline], [override], [virtual]
```

Implements [GiNaC::map_function](#).

References [GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2, T3 >::arg1](#), [GiNaC::pointer_to_member_to_map_functi↵](#)
[GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2, T3 >::arg3](#), and [GiNaC::pointer_to_member_to_map_function_3ar↵](#)

6.116.3 Member Data Documentation

6.116.3.1 ptr

```
template<class C , class T1 , class T2 , class T3 >
ex(C::* GiNaC::pointer\_to\_member\_to\_map\_function\_3args< C, T1, T2, T3 >::ptr) (const ex &, T1,
T2, T3) [protected]
```

6.116.3.2 c

```
template<class C , class T1 , class T2 , class T3 >  
C& GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2, T3 >::c [protected]
```

Referenced by [GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2, T3 >::operator\(\)\(\)](#).

6.116.3.3 arg1

```
template<class C , class T1 , class T2 , class T3 >  
T1 GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2, T3 >::arg1 [protected]
```

Referenced by [GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2, T3 >::operator\(\)\(\)](#).

6.116.3.4 arg2

```
template<class C , class T1 , class T2 , class T3 >  
T2 GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2, T3 >::arg2 [protected]
```

Referenced by [GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2, T3 >::operator\(\)\(\)](#).

6.116.3.5 arg3

```
template<class C , class T1 , class T2 , class T3 >  
T3 GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2, T3 >::arg3 [protected]
```

Referenced by [GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2, T3 >::operator\(\)\(\)](#).

The documentation for this class was generated from the following file:

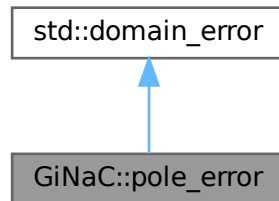
- [ex.h](#)

6.117 GiNaC::pole_error Class Reference

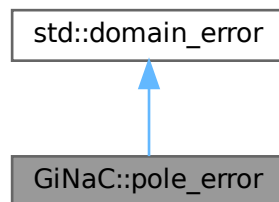
Exception class thrown when a singularity is encountered.

```
#include <numeric.h>
```

Inheritance diagram for GiNaC::pole_error:



Collaboration diagram for GiNaC::pole_error:



Public Member Functions

- `pole_error` (const std::string &what_arg, int degree)
ctor for `pole_error` exception class.
- int `degree` () const
Return the degree of the `pole_error` exception class.

Private Attributes

- int `deg`

6.117.1 Detailed Description

Exception class thrown when a singularity is encountered.

6.117.2 Constructor & Destructor Documentation

6.117.2.1 `pole_error()`

```
GiNaC::pole_error::pole_error (
    const std::string & what_arg,
    int degree ) [explicit]
```

ctor for [pole_error](#) exception class.

6.117.3 Member Function Documentation

6.117.3.1 `degree()`

```
int GiNaC::pole_error::degree ( ) const
```

Return the degree of the [pole_error](#) exception class.

References [deg](#).

6.117.4 Member Data Documentation

6.117.4.1 `deg`

```
int GiNaC::pole_error::deg [private]
```

Referenced by [degree\(\)](#).

The documentation for this class was generated from the following files:

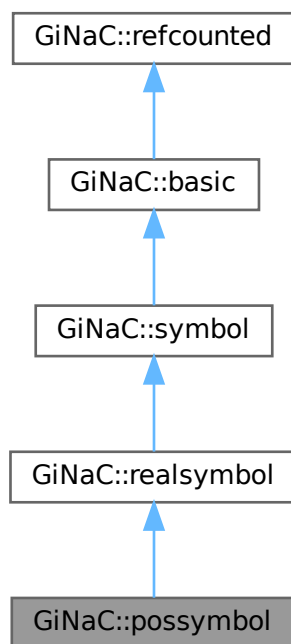
- [numeric.h](#)
- [utils.cpp](#)

6.118 GiNaC::possymbol Class Reference

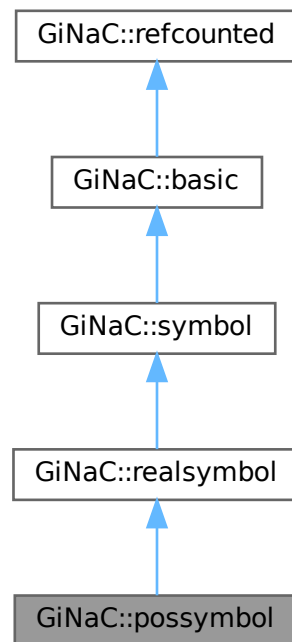
Specialization of symbol to real positive domain.

```
#include <symbol.h>
```

Inheritance diagram for GiNaC::possymbol:



Collaboration diagram for `GiNaC::possymbol`:



Public Member Functions

- [possymbol](#) ()
- [possymbol](#) (const std::string &initname)
- [possymbol](#) (const std::string &initname, const std::string &texname)
- unsigned [get_domain](#) () const override
- [possymbol](#) * [duplicate](#) () const override

Create a clone of this object on the heap.

Public Member Functions inherited from [GiNaC::realsymbol](#)

- [realsymbol](#) ()
- [realsymbol](#) (const std::string &initname)
- [realsymbol](#) (const std::string &initname, const std::string &texname)
- unsigned [get_domain](#) () const override
- [ex conjugate](#) () const override
- [ex real_part](#) () const override
- [ex imag_part](#) () const override
- [realsymbol](#) * [duplicate](#) () const override

Create a clone of this object on the heap.

Public Member Functions inherited from [GiNaC::symbol](#)

- [symbol](#) (const std::string &initname)
- [symbol](#) (const std::string &initname, const std::string &texname)
- bool [info](#) (unsigned inf) const override
Information about the object.
- [ex eval](#) () const override
Perform automatic non-interruptive term rewriting rules.
- [ex evalf](#) () const override
Evaluate object numerically.
- [ex series](#) (const [relational](#) &s, int [order](#), unsigned [options](#)=0) const override
Implementation of [ex::series\(\)](#) for symbols.
- [ex subs](#) (const [exmap](#) &m, unsigned [options](#)=0) const override
Substitute a set of objects by arbitrary expressions.
- [ex normal](#) ([exmap](#) &repl, [exmap](#) &rev_lookup, [lst](#) &modifier) const override
Implementation of [ex::normal\(\)](#) for symbols.
- [ex to_rational](#) ([exmap](#) &repl) const override
Implementation of [ex::to_rational\(\)](#) for symbols.
- [ex to_polynomial](#) ([exmap](#) &repl) const override
Implementation of [ex::to_polynomial\(\)](#) for symbols.
- [ex conjugate](#) () const override
- [ex real_part](#) () const override
- [ex imag_part](#) () const override
- bool [is_polynomial](#) (const [ex](#) &var) const override
Check whether this is a polynomial in the given variables.
- void [archive](#) ([archive_node](#) &n) const override
Save (a.k.a.
- void [read_archive](#) (const [archive_node](#) &n, [lst](#) &syms) override
Read (a.k.a.
- virtual unsigned [get_domain](#) () const
- void [set_name](#) (const std::string &n)
- void [set_TeX_name](#) (const std::string &n)
- std::string [get_name](#) () const
- std::string [get_TeX_name](#) () const

Public Member Functions inherited from [GiNaC::basic](#)

- virtual [~basic](#) ()
basic destructor, virtual because class ex will delete objects of derived classes via a basic.*
- [basic](#) (const [basic](#) &other)
- const [basic](#) & [operator=](#) (const [basic](#) &other)
basic assignment operator: the other object might be of a derived class.
- virtual [basic](#) * [duplicate](#) () const
Create a clone of this object on the heap.
- virtual [ex eval](#) () const
Perform automatic non-interruptive term rewriting rules.
- virtual [ex evalf](#) () const
Evaluate object numerically.
- virtual [ex evalm](#) () const
Evaluate sums, products and integer powers of matrices.
- virtual [ex eval_integ](#) () const

- Evaluate integrals, if result is known.*

 - virtual `ex eval_indexed` (const `basic` &i) const

Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void `print` (const `print_context` &c, unsigned level=0) const

Output to stream.
- virtual void `dbgprint` () const

Little wrapper around print to be called within a debugger.
- virtual void `dbgprnttree` () const

Little wrapper around prnttree to be called within a debugger.
- virtual unsigned `precedence` () const

Return relative operator precedence (for parenthezing output).
- virtual bool `info` (unsigned inf) const

Information about the object.
- virtual size_t `nops` () const

Number of operands/members.
- virtual `ex op` (size_t i) const

Return operand/member at position i.
- virtual `ex operator[]` (const `ex` &index) const
- virtual `ex operator[]` (size_t i) const
- virtual `ex & let_op` (size_t i)

Return modifiable operand/member at position i.
- virtual `ex & operator[]` (const `ex` &index)
- virtual `ex & operator[]` (size_t i)
- virtual bool `has` (const `ex` &other, unsigned `options`=0) const

Test for occurrence of a pattern.
- virtual bool `match` (const `ex` &pattern, `exmap` &repls) const

Check whether the expression matches a given pattern.
- virtual `ex subs` (const `exmap` &m, unsigned `options`=0) const

Substitute a set of objects by arbitrary expressions.
- virtual `ex map` (`map_function` &f) const

Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void `accept` (`GiNaC::visitor` &v) const
- virtual bool `is_polynomial` (const `ex` &var) const

Check whether this is a polynomial in the given variables.
- virtual int `degree` (const `ex` &s) const

Return degree of highest power in object s.
- virtual int `ldegree` (const `ex` &s) const

Return degree of lowest power in object s.
- virtual `ex coeff` (const `ex` &s, int n=1) const

Return coefficient of degree n in object s.
- virtual `ex expand` (unsigned `options`=0) const

Expand expression, i.e.
- virtual `ex collect` (const `ex` &s, bool distributed=false) const

Sort expanded expression in terms of powers of some object(s).
- virtual `ex series` (const `relational` &r, int `order`, unsigned `options`=0) const

Default implementation of `ex::series()`.
- virtual `ex normal` (`exmap` &repl, `exmap` &rev_lookup, `lst` &modifier) const

Default implementation of `ex::normal()`.
- virtual `ex to_rational` (`exmap` &repl) const

Default implementation of `ex::to_rational()`.
- virtual `ex to_polynomial` (`exmap` &repl) const

- virtual [numeric integer_content](#) () const
- virtual [ex smod](#) (const [numeric](#) &xi) const
Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- virtual [numeric max_coefficient](#) () const
Implementation [ex::max_coefficient\(\)](#).
- virtual [exvector get_free_indices](#) () const
Return a vector containing the free indices of an expression.
- virtual [ex add_indexed](#) (const [ex](#) &self, const [ex](#) &other) const
Add two indexed expressions.
- virtual [ex scalar_mul_indexed](#) (const [ex](#) &self, const [numeric](#) &other) const
Multiply an indexed expression with a scalar.
- virtual bool [contract_with](#) (exvector::iterator self, exvector::iterator other, [exvector](#) &v) const
Try to contract two indexed expressions that appear in the same product.
- virtual unsigned [return_type](#) () const
- virtual [return_type_t](#) [return_type_tinfo](#) () const
- virtual [ex conjugate](#) () const
- virtual [ex real_part](#) () const
- virtual [ex imag_part](#) () const
- template<class T >
void [print_dispatch](#) (const [print_context](#) &c, unsigned level) const
Like [print\(\)](#), but dispatch to the specified class.
- void [print_dispatch](#) (const [registered_class_info](#) &ri, const [print_context](#) &c, unsigned level) const
Like [print\(\)](#), but dispatch to the specified class.
- virtual void [archive](#) ([archive_node](#) &n) const
Save (serialize) the object into archive node.
- virtual void [read_archive](#) (const [archive_node](#) &n, [lst](#) &syms)
Load (deserialize) the object from an archive node.
- [ex subs_one_level](#) (const [exmap](#) &m, unsigned [options](#)) const
Helper function for [subs\(\)](#).
- [ex diff](#) (const [symbol](#) &s, unsigned nth=1) const
Default interface of nth derivative [ex::diff\(s, n\)](#).
- int [compare](#) (const [basic](#) &other) const
Compare objects syntactically to establish canonical ordering.
- bool [is_equal](#) (const [basic](#) &other) const
Test for syntactic equality.
- const [basic](#) & [hold](#) () const
Stop further evaluation.
- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const
Set some [status_flags](#).
- const [basic](#) & [clearflag](#) (unsigned f) const
Clear some [status_flags](#).

Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add_reference](#) () noexcept
- unsigned int [remove_reference](#) () noexcept
- unsigned int [get_refcount](#) () const noexcept
- void [set_refcount](#) (unsigned int r) noexcept

Additional Inherited Members

Protected Member Functions inherited from [GiNaC::symbol](#)

- [ex_derivative](#) (const [symbol](#) &s) const override
Implementation of [ex::diff\(\)](#) for single differentiation of a symbol.
- bool [is_equal_same_type](#) (const [basic](#) &other) const override
Returns true if two objects of same type are equal.
- unsigned [calchash](#) () const override
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
- void [do_print_latex](#) (const [print_latex](#) &c, unsigned level) const
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const

Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match_same_type](#) (const [basic](#) &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual [ex_derivative](#) (const [symbol](#) &s) const
Default implementation of [ex::diff\(\)](#).
- virtual int [compare_same_type](#) (const [basic](#) &other) const
Returns order relation between two objects of same type.
- virtual bool [is_equal_same_type](#) (const [basic](#) &other) const
Returns true if two objects of same type are equal.
- virtual unsigned [calchash](#) () const
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- void [ensure_if_modifiable](#) () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
Default output to stream.
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
Tree output to stream.
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
Python parsable output to stream.

Protected Attributes inherited from [GiNaC::symbol](#)

- unsigned [serial](#)
unique serial number for comparison
- std::string [name](#)
printname of this symbol
- std::string [TeX_name](#)
LaTeX name of this symbol.

Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)
of type [status_flags](#)
- unsigned [hashvalue](#)
hash value

6.118.1 Detailed Description

Specialization of symbol to real positive domain.

6.118.2 Constructor & Destructor Documentation**6.118.2.1 possymbol() [1/3]**

```
GiNaC::possymbol::possymbol ( )
```

Referenced by [duplicate\(\)](#).

6.118.2.2 possymbol() [2/3]

```
GiNaC::possymbol::possymbol (
    const std::string & initname ) [explicit]
```

6.118.2.3 possymbol() [3/3]

```
GiNaC::possymbol::possymbol (
    const std::string & initname,
    const std::string & texname )
```

6.118.3 Member Function Documentation**6.118.3.1 get_domain()**

```
unsigned GiNaC::possymbol::get_domain ( ) const [inline], [override], [virtual]
```

Reimplemented from [GiNaC::realsymbol](#).

References [GiNaC::domain::positive](#).

6.118.3.2 duplicate()

```
possymbol * GiNaC::possymbol::duplicate ( ) const [inline], [override], [virtual]
```

Create a clone of this object on the heap.

One can think of this as simulating a virtual copy constructor which is needed for instance by the refcounted construction of an ex from a basic.

Reimplemented from [GiNaC::realsymbol](#).

References [GiNaC::status_flags::dynallocated](#), [possymbol\(\)](#), and [GiNaC::basic::setflag\(\)](#).

The documentation for this class was generated from the following files:

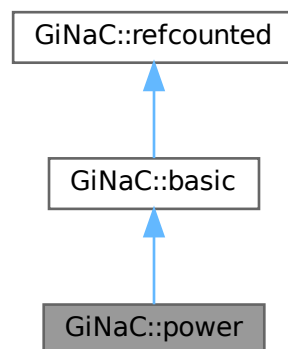
- [symbol.h](#)
- [symbol.cpp](#)

6.119 GiNaC::power Class Reference

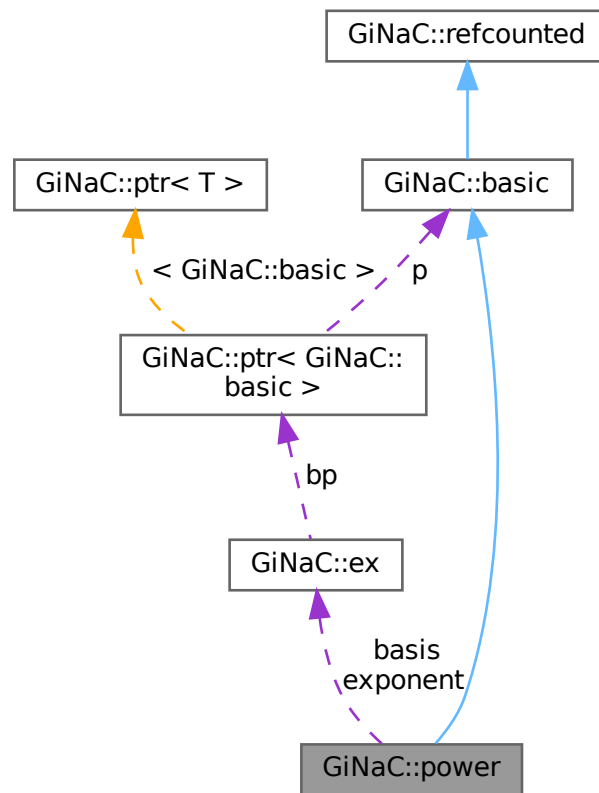
This class holds a two-component object, a basis and an exponent representing exponentiation.

```
#include <power.h>
```

Inheritance diagram for GiNaC::power:



Collaboration diagram for GiNaC::power:



Public Member Functions

- `power` (const `ex` &lh, const `ex` &rh)
- `template<typename T > power` (const `ex` &lh, const T &rh)
- unsigned `precedence` () const override
Return relative operator precedence (for parenthezing output).
- bool `info` (unsigned inf) const override
Information about the object.
- `size_t nops` () const override
Number of operands/members.
- `ex op` (size_t i) const override
Return operand/member at position i.
- `ex map` (`map_function` &f) const override
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- bool `is_polynomial` (const `ex` &var) const override
Check whether this is a polynomial in the given variables.
- int `degree` (const `ex` &s) const override
Return degree of highest power in object s.

- `int ldegree (const ex &s) const` override
Return degree of lowest power in object s.
- `ex coeff (const ex &s, int n=1) const` override
Return coefficient of degree n in object s.
- `ex eval ()` const override
Perform automatic term rewriting rules in this class.
- `ex evalf ()` const override
Evaluate object numerically.
- `ex evalm ()` const override
Evaluate sums, products and integer powers of matrices.
- `ex series (const relational &s, int order, unsigned options=0) const` override
Implementation of [ex::series\(\)](#) for powers.
- `ex subs (const exmap &m, unsigned options=0) const` override
Substitute a set of objects by arbitrary expressions.
- `bool has (const ex &other, unsigned options=0) const` override
Test for occurrence of a pattern.
- `ex normal (exmap &repl, exmap &rev_lookup, lst &modifier) const` override
Implementation of [ex::normal\(\)](#) for powers.
- `ex to_rational (exmap &repl) const` override
Implementation of [ex::to_rational\(\)](#) for powers.
- `ex to_polynomial (exmap &repl) const` override
Implementation of [ex::to_polynomial\(\)](#) for powers.
- `ex conjugate ()` const override
- `ex real_part ()` const override
- `ex imag_part ()` const override
- `void archive (archive_node &n) const` override
Save (a.k.a.
- `void read_archive (const archive_node &n, lst &syms) const` override
Read (a.k.a.

Public Member Functions inherited from [GiNaC::basic](#)

- `virtual ~basic ()`
basic destructor, virtual because class [ex](#) will delete objects of derived classes via a [basic](#).*
- `basic (const basic &other)`
- `const basic & operator= (const basic &other)`
basic assignment operator: the other object might be of a derived class.
- `virtual basic * duplicate () const`
Create a clone of this object on the heap.
- `virtual ex eval () const`
Perform automatic non-interruptive term rewriting rules.
- `virtual ex evalf () const`
Evaluate object numerically.
- `virtual ex evalm () const`
Evaluate sums, products and integer powers of matrices.
- `virtual ex eval_integ () const`
Evaluate integrals, if result is known.
- `virtual ex eval_indexed (const basic &i) const`
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- `virtual void print (const print_context &c, unsigned level=0) const`

- *Output to stream.*
virtual void [dbgprint](#) () const
- *Little wrapper around print to be called within a debugger.*
virtual void [dbgprinttree](#) () const
- *Little wrapper around printtree to be called within a debugger.*
virtual unsigned [precedence](#) () const
- *Return relative operator precedence (for parenthezing output).*
virtual bool [info](#) (unsigned inf) const
- *Information about the object.*
virtual size_t [nops](#) () const
- *Number of operands/members.*
virtual [ex op](#) (size_t i) const
- *Return operand/member at position i.*
virtual [ex operator\[\]](#) (const [ex](#) &index) const
- virtual [ex operator\[\]](#) (size_t i) const
- virtual [ex & let_op](#) (size_t i)
- *Return modifiable operand/member at position i.*
virtual [ex & operator\[\]](#) (const [ex](#) &index)
- virtual [ex & operator\[\]](#) (size_t i)
- virtual bool [has](#) (const [ex](#) &other, unsigned [options](#)=0) const
- *Test for occurrence of a pattern.*
virtual bool [match](#) (const [ex](#) &pattern, [exmap](#) &repls) const
- *Check whether the expression matches a given pattern.*
virtual [ex subs](#) (const [exmap](#) &m, unsigned [options](#)=0) const
- *Substitute a set of objects by arbitrary expressions.*
virtual [ex map](#) ([map_function](#) &f) const
- *Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
virtual void [accept](#) ([GiNaC::visitor](#) &v) const
- virtual bool [is_polynomial](#) (const [ex](#) &var) const
- *Check whether this is a polynomial in the given variables.*
virtual int [degree](#) (const [ex](#) &s) const
- *Return degree of highest power in object s.*
virtual int [ldegree](#) (const [ex](#) &s) const
- *Return degree of lowest power in object s.*
virtual [ex coeff](#) (const [ex](#) &s, int n=1) const
- *Return coefficient of degree n in object s.*
virtual [ex expand](#) (unsigned [options](#)=0) const
- *Expand expression, i.e.*
virtual [ex collect](#) (const [ex](#) &s, bool distributed=false) const
- *Sort expanded expression in terms of powers of some object(s).*
virtual [ex series](#) (const [relational](#) &r, int [order](#), unsigned [options](#)=0) const
- *Default implementation of [ex::series\(\)](#).*
virtual [ex normal](#) ([exmap](#) &repl, [exmap](#) &rev_lookup, [lst](#) &modifier) const
- *Default implementation of [ex::normal\(\)](#).*
virtual [ex to_rational](#) ([exmap](#) &repl) const
- *Default implementation of [ex::to_rational\(\)](#).*
virtual [ex to_polynomial](#) ([exmap](#) &repl) const
- virtual [numeric integer_content](#) () const
- virtual [ex smod](#) (const [numeric](#) &xi) const
- *Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
virtual [numeric max_coefficient](#) () const

- Implementation *ex::max_coefficient()*.

 - virtual `exvector get_free_indices ()` const
 - Return a vector containing the free indices of an expression.
 - virtual `ex add_indexed (const ex &self, const ex &other)` const
 - Add two indexed expressions.
 - virtual `ex scalar_mul_indexed (const ex &self, const numeric &other)` const
 - Multiply an indexed expression with a scalar.
 - virtual `bool contract_with (exvector::iterator self, exvector::iterator other, exvector &v)` const
 - Try to contract two indexed expressions that appear in the same product.
 - virtual `unsigned return_type ()` const
 - virtual `return_type_t return_type_info ()` const
 - virtual `ex conjugate ()` const
 - virtual `ex real_part ()` const
 - virtual `ex imag_part ()` const
 - template<class T >
 - void `print_dispatch (const print_context &c, unsigned level)` const

Like *print()*, but dispatch to the specified class.
 - void `print_dispatch (const registered_class_info &ri, const print_context &c, unsigned level)` const
 - Like *print()*, but dispatch to the specified class.
 - virtual void `archive (archive_node &n)` const
 - Save (serialize) the object into archive node.
 - virtual void `read_archive (const archive_node &n, lst &syms)`
 - Load (deserialize) the object from an archive node.
 - `ex subs_one_level (const exmap &m, unsigned options)` const
 - Helper function for *subs()*.
 - `ex diff (const symbol &s, unsigned nth=1)` const
 - Default interface of *nth* derivative *ex::diff(s, n)*.
 - int `compare (const basic &other)` const
 - Compare objects syntactically to establish canonical ordering.
 - bool `is_equal (const basic &other)` const
 - Test for syntactic equality.
 - const `basic & hold ()` const
 - Stop further evaluation.
 - unsigned `gethash ()` const
 - const `basic & setflag (unsigned f)` const
 - Set some *status_flags*.
 - const `basic & clearflag (unsigned f)` const
 - Clear some *status_flags*.

Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted ()` noexcept
- unsigned int `add_reference ()` noexcept
- unsigned int `remove_reference ()` noexcept
- unsigned int `get_refcount ()` const noexcept
- void `set_refcount (unsigned int r)` noexcept

Protected Member Functions

- `ex derivative` (const `symbol` &s) const override
Implementation of `ex::diff()` for a power.
- `ex eval_ncmul` (const `exvector` &v) const override
- unsigned `return_type` () const override
- `return_type_t return_type_tinfo` () const override
- `ex expand` (unsigned `options`=0) const override
Expand expression, i.e.
- void `print_power` (const `print_context` &c, const char *powersymbol, const char *openbrace, const char *closebrace, unsigned level) const
- void `do_print_dflt` (const `print_dflt` &c, unsigned level) const
- void `do_print_latex` (const `print_latex` &c, unsigned level) const
- void `do_print_csrc` (const `print_csrc` &c, unsigned level) const
- void `do_print_python` (const `print_python` &c, unsigned level) const
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const
- void `do_print_csrc_cl_N` (const `print_csrc_cl_N` &c, unsigned level) const

Protected Member Functions inherited from `GiNaC::basic`

- `basic` ()
- virtual `ex eval_ncmul` (const `exvector` &v) const
- virtual bool `match_same_type` (const `basic` &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual `ex derivative` (const `symbol` &s) const
Default implementation of `ex::diff()`.
- virtual int `compare_same_type` (const `basic` &other) const
Returns order relation between two objects of same type.
- virtual bool `is_equal_same_type` (const `basic` &other) const
Returns true if two objects of same type are equal.
- virtual unsigned `calchash` () const
Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.
- void `ensure_if_modifiable` () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void `do_print` (const `print_context` &c, unsigned level) const
Default output to stream.
- void `do_print_tree` (const `print_tree` &c, unsigned level) const
Tree output to stream.
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const
Python parsable output to stream.

Static Protected Member Functions

- static `ex expand_add` (const `add` &a, long n, unsigned `options`)
expand a^n where a is an add and n is a positive integer.
- static `ex expand_add_2` (const `add` &a, unsigned `options`)
Special case of `power::expand_add`.
- static `ex expand_mul` (const `mul` &m, const `numeric` &n, unsigned `options`, bool from_expand=false)
Expand factors of m in m^n where m is a mul and n is an integer.

Protected Attributes

- [ex basis](#)
- [ex exponent](#)

Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)
of type [status_flags](#)
- unsigned [hashvalue](#)
hash value

Friends

- class [mul](#)

6.119.1 Detailed Description

This class holds a two-component object, a basis and and exponent representing exponentiation.

6.119.2 Constructor & Destructor Documentation

6.119.2.1 [power\(\)](#) [1/2]

```
GiNaC::power::power (  
    const ex & lh,  
    const ex & rh ) [inline]
```

6.119.2.2 [power\(\)](#) [2/2]

```
template<typename T >  
GiNaC::power::power (  
    const ex & lh,  
    const T & rh ) [inline]
```

6.119.3 Member Function Documentation

6.119.3.1 precedence()

```
unsigned GiNaC::power::precedence ( ) const [inline], [override], [virtual]
```

Return relative operator precedence (for parenthezing output).

Reimplemented from [GiNaC::basic](#).

Referenced by [print_power\(\)](#).

6.119.3.2 info()

```
bool GiNaC::power::info (
    unsigned inf ) const [override], [virtual]
```

Information about the object.

See also

class [info_flags](#)

Reimplemented from [GiNaC::basic](#).

References [basis](#), [GiNaC::info_flags::cinteger_polynomial](#), [GiNaC::basic::clearflag\(\)](#), [GiNaC::info_flags::crational_polynomial](#), [GiNaC::info_flags::even](#), [GiNaC::status_flags::expanded](#), [GiNaC::info_flags::expanded](#), [exponent](#), [GiNaC::basic::flags](#), [GiNaC::status_flags::has_indices](#), [GiNaC::info_flags::has_indices](#), [GiNaC::status_flags::has_no_indices](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::integer](#), [GiNaC::info_flags::integer_polynomial](#), [GiNaC::info_flags::nonnegative](#), [GiNaC::info_flags::nonnegint](#), [GiNaC::info_flags::polynomial](#), [GiNaC::info_flags::positive](#), [GiNaC::info_flags::rational_function](#), [GiNaC::info_flags::rational_polynomial](#), [GiNaC::info_flags::real](#), and [GiNaC::basic::setflag\(\)](#).

6.119.3.3 nops()

```
size_t GiNaC::power::nops ( ) const [override], [virtual]
```

Number of operands/members.

Reimplemented from [GiNaC::basic](#).

6.119.3.4 op()

```
ex GiNaC::power::op (
    size_t i ) const [override], [virtual]
```

Return operand/member at position *i*.

Reimplemented from [GiNaC::basic](#).

References [basis](#), [exponent](#), and [GINAC_ASSERT](#).

6.119.3.5 map()

```
ex GiNaC::power::map (
    map_function & f ) const [override], [virtual]
```

Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).

Reimplemented from [GiNaC::basic](#).

References [GiNaC::are_ex_trivially_equal\(\)](#), [basis](#), and [exponent](#).

6.119.3.6 is_polynomial()

```
bool GiNaC::power::is_polynomial (
    const ex & var ) const [override], [virtual]
```

Check whether this is a polynomial in the given variables.

Reimplemented from [GiNaC::basic](#).

References [basis](#), [exponent](#), [GiNaC::ex::has\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is_polynomial\(\)](#), and [GiNaC::info_flags::nonnegint](#).

6.119.3.7 degree()

```
int GiNaC::power::degree (
    const ex & s ) const [override], [virtual]
```

Return degree of highest power in object s.

Reimplemented from [GiNaC::basic](#).

References [basis](#), [GiNaC::ex::degree\(\)](#), [exponent](#), [GiNaC::ex::has\(\)](#), [GiNaC::basic::is_equal\(\)](#), [GiNaC::ex::is_equal\(\)](#), and [GiNaC::is_integer\(\)](#).

6.119.3.8 ldegree()

```
int GiNaC::power::ldegree (
    const ex & s ) const [override], [virtual]
```

Return degree of lowest power in object s.

Reimplemented from [GiNaC::basic](#).

References [basis](#), [exponent](#), [GiNaC::ex::has\(\)](#), [GiNaC::basic::is_equal\(\)](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::is_integer\(\)](#), and [GiNaC::ex::ldegree\(\)](#).

6.119.3.9 coeff()

```
ex GiNaC::power::coeff (
    const ex & s,
    int n = 1 ) const [override], [virtual]
```

Return coefficient of degree n in object s.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex0](#), [GiNaC::_ex1](#), [basis](#), [exponent](#), [GiNaC::basic::is_equal\(\)](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::is_integer\(\)](#), and [n](#).

Referenced by [expand\(\)](#), and [expand_add\(\)](#).

6.119.3.10 eval()

```
ex GiNaC::power::eval ( ) const [override], [virtual]
```

Perform automatic term rewriting rules in this class.

In the following x, x1, x2,... stand for a symbolic variables of type ex and c, c1, c2... stand for such expressions that contain a plain number.

- $x^0 \rightarrow 1$ (also handles 0^0)
- $x^1 \rightarrow x$
- $0^c \rightarrow 0$ or exception (depending on the real part of c)
- $1^x \rightarrow 1$
- $c_1^{c_2} \rightarrow c_1^n c_1^{c_2-n}$ (so that $0 < (c_2-n) < 1$, try to evaluate roots, possibly in numerator and denominator of c1)
- $x^{(x,c_1),c_2} \rightarrow x^{(x,c_1*c_2)}$ if x is positive and c1 is real.
- $x^{(x,c_1),c_2} \rightarrow x^{(x,c_1*c_2)}$ (c2 integer or $-1 < c_1 \leq 1$ or $(c_1=-1 \text{ and } c_2 > 0)$, case $c_1=1$ should not happen, see below!)
- $x^{(x,y,z),c} \rightarrow x^c y^c z^c$ (if c integer)
- $x^{(x,c_1),c_2} \rightarrow x^{(x,c_2)} c_1^{c_2}$ ($c_1 > 0$)
- $x^{(x,c_1),c_2} \rightarrow x^{(-x,c_2)} c_1^{c_2}$ ($c_1 < 0$)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex0](#), [GiNaC::_ex1](#), [GiNaC::_ex1](#), [GiNaC::_num0_p](#), [GiNaC::_num1_p](#), [GiNaC::_num1_p](#), [GiNaC::abs\(\)](#), [basis](#), [c](#), [GiNaC::basic::clearflag\(\)](#), [GiNaC::ex::coeff\(\)](#), [GiNaC::return_types::commutative](#), [GiNaC::numeric::compare\(\)](#), [GiNaC::numeric::denom\(\)](#), [GiNaC::numeric::div\(\)](#), [GiNaC::status_flags::evaluated](#), [expand_mul\(\)](#), [exponent](#), [GiNaC::basic::flags](#), [GINAC_ASSERT](#), [GiNaC::status_flags::hash_calculated](#), [GiNaC::basic::hold\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::integer_content\(\)](#), [GiNaC::numeric::inverse\(\)](#), [GiNaC::iquo\(\)](#), [GiNaC::numeric::is_crational\(\)](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::numeric::is_equal\(\)](#), [GiNaC::numeric::is_integer\(\)](#), [GiNaC::is_negative\(\)](#), [GiNaC::numeric::is_pos_integ](#), [GiNaC::numeric::is_positive\(\)](#), [GiNaC::numeric::is_rational\(\)](#), [GiNaC::numeric::is_real\(\)](#), [GiNaC::ex::is_zero\(\)](#), [GiNaC::numeric::is_zero\(\)](#), [likely](#), [m](#), [GiNaC::numeric::mul\(\)](#), [n](#), [GiNaC::numeric::numer\(\)](#), [GiNaC::ex::op\(\)](#), [GiNaC::expairseq::overall_coeff](#), [GiNaC::info_flags::positive](#), [GiNaC::pow\(\)](#), [GiNaC::numeric::power\(\)](#), [r](#), [GiNaC::info_flags::real](#), [GiNaC::numeric::real\(\)](#), [GiNaC::ex::return_type\(\)](#), [GiNaC::expairseq::seq](#), [GiNaC::basic::setflag\(\)](#), and [GiNaC::numeric::to_int\(\)](#).

Referenced by [do_print_latex\(\)](#).

6.119.3.11 evalf()

```
ex GiNaC::power::evalf ( ) const [override], [virtual]
```

Evaluate object numerically.

Reimplemented from [GiNaC::basic](#).

References [basis](#), [GiNaC::ex::evalf\(\)](#), and [exponent](#).

6.119.3.12 evalm()

```
ex GiNaC::power::evalm ( ) const [override], [virtual]
```

Evaluate sums, products and integer powers of matrices.

Reimplemented from [GiNaC::basic](#).

References [basis](#), [GiNaC::ex::evalm\(\)](#), [exponent](#), and [GiNaC::pow\(\)](#).

6.119.3.13 series()

```
ex GiNaC::power::series (
    const relational & r,
    int order,
    unsigned options = 0 ) const [override], [virtual]
```

Implementation of [ex::series\(\)](#) for powers.

This performs Laurent expansion of reciprocals of series at singularities.

See also

[ex::series](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex1](#), [basis](#), [GiNaC::exp\(\)](#), [GiNaC::ex::expand\(\)](#), [exponent](#), [GiNaC::ex::info\(\)](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::is_integer\(\)](#), [GiNaC::ex::is_zero\(\)](#), [GiNaC::ex::lddegree\(\)](#), [GiNaC::log\(\)](#), [GiNaC::info_flags::negint](#), [GiNaC::subs_options::no_pattern](#), [options](#), [order](#), [r](#), [GiNaC::info_flags::rational_function](#), [GiNaC::ex::series\(\)](#), [GiNaC::basic::series\(\)](#), [GiNaC::ex::subs\(\)](#), and [GiNaC::to_int\(\)](#).

Referenced by [GiNaC::psi1_series\(\)](#).

6.119.3.14 subs()

```
ex GiNaC::power::subs (
    const exmap & m,
    unsigned options = 0 ) const [override], [virtual]
```

Substitute a set of objects by arbitrary expressions.

The ex returned will already be evaluated.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::subs_options::algebraic](#), [GiNaC::are_ex_trivially_equal\(\)](#), [basis](#), [exponent](#), [m](#), [GiNaC::subs_options::no_pattern](#), [options](#), [GiNaC::pow\(\)](#), [GiNaC::ex::subs\(\)](#), [GiNaC::basic::subs_one_level\(\)](#), and [GiNaC::tryfactsubs\(\)](#).

6.119.3.15 has()

```
bool GiNaC::power::has (
    const ex & pattern,
    unsigned options = 0 ) const [override], [virtual]
```

Test for occurrence of a pattern.

An object 'has' a pattern if it matches the pattern itself or one of the children 'has' it. As a consequence (according to the definition of children) given $e=x+y+z$, $e.has(x)$ is true but $e.has(x+y)$ is false.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::has_options::algebraic](#), [basis](#), [exponent](#), [GiNaC::basic::has\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::integer](#), [GiNaC::ex::match\(\)](#), [GiNaC::info_flags::negint](#), [GiNaC::ex::op\(\)](#), [options](#), and [GiNaC::info_flags::posint](#).

6.119.3.16 normal()

```
ex GiNaC::power::normal (
    exmap & repl,
    exmap & rev_lookup,
    lst & modifier ) const [override], [virtual]
```

Implementation of [ex::normal\(\)](#) for powers.

It normalizes the basis, distributes integer exponents to numerator and denominator, and replaces non-integer powers by temporary symbols.

See also

[ex::normal](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex1](#), [basis](#), [exponent](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::integer](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::info_flags::negative](#), [GiNaC::subs_options::no_pattern](#), [GiNaC::container< C >::nops\(\)](#), [GiNaC::ex::normal\(\)](#), [GiNaC::ex::op\(\)](#), [GiNaC::container< C >::op\(\)](#), [GiNaC::info_flags::positive](#), [GiNaC::pow\(\)](#), [GiNaC::replace_with_symbol\(\)](#), and [GiNaC::ex::subs\(\)](#).

6.119.3.17 to_rational()

```
ex GiNaC::power::to_rational (
    exmap & repl ) const [override], [virtual]
```

Implementation of [ex::to_rational\(\)](#) for powers.

It replaces non-integer powers by temporary symbols.

Reimplemented from [GiNaC::basic](#).

References [basis](#), [exponent](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::integer](#), [GiNaC::pow\(\)](#), [GiNaC::replace_with_symbol\(\)](#), and [GiNaC::ex::to_rational\(\)](#).

6.119.3.18 to_polynomial()

```
ex GiNaC::power::to_polynomial (
    exmap & repl ) const [override], [virtual]
```

Implementation of [ex::to_polynomial\(\)](#) for powers.

It replaces non-posint powers by temporary symbols.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex_1](#), [basis](#), [GiNaC::collect_common_factors\(\)](#), [exponent](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::negint](#), [GiNaC::info_flags::posint](#), [GiNaC::pow\(\)](#), [GiNaC::replace_with_symbol\(\)](#), and [GiNaC::ex::to_polynomial\(\)](#).

6.119.3.19 conjugate()

```
ex GiNaC::power::conjugate ( ) const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::are_ex_trivially_equal\(\)](#), [basis](#), [GiNaC::ex::conjugate\(\)](#), [exponent](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::integer](#), and [GiNaC::info_flags::positive](#).

6.119.3.20 real_part()

```
ex GiNaC::power::real_part ( ) const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex1](#), [GiNaC::abs\(\)](#), [basis](#), [GiNaC::binomial\(\)](#), [c](#), [GiNaC::cos\(\)](#), [GiNaC::exp\(\)](#), [exponent](#), [GiNaC::ex::imag_part\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::integer](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::log\(\)](#), [n](#), [GiNaC::info_flags::nonnegative](#), [GiNaC::numer\(\)](#), [GiNaC::pow\(\)](#), and [GiNaC::ex::real_part\(\)](#).

6.119.3.21 imag_part()

```
ex GiNaC::power::imag_part ( ) const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex1](#), [GiNaC::abs\(\)](#), [basis](#), [GiNaC::binomial\(\)](#), [c](#), [GiNaC::exp\(\)](#), [exponent](#), [GiNaC::ex::imag_part\(\)](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::integer](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::log\(\)](#), [n](#), [GiNaC::info_flags::nonnegative](#), [GiNaC::numer\(\)](#), [GiNaC::pow\(\)](#), [GiNaC::ex::real_part\(\)](#), and [GiNaC::sin\(\)](#).

6.119.3.22 archive()

```
void GiNaC::power::archive (
    archive_node & n ) const [override], [virtual]
```

Save (a.k.a.

serialize) object into archive.

Reimplemented from [GiNaC::basic](#).

References [basis](#), [exponent](#), and [n](#).

6.119.3.23 read_archive()

```
void GiNaC::power::read_archive (
    const archive_node & n,
    lst & syms ) [override], [virtual]
```

Read (a.k.a.

deserialize) object from archive.

Reimplemented from [GiNaC::basic](#).

References [basis](#), [exponent](#), and [n](#).

6.119.3.24 derivative()

```
ex GiNaC::power::derivative (
    const symbol & s ) const [override], [protected], [virtual]
```

Implementation of [ex::diff\(\)](#) for a power.

See also

[ex::diff](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex1](#), [GiNaC::_ex_1](#), [basis](#), [GiNaC::ex::diff\(\)](#), [exponent](#), [GiNaC::log\(\)](#), and [GiNaC::pow\(\)](#).

6.119.3.25 eval_ncmul()

```
ex GiNaC::power::eval_ncmul (
    const exvector & v ) const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

6.119.3.26 return_type()

```
unsigned GiNaC::power::return_type ( ) const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [basis](#), and [GiNaC::ex::return_type\(\)](#).

6.119.3.27 return_type_tinfo()

```
return\_type\_t GiNaC::power::return_type_tinfo ( ) const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [basis](#), and [GiNaC::ex::return_type_tinfo\(\)](#).

6.119.3.28 expand()

```
ex GiNaC::power::expand (
    unsigned options = 0 ) const [override], [protected], [virtual]
```

Expand expression, i.e.

multiply it out and return the result as a new expression.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex1](#), [GiNaC::_ex_1](#), [GiNaC::are_ex_trivially_equal\(\)](#), [basis](#), [coeff\(\)](#), [GiNaC::ex::expand\(\)](#), [expand\(\)](#), [expand_add\(\)](#), [expand_mul\(\)](#), [GiNaC::status_flags::expanded](#), [exponent](#), [GiNaC::basic::hold\(\)](#), [GiNaC::info_flags::indefinite](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::integer](#), [GiNaC::is_integer\(\)](#), [m](#), [GiNaC::info_flags::negative](#), [options](#), [GiNaC::expairseq::overall_coeff](#), [GiNaC::info_flags::positive](#), [GiNaC::pow\(\)](#), [GiNaC::status_flags::purely_indefinite](#), [r](#), [GiNaC::add::recombine_pair_to_ex\(\)](#), [GiNaC::expairseq::seq](#), [GiNaC::basic::setflag\(\)](#), [GiNaC::numeric::to_int\(\)](#), and [GiNaC::numeric::to_long\(\)](#).

Referenced by [expand\(\)](#), [expand_add\(\)](#), and [expand_add_2\(\)](#).

6.119.3.29 print_power()

```
void GiNaC::power::print_power (
    const print\_context & c,
    const char * powersymbol,
    const char * openbrace,
    const char * closebrace,
    unsigned level ) const [protected]
```

References [basis](#), [c](#), [exponent](#), [precedence\(\)](#), and [GiNaC::ex::print\(\)](#).

Referenced by [do_print_dflt\(\)](#), [do_print_latex\(\)](#), and [do_print_python\(\)](#).

6.119.3.30 do_print_dflt()

```
void GiNaC::power::do_print_dflt (
    const print\_dflt & c,
    unsigned level ) const [protected]
```

References [GiNaC::_ex1_2](#), [basis](#), [c](#), [exponent](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::ex::print\(\)](#), and [print_power\(\)](#).

6.119.3.31 do_print_latex()

```
void GiNaC::power::do_print_latex (
    const print\_latex & c,
    unsigned level ) const [protected]
```

References [GiNaC::_ex1_2](#), [basis](#), [c](#), [eval\(\)](#), [exponent](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::is_negative\(\)](#), [GiNaC::ex::print\(\)](#), and [print_power\(\)](#).

6.119.3.32 do_print_csrc()

```
void GiNaC::power::do_print_csrc (
    const print\_csrc & c,
    unsigned level ) const [protected]
```

References [GiNaC::_ex1_1](#), [basis](#), [c](#), [GiNaC::exp\(\)](#), [exponent](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::integer](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::ex::print\(\)](#), [GiNaC::print_sym_pow\(\)](#), and [GiNaC::numeric::to_int\(\)](#).

6.119.3.33 do_print_python()

```
void GiNaC::power::do_print_python (
    const print\_python & c,
    unsigned level ) const [protected]
```

References [c](#), and [print_power\(\)](#).

6.119.3.34 do_print_python_repr()

```
void GiNaC::power::do_print_python_repr (
    const print\_python\_repr & c,
    unsigned level ) const [protected]
```

References [basis](#), [c](#), [exponent](#), and [GiNaC::ex::print\(\)](#).

6.119.3.35 do_print_csrc_cl_N()

```
void GiNaC::power::do_print_csrc_cl_N (
    const print\_csrc\_cl\_N & c,
    unsigned level ) const [protected]
```

References [GiNaC::_ex_1](#), [basis](#), [c](#), [exponent](#), [GiNaC::ex::is_equal\(\)](#), and [GiNaC::ex::print\(\)](#).

6.119.3.36 expand_add()

```
ex GiNaC::power::expand_add (
    const add & a,
    long n,
    unsigned options ) [static], [protected]
```

expand a^n where a is an [add](#) and n is a positive integer.

See also

[power::expand](#)

References [GiNaC::_ex1](#), [GiNaC::_num1_p](#), [basis](#), [GiNaC::binomial\(\)](#), [c](#), [coeff\(\)](#), [expand\(\)](#), [expand_add_2\(\)](#), [GiNaC::status_flags::expanded](#), [exponent](#), [GiNaC::factor\(\)](#), [GiNaC::partition_with_zero_parts_generator::get\(\)](#), [GiNaC::composition_generator::get\(\)](#), [GINAC_ASSERT](#), [GiNaC::is_pos_integer\(\)](#), [GiNaC::ex::is_zero\(\)](#), [k](#), [mul](#), [GiNaC::multinomial_coefficient\(\)](#), [n](#), [GiNaC::partition_with_zero_parts_generator::next\(\)](#), [GiNaC::composition_generator::next\(\)](#), [GiNaC::expairseq::nops\(\)](#), [options](#), [GiNaC::expairseq::overall_coeff](#), [GiNaC::pow\(\)](#), [r](#), [GiNaC::expairseq::seq](#), and [GiNaC::numeric::to_long\(\)](#).

Referenced by [expand\(\)](#).

6.119.3.37 expand_add_2()

```
ex GiNaC::power::expand_add_2 (
    const add & a,
    unsigned options ) [static], [protected]
```

Special case of [power::expand_add](#).

Expands a^2 where a is an add.

See also

[power::expand_add](#)

References [GiNaC::_ex1](#), [GiNaC::_ex2](#), [GiNaC::_num2_p](#), [basis](#), [c](#), [GiNaC::ex::coeff\(\)](#), [GiNaC::add::combine_pair_with_coeff_to_pair](#), [expand\(\)](#), [expand_mul\(\)](#), [GiNaC::status_flags::expanded](#), [exponent](#), [GINAC_ASSERT](#), [GiNaC::is_pos_integer\(\)](#), [GiNaC::ex::is_zero\(\)](#), [last](#), [GiNaC::numeric::mul\(\)](#), [mul](#), [GiNaC::numeric::mul_dyn\(\)](#), [GiNaC::expairseq::nops\(\)](#), [options](#), [GiNaC::expairseq::overall_coeff](#), [r](#), and [GiNaC::expairseq::seq](#).

Referenced by [expand_add\(\)](#).

6.119.3.38 expand_mul()

```
ex GiNaC::power::expand_mul (
    const mul & m,
    const numeric & n,
    unsigned options,
    bool from_expand = false ) [static], [protected]
```

Expand factors of m in m^n where m is a mul and n is an integer.

See also

[power::expand](#)

References [GiNaC::_ex1](#), [GiNaC::expair::coeff](#), [GiNaC::basic::ex](#), [GiNaC::expand_options::expand_rename_idx](#), [GiNaC::status_flags::expanded](#), [GiNaC::get_all_dummy_indices\(\)](#), [GINAC_ASSERT](#), [GiNaC::info_flags::has_indices](#), [m](#), [n](#), [options](#), [GiNaC::rename_dummy_indices_uniquely\(\)](#), and [GiNaC::basic::setflag\(\)](#).

Referenced by [eval\(\)](#), [expand\(\)](#), and [expand_add_2\(\)](#).

6.119.4 Friends And Related Function Documentation

6.119.4.1 mul

```
friend class mul [friend]
```

Referenced by [expand_add\(\)](#), and [expand_add_2\(\)](#).

6.119.5 Member Data Documentation

6.119.5.1 basis

`ex GiNaC::power::basis` [protected]

Referenced by [archive\(\)](#), [coeff\(\)](#), [conjugate\(\)](#), [degree\(\)](#), [derivative\(\)](#), [do_print_csrc\(\)](#), [do_print_csrc_cl_N\(\)](#), [do_print_dflt\(\)](#), [do_print_latex\(\)](#), [do_print_python_repr\(\)](#), [eval\(\)](#), [evalf\(\)](#), [evalm\(\)](#), [expand\(\)](#), [expand_add\(\)](#), [expand_add_2\(\)](#), [has\(\)](#), [imag_part\(\)](#), [info\(\)](#), [is_polynomial\(\)](#), [ldegree\(\)](#), [map\(\)](#), [normal\(\)](#), [op\(\)](#), [print_power\(\)](#), [read_archive\(\)](#), [real_part\(\)](#), [return_type\(\)](#), [return_type_tinfo\(\)](#), [series\(\)](#), [GiNaC::mul::split_ex_to_pair\(\)](#), [subs\(\)](#), [to_polynomial\(\)](#), and [to_rational\(\)](#).

6.119.5.2 exponent

`ex GiNaC::power::exponent` [protected]

Referenced by [archive\(\)](#), [coeff\(\)](#), [conjugate\(\)](#), [degree\(\)](#), [derivative\(\)](#), [do_print_csrc\(\)](#), [do_print_csrc_cl_N\(\)](#), [do_print_dflt\(\)](#), [do_print_latex\(\)](#), [do_print_python_repr\(\)](#), [eval\(\)](#), [evalf\(\)](#), [evalm\(\)](#), [expand\(\)](#), [expand_add\(\)](#), [expand_add_2\(\)](#), [has\(\)](#), [imag_part\(\)](#), [info\(\)](#), [is_polynomial\(\)](#), [ldegree\(\)](#), [map\(\)](#), [normal\(\)](#), [op\(\)](#), [print_power\(\)](#), [read_archive\(\)](#), [real_part\(\)](#), [series\(\)](#), [GiNaC::mul::split_ex_to_pair\(\)](#), [subs\(\)](#), [to_polynomial\(\)](#), and [to_rational\(\)](#).

The documentation for this class was generated from the following files:

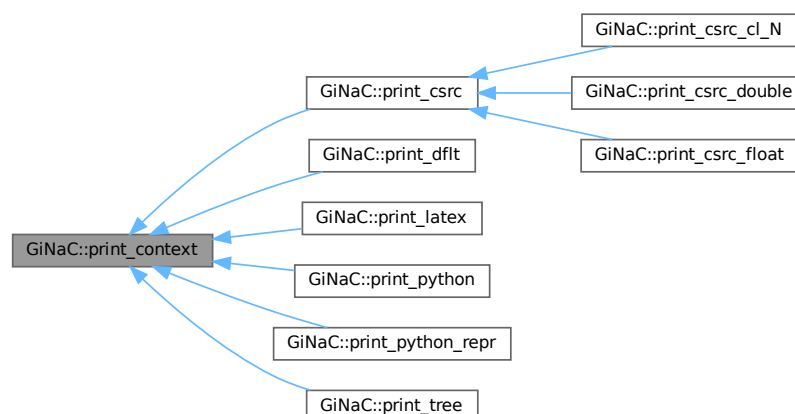
- [power.h](#)
- [normal.cpp](#)
- [power.cpp](#)
- [pseries.cpp](#)

6.120 GiNaC::print_context Class Reference

Base class for print_contexts.

```
#include <print.h>
```

Inheritance diagram for GiNaC::print_context:



Public Member Functions

- [print_context](#) (std::ostream &, unsigned [options](#)=0)
- virtual [~print_context](#) ()

Public Attributes

- std::ostream & [s](#)
stream to output to
- unsigned [options](#)
option flags

6.120.1 Detailed Description

Base class for print_contexts.

6.120.2 Constructor & Destructor Documentation

6.120.2.1 print_context()

```
GiNaC::print_context::print_context (
    std::ostream & os,
    unsigned options = 0 )
```

6.120.2.2 ~print_context()

```
virtual GiNaC::print_context::~~print_context ( ) [inline], [virtual]
```

6.120.3 Member Data Documentation

6.120.3.1 s

```
std::ostream& GiNaC::print_context::s
```

stream to output to

Referenced by [GiNaC::numeric::print_numeric\(\)](#).

6.120.3.2 options

`unsigned GiNaC::print_context::options`

option flags

Referenced by [GiNaC::get_print_options\(\)](#), [GiNaC::set_print_context\(\)](#), and [GiNaC::set_print_options\(\)](#).

The documentation for this class was generated from the following files:

- [print.h](#)
- [print.cpp](#)

6.121 GiNaC::print_context_options Class Reference

This class stores information about a registered [print_context](#) class.

```
#include <print.h>
```

Public Member Functions

- [print_context_options](#) (const char *n, const char *p, unsigned i)
- const char * [get_name](#) () const
- const char * [get_parent_name](#) () const
- unsigned [get_id](#) () const

Private Attributes

- const char * [name](#)
Class name.
- const char * [parent_name](#)
Name of superclass.
- unsigned [id](#)
ID number (assigned automatically).

6.121.1 Detailed Description

This class stores information about a registered [print_context](#) class.

6.121.2 Constructor & Destructor Documentation

6.121.2.1 print_context_options()

```
GiNaC::print_context_options::print_context_options (
    const char * n,
    const char * p,
    unsigned i ) [inline]
```

6.121.3 Member Function Documentation

6.121.3.1 get_name()

```
const char * GiNaC::print_context_options::get_name ( ) const [inline]
```

References [name](#).

6.121.3.2 get_parent_name()

```
const char * GiNaC::print_context_options::get_parent_name ( ) const [inline]
```

References [parent_name](#).

6.121.3.3 get_id()

```
unsigned GiNaC::print_context_options::get_id ( ) const [inline]
```

References [id](#).

6.121.4 Member Data Documentation

6.121.4.1 name

```
const char* GiNaC::print_context_options::name [private]
```

Class name.

Referenced by [get_name\(\)](#).

6.121.4.2 parent_name

```
const char* GiNaC::print_context_options::parent_name [private]
```

Name of superclass.

Referenced by [get_parent_name\(\)](#).

6.121.4.3 id

```
unsigned GiNaC::print_context_options::id [private]
```

ID number (assigned automatically).

Referenced by [get_id\(\)](#).

The documentation for this class was generated from the following file:

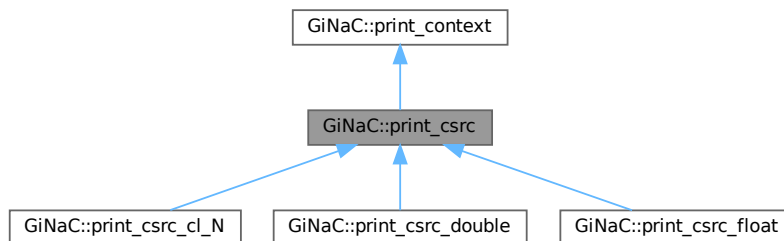
- [print.h](#)

6.122 GiNaC::print_csrc Class Reference

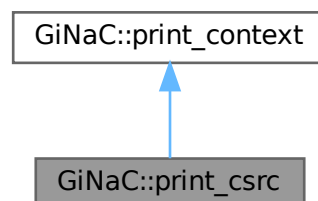
Base context for C source output.

```
#include <print.h>
```

Inheritance diagram for GiNaC::print_csrc:



Collaboration diagram for GiNaC::print_csrc:



Public Member Functions

- [print_csrc](#) (std::ostream &, unsigned [options](#)=0)

Public Member Functions inherited from [GiNaC::print_context](#)

- [print_context](#) (std::ostream &, unsigned [options](#)=0)
- virtual [~print_context](#) ()

Additional Inherited Members

Public Attributes inherited from [GiNaC::print_context](#)

- std::ostream & [s](#)
stream to output to
- unsigned [options](#)
option flags

6.122.1 Detailed Description

Base context for C source output.

6.122.2 Constructor & Destructor Documentation

6.122.2.1 [print_csrc\(\)](#)

```
GiNaC::print_csrc::print_csrc (
    std::ostream & os,
    unsigned options = 0 )
```

The documentation for this class was generated from the following files:

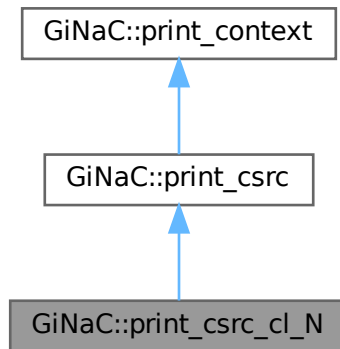
- [print.h](#)
- [print.cpp](#)

6.123 GiNaC::print_csrc_cl_N Class Reference

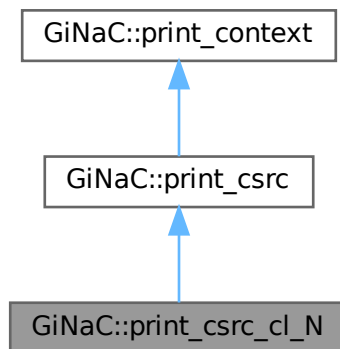
Context for C source output using CLN numbers.

```
#include <print.h>
```

Inheritance diagram for GiNaC::print_csrc_cl_N:



Collaboration diagram for GiNaC::print_csrc_cl_N:



Public Member Functions

- [print_csrc_cl_N](#) (std::ostream &, unsigned [options](#)=0)

Public Member Functions inherited from [GiNaC::print_csrc](#)

- [print_csrc](#) (std::ostream &, unsigned [options](#)=0)

Public Member Functions inherited from [GiNaC::print_context](#)

- [print_context](#) (std::ostream &, unsigned [options](#)=0)
- virtual [~print_context](#) ()

Additional Inherited Members**Public Attributes inherited from [GiNaC::print_context](#)**

- std::ostream & [s](#)
stream to output to
- unsigned [options](#)
option flags

6.123.1 Detailed Description

Context for C source output using CLN numbers.

6.123.2 Constructor & Destructor Documentation**6.123.2.1 [print_csrc_cl_N\(\)](#)**

```
GiNaC::print_csrc_cl_N::print_csrc_cl_N (
    std::ostream & os,
    unsigned options = 0 )
```

The documentation for this class was generated from the following files:

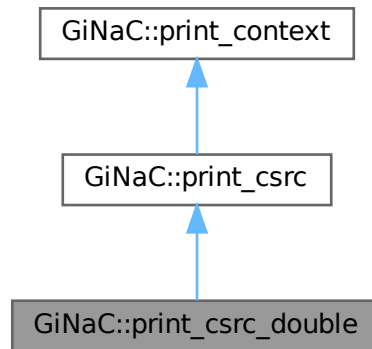
- [print.h](#)
- [print.cpp](#)

6.124 GiNaC::print_csrc_double Class Reference

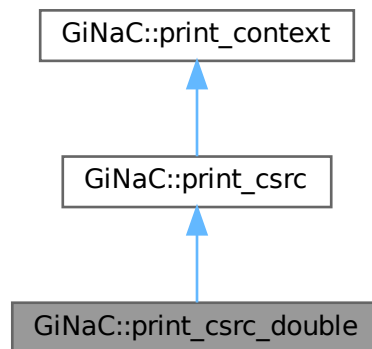
Context for C source output using double precision.

```
#include <print.h>
```

Inheritance diagram for GiNaC::print_csrc_double:



Collaboration diagram for GiNaC::print_csrc_double:



Public Member Functions

- [print_csrc_double](#) (std::ostream &, unsigned [options](#)=0)

Public Member Functions inherited from [GiNaC::print_csrc](#)

- [print_csrc](#) (std::ostream &, unsigned [options](#)=0)

Public Member Functions inherited from [GiNaC::print_context](#)

- [print_context](#) (std::ostream &, unsigned [options](#)=0)
- virtual [~print_context](#) ()

Additional Inherited Members**Public Attributes inherited from [GiNaC::print_context](#)**

- std::ostream & [s](#)
stream to output to
- unsigned [options](#)
option flags

6.124.1 Detailed Description

Context for C source output using double precision.

6.124.2 Constructor & Destructor Documentation**6.124.2.1 [print_csrc_double](#)()**

```
GiNaC::print_csrc_double::print_csrc_double (
    std::ostream & os,
    unsigned options = 0 )
```

The documentation for this class was generated from the following files:

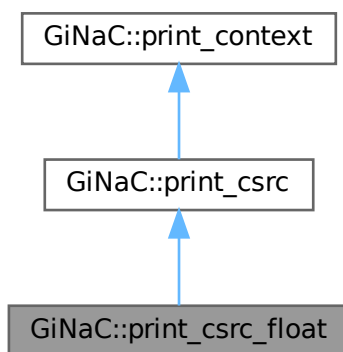
- [print.h](#)
- [print.cpp](#)

6.125 GiNaC::print_csrc_float Class Reference

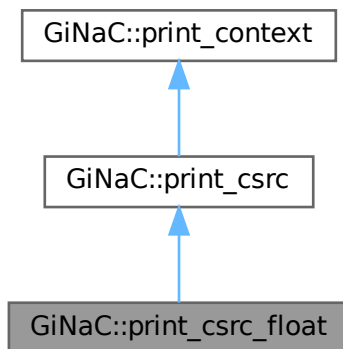
Context for C source output using float precision.

```
#include <print.h>
```

Inheritance diagram for GiNaC::print_csrc_float:



Collaboration diagram for GiNaC::print_csrc_float:



Public Member Functions

- [print_csrc_float](#) (std::ostream &, unsigned [options](#)=0)

Public Member Functions inherited from [GiNaC::print_csrc](#)

- [print_csrc](#) (std::ostream &, unsigned [options](#)=0)

Public Member Functions inherited from [GiNaC::print_context](#)

- [print_context](#) (std::ostream &, unsigned [options](#)=0)
- virtual [~print_context](#) ()

Additional Inherited Members**Public Attributes inherited from [GiNaC::print_context](#)**

- std::ostream & [s](#)
stream to output to
- unsigned [options](#)
option flags

6.125.1 Detailed Description

Context for C source output using float precision.

6.125.2 Constructor & Destructor Documentation**6.125.2.1 [print_csrc_float\(\)](#)**

```
GiNaC::print_csrc_float::print_csrc_float (
    std::ostream & os,
    unsigned options = 0 )
```

The documentation for this class was generated from the following files:

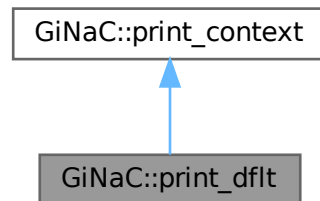
- [print.h](#)
- [print.cpp](#)

6.126 GiNaC::print_dflt Class Reference

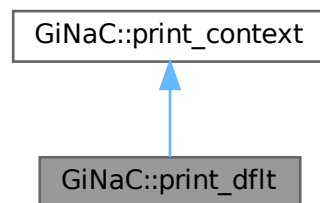
Context for default (ginsh-parsable) output.

```
#include <print.h>
```

Inheritance diagram for GiNaC::print_dflt:



Collaboration diagram for GiNaC::print_dflt:



Public Member Functions

- [print_dflt](#) (std::ostream &, unsigned [options](#)=0)

Public Member Functions inherited from [GiNaC::print_context](#)

- [print_context](#) (std::ostream &, unsigned [options](#)=0)
- virtual [~print_context](#) ()

Additional Inherited Members

Public Attributes inherited from [GiNaC::print_context](#)

- std::ostream & [s](#)
stream to output to
- unsigned [options](#)
option flags

6.126.1 Detailed Description

Context for default (ginsh-parsable) output.

6.126.2 Constructor & Destructor Documentation

6.126.2.1 print_dflt()

```
GiNaC::print_dflt::print_dflt (
    std::ostream & os,
    unsigned options = 0 )
```

The documentation for this class was generated from the following files:

- [print.h](#)
- [print.cpp](#)

6.127 GiNaC::print_funcor Class Reference

This class represents a print method for a certain algebraic class and [print_context](#) type.

```
#include <print.h>
```

Public Member Functions

- [print_funcor](#) ()
- [print_funcor](#) (const [print_funcor](#) &other)
- [print_funcor](#) (std::unique_ptr< [print_funcor_impl](#) > impl_)
- template<class T, class C >
[print_funcor](#) (void f(const T &, const C &, unsigned))
- template<class T, class C >
[print_funcor](#) (void(T::*f)(const C &, unsigned) const)
- [print_funcor](#) & [operator=](#) (const [print_funcor](#) &other)
- void [operator\(\)](#) (const [basic](#) &obj, const [print_context](#) &c, unsigned level) const
- bool [is_valid](#) () const

Private Attributes

- std::unique_ptr< [print_funcor_impl](#) > impl

6.127.1 Detailed Description

This class represents a print method for a certain algebraic class and [print_context](#) type.

Its main purpose is to hide the difference between member functions and nonmember functions behind one unified [operator\(\)](#) interface. [print_funcor](#) has value semantics and acts as a smart pointer (with deep copy) to a class derived from [print_funcor_impl](#) which implements the actual function call.

6.127.2 Constructor & Destructor Documentation

6.127.2.1 `print_functor()` [1/5]

```
GiNaC::print_functor::print_functor ( ) [inline]
```

6.127.2.2 `print_functor()` [2/5]

```
GiNaC::print_functor::print_functor (
    const print_functor & other ) [inline]
```

6.127.2.3 `print_functor()` [3/5]

```
GiNaC::print_functor::print_functor (
    std::unique_ptr< print_functor_impl > impl_ ) [inline]
```

6.127.2.4 `print_functor()` [4/5]

```
template<class T , class C >
GiNaC::print_functor::print_functor (
    void fconst T &, const C &, unsigned ) [inline]
```

6.127.2.5 `print_functor()` [5/5]

```
template<class T , class C >
GiNaC::print_functor::print_functor (
    void(T::*)(const C &, unsigned) const f ) [inline]
```

6.127.3 Member Function Documentation

6.127.3.1 operator=()

```
print_functor & GiNaC::print_functor::operator= (
    const print_functor & other ) [inline]
```

References [impl](#).

6.127.3.2 operator>()()

```
void GiNaC::print_functor::operator() (
    const basic & obj,
    const print_context & c,
    unsigned level ) const [inline]
```

References [c](#).

6.127.3.3 is_valid()

```
bool GiNaC::print_functor::is_valid ( ) const [inline]
```

References [impl](#).

6.127.4 Member Data Documentation

6.127.4.1 impl

```
std::unique_ptr<print_functor_impl> GiNaC::print_functor::impl [private]
```

Referenced by [is_valid\(\)](#), and [operator=\(\)](#).

The documentation for this class was generated from the following file:

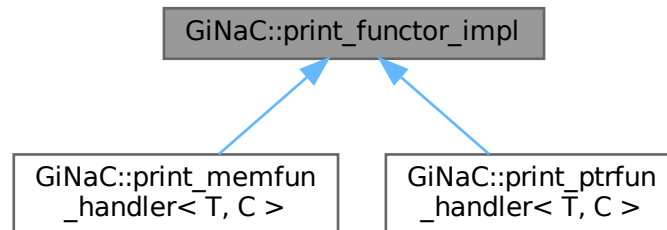
- [print.h](#)

6.128 GiNaC::print_functor_impl Class Reference

Base class for [print_functor](#) handlers.

```
#include <print.h>
```

Inheritance diagram for GiNaC::print_functor_impl:



Public Member Functions

- virtual [~print_functor_impl](#) ()
- virtual [print_functor_impl](#) * [duplicate](#) () const =0
- virtual void [operator\(\)](#) (const [basic](#) &obj, const [print_context](#) &c, unsigned level) const =0

6.128.1 Detailed Description

Base class for [print_functor](#) handlers.

6.128.2 Constructor & Destructor Documentation

6.128.2.1 ~print_functor_impl()

```
virtual GiNaC::print_functor_impl::~~print_functor_impl ( ) [inline], [virtual]
```

6.128.3 Member Function Documentation

6.128.3.1 duplicate()

```
virtual print\_functor\_impl * GiNaC::print_functor_impl::duplicate ( ) const [pure virtual]
```

Implemented in [GiNaC::print_ptrfun_handler< T, C >](#), and [GiNaC::print_memfun_handler< T, C >](#).

6.128.3.2 operator>()

```
virtual void GiNaC::print_functor_impl::operator() (
    const basic & obj,
    const print\_context & c,
    unsigned level ) const [pure virtual]
```

Implemented in [GiNaC::print_ptrfun_handler< T, C >](#), and [GiNaC::print_memfun_handler< T, C >](#).

The documentation for this class was generated from the following file:

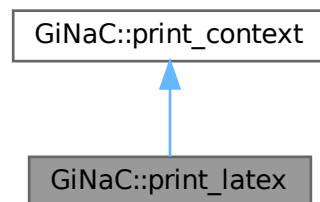
- [print.h](#)

6.129 GiNaC::print_latex Class Reference

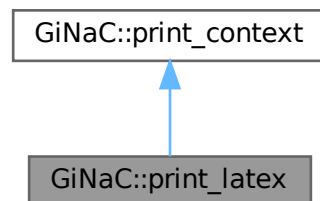
Context for latex-parsable output.

```
#include <print.h>
```

Inheritance diagram for GiNaC::print_latex:



Collaboration diagram for GiNaC::print_latex:



Public Member Functions

- [print_latex](#) (std::ostream &, unsigned [options](#)=0)

Public Member Functions inherited from [GiNaC::print_context](#)

- [print_context](#) (std::ostream &, unsigned [options](#)=0)
- virtual [~print_context](#) ()

Additional Inherited Members

Public Attributes inherited from [GiNaC::print_context](#)

- std::ostream & [s](#)
stream to output to
- unsigned [options](#)
option flags

6.129.1 Detailed Description

Context for latex-parsable output.

6.129.2 Constructor & Destructor Documentation

6.129.2.1 [print_latex\(\)](#)

```
GiNaC::print_latex::print_latex (
    std::ostream & os,
    unsigned options = 0 )
```

The documentation for this class was generated from the following files:

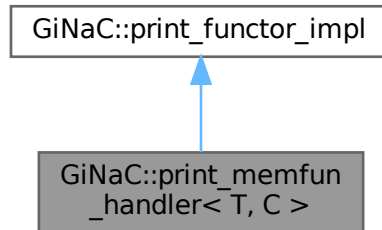
- [print.h](#)
- [print.cpp](#)

6.130 GiNaC::print_memfun_handler< T, C > Class Template Reference

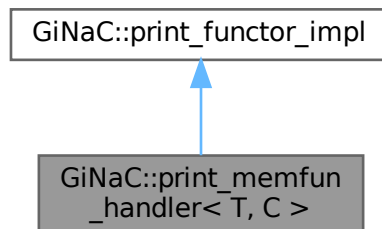
[print_functor](#) handler for member functions of class T, context type C

```
#include <print.h>
```

Inheritance diagram for GiNaC::print_memfun_handler< T, C >:



Collaboration diagram for GiNaC::print_memfun_handler< T, C >:



Public Types

- typedef void(T::* [F](#)) (const C &[c](#), unsigned level) const

Public Member Functions

- [print_memfun_handler](#) ([F](#) f_)
- [print_memfun_handler](#) * [duplicate](#) () const override
- void [operator](#)() (const [basic](#) &obj, const [print_context](#) &[c](#), unsigned level) const override

Public Member Functions inherited from [GiNaC::print_functor_impl](#)

- virtual [~print_functor_impl](#) ()
- virtual [print_functor_impl](#) * [duplicate](#) () const =0
- virtual void [operator\(\)](#) (const [basic](#) &obj, const [print_context](#) &c, unsigned level) const =0

Private Attributes

- [F f](#)

6.130.1 Detailed Description

```
template<class T, class C>
class GiNaC::print_memfun_handler< T, C >
```

[print_functor](#) handler for member functions of class T, context type C

6.130.2 Member Typedef Documentation

6.130.2.1 F

```
template<class T , class C >
typedef void(T::* GiNaC::print\_memfun\_handler< T, C >::F) (const C &c, unsigned level) const
```

6.130.3 Constructor & Destructor Documentation

6.130.3.1 [print_memfun_handler\(\)](#)

```
template<class T , class C >
GiNaC::print\_memfun\_handler< T, C >::print_memfun_handler (
    F f_ ) [inline]
```

6.130.4 Member Function Documentation

6.130.4.1 duplicate()

```
template<class T , class C >
print_memfun_handler * GiNaC::print_memfun_handler< T, C >::duplicate ( ) const [inline],
[override], [virtual]
```

Implements [GiNaC::print_functor_impl](#).

6.130.4.2 operator>()()

```
template<class T , class C >
void GiNaC::print_memfun_handler< T, C >::operator() (
    const basic & obj,
    const print_context & c,
    unsigned level ) const [inline], [override], [virtual]
```

Implements [GiNaC::print_functor_impl](#).

References [c](#), and [GiNaC::print_memfun_handler< T, C >::f](#).

6.130.5 Member Data Documentation

6.130.5.1 f

```
template<class T , class C >
F GiNaC::print_memfun_handler< T, C >::f [private]
```

Referenced by [GiNaC::print_memfun_handler< T, C >::operator>\(\)](#).

The documentation for this class was generated from the following file:

- [print.h](#)

6.131 GiNaC::print_options Class Reference

Flags to control the behavior of a [print_context](#).

```
#include <print.h>
```

Public Types

- enum { [print_index_dimensions](#) = 0x0001 }

6.131.1 Detailed Description

Flags to control the behavior of a [print_context](#).

6.131.2 Member Enumeration Documentation

6.131.2.1 anonymous enum

`anonymous enum`

Enumerator

print_index_dimensions	print the dimensions of indices
------------------------	---------------------------------

The documentation for this class was generated from the following file:

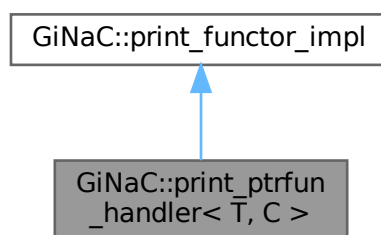
- [print.h](#)

6.132 GiNaC::print_ptrfun_handler< T, C > Class Template Reference

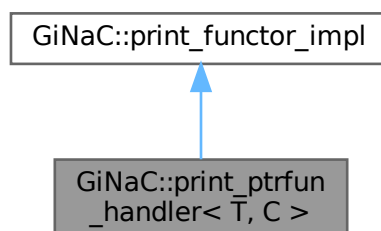
[print_functor](#) handler for pointer-to-functions of class T, context type C

```
#include <print.h>
```

Inheritance diagram for GiNaC::print_ptrfun_handler< T, C >:



Collaboration diagram for GiNaC::print_ptrfun_handler< T, C >:



Public Types

- typedef void(* [F](#)) (const T &, const C &, unsigned)

Public Member Functions

- [print_ptrfun_handler](#) (F f_)
- [print_ptrfun_handler](#) * [duplicate](#) () const override
- void [operator](#)() (const [basic](#) &obj, const [print_context](#) &c, unsigned level) const override

Public Member Functions inherited from [GiNaC::print_functor_impl](#)

- virtual [~print_functor_impl](#) ()
- virtual [print_functor_impl](#) * [duplicate](#) () const =0
- virtual void [operator](#)() (const [basic](#) &obj, const [print_context](#) &c, unsigned level) const =0

Private Attributes

- [F f](#)

6.132.1 Detailed Description

```
template<class T, class C>
class GiNaC::print_ptrfun_handler< T, C >
```

[print_functor](#) handler for pointer-to-functions of class T, context type C

6.132.2 Member Typedef Documentation

6.132.2.1 F

```
template<class T , class C >
typedef void(* GiNaC::print\_ptrfun\_handler< T, C >::F) (const T &, const C &, unsigned)
```

6.132.3 Constructor & Destructor Documentation

6.132.3.1 [print_ptrfun_handler](#)()

```
template<class T , class C >
GiNaC::print\_ptrfun\_handler< T, C >::print_ptrfun_handler (
    F f_ ) [inline]
```

6.132.4 Member Function Documentation

6.132.4.1 duplicate()

```
template<class T , class C >
print\_ptrfun\_handler * GiNaC::print\_ptrfun\_handler< T, C >::duplicate ( ) const [inline],
[override], [virtual]
```

Implements [GiNaC::print_functor_impl](#).

6.132.4.2 operator>()()

```
template<class T , class C >
void GiNaC::print\_ptrfun\_handler< T, C >::operator() (
    const basic & obj,
    const print\_context & c,
    unsigned level ) const [inline], [override], [virtual]
```

Implements [GiNaC::print_functor_impl](#).

References [c](#), and [GiNaC::print_ptrfun_handler< T, C >::f](#).

6.132.5 Member Data Documentation

6.132.5.1 f

```
template<class T , class C >
F GiNaC::print\_ptrfun\_handler< T, C >::f [private]
```

Referenced by [GiNaC::print_ptrfun_handler< T, C >::operator>\(\)\(\)](#).

The documentation for this class was generated from the following file:

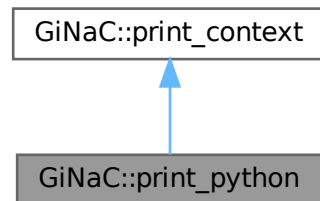
- [print.h](#)

6.133 GiNaC::print_python Class Reference

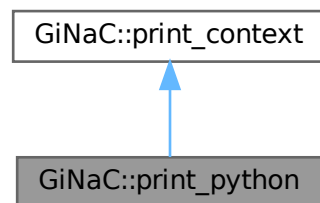
Context for python pretty-print output.

```
#include <print.h>
```

Inheritance diagram for GiNaC::print_python:



Collaboration diagram for GiNaC::print_python:



Public Member Functions

- [print_python](#) (std::ostream &, unsigned [options](#)=0)

Public Member Functions inherited from [GiNaC::print_context](#)

- [print_context](#) (std::ostream &, unsigned [options](#)=0)
- virtual [~print_context](#) ()

Additional Inherited Members

Public Attributes inherited from [GiNaC::print_context](#)

- std::ostream & [s](#)
stream to output to
- unsigned [options](#)
option flags

6.133.1 Detailed Description

Context for python pretty-print output.

6.133.2 Constructor & Destructor Documentation

6.133.2.1 print_python()

```
GiNaC::print_python::print_python (
    std::ostream & os,
    unsigned options = 0 )
```

The documentation for this class was generated from the following files:

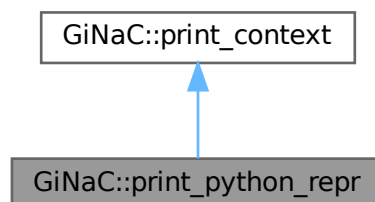
- [print.h](#)
- [print.cpp](#)

6.134 GiNaC::print_python_repr Class Reference

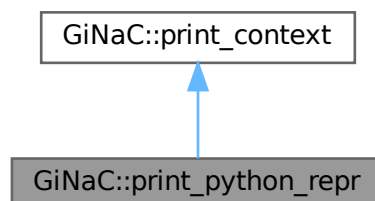
Context for python-parsable output.

```
#include <print.h>
```

Inheritance diagram for GiNaC::print_python_repr:



Collaboration diagram for GiNaC::print_python_repr:



Public Member Functions

- [print_python_repr](#) (std::ostream &, unsigned [options](#)=0)

Public Member Functions inherited from [GiNaC::print_context](#)

- [print_context](#) (std::ostream &, unsigned [options](#)=0)
- virtual [~print_context](#) ()

Additional Inherited Members

Public Attributes inherited from [GiNaC::print_context](#)

- std::ostream & [s](#)
stream to output to
- unsigned [options](#)
option flags

6.134.1 Detailed Description

Context for python-parsable output.

6.134.2 Constructor & Destructor Documentation

6.134.2.1 [print_python_repr\(\)](#)

```
GiNaC::print_python_repr::print_python_repr (
    std::ostream & os,
    unsigned options = 0 )
```

The documentation for this class was generated from the following files:

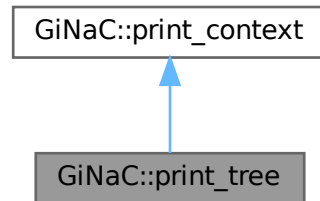
- [print.h](#)
- [print.cpp](#)

6.135 GiNaC::print_tree Class Reference

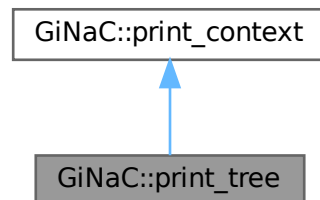
Context for tree-like output for debugging.

```
#include <print.h>
```

Inheritance diagram for GiNaC::print_tree:



Collaboration diagram for GiNaC::print_tree:



Public Member Functions

- [print_tree](#) (unsigned d)
- [print_tree](#) (std::ostream &, unsigned [options](#)=0, unsigned d=4)

Public Member Functions inherited from [GiNaC::print_context](#)

- [print_context](#) (std::ostream &, unsigned [options](#)=0)
- virtual [~print_context](#) ()

Public Attributes

- const unsigned [delta_indent](#)
size of indentation step

Public Attributes inherited from [GiNaC::print_context](#)

- [std::ostream & s](#)
stream to output to
- unsigned [options](#)
option flags

6.135.1 Detailed Description

Context for tree-like output for debugging.

6.135.2 Constructor & Destructor Documentation

6.135.2.1 [print_tree\(\)](#) [1/2]

```
GiNaC::print_tree::print_tree (  
    unsigned d )
```

6.135.2.2 [print_tree\(\)](#) [2/2]

```
GiNaC::print_tree::print_tree (  
    std::ostream & os,  
    unsigned options = 0,  
    unsigned d = 4 )
```

6.135.3 Member Data Documentation

6.135.3.1 [delta_indent](#)

```
const unsigned GiNaC::print_tree::delta_indent
```

size of indentation step

The documentation for this class was generated from the following files:

- [print.h](#)
- [print.cpp](#)

6.136 GiNaC::archive_node::property Struct Reference

Archived property (data type, name and associated data)

```
#include <archive.h>
```

Public Member Functions

- [property](#) ()
- [property](#) ([archive_atom](#) n, [property_type](#) t, unsigned v)

Public Attributes

- [property_type](#) type
Data type of property.
- [archive_atom](#) name
Name of property.
- unsigned [value](#)
Stored value.

6.136.1 Detailed Description

Archived property (data type, name and associated data)

6.136.2 Constructor & Destructor Documentation

6.136.2.1 [property\(\)](#) [1/2]

```
GiNaC::archive_node::property::property ( ) [inline]
```

6.136.2.2 [property\(\)](#) [2/2]

```
GiNaC::archive_node::property::property (
    archive\_atom n,
    property\_type t,
    unsigned v ) [inline]
```

6.136.3 Member Data Documentation

6.136.3.1 type

`property_type` `GiNaC::archive_node::property::type`

Data type of property.

6.136.3.2 name

`archive_atom` `GiNaC::archive_node::property::name`

Name of property.

6.136.3.3 value

`unsigned` `GiNaC::archive_node::property::value`

Stored value.

The documentation for this struct was generated from the following file:

- [archive.h](#)

6.137 GiNaC::archive_node::property_info Struct Reference

Information about a stored property.

```
#include <archive.h>
```

Public Member Functions

- [property_info](#) ()
- [property_info](#) ([property_type](#) t, const std::string &n, unsigned c=1)

Public Attributes

- [property_type](#) `type`
Data type of property.
- std::string [name](#)
Name of property.
- unsigned [count](#)
Number of occurrences.

6.137.1 Detailed Description

Information about a stored property.

A vector of these structures is returned by [get_properties\(\)](#).

See also

[get_properties](#)

6.137.2 Constructor & Destructor Documentation

6.137.2.1 `property_info()` [1/2]

```
GiNaC::archive_node::property_info::property_info ( ) [inline]
```

6.137.2.2 `property_info()` [2/2]

```
GiNaC::archive_node::property_info::property_info (
    property\_type t,
    const std::string & n,
    unsigned c = 1 ) [inline]
```

6.137.3 Member Data Documentation

6.137.3.1 `type`

[property_type](#) GiNaC::archive_node::property_info::type

Data type of property.

6.137.3.2 `name`

std::string GiNaC::archive_node::property_info::name

Name of property.

6.137.3.3 count

```
unsigned GiNaC::archive_node::property_info::count
```

Number of occurrences.

The documentation for this struct was generated from the following file:

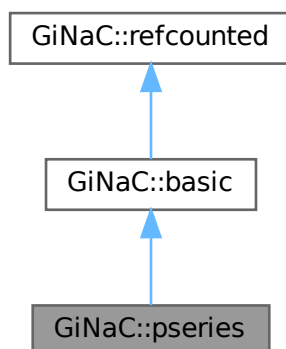
- [archive.h](#)

6.138 GiNaC::pseries Class Reference

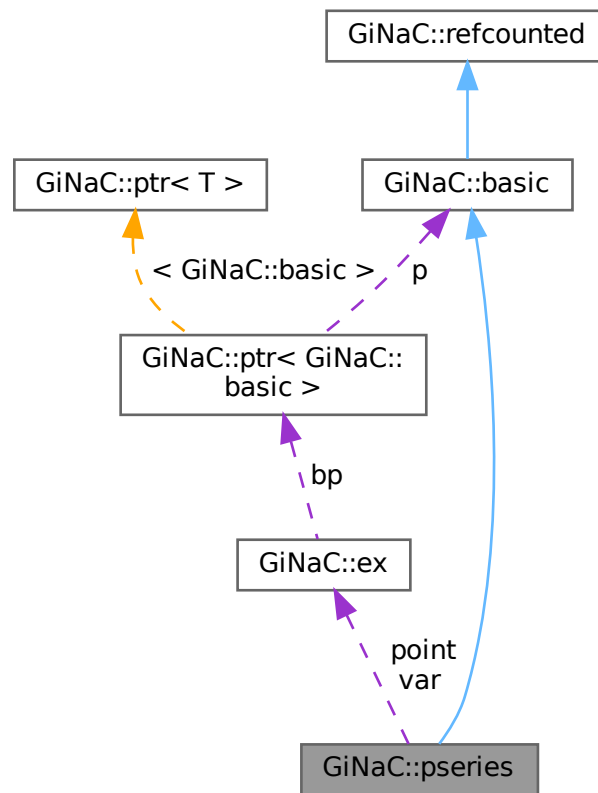
This class holds a extended truncated power series (positive and negative integer powers).

```
#include <pseries.h>
```

Inheritance diagram for GiNaC::pseries:



Collaboration diagram for GiNaC::pseries:



Public Member Functions

- `pseries` (const `ex` &rel_, const `epvector` &ops_)
Construct `pseries` from a vector of coefficients and powers.
- `pseries` (const `ex` &rel_, `epvector` &&ops_)
- unsigned `precedence` () const override
Return relative operator precedence (for parenthesizing output).
- `size_t` `nops` () const override
Return the number of operands including a possible order term.
- `ex op` (size_t i) const override
Return the *i*th term in the series when represented as a sum.
- int `degree` (const `ex` &s) const override
Return degree of highest power of the series.
- int `ldegree` (const `ex` &s) const override
Return degree of lowest power of the series.
- `ex coeff` (const `ex` &s, int `n`=1) const override
Return coefficient of degree *n* in power series if *s* is the expansion variable.
- `ex collect` (const `ex` &s, bool distributed=false) const override
Does nothing.

- `ex eval ()` const override
Perform coefficient-wise automatic term rewriting rules in this class.
- `ex evalf ()` const override
Evaluate coefficients numerically.
- `ex series (const relational &r, int order, unsigned options=0)` const override
Re-expansion of a pseries object.
- `ex subs (const exmap &m, unsigned options=0)` const override
Substitute a set of objects by arbitrary expressions.
- `ex normal (exmap &repl, exmap &rev_lookup, lst &modifier)` const override
Implementation of `ex::normal()` for pseries.
- `ex expand (unsigned options=0)` const override
Implementation of `ex::expand()` for a power series.
- `ex conjugate ()` const override
- `ex real_part ()` const override
- `ex imag_part ()` const override
- `ex eval_integ ()` const override
Evaluate integrals, if result is known.
- `ex evalm ()` const override
Evaluate sums, products and integer powers of matrices.
- `void archive (archive_node &n)` const override
Save (a.k.a.
- `void read_archive (const archive_node &n, lst &syms)` override
Read (a.k.a.
- `ex get_var ()` const
Get the expansion variable.
- `ex get_point ()` const
Get the expansion point.
- `ex convert_to_poly (bool no_order=false)` const
Convert the pseries object to an ordinary polynomial.
- `bool is_compatible_to (const pseries &other)` const
Check whether series is compatible to another series (expansion variable and point are the same.
- `bool is_zero ()` const
Check whether series has the value zero.
- `bool is_terminating ()` const
Returns true if there is no order term, i.e.
- `ex coeffop (size_t i)` const
Get coefficients and exponents.
- `ex exponop (size_t i)` const
- `ex add_series (const pseries &other)` const
Add one series object to another, producing a pseries object that represents the sum.
- `ex mul_const (const numeric &other)` const
Multiply a pseries object with a numeric constant, producing a pseries object that represents the product.
- `ex mul_series (const pseries &other)` const
Multiply one pseries object to another, producing a pseries object that represents the product.
- `ex power_const (const numeric &p, int deg)` const
Compute the p-th power of a series.
- `pseries shift_exponents (int deg)` const
Return a new pseries object with the powers shifted by deg.

Public Member Functions inherited from [GiNaC::basic](#)

- virtual [~basic](#) ()
basic destructor, virtual because class ex will delete objects of derived classes via a basic.*
- [basic](#) (const [basic](#) &other)
- const [basic](#) & [operator=](#) (const [basic](#) &other)
basic assignment operator: the other object might be of a derived class.
- virtual [basic](#) * [duplicate](#) () const
Create a clone of this object on the heap.
- virtual [ex eval](#) () const
Perform automatic non-interruptive term rewriting rules.
- virtual [ex evalf](#) () const
Evaluate object numerically.
- virtual [ex evalm](#) () const
Evaluate sums, products and integer powers of matrices.
- virtual [ex eval_integ](#) () const
Evaluate integrals, if result is known.
- virtual [ex eval_indexed](#) (const [basic](#) &i) const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void [print](#) (const [print_context](#) &c, unsigned level=0) const
Output to stream.
- virtual void [dbgprint](#) () const
Little wrapper around print to be called within a debugger.
- virtual void [dbgprinttree](#) () const
Little wrapper around printtree to be called within a debugger.
- virtual unsigned [precedence](#) () const
Return relative operator precedence (for parenthezing output).
- virtual bool [info](#) (unsigned inf) const
Information about the object.
- virtual size_t [nops](#) () const
Number of operands/members.
- virtual [ex op](#) (size_t i) const
Return operand/member at position i.
- virtual [ex operator\[\]](#) (const [ex](#) &index) const
- virtual [ex operator\[\]](#) (size_t i) const
- virtual [ex](#) & [let_op](#) (size_t i)
Return modifiable operand/member at position i.
- virtual [ex](#) & [operator\[\]](#) (const [ex](#) &index)
- virtual [ex](#) & [operator\[\]](#) (size_t i)
- virtual bool [has](#) (const [ex](#) &other, unsigned [options](#)=0) const
Test for occurrence of a pattern.
- virtual bool [match](#) (const [ex](#) &pattern, [exmap](#) &repls) const
Check whether the expression matches a given pattern.
- virtual [ex subs](#) (const [exmap](#) &m, unsigned [options](#)=0) const
Substitute a set of objects by arbitrary expressions.
- virtual [ex map](#) ([map_function](#) &f) const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void [accept](#) ([GiNaC::visitor](#) &v) const
- virtual bool [is_polynomial](#) (const [ex](#) &var) const
Check whether this is a polynomial in the given variables.
- virtual int [degree](#) (const [ex](#) &s) const

- Return degree of highest power in object s.*

 - virtual int `ldegree` (const `ex` &s) const
- Return degree of lowest power in object s.*

 - virtual `ex coeff` (const `ex` &s, int `n`=1) const
- Return coefficient of degree n in object s.*

 - virtual `ex expand` (unsigned `options`=0) const
- Expand expression, i.e.*

 - virtual `ex collect` (const `ex` &s, bool `distributed`=false) const
- Sort expanded expression in terms of powers of some object(s).*

 - virtual `ex series` (const `relational` &r, int `order`, unsigned `options`=0) const
- Default implementation of `ex::series()`.*

 - virtual `ex normal` (`exmap` &repl, `exmap` &rev_lookup, `lst` &modifier) const
- Default implementation of `ex::normal()`.*

 - virtual `ex to_rational` (`exmap` &repl) const
- Default implementation of `ex::to_rational()`.*

 - virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const
- Apply symmetric modular homomorphism to an expanded multivariate polynomial.*

 - virtual `numeric max_coefficient` () const
- Implementation `ex::max_coefficient()`.*

 - virtual `exvector get_free_indices` () const
- Return a vector containing the free indices of an expression.*

 - virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
- Add two indexed expressions.*

 - virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
- Multiply an indexed expression with a scalar.*

 - virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const
- Try to contract two indexed expressions that appear in the same product.*

 - virtual unsigned `return_type` () const
 - virtual `return_type_t return_type_tinfo` () const
 - virtual `ex conjugate` () const
 - virtual `ex real_part` () const
 - virtual `ex imag_part` () const
- template<class T >

 - void `print_dispatch` (const `print_context` &c, unsigned level) const
- Like `print()`, but dispatch to the specified class.*

 - void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const
- Like `print()`, but dispatch to the specified class.*

 - virtual void `archive` (`archive_node` &n) const
- Save (serialize) the object into archive node.*

 - virtual void `read_archive` (const `archive_node` &n, `lst` &syms)
- Load (deserialize) the object from an archive node.*

 - `ex subs_one_level` (const `exmap` &m, unsigned `options`) const
- Helper function for `subs()`.*

 - `ex diff` (const `symbol` &s, unsigned `nth`=1) const
- Default interface of nth derivative `ex::diff(s, n)`.*

 - int `compare` (const `basic` &other) const
- Compare objects syntactically to establish canonical ordering.*

 - bool `is_equal` (const `basic` &other) const
- Test for syntactic equality.*

- const [basic](#) & [hold](#) () const
Stop further evaluation.
- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const
Set some [status_flags](#).
- const [basic](#) & [clearflag](#) (unsigned f) const
Clear some [status_flags](#).

Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add_reference](#) () noexcept
- unsigned int [remove_reference](#) () noexcept
- unsigned int [get_refcount](#) () const noexcept
- void [set_refcount](#) (unsigned int r) noexcept

Protected Member Functions

- [ex_derivative](#) (const [symbol](#) &s) const override
Implementation of [ex::diff\(\)](#) for a power series.
- void [print_series](#) (const [print_context](#) &c, const char *openbrace, const char *closebrace, const char *mul←
_sym, const char *pow_sym, unsigned level) const
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
- void [do_print_latex](#) (const [print_latex](#) &c, unsigned level) const
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
- void [do_print_python](#) (const [print_python](#) &c, unsigned level) const
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const

Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match_same_type](#) (const [basic](#) &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual [ex_derivative](#) (const [symbol](#) &s) const
Default implementation of [ex::diff\(\)](#).
- virtual int [compare_same_type](#) (const [basic](#) &other) const
Returns order relation between two objects of same type.
- virtual bool [is_equal_same_type](#) (const [basic](#) &other) const
Returns true if two objects of same type are equal.
- virtual unsigned [calchash](#) () const
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- void [ensure_if_modifiable](#) () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
Default output to stream.
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
Tree output to stream.
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
Python parsable output to stream.

Protected Attributes

- [epvector seq](#)
Vector of {coefficient, power} pairs.
- [ex var](#)
Series variable (holds a symbol)
- [ex point](#)
Expansion point.

Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)
of type [status_flags](#)
- unsigned [hashvalue](#)
hash value

6.138.1 Detailed Description

This class holds a extended truncated power series (positive and negative integer powers).

It consists of expression coefficients (only non-zero coefficients are stored), an expansion variable and an expansion point. Other classes must provide members to convert into this type.

6.138.2 Constructor & Destructor Documentation

6.138.2.1 [pseries\(\)](#) [1/2]

```
GiNaC::pseries::pseries (
    const ex & rel_,
    const epvector & ops_ )
```

Construct pseries from a vector of coefficients and powers.

[expair.rest](#) holds the coefficient, [expair.coeff](#) holds the power. The powers must be integers (positive or negative) and in ascending order; the last coefficient can be `Order(_ex1)` to represent a truncated, non-terminating series.

Parameters

rel ↔ —	expansion variable and point (must hold a relational)
ops ↔ —	vector of {coefficient, power} pairs (coefficient must not be zero)

References [GINAC_ASSERT](#), [GiNaC::is_order_function\(\)](#), [GiNaC::ex::lhs\(\)](#), [point](#), [GiNaC::ex::rhs\(\)](#), [seq](#), and [var](#).

6.138.2.2 pseries() [2/2]

```
GiNaC::pseries::pseries (
    const ex & rel_,
    epvector && ops_ )
```

References [GINAC_ASSERT](#), [GiNaC::is_order_function\(\)](#), [GiNaC::ex::lhs\(\)](#), [point](#), [GiNaC::ex::rhs\(\)](#), [seq](#), and [var](#).

6.138.3 Member Function Documentation

6.138.3.1 precedence()

```
unsigned GiNaC::pseries::precedence ( ) const [inline], [override], [virtual]
```

Return relative operator precedence (for parenthezing output).

Reimplemented from [GiNaC::basic](#).

Referenced by [print_series\(\)](#).

6.138.3.2 nops()

```
size_t GiNaC::pseries::nops ( ) const [override], [virtual]
```

Return the number of operands including a possible order term.

Reimplemented from [GiNaC::basic](#).

References [seq](#).

Referenced by [coeffop\(\)](#), [exponop\(\)](#), and [GiNaC::log_series\(\)](#).

6.138.3.3 op()

```
ex GiNaC::pseries::op (
    size_t i ) const [override], [virtual]
```

Return the ith term in the series when represented as a sum.

Reimplemented from [GiNaC::basic](#).

References [coeff\(\)](#), [GiNaC::is_order_function\(\)](#), [point](#), [GiNaC::pow\(\)](#), [seq](#), and [var](#).

6.138.3.4 degree()

```
int GiNaC::pseries::degree (
    const ex & s ) const [override], [virtual]
```

Return degree of highest power of the series.

This is usually the exponent of the Order term. If s is not the expansion variable of the series, the series is examined termwise.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::ex::is_equal\(\)](#), [seq](#), and [var](#).

Referenced by [mul_series\(\)](#), [power_const\(\)](#), and [series\(\)](#).

6.138.3.5 ldegree()

```
int GiNaC::pseries::ldegree (
    const ex & s ) const [override], [virtual]
```

Return degree of lowest power of the series.

This is usually the exponent of the leading term. If s is not the expansion variable of the series, the series is examined termwise. If s is the expansion variable but the expansion point is not zero the series is not expanded to find the degree. I.e.: $(1-x) + (1-x)^2 + \text{Order}((1-x)^3)$ has `ldegree(x)` 1, not 0.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::ex::is_equal\(\)](#), [seq](#), and [var](#).

Referenced by [GiNaC::log_series\(\)](#), [mul_series\(\)](#), and [power_const\(\)](#).

6.138.3.6 coeff()

```
ex GiNaC::pseries::coeff (
    const ex & s,
    int n = 1 ) const [override], [virtual]
```

Return coefficient of degree n in power series if s is the expansion variable.

If the expansion point is nonzero, by definition the $n=1$ coefficient in s of $a+b*(s-z)+c*(s-z)^2+\text{Order}((s-z)^3)$ is b (assuming the expansion took place in the s in the first place). If s is not the expansion variable, an attempt is made to convert the series to a polynomial and return the corresponding coefficient from there.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex0](#), [GiNaC::ex::coeff\(\)](#), [coeff\(\)](#), [convert_to_poly\(\)](#), [GINAC_ASSERT](#), [GiNaC::ex::is_equal\(\)](#), [n](#), [seq](#), and [var](#).

Referenced by [coeff\(\)](#), [GiNaC::log_series\(\)](#), [mul_series\(\)](#), [op\(\)](#), [power_const\(\)](#), and [read_archive\(\)](#).

6.138.3.7 collect()

```
ex GiNaC::pseries::collect (
    const ex & s,
    bool distributed = false ) const [override], [virtual]
```

Does nothing.

Reimplemented from [GiNaC::basic](#).

6.138.3.8 eval()

```
ex GiNaC::pseries::eval ( ) const [override], [virtual]
```

Perform coefficient-wise automatic term rewriting rules in this class.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::hold\(\)](#).

6.138.3.9 evalf()

```
ex GiNaC::pseries::evalf ( ) const [override], [virtual]
```

Evaluate coefficients numerically.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::status_flags::evaluated](#), [point](#), [seq](#), and [var](#).

6.138.3.10 series()

```
ex GiNaC::pseries::series (
    const relational & r,
    int order,
    unsigned options = 0 ) const [override], [virtual]
```

Re-expansion of a pseries object.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex1](#), [convert_to_poly\(\)](#), [degree\(\)](#), [GINAC_ASSERT](#), [GiNaC::ex::is_equal\(\)](#), [options](#), [order](#), [point](#), [r](#), [seq](#), [GiNaC::ex::series\(\)](#), and [var](#).

6.138.3.11 subs()

```
ex GiNaC::pseries::subs (
    const exmap & m,
    unsigned options = 0 ) const [override], [virtual]
```

Substitute a set of objects by arbitrary expressions.

The ex returned will already be evaluated.

Reimplemented from [GiNaC::basic](#).

References [convert_to_poly\(\)](#), [m](#), [options](#), [point](#), [seq](#), [GiNaC::ex::subs\(\)](#), and [var](#).

6.138.3.12 normal()

```
ex GiNaC::pseries::normal (
    exmap & repl,
    exmap & rev_lookup,
    lst & modifier ) const [override], [virtual]
```

Implementation of [ex::normal\(\)](#) for pseries.

It normalizes each coefficient and replaces the series by a temporary symbol.

See also

[ex::normal](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex1](#), [GiNaC::ex::coeff\(\)](#), [GiNaC::ex::is_zero\(\)](#), [n](#), [GiNaC::ex::normal\(\)](#), [point](#), [GiNaC::replace_with_symbol\(\)](#), [seq](#), and [var](#).

6.138.3.13 expand()

```
ex GiNaC::pseries::expand (
    unsigned options = 0 ) const [override], [virtual]
```

Implementation of [ex::expand\(\)](#) for a power series.

It expands all the terms individually and returns the resulting series as a new pseries.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::ex::coeff\(\)](#), [GiNaC::ex::expand\(\)](#), [GiNaC::status_flags::expanded](#), [GiNaC::ex::is_zero\(\)](#), [options](#), [point](#), [seq](#), and [var](#).

6.138.3.14 conjugate()

```
ex GiNaC::pseries::conjugate ( ) const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::are_ex_trivially_equal\(\)](#), [GiNaC::ex::conjugate\(\)](#), [GiNaC::conjugateepvector\(\)](#), [GiNaC::ex::info\(\)](#), [point](#), [GiNaC::info_flags::real](#), [seq](#), and [var](#).

6.138.3.15 real_part()

```
ex GiNaC::pseries::real_part ( ) const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::ex::info\(\)](#), [point](#), [GiNaC::info_flags::real](#), [GiNaC::ex::real_part\(\)](#), [seq](#), and [var](#).

6.138.3.16 imag_part()

```
ex GiNaC::pseries::imag_part ( ) const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::ex::info\(\)](#), [point](#), [GiNaC::info_flags::real](#), [GiNaC::ex::real_part\(\)](#), [seq](#), and [var](#).

6.138.3.17 eval_integ()

```
ex GiNaC::pseries::eval_integ ( ) const [override], [virtual]
```

Evaluate integrals, if result is known.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::are_ex_trivially_equal\(\)](#), [GiNaC::ex::coeff\(\)](#), [GiNaC::ex::eval_integ\(\)](#), [point](#), [seq](#), and [var](#).

6.138.3.18 evalm()

```
ex GiNaC::pseries::evalm ( ) const [override], [virtual]
```

Evaluate sums, products and integer powers of matrices.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::are_ex_trivially_equal\(\)](#), [GiNaC::ex::coeff\(\)](#), [GiNaC::ex::evalm\(\)](#), [GiNaC::ex::is_zero\(\)](#), [point](#), [seq](#), and [var](#).

6.138.3.19 archive()

```
void GiNaC::pseries::archive (
    archive_node & n ) const [override], [virtual]
```

Save (a.k.a.

serialize) object into archive.

Reimplemented from [GiNaC::basic](#).

References [n](#), [point](#), [seq](#), and [var](#).

6.138.3.20 read_archive()

```
void GiNaC::pseries::read_archive (
    const archive_node & n,
    lst & syms ) [override], [virtual]
```

Read (a.k.a.

deserialize) object from archive.

Reimplemented from [GiNaC::basic](#).

References [coeff\(\)](#), [n](#), [point](#), [seq](#), and [var](#).

6.138.3.21 derivative()

```
ex GiNaC::pseries::derivative (
    const symbol & s ) const [override], [protected], [virtual]
```

Implementation of [ex::diff\(\)](#) for a power series.

See also

[ex::diff](#)

Reimplemented from [GiNaC::basic](#).

References [c](#), [GiNaC::is_order_function\(\)](#), [point](#), [seq](#), and [var](#).

6.138.3.22 get_var()

```
ex GiNaC::pseries::get_var ( ) const [inline]
```

Get the expansion variable.

References [var](#).

6.138.3.23 get_point()

```
ex GiNaC::pseries::get_point ( ) const [inline]
```

Get the expansion point.

References [point](#).

6.138.3.24 convert_to_poly()

```
ex GiNaC::pseries::convert_to_poly (
    bool no_order = false ) const
```

Convert the pseries object to an ordinary polynomial.

Parameters

<i>no_order</i>	flag: discard higher order terms
-----------------	----------------------------------

References [GiNaC::ex::coeff\(\)](#), [GiNaC::is_order_function\(\)](#), [point](#), [GiNaC::pow\(\)](#), [seq](#), and [var](#).

Referenced by [coeff\(\)](#), [series\(\)](#), and [subs\(\)](#).

6.138.3.25 is_compatible_to()

```
bool GiNaC::pseries::is_compatible_to (
    const pseries & other ) const [inline]
```

Check whether series is compatible to another series (expansion variable and point are the same).

References [GiNaC::ex::is_equal\(\)](#), [point](#), and [var](#).

Referenced by [add_series\(\)](#), and [mul_series\(\)](#).

6.138.3.26 `is_zero()`

```
bool GiNaC::pseries::is_zero ( ) const [inline]
```

Check whether series has the value zero.

References [seq](#).

Referenced by [power_const\(\)](#).

6.138.3.27 `is_terminating()`

```
bool GiNaC::pseries::is_terminating ( ) const
```

Returns true if there is no order term, i.e.

the series terminates and false otherwise.

References [GiNaC::is_order_function\(\)](#), and [seq](#).

Referenced by [GiNaC::is_terminating\(\)](#), and [GiNaC::log_series\(\)](#).

6.138.3.28 `coeffop()`

```
ex GiNaC::pseries::coeffop (
    size_t i ) const
```

Get coefficients and exponents.

References [nops\(\)](#), and [seq](#).

6.138.3.29 `exponop()`

```
ex GiNaC::pseries::exponop (
    size_t i ) const
```

References [nops\(\)](#), and [seq](#).

6.138.3.30 `add_series()`

```
ex GiNaC::pseries::add_series (
    const pseries & other ) const
```

Add one series object to another, producing a pseries object that represents the sum.

Parameters

<i>other</i>	pseries object to add with
--------------	----------------------------

Returns

the sum as a pseries

References [GiNaC::_ex0](#), [GiNaC::_ex1](#), [is_compatible_to\(\)](#), [GiNaC::is_order_function\(\)](#), [GiNaC::ex::is_zero\(\)](#), [point](#), [seq](#), and [var](#).

Referenced by [GiNaC::log_series\(\)](#).

6.138.3.31 mul_const()

```
ex GiNaC::pseries::mul_const (
    const numeric & other ) const
```

Multiply a pseries object with a numeric constant, producing a pseries object that represents the product.

Parameters

<i>other</i>	constant to multiply with
--------------	---------------------------

Returns

the product as a pseries

References [GiNaC::numeric::coeff\(\)](#), [GiNaC::is_order_function\(\)](#), [point](#), [seq](#), and [var](#).

Referenced by [GiNaC::mul::series\(\)](#).

6.138.3.32 mul_series()

```
ex GiNaC::pseries::mul_series (
    const pseries & other ) const
```

Multiply one pseries object to another, producing a pseries object that represents the product.

Parameters

<i>other</i>	pseries object to multiply with
--------------	---------------------------------

Returns

the product as a pseries

References [GiNaC::_ex0](#), [GiNaC::_ex1](#), [coeff\(\)](#), [degree\(\)](#), [GiNaC::ex::find\(\)](#), [is_compatible_to\(\)](#), [GiNaC::ex::is_equal\(\)](#), [GiNaC::is_order_function\(\)](#), [GiNaC::ex::is_zero\(\)](#), [ldegree\(\)](#), [point](#), [seq](#), and [var](#).

Referenced by [GiNaC::mul::series\(\)](#).

6.138.3.33 power_const()

```
ex GiNaC::pseries::power_const (
    const numeric & p,
    int deg ) const
```

Compute the p-th power of a series.

Parameters

<i>p</i>	power to compute
<i>deg</i>	truncation order of series calculation

References [GiNaC::_ex0](#), [GiNaC::_ex1](#), [c](#), [coeff\(\)](#), [degree\(\)](#), [GiNaC::is_integer\(\)](#), [GiNaC::numeric::is_negative\(\)](#), [GiNaC::is_order_function\(\)](#), [GiNaC::numeric::is_pos_integer\(\)](#), [GiNaC::numeric::is_zero\(\)](#), [is_zero\(\)](#), [ldegree\(\)](#), [point](#), [GiNaC::pow\(\)](#), [GiNaC::numeric::real\(\)](#), [seq](#), [GiNaC::to_int\(\)](#), and [var](#).

6.138.3.34 shift_exponents()

```
pseries GiNaC::pseries::shift_exponents (
    int deg ) const
```

Return a new pseries object with the powers shifted by deg.

References [point](#), [seq](#), and [var](#).

6.138.3.35 print_series()

```
void GiNaC::pseries::print_series (
    const print_context & c,
    const char * openbrace,
    const char * closebrace,
    const char * mul_sym,
    const char * pow_sym,
    unsigned level ) const [protected]
```

References [GiNaC::_ex1](#), [c](#), [GiNaC::ex::coeff\(\)](#), [GiNaC::is_order_function\(\)](#), [GiNaC::ex::is_zero\(\)](#), [GiNaC::info_flags::negative](#), [GiNaC::info_flags::numeric](#), [point](#), [GiNaC::info_flags::positive](#), [GiNaC::pow\(\)](#), [precedence\(\)](#), [GiNaC::basic::print\(\)](#), [GiNaC::ex::print\(\)](#), [seq](#), and [var](#).

Referenced by [do_print\(\)](#), [do_print_latex\(\)](#), and [do_print_python\(\)](#).

6.138.3.36 do_print()

```
void GiNaC::pseries::do_print (
    const print\_context & c,
    unsigned level ) const [protected]
```

References [c](#), and [print_series\(\)](#).

6.138.3.37 do_print_latex()

```
void GiNaC::pseries::do_print_latex (
    const print\_latex & c,
    unsigned level ) const [protected]
```

References [c](#), and [print_series\(\)](#).

6.138.3.38 do_print_tree()

```
void GiNaC::pseries::do_print_tree (
    const print\_tree & c,
    unsigned level ) const [protected]
```

References [c](#), [GiNaC::basic::flags](#), [GiNaC::basic::hashvalue](#), [point](#), [GiNaC::ex::print\(\)](#), [seq](#), and [var](#).

6.138.3.39 do_print_python()

```
void GiNaC::pseries::do_print_python (
    const print\_python & c,
    unsigned level ) const [protected]
```

References [c](#), and [print_series\(\)](#).

6.138.3.40 do_print_python_repr()

```
void GiNaC::pseries::do_print_python_repr (
    const print\_python\_repr & c,
    unsigned level ) const [protected]
```

References [c](#), [point](#), [GiNaC::ex::print\(\)](#), [seq](#), and [var](#).

6.138.4 Member Data Documentation

6.138.4.1 seq

`epvector` `GiNaC::pseries::seq` [protected]

Vector of {coefficient, power} pairs.

Referenced by [add_series\(\)](#), [archive\(\)](#), [coeff\(\)](#), [coeffop\(\)](#), [conjugate\(\)](#), [convert_to_poly\(\)](#), [degree\(\)](#), [derivative\(\)](#), [do_print_python_repr\(\)](#), [do_print_tree\(\)](#), [eval_integ\(\)](#), [evalf\(\)](#), [evalm\(\)](#), [expand\(\)](#), [exponop\(\)](#), [imag_part\(\)](#), [is_terminating\(\)](#), [is_zero\(\)](#), [ldegree\(\)](#), [mul_const\(\)](#), [mul_series\(\)](#), [nops\(\)](#), [normal\(\)](#), [op\(\)](#), [power_const\(\)](#), [print_series\(\)](#), [pseries\(\)](#), [read_archive\(\)](#), [real_part\(\)](#), [series\(\)](#), [shift_exponents\(\)](#), and [subs\(\)](#).

6.138.4.2 var

`ex` `GiNaC::pseries::var` [protected]

Series variable (holds a symbol)

Referenced by [add_series\(\)](#), [archive\(\)](#), [coeff\(\)](#), [conjugate\(\)](#), [convert_to_poly\(\)](#), [degree\(\)](#), [derivative\(\)](#), [do_print_python_repr\(\)](#), [do_print_tree\(\)](#), [eval_integ\(\)](#), [evalf\(\)](#), [evalm\(\)](#), [expand\(\)](#), [get_var\(\)](#), [imag_part\(\)](#), [is_compatible_to\(\)](#), [ldegree\(\)](#), [mul_const\(\)](#), [mul_series\(\)](#), [normal\(\)](#), [op\(\)](#), [power_const\(\)](#), [print_series\(\)](#), [pseries\(\)](#), [read_archive\(\)](#), [real_part\(\)](#), [series\(\)](#), [shift_exponents\(\)](#), and [subs\(\)](#).

6.138.4.3 point

`ex` `GiNaC::pseries::point` [protected]

Expansion point.

Referenced by [add_series\(\)](#), [archive\(\)](#), [conjugate\(\)](#), [convert_to_poly\(\)](#), [derivative\(\)](#), [do_print_python_repr\(\)](#), [do_print_tree\(\)](#), [eval_integ\(\)](#), [evalf\(\)](#), [evalm\(\)](#), [expand\(\)](#), [get_point\(\)](#), [imag_part\(\)](#), [is_compatible_to\(\)](#), [mul_const\(\)](#), [mul_series\(\)](#), [normal\(\)](#), [op\(\)](#), [power_const\(\)](#), [print_series\(\)](#), [pseries\(\)](#), [read_archive\(\)](#), [real_part\(\)](#), [series\(\)](#), [shift_exponents\(\)](#), and [subs\(\)](#).

The documentation for this class was generated from the following files:

- [pseries.h](#)
- [normal.cpp](#)
- [pseries.cpp](#)

6.139 GiNaC::psi1_SERIAL Class Reference

Polylogarithm and multiple polylogarithm.

```
#include <inifcns.h>
```


Static Public Attributes

- static unsigned [serial](#)

6.139.1 Detailed Description

Polylogarithm and multiple polylogarithm.

Nielsen's generalized polylogarithm. Harmonic polylogarithm. Gamma-function. Beta-function. Psi-function (aka digamma-function).

6.139.2 Member Data Documentation

6.139.2.1 serial

```
unsigned GiNaC::psi1_SERIAL::serial [static]
```

Initial value:

```
=
    function::register_new(function_options("psi", 1).
        eval_func(psi1_eval).
        evalf_func(psi1_evalf).
        derivative_func(psi1_deriv).
        series_func(psi1_series).
        latex_name("\\psi").
        overloaded(2))
```

Referenced by [GiNaC::psi\(\)](#).

The documentation for this class was generated from the following files:

- [inifcns.h](#)
- [inifcns_gamma.cpp](#)

6.140 GiNaC::psi2_SERIAL Class Reference

Derivatives of Psi-function (aka polygamma-functions).

```
#include <inifcns.h>
```

Static Public Attributes

- static unsigned [serial](#)

6.140.1 Detailed Description

Derivatives of Psi-function (aka polygamma-functions).

6.140.2 Member Data Documentation

6.140.2.1 serial

unsigned GiNaC::psi2_SERIAL::serial [static]

Initial value:

```
=
function::register_new(function_options("psi", 2).
    eval_func(psi2_eval).
    evalf_func(psi2_evalf).
    derivative_func(psi2_deriv).
    series_func(psi2_series).
    latex_name("\\psi").
    overloaded(2))
```

Referenced by [GiNaC::psi\(\)](#).

The documentation for this class was generated from the following files:

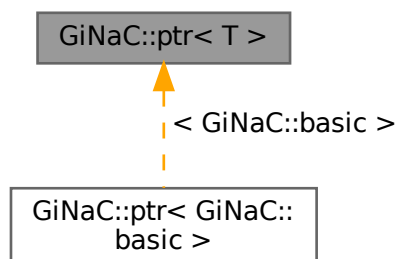
- [inifcns.h](#)
- [inifcns_gamma.cpp](#)

6.141 GiNaC::ptr< T > Class Template Reference

Class of (intrusively) reference-counted pointers that support copy-on-write semantics.

```
#include <ptr.h>
```

Inheritance diagram for GiNaC::ptr< T >:



Public Member Functions

- `ptr (T *t)` noexcept
Bind ptr to newly created object, start reference counting.
- `ptr (T &t)` noexcept
Bind ptr to existing reference-counted object.
- `ptr (const ptr &other)` noexcept
- `~ptr ()`
- `ptr & operator= (const ptr &other)`
- `T & operator* ()` const noexcept
- `T * operator-> ()` const noexcept
- `void makewritable ()`
Announce your intention to modify the object bound to this ptr.
- `void swap (ptr &other)` noexcept
Swap the bound object of this ptr with another ptr.
- `template<class U >`
`bool operator== (const ptr< U > &rhs)` const noexcept
- `template<class U >`
`bool operator!= (const ptr< U > &rhs)` const noexcept

Private Attributes

- `T * p`

Friends

- `struct std::less< ptr< T > >`
- `T * get_pointer (const ptr &x)` noexcept
- `template<class U >`
`bool operator== (const ptr &lhs, const U *rhs)` noexcept
- `template<class U >`
`bool operator!= (const ptr &lhs, const U *rhs)` noexcept
- `template<class U >`
`bool operator== (const U *lhs, const ptr &rhs)` noexcept
- `template<class U >`
`bool operator!= (const U *lhs, const ptr &rhs)` noexcept
- `std::ostream & operator<< (std::ostream &os, const ptr< T > &rhs)`

6.141.1 Detailed Description

```
template<class T>
class GiNaC::ptr< T >
```

Class of (intrusively) reference-counted pointers that support copy-on-write semantics.

Requirements for T: must support the refcounted interface (usually by being derived from refcounted) T* T↔::duplicate() member function (only if makewritable() is used)

6.141.2 Constructor & Destructor Documentation

6.141.2.1 ptr() [1/3]

```
template<class T >
GiNaC::ptr< T >::ptr (
    T * t ) [inline], [noexcept]
```

Bind ptr to newly created object, start reference counting.

References [GINAC_ASSERT](#), and [GiNaC::ptr< T >::p](#).

6.141.2.2 ptr() [2/3]

```
template<class T >
GiNaC::ptr< T >::ptr (
    T & t ) [inline], [explicit], [noexcept]
```

Bind ptr to existing reference-counted object.

References [GiNaC::ptr< T >::p](#).

6.141.2.3 ptr() [3/3]

```
template<class T >
GiNaC::ptr< T >::ptr (
    const ptr< T > & other ) [inline], [noexcept]
```

References [GiNaC::ptr< T >::p](#).

6.141.2.4 ~ptr()

```
template<class T >
GiNaC::ptr< T >::~~ptr ( ) [inline]
```

References [GiNaC::ptr< T >::p](#).

6.141.3 Member Function Documentation

6.141.3.1 operator=()

```
template<class T >
ptr & GiNaC::ptr< T >::operator= (
    const ptr< T > & other ) [inline]
```

References [GiNaC::ptr< T >::p](#).

6.141.3.2 operator*()

```
template<class T >
T & GiNaC::ptr< T >::operator* ( ) const [inline], [noexcept]
```

References [GiNaC::ptr< T >::p](#).

6.141.3.3 operator->()

```
template<class T >
T * GiNaC::ptr< T >::operator-> ( ) const [inline], [noexcept]
```

References [GiNaC::ptr< T >::p](#).

6.141.3.4 makewritable()

```
template<class T >
void GiNaC::ptr< T >::makewritable ( ) [inline]
```

Announce your intention to modify the object bound to this ptr.

This ensures that the object is not shared by any other ptrs.

References [GiNaC::ptr< T >::p](#).

6.141.3.5 swap()

```
template<class T >
void GiNaC::ptr< T >::swap (
    ptr< T > & other ) [inline], [noexcept]
```

Swap the bound object of this ptr with another ptr.

References [GiNaC::ptr< T >::p](#).

6.141.3.6 operator==()

```
template<class T >
template<class U >
bool GiNaC::ptr< T >::operator== (
    const ptr< U > & rhs ) const [inline], [noexcept]
```

References [GiNaC::ptr< T >::get_pointer](#), [GiNaC::ptr< T >::p](#), and [GiNaC::rhs\(\)](#).

6.141.3.7 operator!=()

```
template<class T >
template<class U >
bool GiNaC::ptr< T >::operator!= (
    const ptr< U > & rhs ) const [inline], [noexcept]
```

References [GiNaC::ptr< T >::get_pointer](#), [GiNaC::ptr< T >::p](#), and [GiNaC::rhs\(\)](#).

6.141.4 Friends And Related Function Documentation**6.141.4.1 std::less< ptr< T > >**

```
template<class T >
friend struct std::less< ptr< T > > [friend]
```

6.141.4.2 get_pointer

```
template<class T >
T * get_pointer (
    const ptr< T > & x ) [friend]
```

Referenced by [GiNaC::ptr< T >::operator!=\(\)](#), and [GiNaC::ptr< T >::operator==\(\)](#).

6.141.4.3 operator== [1/2]

```
template<class T >
template<class U >
bool operator== (
    const ptr< T > & lhs,
    const U * rhs ) [friend]
```

6.141.4.4 operator"!= [1/2]

```
template<class T >
template<class U >
bool operator!= (
    const ptr< T > & lhs,
    const U * rhs ) [friend]
```

6.141.4.5 operator== [2/2]

```
template<class T >
template<class U >
bool operator== (
    const U * lhs,
    const ptr< T > & rhs ) [friend]
```

6.141.4.6 operator"!= [2/2]

```
template<class T >
template<class U >
bool operator!= (
    const U * lhs,
    const ptr< T > & rhs ) [friend]
```

6.141.4.7 operator<<

```
template<class T >
std::ostream & operator<< (
    std::ostream & os,
    const ptr< T > & rhs ) [friend]
```

6.141.5 Member Data Documentation**6.141.5.1 p**

```
template<class T >
T* GiNaC::ptr< T >::p [private]
```

Referenced by [GiNaC::ptr< T >::makewritable\(\)](#), [GiNaC::ptr< T >::operator!=\(\)](#), [GiNaC::ptr< T >::operator*\(\)](#), [GiNaC::ptr< T >::operator->\(\)](#), [GiNaC::ptr< T >::operator=\(\)](#), [GiNaC::ptr< T >::operator==\(\)](#), [GiNaC::ptr< T >::ptr\(\)](#), [GiNaC::ptr< T >::swap\(\)](#), and [GiNaC::ptr< T >::~~ptr\(\)](#).

The documentation for this class was generated from the following file:

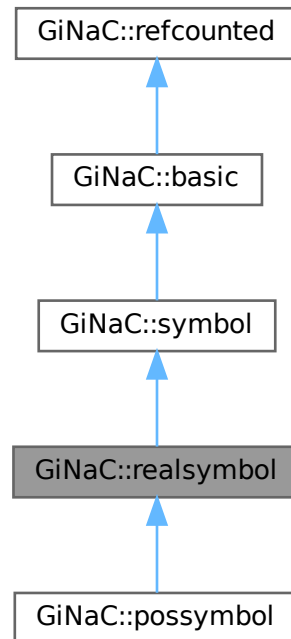
- [ptr.h](#)

6.142 GiNaC::realsymbol Class Reference

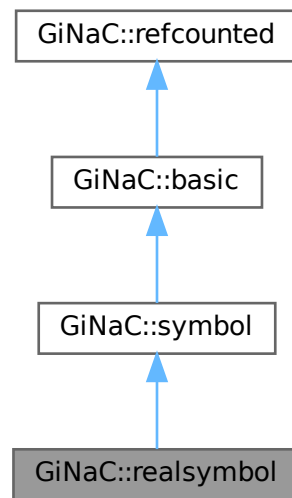
Specialization of symbol to real domain.

```
#include <symbol.h>
```

Inheritance diagram for GiNaC::realsymbol:



Collaboration diagram for GiNaC::realsymbol:



Public Member Functions

- [realsymbol](#) ()
- [realsymbol](#) (const std::string &initname)
- [realsymbol](#) (const std::string &initname, const std::string &texname)
- unsigned [get_domain](#) () const override
- [ex conjugate](#) () const override
- [ex real_part](#) () const override
- [ex imag_part](#) () const override
- [realsymbol](#) * [duplicate](#) () const override

Create a clone of this object on the heap.

Public Member Functions inherited from [GiNaC::symbol](#)

- [symbol](#) (const std::string &initname)
- [symbol](#) (const std::string &initname, const std::string &texname)
- bool [info](#) (unsigned inf) const override
Information about the object.
- [ex eval](#) () const override
Perform automatic non-interruptive term rewriting rules.
- [ex evalf](#) () const override
Evaluate object numerically.
- [ex series](#) (const [relational](#) &s, int [order](#), unsigned [options](#)=0) const override
Implementation of [ex::series\(\)](#) for symbols.
- [ex subs](#) (const [exmap](#) &m, unsigned [options](#)=0) const override
Substitute a set of objects by arbitrary expressions.
- [ex normal](#) ([exmap](#) &repl, [exmap](#) &rev_lookup, [lst](#) &modifier) const override

- *Implementation of `ex::normal()` for symbols.*
- `ex to_rational` (`exmap` &`repl`) const override
- *Implementation of `ex::to_rational()` for symbols.*
- `ex to_polynomial` (`exmap` &`repl`) const override
- *Implementation of `ex::to_polynomial()` for symbols.*
- `ex conjugate` () const override
- `ex real_part` () const override
- `ex imag_part` () const override
- `bool is_polynomial` (const `ex` &`var`) const override
- *Check whether this is a polynomial in the given variables.*
- `void archive` (`archive_node` &`n`) const override
- *Save (a.k.a.*
- `void read_archive` (const `archive_node` &`n`, `lst` &`syms`) override
- *Read (a.k.a.*
- virtual unsigned `get_domain` () const
- `void set_name` (const std::string &`n`)
- `void set_TeX_name` (const std::string &`n`)
- std::string `get_name` () const
- std::string `get_TeX_name` () const

Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()
- *basic destructor, virtual because class `ex` will delete objects of derived classes via a `basic*`.*
- `basic` (const `basic` &`other`)
- `const basic & operator=` (const `basic` &`other`)
- *basic assignment operator: the other object might be of a derived class.*
- virtual `basic * duplicate` () const
- *Create a clone of this object on the heap.*
- virtual `ex eval` () const
- *Perform automatic non-interruptive term rewriting rules.*
- virtual `ex evalf` () const
- *Evaluate object numerically.*
- virtual `ex evalm` () const
- *Evaluate sums, products and integer powers of matrices.*
- virtual `ex eval_integ` () const
- *Evaluate integrals, if result is known.*
- virtual `ex eval_indexed` (const `basic` &`i`) const
- *Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual void `print` (const `print_context` &`c`, unsigned level=0) const
- *Output to stream.*
- virtual void `dbgprint` () const
- *Little wrapper around `print` to be called within a debugger.*
- virtual void `dbgprinttree` () const
- *Little wrapper around `printtree` to be called within a debugger.*
- virtual unsigned `precedence` () const
- *Return relative operator precedence (for parenthezing output).*
- virtual bool `info` (unsigned inf) const
- *Information about the object.*
- virtual size_t `nops` () const
- *Number of operands/members.*

- virtual `ex op` (`size_t i`) const
Return operand/member at position i.
- virtual `ex operator[]` (const `ex &index`) const
- virtual `ex operator[]` (`size_t i`) const
- virtual `ex & let_op` (`size_t i`)
Return modifiable operand/member at position i.
- virtual `ex & operator[]` (const `ex &index`)
- virtual `ex & operator[]` (`size_t i`)
- virtual bool `has` (const `ex &other`, unsigned `options=0`) const
Test for occurrence of a pattern.
- virtual bool `match` (const `ex &pattern`, `exmap &repls`) const
Check whether the expression matches a given pattern.
- virtual `ex subs` (const `exmap &m`, unsigned `options=0`) const
Substitute a set of objects by arbitrary expressions.
- virtual `ex map` (`map_function &f`) const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void `accept` (`GiNaC::visitor &v`) const
- virtual bool `is_polynomial` (const `ex &var`) const
Check whether this is a polynomial in the given variables.
- virtual int `degree` (const `ex &s`) const
Return degree of highest power in object s.
- virtual int `ldegree` (const `ex &s`) const
Return degree of lowest power in object s.
- virtual `ex coeff` (const `ex &s`, int `n=1`) const
Return coefficient of degree n in object s.
- virtual `ex expand` (unsigned `options=0`) const
Expand expression, i.e.
- virtual `ex collect` (const `ex &s`, bool `distributed=false`) const
Sort expanded expression in terms of powers of some object(s).
- virtual `ex series` (const `relational &r`, int `order`, unsigned `options=0`) const
Default implementation of `ex::series()`.
- virtual `ex normal` (`exmap &repl`, `exmap &rev_lookup`, `lst &modifier`) const
Default implementation of `ex::normal()`.
- virtual `ex to_rational` (`exmap &repl`) const
Default implementation of `ex::to_rational()`.
- virtual `ex to_polynomial` (`exmap &repl`) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric &xi`) const
Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- virtual `numeric max_coefficient` () const
Implementation `ex::max_coefficient()`.
- virtual `exvector get_free_indices` () const
Return a vector containing the free indices of an expression.
- virtual `ex add_indexed` (const `ex &self`, const `ex &other`) const
Add two indexed expressions.
- virtual `ex scalar_mul_indexed` (const `ex &self`, const `numeric &other`) const
Multiply an indexed expression with a scalar.
- virtual bool `contract_with` (`exvector::iterator self`, `exvector::iterator other`, `exvector &v`) const
Try to contract two indexed expressions that appear in the same product.
- virtual unsigned `return_type` () const
- virtual `return_type_t return_type_tinfo` () const

- virtual `ex conjugate ()` const
- virtual `ex real_part ()` const
- virtual `ex imag_part ()` const
- template<class T >
void `print_dispatch` (const `print_context` &c, unsigned level) const
Like `print()`, but dispatch to the specified class.
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const
Like `print()`, but dispatch to the specified class.
- virtual void `archive` (`archive_node` &n) const
Save (serialize) the object into archive node.
- virtual void `read_archive` (const `archive_node` &n, `lst` &syms)
Load (deserialize) the object from an archive node.
- `ex subs_one_level` (const `exmap` &m, unsigned `options`) const
Helper function for `subs()`.
- `ex diff` (const `symbol` &s, unsigned nth=1) const
Default interface of nth derivative `ex::diff(s, n)`.
- int `compare` (const `basic` &other) const
Compare objects syntactically to establish canonical ordering.
- bool `is_equal` (const `basic` &other) const
Test for syntactic equality.
- const `basic` & `hold` () const
Stop further evaluation.
- unsigned `gethash` () const
- const `basic` & `setflag` (unsigned f) const
Set some `status_flags`.
- const `basic` & `clearflag` (unsigned f) const
Clear some `status_flags`.

Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- unsigned int `add_reference` () noexcept
- unsigned int `remove_reference` () noexcept
- unsigned int `get_refcount` () const noexcept
- void `set_refcount` (unsigned int r) noexcept

Additional Inherited Members

Protected Member Functions inherited from `GiNaC::symbol`

- `ex derivative` (const `symbol` &s) const override
Implementation of `ex::diff()` for single differentiation of a symbol.
- bool `is_equal_same_type` (const `basic` &other) const override
Returns true if two objects of same type are equal.
- unsigned `calchash` () const override
Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.
- void `do_print` (const `print_context` &c, unsigned level) const
- void `do_print_latex` (const `print_latex` &c, unsigned level) const
- void `do_print_tree` (const `print_tree` &c, unsigned level) const
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const

Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match_same_type](#) (const [basic](#) &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual [ex derivative](#) (const [symbol](#) &s) const
Default implementation of [ex::diff\(\)](#).
- virtual int [compare_same_type](#) (const [basic](#) &other) const
Returns order relation between two objects of same type.
- virtual bool [is_equal_same_type](#) (const [basic](#) &other) const
Returns true if two objects of same type are equal.
- virtual unsigned [calchash](#) () const
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- void [ensure_if_modifiable](#) () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
Default output to stream.
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
Tree output to stream.
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
Python parsable output to stream.

Protected Attributes inherited from [GiNaC::symbol](#)

- unsigned [serial](#)
unique serial number for comparison
- std::string [name](#)
printname of this symbol
- std::string [TeX_name](#)
LaTeX name of this symbol.

Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)
of type [status_flags](#)
- unsigned [hashvalue](#)
hash value

6.142.1 Detailed Description

Specialization of symbol to real domain.

6.142.2 Constructor & Destructor Documentation

6.142.2.1 `realsymbol()` [1/3]

```
GiNaC::realsymbol::realsymbol ( )
```

Referenced by [duplicate\(\)](#).

6.142.2.2 `realsymbol()` [2/3]

```
GiNaC::realsymbol::realsymbol (
    const std::string & initname ) [explicit]
```

6.142.2.3 `realsymbol()` [3/3]

```
GiNaC::realsymbol::realsymbol (
    const std::string & initname,
    const std::string & texname )
```

6.142.3 Member Function Documentation

6.142.3.1 `get_domain()`

```
unsigned GiNaC::realsymbol::get_domain ( ) const [inline], [override], [virtual]
```

Reimplemented from [GiNaC::symbol](#).

Reimplemented in [GiNaC::possymbol](#).

References [GiNaC::domain::real](#).

6.142.3.2 `conjugate()`

```
ex GiNaC::realsymbol::conjugate ( ) const [inline], [override], [virtual]
```

Reimplemented from [GiNaC::symbol](#).

6.142.3.3 real_part()

```
ex GiNaC::realsymbol::real_part ( ) const [inline], [override], [virtual]
```

Reimplemented from [GiNaC::symbol](#).

6.142.3.4 imag_part()

```
ex GiNaC::realsymbol::imag_part ( ) const [inline], [override], [virtual]
```

Reimplemented from [GiNaC::symbol](#).

6.142.3.5 duplicate()

```
realsymbol * GiNaC::realsymbol::duplicate ( ) const [inline], [override], [virtual]
```

Create a clone of this object on the heap.

One can think of this as simulating a virtual copy constructor which is needed for instance by the refcounted construction of an ex from a basic.

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::possymbol](#).

References [GiNaC::status_flags::dynallocated](#), [realsymbol\(\)](#), and [GiNaC::basic::setflag\(\)](#).

The documentation for this class was generated from the following files:

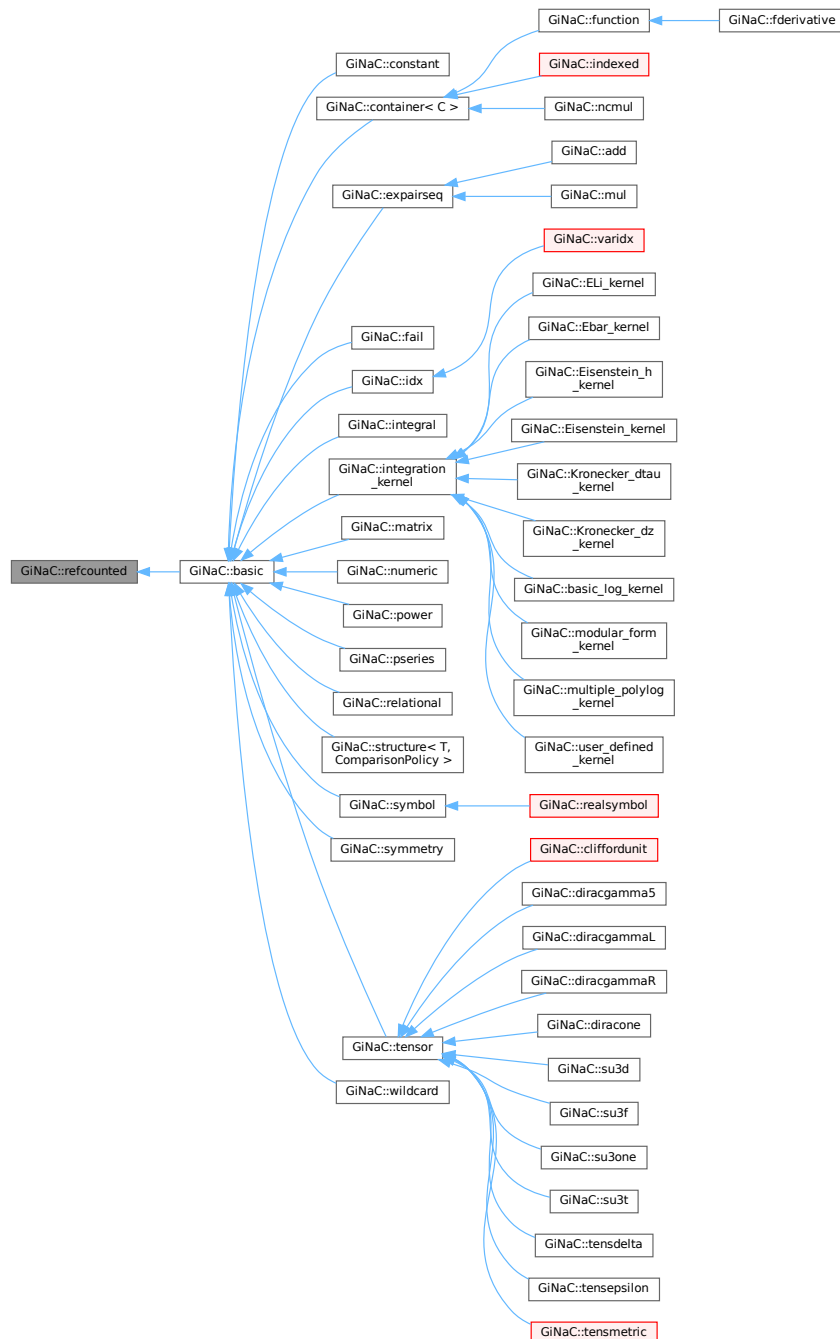
- [symbol.h](#)
- [symbol.cpp](#)

6.143 GiNaC::refcounted Class Reference

Base class for reference-counted objects.

```
#include <ptr.h>
```

Inheritance diagram for GiNaC::refcounted:



Public Member Functions

- [refcounted](#) () noexcept

- unsigned int [add_reference](#) () noexcept
- unsigned int [remove_reference](#) () noexcept
- unsigned int [get_refcount](#) () const noexcept
- void [set_refcount](#) (unsigned int r) noexcept

Private Attributes

- unsigned int [refcount](#)
reference counter

6.143.1 Detailed Description

Base class for reference-counted objects.

6.143.2 Constructor & Destructor Documentation

6.143.2.1 refcounted()

```
GiNaC::refcounted::refcounted ( ) [inline], [noexcept]
```

6.143.3 Member Function Documentation

6.143.3.1 add_reference()

```
unsigned int GiNaC::refcounted::add_reference ( ) [inline], [noexcept]
```

References [refcount](#).

6.143.3.2 remove_reference()

```
unsigned int GiNaC::refcounted::remove_reference ( ) [inline], [noexcept]
```

References [refcount](#).

6.143.3.3 `get_refcount()`

```
unsigned int GiNaC::refcounted::get_refcount ( ) const [inline], [noexcept]
```

References [refcount](#).

Referenced by [GiNaC::ex::construct_from_basic\(\)](#), and [GiNaC::basic::~~basic\(\)](#).

6.143.3.4 `set_refcount()`

```
void GiNaC::refcounted::set_refcount (
    unsigned int r ) [inline], [noexcept]
```

References [r](#), and [refcount](#).

6.143.4 Member Data Documentation

6.143.4.1 `refcount`

```
unsigned int GiNaC::refcounted::refcount [private]
```

reference counter

Referenced by [add_reference\(\)](#), [get_refcount\(\)](#), [remove_reference\(\)](#), and [set_refcount\(\)](#).

The documentation for this class was generated from the following file:

- [ptr.h](#)

6.144 `GiNaC::registered_class_options` Class Reference

This class stores information about a registered [GiNaC](#) class.

```
#include <registrar.h>
```

Public Member Functions

- [registered_class_options](#) (const char *n, const char *p, const std::type_info &ti)
- const char * [get_name](#) () const
- const char * [get_parent_name](#) () const
- std::type_info const * [get_id](#) () const
- const std::vector< [print_func](#) > & [get_print_dispatch_table](#) () const
- template<class Ctx, class T, class C >
[registered_class_options](#) & [print_func](#) (void f(const T &, const C &c, unsigned))
- template<class Ctx, class T, class C >
[registered_class_options](#) & [print_func](#) (void(T::*f)(const C &, unsigned))
- template<class Ctx >
[registered_class_options](#) & [print_func](#) (const [print_func](#) &f)
- void [set_print_func](#) (unsigned id, const [print_func](#) &f)

Private Attributes

- const char * [name](#)
Class name.
- const char * [parent_name](#)
Name of superclass.
- std::type_info const * [tinfo_key](#)
Type information key.
- std::vector< [print_functor](#) > [print_dispatch_table](#)
Method table for print() dispatch.

6.144.1 Detailed Description

This class stores information about a registered [GiNaC](#) class.

6.144.2 Constructor & Destructor Documentation

6.144.2.1 registered_class_options()

```
GiNaC::registered_class_options::registered_class_options (
    const char * n,
    const char * p,
    const std::type_info & ti ) [inline]
```

6.144.3 Member Function Documentation

6.144.3.1 get_name()

```
const char * GiNaC::registered_class_options::get_name ( ) const [inline]
```

References [name](#).

6.144.3.2 get_parent_name()

```
const char * GiNaC::registered_class_options::get_parent_name ( ) const [inline]
```

References [parent_name](#).

6.144.3.3 `get_id()`

```
std::type_info const * GiNaC::registered_class_options::get_id ( ) const [inline]
```

References [tinfo_key](#).

6.144.3.4 `get_print_dispatch_table()`

```
const std::vector< print\_func > & GiNaC::registered_class_options::get_print_dispatch_table  
( ) const [inline]
```

References [print_dispatch_table](#).

6.144.3.5 `print_func()` [1/3]

```
template<class Ctx , class T , class C >  
registered\_class\_options & GiNaC::registered_class_options::print_func (   
    void fconst T &, const C &c, unsigned ) [inline]
```

References [options](#), and [set_print_func\(\)](#).

6.144.3.6 `print_func()` [2/3]

```
template<class Ctx , class T , class C >  
registered\_class\_options & GiNaC::registered_class_options::print_func (   
    void(T::*)(const C &, unsigned) f ) [inline]
```

References [options](#), and [set_print_func\(\)](#).

6.144.3.7 `print_func()` [3/3]

```
template<class Ctx >  
registered\_class\_options & GiNaC::registered_class_options::print_func (   
    const print\_func & f ) [inline]
```

References [options](#), and [set_print_func\(\)](#).

6.144.3.8 set_print_func()

```
void GiNaC::registered_class_options::set_print_func (
    unsigned id,
    const print\_functor & f ) [inline]
```

References [print_dispatch_table](#).

Referenced by [print_func\(\)](#).

6.144.4 Member Data Documentation

6.144.4.1 name

```
const char* GiNaC::registered_class_options::name [private]
```

Class name.

Referenced by [get_name\(\)](#).

6.144.4.2 parent_name

```
const char* GiNaC::registered_class_options::parent_name [private]
```

Name of superclass.

Referenced by [get_parent_name\(\)](#).

6.144.4.3 tinfo_key

```
std::type_info const* GiNaC::registered_class_options::tinfo_key [private]
```

Type information key.

Referenced by [get_id\(\)](#).

6.144.4.4 print_dispatch_table

```
std::vector<print_functor> GiNaC::registered_class_options::print_dispatch_table [private]
```

Method table for print() dispatch.

Referenced by [get_print_dispatch_table\(\)](#), and [set_print_func\(\)](#).

The documentation for this class was generated from the following file:

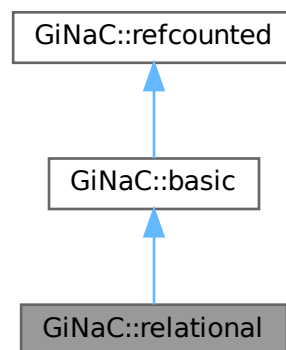
- [registrar.h](#)

6.145 GiNaC::relational Class Reference

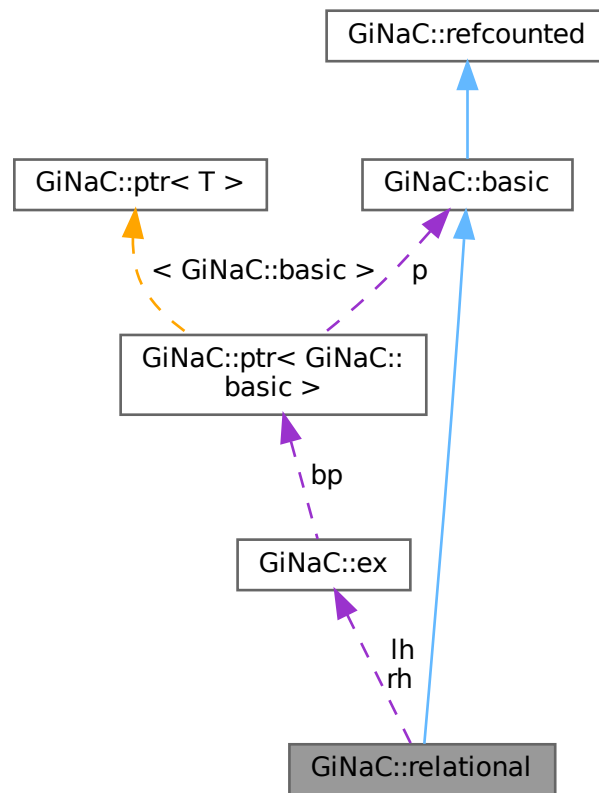
This class holds a relation consisting of two expressions and a logical relation between them.

```
#include <relational.h>
```

Inheritance diagram for GiNaC::relational:



Collaboration diagram for GiNaC::relational:



Classes

- struct [safe_bool_helper](#)

Public Types

- enum [operators](#) {
[equal](#) , [not_equal](#) , [less](#) , [less_or_equal](#) ,
[greater](#) , [greater_or_equal](#) }

Public Member Functions

- [relational](#) (const [ex](#) &lhs, const [ex](#) &rhs, [operators](#) oper=[equal](#))
- unsigned [precedence](#) () const override
Return relative operator precedence (for parenthezing output).
- bool [info](#) (unsigned inf) const override
Information about the object.
- size_t [nops](#) () const override

- *Number of operands/members.*
- `ex op` (`size_t i`) `const` override
Return operand/member at position i.
- `ex map` (`map_function &f`) `const` override
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- `ex subs` (`const exmap &m`, unsigned `options=0`) `const` override
Substitute a set of objects by arbitrary expressions.
- `void archive` (`archive_node &n`) `const` override
Save (a.k.a.
- `void read_archive` (`const archive_node &n`, `lst &symbols`) override
Read (a.k.a.
- `ex canonical` () `const`
Returns an equivalent relational with zero right-hand side.
- `ex lhs` () `const`
- `ex rhs` () `const`
- `operator safe_bool` () `const`
Cast the relational into a Boolean, mainly for evaluation within an if-statement.
- `safe_bool operator!` () `const`

Public Member Functions inherited from `GiNaC::basic`

- `virtual ~basic` ()
basic destructor, virtual because class ex will delete objects of derived classes via a basic.*
- `basic` (`const basic &other`)
- `const basic & operator=` (`const basic &other`)
basic assignment operator: the other object might be of a derived class.
- `virtual basic * duplicate` () `const`
Create a clone of this object on the heap.
- `virtual ex eval` () `const`
Perform automatic non-interruptive term rewriting rules.
- `virtual ex evalf` () `const`
Evaluate object numerically.
- `virtual ex evalm` () `const`
Evaluate sums, products and integer powers of matrices.
- `virtual ex eval_integ` () `const`
Evaluate integrals, if result is known.
- `virtual ex eval_indexed` (`const basic &i`) `const`
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- `virtual void print` (`const print_context &c`, unsigned `level=0`) `const`
Output to stream.
- `virtual void dbgprint` () `const`
Little wrapper around print to be called within a debugger.
- `virtual void dbgprinttree` () `const`
Little wrapper around printtree to be called within a debugger.
- `virtual unsigned precedence` () `const`
Return relative operator precedence (for parenthezing output).
- `virtual bool info` (unsigned `inf`) `const`
Information about the object.
- `virtual size_t nops` () `const`
Number of operands/members.

- virtual `ex op` (`size_t i`) const
Return operand/member at position i.
- virtual `ex operator[]` (const `ex &index`) const
- virtual `ex operator[]` (`size_t i`) const
- virtual `ex & let_op` (`size_t i`)
Return modifiable operand/member at position i.
- virtual `ex & operator[]` (const `ex &index`)
- virtual `ex & operator[]` (`size_t i`)
- virtual bool `has` (const `ex &other`, unsigned `options=0`) const
Test for occurrence of a pattern.
- virtual bool `match` (const `ex &pattern`, `exmap &repls`) const
Check whether the expression matches a given pattern.
- virtual `ex subs` (const `exmap &m`, unsigned `options=0`) const
Substitute a set of objects by arbitrary expressions.
- virtual `ex map` (`map_function &f`) const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void `accept` (`GiNaC::visitor &v`) const
- virtual bool `is_polynomial` (const `ex &var`) const
Check whether this is a polynomial in the given variables.
- virtual int `degree` (const `ex &s`) const
Return degree of highest power in object s.
- virtual int `ldegree` (const `ex &s`) const
Return degree of lowest power in object s.
- virtual `ex coeff` (const `ex &s`, int `n=1`) const
Return coefficient of degree n in object s.
- virtual `ex expand` (unsigned `options=0`) const
Expand expression, i.e.
- virtual `ex collect` (const `ex &s`, bool `distributed=false`) const
Sort expanded expression in terms of powers of some object(s).
- virtual `ex series` (const `relational &r`, int `order`, unsigned `options=0`) const
Default implementation of `ex::series()`.
- virtual `ex normal` (`exmap &repl`, `exmap &rev_lookup`, `lst &modifier`) const
Default implementation of `ex::normal()`.
- virtual `ex to_rational` (`exmap &repl`) const
Default implementation of `ex::to_rational()`.
- virtual `ex to_polynomial` (`exmap &repl`) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric &xi`) const
Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- virtual `numeric max_coefficient` () const
Implementation `ex::max_coefficient()`.
- virtual `exvector get_free_indices` () const
Return a vector containing the free indices of an expression.
- virtual `ex add_indexed` (const `ex &self`, const `ex &other`) const
Add two indexed expressions.
- virtual `ex scalar_mul_indexed` (const `ex &self`, const `numeric &other`) const
Multiply an indexed expression with a scalar.
- virtual bool `contract_with` (`exvector::iterator self`, `exvector::iterator other`, `exvector &v`) const
Try to contract two indexed expressions that appear in the same product.
- virtual unsigned `return_type` () const
- virtual `return_type_t return_type_tinfo` () const

- virtual `ex conjugate ()` const
- virtual `ex real_part ()` const
- virtual `ex imag_part ()` const
- template<class T >
void `print_dispatch` (const `print_context` &c, unsigned level) const
Like `print()`, but dispatch to the specified class.
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const
Like `print()`, but dispatch to the specified class.
- virtual void `archive` (`archive_node` &n) const
Save (serialize) the object into archive node.
- virtual void `read_archive` (const `archive_node` &n, `lst` &syms)
Load (deserialize) the object from an archive node.
- `ex subs_one_level` (const `exmap` &m, unsigned `options`) const
Helper function for `subs()`.
- `ex diff` (const `symbol` &s, unsigned nth=1) const
Default interface of nth derivative `ex::diff(s, n)`.
- int `compare` (const `basic` &other) const
Compare objects syntactically to establish canonical ordering.
- bool `is_equal` (const `basic` &other) const
Test for syntactic equality.
- const `basic` & `hold` () const
Stop further evaluation.
- unsigned `gethash` () const
- const `basic` & `setflag` (unsigned f) const
Set some `status_flags`.
- const `basic` & `clearflag` (unsigned f) const
Clear some `status_flags`.

Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- unsigned int `add_reference` () noexcept
- unsigned int `remove_reference` () noexcept
- unsigned int `get_refcount` () const noexcept
- void `set_refcount` (unsigned int r) noexcept

Protected Member Functions

- `ex eval_ncmul` (const `exvector` &v) const override
- bool `match_same_type` (const `basic` &other) const override
Returns true if the attributes of two objects are similar enough for a match.
- unsigned `return_type` () const override
- `return_type_t` `return_type_tinfo` () const override
- unsigned `calchash` () const override
Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.
- void `do_print` (const `print_context` &c, unsigned level) const
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const

Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match_same_type](#) (const [basic](#) &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual [ex derivative](#) (const [symbol](#) &s) const
Default implementation of [ex::diff\(\)](#).
- virtual int [compare_same_type](#) (const [basic](#) &other) const
Returns order relation between two objects of same type.
- virtual bool [is_equal_same_type](#) (const [basic](#) &other) const
Returns true if two objects of same type are equal.
- virtual unsigned [calchash](#) () const
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- void [ensure_if_modifiable](#) () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
Default output to stream.
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
Tree output to stream.
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
Python parsable output to stream.

Protected Attributes

- [ex](#) lh
- [ex](#) rh
- [operators](#) o

Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)
of type [status_flags](#)
- unsigned [hashvalue](#)
hash value

Private Types

- typedef void(safe_bool_helper::* [safe_bool](#)) ()

Private Member Functions

- [safe_bool](#) [make_safe_bool](#) (bool) const

6.145.1 Detailed Description

This class holds a relation consisting of two expressions and a logical relation between them.

6.145.2 Member Typedef Documentation

6.145.2.1 safe_bool

```
typedef void(safe_bool_helper::* GiNaC::relational::safe_bool) () [private]
```

6.145.3 Member Enumeration Documentation

6.145.3.1 operators

```
enum GiNaC::relational::operators
```

Enumerator

equal	
not_equal	
less	
less_or_equal	
greater	
greater_or_equal	

6.145.4 Constructor & Destructor Documentation

6.145.4.1 relational()

```
GiNaC::relational::relational (
    const ex & lhs,
    const ex & rhs,
    operators oper = equal )
```

6.145.5 Member Function Documentation

6.145.5.1 precedence()

```
unsigned GiNaC::relational::precedence ( ) const [inline], [override], [virtual]
```

Return relative operator precedence (for parenthezing output).

Reimplemented from [GiNaC::basic](#).

Referenced by [do_print\(\)](#).

6.145.5.2 info()

```
bool GiNaC::relational::info (
    unsigned inf ) const [override], [virtual]
```

Information about the object.

See also

class [info_flags](#)

Reimplemented from [GiNaC::basic](#).

References [equal](#), [greater](#), [greater_or_equal](#), [less](#), [less_or_equal](#), [not_equal](#), [o](#), [GiNaC::info_flags::relation](#), [GiNaC::info_flags::relation_equal](#), [GiNaC::info_flags::relation_greater](#), [GiNaC::info_flags::relation_greater_or_equal](#), [GiNaC::info_flags::relation_less](#), [GiNaC::info_flags::relation_less_or_equal](#), and [GiNaC::info_flags::relation_not_equal](#).

Referenced by [operator safe_bool\(\)](#).

6.145.5.3 nops()

```
size_t GiNaC::relational::nops ( ) const [override], [virtual]
```

Number of operands/members.

Reimplemented from [GiNaC::basic](#).

6.145.5.4 op()

```
ex GiNaC::relational::op (
    size_t i ) const [override], [virtual]
```

Return operand/member at position *i*.

Reimplemented from [GiNaC::basic](#).

References [GINAC_ASSERT](#), [lh](#), and [rh](#).

6.145.5.5 map()

```
ex GiNaC::relational::map (
    map_function & f ) const [override], [virtual]
```

Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).

Reimplemented from [GiNaC::basic](#).

References [GiNaC::are_ex_trivially_equal\(\)](#), [lh](#), [o](#), and [rh](#).

6.145.5.6 subs()

```
ex GiNaC::relational::subs (
    const exmap & m,
    unsigned options = 0 ) const [override], [virtual]
```

Substitute a set of objects by arbitrary expressions.

The ex returned will already be evaluated.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::are_ex_trivially_equal\(\)](#), [lh](#), [m](#), [o](#), [options](#), [rh](#), [GiNaC::ex::subs\(\)](#), and [GiNaC::basic::subs_one_level\(\)](#).

6.145.5.7 archive()

```
void GiNaC::relational::archive (
    archive_node & n ) const [override], [virtual]
```

Save (a.k.a.

serialize) object into archive.

Reimplemented from [GiNaC::basic](#).

References [lh](#), [n](#), [o](#), and [rh](#).

6.145.5.8 read_archive()

```
void GiNaC::relational::read_archive (
    const archive_node & n,
    lst & syms ) [override], [virtual]
```

Read (a.k.a.

deserialize) object from archive.

Reimplemented from [GiNaC::basic](#).

References [lh](#), [n](#), [o](#), and [rh](#).

6.145.5.9 canonical()

```
ex GiNaC::relational::canonical ( ) const
```

Returns an equivalent relational with zero right-hand side.

References [GiNaC::_ex0](#), [lh](#), [o](#), and [rh](#).

6.145.5.10 eval_ncmul()

```
ex GiNaC::relational::eval_ncmul (
    const exvector & v ) const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::ex::eval_ncmul\(\)](#), and [lh](#).

6.145.5.11 match_same_type()

```
bool GiNaC::relational::match_same_type (
    const basic & other ) const [override], [protected], [virtual]
```

Returns true if the attributes of two objects are similar enough for a match.

This function must not match subexpressions (this is already done by [basic::match\(\)](#)). Only attributes not accessible by [op\(\)](#) should be compared. This is also the reason why this function doesn't take the wildcard replacement list from [match\(\)](#) as an argument: only subexpressions are subject to wildcard matches. Also, this function only needs to be implemented for container classes because [is_equal_same_type\(\)](#) is automatically used instead of [match_same_type\(\)](#) if [nops\(\)](#) == 0.

See also

[basic::match](#)

Reimplemented from [GiNaC::basic](#).

References [GINAC_ASSERT](#), and [o](#).

6.145.5.12 return_type()

```
unsigned GiNaC::relational::return_type ( ) const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GINAC_ASSERT](#), [lh](#), [GiNaC::ex::return_type\(\)](#), and [rh](#).

6.145.5.13 return_type_tinfo()

```
return_type_t GiNaC::relational::return_type_tinfo ( ) const [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GINAC_ASSERT](#), [lh](#), [GiNaC::ex::return_type_tinfo\(\)](#), and [rh](#).

6.145.5.14 calchash()

```
unsigned GiNaC::relational::calchash ( ) const [override], [protected], [virtual]
```

Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.

The method inherited from class basic computes a hash value based on the type and hash values of possible members. For this reason it is well suited for container classes but atomic classes should override this implementation because otherwise they would all end up with the same hashvalue.

Reimplemented from [GiNaC::basic](#).

References [equal](#), [GiNaC::status_flags::evaluated](#), [GiNaC::basic::flags](#), [GiNaC::ex::gethash\(\)](#), [greater](#), [greater_or_equal](#), [GiNaC::status_flags::hash_calculated](#), [GiNaC::basic::hashvalue](#), [less](#), [less_or_equal](#), [lh](#), [GiNaC::make_hash_seed\(\)](#), [not_equal](#), [o](#), [rh](#), [GiNaC::rotate_left\(\)](#), and [GiNaC::basic::setflag\(\)](#).

6.145.5.15 do_print()

```
void GiNaC::relational::do_print (
    const print_context & c,
    unsigned level ) const [protected]
```

References [c](#), [lh](#), [o](#), [precedence\(\)](#), [GiNaC::ex::print\(\)](#), [GiNaC::print_operator\(\)](#), and [rh](#).

6.145.5.16 do_print_python_repr()

```
void GiNaC::relational::do_print_python_repr (
    const print_python_repr & c,
    unsigned level ) const [protected]
```

References [c](#), [lh](#), [o](#), [GiNaC::ex::print\(\)](#), [GiNaC::print_operator\(\)](#), and [rh](#).

6.145.5.17 lhs()

```
ex GiNaC::relational::lhs ( ) const [inline]
```

References [lh](#).

Referenced by [GiNaC::atan_series\(\)](#), [GiNaC::atanh_series\(\)](#), [GiNaC::beta_series\(\)](#), [GiNaC::Li2_series\(\)](#), [GiNaC::log_series\(\)](#), [GiNaC::tan_series\(\)](#), and [GiNaC::tanh_series\(\)](#).

6.145.5.18 rhs()

```
ex GiNaC::relational::rhs ( ) const [inline]
```

References [rh](#).

Referenced by [GiNaC::atan_series\(\)](#), [GiNaC::atanh_series\(\)](#), [GiNaC::Li2_series\(\)](#), and [GiNaC::log_series\(\)](#).

6.145.5.19 make_safe_bool()

```
relational::safe_bool GiNaC::relational::make_safe_bool (
    bool cond ) const [private]
```

References [GiNaC::relational::safe_bool_helper::nonnull\(\)](#).

Referenced by [operator safe_bool\(\)](#), and [operator!\(\)](#).

6.145.5.20 operator safe_bool()

```
GiNaC::relational::operator relational::safe_bool ( ) const
```

Cast the relational into a Boolean, mainly for evaluation within an if-statement.

Note that $(a < b) == \text{false}$ does not imply $(a \geq b) == \text{true}$ in the general symbolic case. A false result means the comparison is either false or undecidable (except of course for $!=$, where true means either unequal or undecidable).

References [GiNaC::_num0_p](#), [equal](#), [greater](#), [greater_or_equal](#), [GiNaC::ex::info\(\)](#), [info\(\)](#), [GiNaC::ex::is_zero\(\)](#), [GiNaC::is_zero\(\)](#), [less](#), [less_or_equal](#), [lh](#), [make_safe_bool\(\)](#), [GiNaC::info_flags::negative](#), [GiNaC::info_flags::nonnegative](#), [not_equal](#), [o](#), [GiNaC::info_flags::positive](#), and [rh](#).

6.145.5.21 operator"!()

```
relational::safe_bool GiNaC::relational::operator! ( ) const [inline]
```

References [make_safe_bool\(\)](#).

6.145.6 Member Data Documentation

6.145.6.1 lh

`ex GiNaC::relational::lh` [protected]

Referenced by [archive\(\)](#), [calchash\(\)](#), [canonical\(\)](#), [do_print\(\)](#), [do_print_python_repr\(\)](#), [eval_ncmul\(\)](#), [lhs\(\)](#), [map\(\)](#), [op\(\)](#), [operator safe_bool\(\)](#), [read_archive\(\)](#), [return_type\(\)](#), [return_type_tinfo\(\)](#), and [subs\(\)](#).

6.145.6.2 rh

`ex GiNaC::relational::rh` [protected]

Referenced by [archive\(\)](#), [calchash\(\)](#), [canonical\(\)](#), [do_print\(\)](#), [do_print_python_repr\(\)](#), [map\(\)](#), [op\(\)](#), [operator safe_bool\(\)](#), [read_archive\(\)](#), [return_type\(\)](#), [return_type_tinfo\(\)](#), [rhs\(\)](#), and [subs\(\)](#).

6.145.6.3 o

`operators GiNaC::relational::o` [protected]

Referenced by [archive\(\)](#), [calchash\(\)](#), [canonical\(\)](#), [do_print\(\)](#), [do_print_python_repr\(\)](#), [info\(\)](#), [map\(\)](#), [match_same_type\(\)](#), [operator safe_bool\(\)](#), [read_archive\(\)](#), and [subs\(\)](#).

The documentation for this class was generated from the following files:

- [relational.h](#)
- [relational.cpp](#)

6.146 GiNaC::remember_strategies Class Reference

Strategies how to clean up the function remember cache.

```
#include <flags.h>
```

Public Types

- enum { [delete_never](#) , [delete_lru](#) , [delete_lfu](#) , [delete_cyclic](#) }

6.146.1 Detailed Description

Strategies how to clean up the function remember cache.

See also

[remember_table](#)

6.146.2 Member Enumeration Documentation

6.146.2.1 anonymous enum

anonymous enum

Enumerator

delete_never	Let table grow indefinitely.
delete_lru	Least recently used.
delete_lfu	Least frequently used.
delete_cyclic	First (oldest) one in list.

The documentation for this class was generated from the following file:

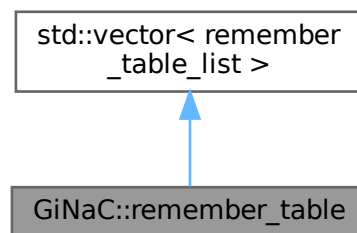
- [flags.h](#)

6.147 GiNaC::remember_table Class Reference

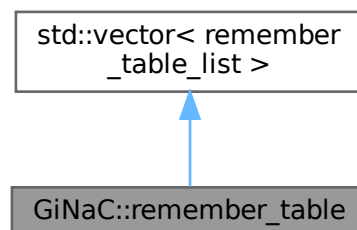
The remember table is organized like an n-fold associative cache in a microprocessor.

```
#include <remember.h>
```

Inheritance diagram for GiNaC::remember_table:



Collaboration diagram for GiNaC::remember_table:



Public Member Functions

- [remember_table](#) ()
- [remember_table](#) (unsigned s, unsigned as, unsigned strat)
- bool [lookup_entry](#) (function const &f, [ex](#) &result) const
- void [add_entry](#) (function const &f, [ex](#) const &result)
- void [clear_all_entries](#) ()
- void [show_statistics](#) (std::ostream &os, unsigned level) const

Static Public Member Functions

- static std::vector< [remember_table](#) > & [remember_tables](#) ()

Protected Member Functions

- void [init_table](#) ()

Protected Attributes

- unsigned [table_size](#)
- unsigned [max_assoc_size](#)
- unsigned [remember_strategy](#)

6.147.1 Detailed Description

The remember table is organized like an n-fold associative cache in a microprocessor.

The table has a width of 's' (which is rounded to `table_size`, some power of 2 near 's', internally) and a depth of 'as' (unless you choose that entries are never discarded). The place where an entry is stored depends on the hashvalue of the parameters of the function (this corresponds to the address of byte to be cached). The '`log_2(table_size)`' least significant bits of this hashvalue give the slot in which the entry will be stored or looked up. Each slot can take up to 'as' entries. If a slot is full, an older entry is removed by one of the following strategies:

- oldest entry (the first one in the list)
- least recently used (the one with the lowest '`last_access`')
- least frequently used (the one with the lowest '`successful_hits`') or all entries are kept which means that the table grows indefinitely.

6.147.2 Constructor & Destructor Documentation

6.147.2.1 `remember_table()` [1/2]

```
GiNaC::remember_table::remember_table ( )
```

References [GiNaC::remember_strategies::delete_never](#), [max_assoc_size](#), [remember_strategy](#), and [table_size](#).

6.147.2.2 `remember_table()` [2/2]

```
GiNaC::remember_table::remember_table (
    unsigned s,
    unsigned as,
    unsigned strat )
```

References [init_table\(\)](#), [GiNaC::log2\(\)](#), and [table_size](#).

6.147.3 Member Function Documentation

6.147.3.1 `lookup_entry()`

```
bool GiNaC::remember_table::lookup_entry (
    function const & f,
    ex & result ) const
```

References [GiNaC::basic::gethash\(\)](#), [GINAC_ASSERT](#), and [table_size](#).

6.147.3.2 `add_entry()`

```
void GiNaC::remember_table::add_entry (
    function const & f,
    ex const & result )
```

References [GiNaC::basic::gethash\(\)](#), [GINAC_ASSERT](#), and [table_size](#).

6.147.3.3 `clear_all_entries()`

```
void GiNaC::remember_table::clear_all_entries ( )
```

References [init_table\(\)](#).

6.147.3.4 `show_statistics()`

```
void GiNaC::remember_table::show_statistics (
    std::ostream & os,
    unsigned level ) const
```

6.147.3.5 remember_tables()

```
std::vector< remember_table > & GiNaC::remember_table::remember_tables ( ) [static]
```

Referenced by [GiNaC::function::lookup_remember_table\(\)](#), [GiNaC::function::register_new\(\)](#), and [GiNaC::function::store_remember_t](#).

6.147.3.6 init_table()

```
void GiNaC::remember_table::init_table ( ) [protected]
```

References [max_assoc_size](#), [remember_strategy](#), and [table_size](#).

Referenced by [clear_all_entries\(\)](#), and [remember_table\(\)](#).

6.147.4 Member Data Documentation

6.147.4.1 table_size

```
unsigned GiNaC::remember_table::table_size [protected]
```

Referenced by [add_entry\(\)](#), [init_table\(\)](#), [lookup_entry\(\)](#), and [remember_table\(\)](#).

6.147.4.2 max_assoc_size

```
unsigned GiNaC::remember_table::max_assoc_size [protected]
```

Referenced by [init_table\(\)](#), and [remember_table\(\)](#).

6.147.4.3 remember_strategy

```
unsigned GiNaC::remember_table::remember_strategy [protected]
```

Referenced by [init_table\(\)](#), and [remember_table\(\)](#).

The documentation for this class was generated from the following files:

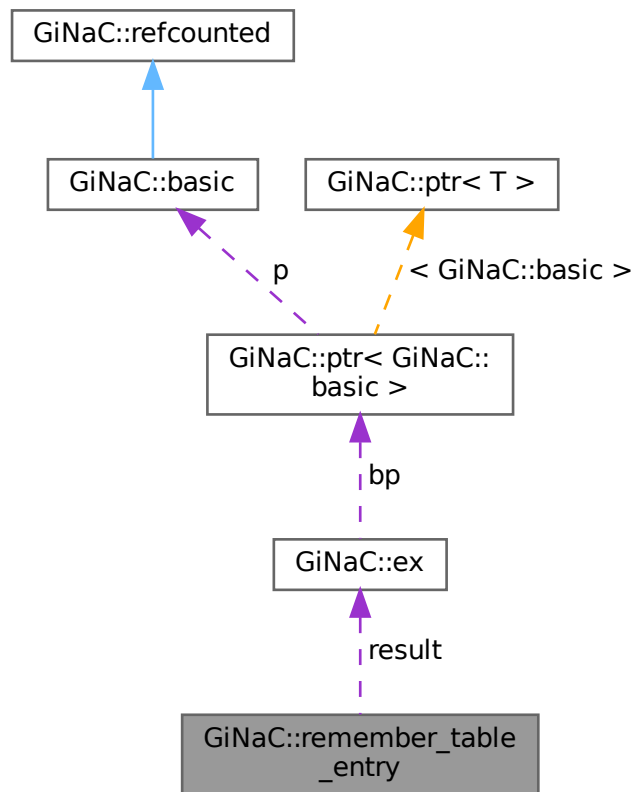
- [remember.h](#)
- [remember.cpp](#)

6.148 GiNaC::remember_table_entry Class Reference

A single entry in the remember table of a function.

```
#include <remember.h>
```

Collaboration diagram for GiNaC::remember_table_entry:



Public Member Functions

- [remember_table_entry](#) (function const &f, [ex](#) const &r)
- bool [is_equal](#) (function const &f) const
- [ex get_result](#) () const
- unsigned long [get_last_access](#) () const
- unsigned long [get_successful_hits](#) () const

Protected Attributes

- unsigned [hashvalue](#)
- [exvector seq](#)
- [ex result](#)
- unsigned long [last_access](#)
- unsigned [successful_hits](#)

Static Protected Attributes

- static unsigned long [access_counter](#) = 0

6.148.1 Detailed Description

A single entry in the remember table of a function.

Needs to be a friend of class function to access 'seq'. 'last_access' and 'successful_hits' are updated at each successful 'is_equal'.

6.148.2 Constructor & Destructor Documentation

6.148.2.1 remember_table_entry()

```
GiNaC::remember_table_entry::remember_table_entry (
    function const & f,
    ex const & r )
```

References [access_counter](#), [last_access](#), and [successful_hits](#).

6.148.3 Member Function Documentation

6.148.3.1 is_equal()

```
bool GiNaC::remember_table_entry::is_equal (
    function const & f ) const
```

References [access_counter](#), [GiNaC::basic::gethash\(\)](#), [GINAC_ASSERT](#), [hashvalue](#), [is_equal\(\)](#), [last_access](#), [GiNaC::container_storage< C >::seq](#), [seq](#), and [successful_hits](#).

Referenced by [is_equal\(\)](#).

6.148.3.2 get_result()

```
ex GiNaC::remember_table_entry::get_result ( ) const [inline]
```

References [result](#).

6.148.3.3 `get_last_access()`

```
unsigned long GiNaC::remember_table_entry::get_last_access ( ) const [inline]
```

References [last_access](#).

6.148.3.4 `get_successful_hits()`

```
unsigned long GiNaC::remember_table_entry::get_successful_hits ( ) const [inline]
```

References [successful_hits](#).

6.148.4 Member Data Documentation

6.148.4.1 `hashvalue`

```
unsigned GiNaC::remember_table_entry::hashvalue [protected]
```

Referenced by [is_equal\(\)](#).

6.148.4.2 `seq`

```
exvector GiNaC::remember_table_entry::seq [protected]
```

Referenced by [is_equal\(\)](#).

6.148.4.3 `result`

```
ex GiNaC::remember_table_entry::result [protected]
```

Referenced by [get_result\(\)](#).

6.148.4.4 `last_access`

```
unsigned long GiNaC::remember_table_entry::last_access [mutable], [protected]
```

Referenced by [get_last_access\(\)](#), [is_equal\(\)](#), and [remember_table_entry\(\)](#).

6.148.4.5 successful_hits

```
unsigned GiNaC::remember_table_entry::successful_hits [mutable], [protected]
```

Referenced by [get_successful_hits\(\)](#), [is_equal\(\)](#), and [remember_table_entry\(\)](#).

6.148.4.6 access_counter

```
unsigned long GiNaC::remember_table_entry::access_counter = 0 [static], [protected]
```

Referenced by [is_equal\(\)](#), and [remember_table_entry\(\)](#).

The documentation for this class was generated from the following files:

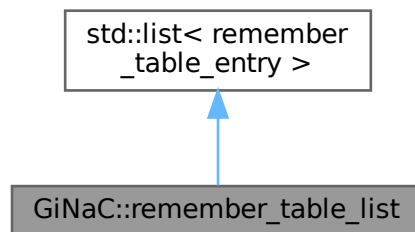
- [remember.h](#)
- [remember.cpp](#)

6.149 GiNaC::remember_table_list Class Reference

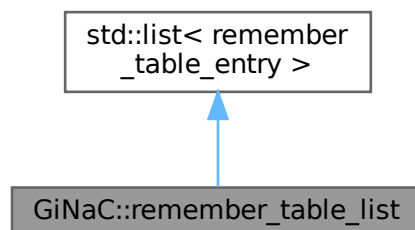
A list of entries in the remember table having some least significant bits of the hashvalue in common.

```
#include <remember.h>
```

Inheritance diagram for GiNaC::remember_table_list:



Collaboration diagram for GiNaC::remember_table_list:



Public Member Functions

- [remember_table_list](#) (unsigned *as*, unsigned *strat*)
- void [add_entry](#) (function const &*f*, *ex* const &*result*)
- bool [lookup_entry](#) (function const &*f*, *ex* &*result*) const

Protected Attributes

- unsigned [max_assoc_size](#)
- unsigned [remember_strategy](#)

6.149.1 Detailed Description

A list of entries in the remember table having some least significant bits of the hashvalue in common.

6.149.2 Constructor & Destructor Documentation

6.149.2.1 [remember_table_list\(\)](#)

```
GiNaC::remember_table_list::remember_table_list (
    unsigned as,
    unsigned strat )
```

References [max_assoc_size](#), and [remember_strategy](#).

6.149.3 Member Function Documentation

6.149.3.1 [add_entry\(\)](#)

```
void GiNaC::remember_table_list::add_entry (
    function const & f,
    ex const & result )
```

References [GiNaC::remember_strategies::delete_cyclic](#), [GiNaC::remember_strategies::delete_ifu](#), [GiNaC::remember_strategies::delete_never](#), [GINAC_ASSERT](#), [max_assoc_size](#), and [remember_strategy](#).

6.149.3.2 [lookup_entry\(\)](#)

```
bool GiNaC::remember_table_list::lookup_entry (
    function const & f,
    ex & result ) const
```

6.149.4 Member Data Documentation

6.149.4.1 max_assoc_size

unsigned GiNaC::remember_table_list::max_assoc_size [protected]

Referenced by [add_entry\(\)](#), and [remember_table_list\(\)](#).

6.149.4.2 remember_strategy

unsigned GiNaC::remember_table_list::remember_strategy [protected]

Referenced by [add_entry\(\)](#), and [remember_table_list\(\)](#).

The documentation for this class was generated from the following files:

- [remember.h](#)
- [remember.cpp](#)

6.150 GiNaC::return_type_t Struct Reference

To distinguish between different kinds of non-commutative objects.

```
#include <registrar.h>
```

Public Member Functions

- bool [operator<](#) (const [return_type_t](#) &other) const
Strict weak ordering (so one can put [return_type_t](#)'s into a STL container).
- bool [operator==](#) (const [return_type_t](#) &other) const
- bool [operator!=](#) (const [return_type_t](#) &other) const

Public Attributes

- std::type_info const * [tinfo](#)
to distinguish between non-commutative objects of different type.
- unsigned [rl](#)
to distinguish between non-commutative objects of the same type.

6.150.1 Detailed Description

To distinguish between different kinds of non-commutative objects.

6.150.2 Member Function Documentation

6.150.2.1 `operator<()`

```
bool GiNaC::return_type_t::operator< (
    const return_type_t & other ) const [inline]
```

Strict weak ordering (so one can put `return_type_t`'s into a STL container).

References [rl](#), and [tinfo](#).

6.150.2.2 `operator==()`

```
bool GiNaC::return_type_t::operator== (
    const return_type_t & other ) const [inline]
```

References [rl](#), and [tinfo](#).

Referenced by [operator!=\(\)](#).

6.150.2.3 `operator"!=()`

```
bool GiNaC::return_type_t::operator!= (
    const return_type_t & other ) const [inline]
```

References [operator==\(\)](#).

6.150.3 Member Data Documentation

6.150.3.1 `tinfo`

```
std::type_info const* GiNaC::return_type_t::tinfo
```

to distinguish between non-commutative objects of different type.

Referenced by [GiNaC::is_clifford_tinfo\(\)](#), [GiNaC::is_color_tinfo\(\)](#), [GiNaC::make_return_type_t\(\)](#), [operator<\(\)](#), [operator==\(\)](#), and [GiNaC::basic::return_type_tinfo\(\)](#).

6.150.3.2 rl

```
unsigned GiNaC::return_type_t::rl
```

to distinguish between non-commutative objects of the same type.

Think of gamma matrices with different representation labels.

Referenced by [GiNaC::get_representation_label\(\)](#), [GiNaC::make_return_type_t\(\)](#), [operator<\(\)](#), [operator==\(\)](#), and [GiNaC::basic::return_type_tinfo\(\)](#).

The documentation for this struct was generated from the following file:

- [registrar.h](#)

6.151 GiNaC::return_types Class Reference

```
#include <flags.h>
```

Public Types

- enum { [commutative](#) , [noncommutative](#) , [noncommutative_composite](#) }

6.151.1 Member Enumeration Documentation

6.151.1.1 anonymous enum

```
anonymous enum
```

Enumerator

commutative	
noncommutative	
noncommutative_composite	

The documentation for this class was generated from the following file:

- [flags.h](#)

6.152 GiNaC::relational::safe_bool_helper Struct Reference

Public Member Functions

- void [nonnull](#) ()

6.152.1 Member Function Documentation

6.152.1.1 `nonnull()`

```
void GiNaC::relational::safe_bool_helper::nonnull ( ) [inline]
```

Referenced by [GiNaC::relational::make_safe_bool\(\)](#).

The documentation for this struct was generated from the following file:

- [relational.h](#)

6.153 GiNaC::scalar_products Class Reference

Helper class for storing information about known scalar products which are to be automatically replaced by [simplify_indexed\(\)](#).

```
#include <indexed.h>
```

Public Member Functions

- void [add](#) (const [ex](#) &v1, const [ex](#) &v2, const [ex](#) &sp)
Register scalar product pair and its value.
- void [add](#) (const [ex](#) &v1, const [ex](#) &v2, const [ex](#) &dim, const [ex](#) &sp)
Register scalar product pair and its value for a specific space dimension.
- void [add_vectors](#) (const [lst](#) &l, const [ex](#) &dim=[wild](#)())
Register list of vectors.
- void [clear](#) ()
Clear all registered scalar products.
- bool [is_defined](#) (const [ex](#) &v1, const [ex](#) &v2, const [ex](#) &dim) const
Check whether scalar product pair is defined.
- [ex](#) [evaluate](#) (const [ex](#) &v1, const [ex](#) &v2, const [ex](#) &dim) const
Return value of defined scalar product pair.
- void [debugprint](#) () const

Protected Attributes

- [smap](#) [spm](#)

6.153.1 Detailed Description

Helper class for storing information about known scalar products which are to be automatically replaced by [simplify_indexed\(\)](#).

See also

[simplify_indexed](#)

6.153.2 Member Function Documentation

6.153.2.1 add() [1/2]

```
void GiNaC::scalar_products::add (
    const ex & v1,
    const ex & v2,
    const ex & sp )
```

Register scalar product pair and its value.

References [spm](#).

6.153.2.2 add() [2/2]

```
void GiNaC::scalar_products::add (
    const ex & v1,
    const ex & v2,
    const ex & dim,
    const ex & sp )
```

Register scalar product pair and its value for a specific space dimension.

References [spm](#).

6.153.2.3 add_vectors()

```
void GiNaC::scalar_products::add_vectors (
    const lst & l,
    const ex & dim = wild\(\) )
```

Register list of vectors.

This adds all possible pairs of products $a.i * b.i$ with the value $a*b$ (note that this is not a scalar vector product but an ordinary product of scalars).

6.153.2.4 clear()

```
void GiNaC::scalar_products::clear ( )
```

Clear all registered scalar products.

References [spm](#).

6.153.2.5 is_defined()

```
bool GiNaC::scalar_products::is_defined (
    const ex & v1,
    const ex & v2,
    const ex & dim ) const
```

Check whether scalar product pair is defined.

References [spm](#).

6.153.2.6 evaluate()

```
ex GiNaC::scalar_products::evaluate (
    const ex & v1,
    const ex & v2,
    const ex & dim ) const
```

Return value of defined scalar product pair.

References [spm](#).

6.153.2.7 debugprint()

```
void GiNaC::scalar_products::debugprint ( ) const
```

References [k](#), and [spm](#).

6.153.3 Member Data Documentation

6.153.3.1 spm

```
spm GiNaC::scalar_products::spm [protected]
```

Referenced by [add\(\)](#), [clear\(\)](#), [debugprint\(\)](#), [evaluate\(\)](#), and [is_defined\(\)](#).

The documentation for this class was generated from the following files:

- [indexed.h](#)
- [indexed.cpp](#)

6.154 GiNaC::series_options Class Reference

Flags to control series expansion.

```
#include <flags.h>
```

Public Types

- enum { [suppress_branchcut](#) = 0x0001 }

6.154.1 Detailed Description

Flags to control series expansion.

6.154.2 Member Enumeration Documentation

6.154.2.1 anonymous enum

anonymous enum

Enumerator

suppress_branchcut	Suppress branch cuts in series expansion. Branch cuts manifest themselves as step functions, if this option is not passed. If it is passed and expansion at a point on a cut is performed, then the analytic continuation of the function is expanded.
------------------------------------	--

The documentation for this class was generated from the following file:

- [flags.h](#)

6.155 GiNaC::solve_algo Class Reference

Switch to control algorithm for linear system solving.

```
#include <flags.h>
```

Public Types

- enum {
[automatic](#) , [gauss](#) , [divfree](#) , [bareiss](#) ,
[markowitz](#) }

6.155.1 Detailed Description

Switch to control algorithm for linear system solving.

6.155.2 Member Enumeration Documentation

6.155.2.1 anonymous enum

anonymous enum

Enumerator

automatic	Let the system choose. A heuristics is applied for automatic determination of a suitable algorithm.
gauss	<p>Gauss elimination. If $m_{i,j}^{(0)}$ are the entries of the original matrix, then the matrix is transformed into triangular form by applying the rules</p> $m_{i,j}^{(k+1)} = m_{i,j}^{(k)} - m_{i,k}^{(k)} m_{k,j}^{(k)} / m_{k,k}^{(k)}$ <p>This algorithm is well-suited for numerical matrices but generally suffers from the expensive division (and computation of GCDs) at each step.</p>
divfree	<p>Division-free elimination. This is a modification of Gauss elimination where the division by the pivot element is not carried out. If $m_{i,j}^{(0)}$ are the entries of the original matrix, then the matrix is transformed into triangular form by applying the rules</p> $m_{i,j}^{(k+1)} = m_{i,j}^{(k)} m_{k,k}^{(k)} - m_{i,k}^{(k)} m_{k,j}^{(k)}$ <p>This algorithm is only there for the purpose of cross-checks. It suffers from exponential intermediate expression swell. Use it only for small systems.</p>
bareiss	<p>Bareiss fraction-free elimination. This is a modification of Gauss elimination where the division by the pivot element is <i>delayed</i> until it can be carried out without computing GCDs. If $m_{i,j}^{(0)}$ are the entries of the original matrix, then the matrix is transformed into triangular form by applying the rules</p> $m_{i,j}^{(k+1)} = (m_{i,j}^{(k)} m_{k,k}^{(k)} - m_{i,k}^{(k)} m_{k,j}^{(k)}) / m_{k-1,k-1}^{(k-1)}$ <p>(We have set $m_{-1,-1}^{(-1)} = 1$ in order to avoid a case distinction in above formula.) It can be shown that nothing more than polynomial long division is needed for carrying out the division. This is generally the fastest algorithm for solving linear systems. In contrast to division-free elimination it only has a linear expression swell. For two-dimensional systems, the two algorithms are equivalent, however.</p>
markowitz	Markowitz-ordered Gaussian elimination. Same as the usual Gaussian elimination, but with additional effort spent on selecting pivots that minimize fill-in. Faster than the methods above for large sparse matrices (particularly with symbolic coefficients), otherwise slightly slower than Gaussian elimination.

The documentation for this class was generated from the following file:

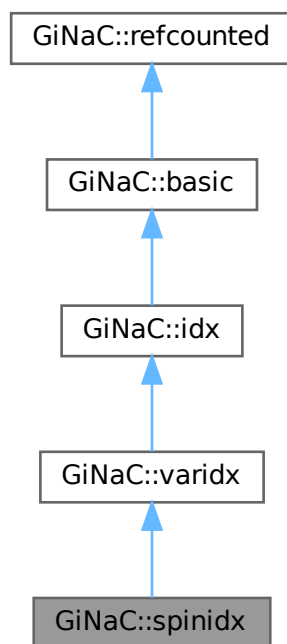
- [flags.h](#)

6.156 GiNaC::spinidx Class Reference

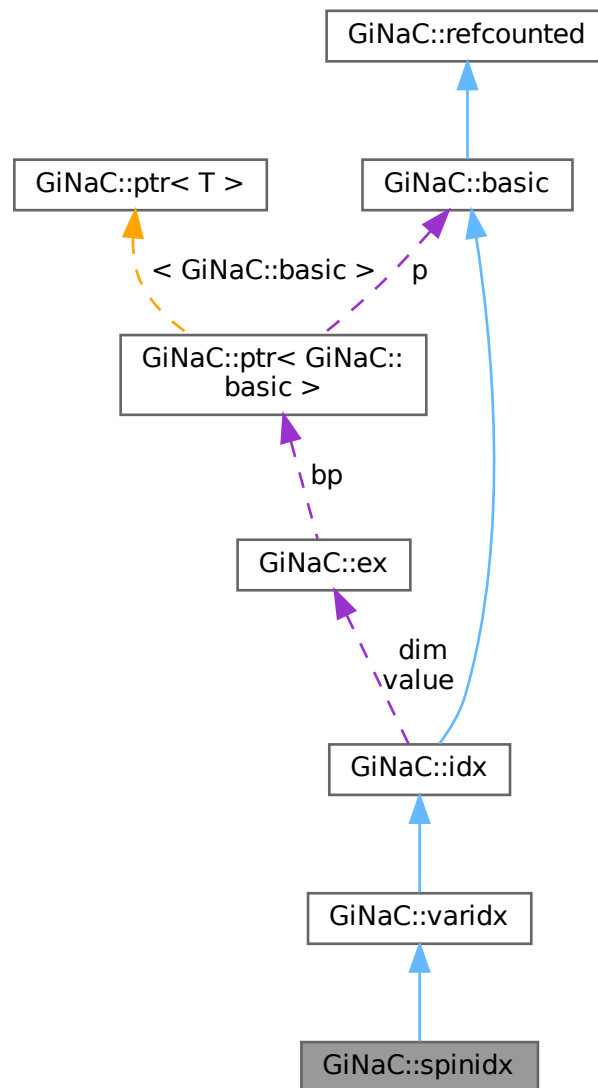
This class holds a spinor index that can be dotted or undotted and that also has a variance.

```
#include <idx.h>
```

Inheritance diagram for GiNaC::spinidx:



Collaboration diagram for `GiNaC::spinidx`:



Public Member Functions

- `spinidx` (const `ex` &`v`, const `ex` &`dim`=2, bool `covariant`=false, bool `dotted`=false)
Construct index with given value, dimension, variance and dot.
- bool `is_dummy_pair_same_type` (const `basic` &`other`) const override
Check whether the index forms a dummy index pair with another index of the same type.
- `ex conjugate` () const override
- void `archive` (`archive_node` &`n`) const override
Save (serialize) the object into archive node.
- void `read_archive` (const `archive_node` &`n`, `lst` &`syms`) override
Load (deserialize) the object from an archive node.

- `bool is_dotted () const`
Check whether the index is dotted.
- `bool is_undotted () const`
Check whether the index is not dotted.
- `ex toggle_dot () const`
Make a new index with the same value and variance but the opposite dottedness.
- `ex toggle_variance_dot () const`
Make a new index with the same value but opposite variance and dottedness.

Public Member Functions inherited from `GiNaC::varidx`

- `varidx (const ex &v, const ex &dim, bool covariant=false)`
Construct index with given value, dimension and variance.
- `bool is_dummy_pair_same_type (const basic &other) const override`
Check whether the index forms a dummy index pair with another index of the same type.
- `void archive (archive_node &n) const override`
Save (serialize) the object into archive node.
- `void read_archive (const archive_node &n, lst &syms) override`
Load (deserialize) the object from an archive node.
- `bool is_covariant () const`
Check whether the index is covariant.
- `bool is_contravariant () const`
Check whether the index is contravariant (not covariant).
- `ex toggle_variance () const`
Make a new index with the same value but the opposite variance.

Public Member Functions inherited from `GiNaC::idx`

- `idx (const ex &v, const ex &dim)`
Construct index with given value and dimension.
- `bool info (unsigned inf) const override`
Information about the object.
- `size_t nops () const override`
Number of operands/members.
- `ex op (size_t i) const override`
Return operand/member at position i.
- `ex map (map_function &f) const override`
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- `ex evalf () const override`
By default, `basic::evalf` would evaluate the index value but we don't want a.1 to become a.
- `ex subs (const exmap &m, unsigned options=0) const override`
Substitute a set of objects by arbitrary expressions.
- `void archive (archive_node &n) const override`
Save (serialize) the object into archive node.
- `void read_archive (const archive_node &n, lst &syms) override`
Load (deserialize) the object from an archive node.
- `virtual bool is_dummy_pair_same_type (const basic &other) const`
Check whether the index forms a dummy index pair with another index of the same type.
- `ex get_value () const`

- *Get value of index.*
- `bool is_numeric () const`
Check whether the index is numeric.
- `bool is_symbolic () const`
Check whether the index is symbolic.
- `ex get_dim () const`
Get dimension of index space.
- `bool is_dim_numeric () const`
Check whether the dimension is numeric.
- `bool is_dim_symbolic () const`
Check whether the dimension is symbolic.
- `ex replace_dim (const ex &new_dim) const`
Make a new index with the same value but a different dimension.
- `ex minimal_dim (const idx &other) const`
Return the minimum of the dimensions of this and another index.

Public Member Functions inherited from `GiNaC::basic`

- `virtual ~basic ()`
basic destructor, virtual because class ex will delete objects of derived classes via a basic.*
- `basic (const basic &other)`
- `const basic & operator= (const basic &other)`
basic assignment operator: the other object might be of a derived class.
- `virtual basic * duplicate () const`
Create a clone of this object on the heap.
- `virtual ex eval () const`
Perform automatic non-interruptive term rewriting rules.
- `virtual ex evalf () const`
Evaluate object numerically.
- `virtual ex evalm () const`
Evaluate sums, products and integer powers of matrices.
- `virtual ex eval_integ () const`
Evaluate integrals, if result is known.
- `virtual ex eval_indexed (const basic &i) const`
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- `virtual void print (const print_context &c, unsigned level=0) const`
Output to stream.
- `virtual void dbgprint () const`
Little wrapper around print to be called within a debugger.
- `virtual void dbgprinttree () const`
Little wrapper around printtree to be called within a debugger.
- `virtual unsigned precedence () const`
Return relative operator precedence (for parenthezing output).
- `virtual bool info (unsigned inf) const`
Information about the object.
- `virtual size_t nops () const`
Number of operands/members.
- `virtual ex op (size_t i) const`
Return operand/member at position i.
- `virtual ex operator[] (const ex &index) const`

- virtual `ex operator[]` (size_t i) const
- virtual `ex & let_op` (size_t i)
Return modifiable operand/member at position i.
- virtual `ex & operator[]` (const `ex` &index)
- virtual `ex & operator[]` (size_t i)
- virtual bool `has` (const `ex` &other, unsigned `options`=0) const
Test for occurrence of a pattern.
- virtual bool `match` (const `ex` &pattern, `exmap` &repls) const
Check whether the expression matches a given pattern.
- virtual `ex subs` (const `exmap` &m, unsigned `options`=0) const
Substitute a set of objects by arbitrary expressions.
- virtual `ex map` (`map_function` &f) const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void `accept` (GiNaC::visitor &v) const
- virtual bool `is_polynomial` (const `ex` &var) const
Check whether this is a polynomial in the given variables.
- virtual int `degree` (const `ex` &s) const
Return degree of highest power in object s.
- virtual int `ldegree` (const `ex` &s) const
Return degree of lowest power in object s.
- virtual `ex coeff` (const `ex` &s, int n=1) const
Return coefficient of degree n in object s.
- virtual `ex expand` (unsigned `options`=0) const
Expand expression, i.e.
- virtual `ex collect` (const `ex` &s, bool distributed=false) const
Sort expanded expression in terms of powers of some object(s).
- virtual `ex series` (const `relational` &r, int `order`, unsigned `options`=0) const
Default implementation of `ex::series()`.
- virtual `ex normal` (`exmap` &repl, `exmap` &rev_lookup, `lst` &modifier) const
Default implementation of `ex::normal()`.
- virtual `ex to_rational` (`exmap` &repl) const
Default implementation of `ex::to_rational()`.
- virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const
Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- virtual `numeric max_coefficient` () const
Implementation `ex::max_coefficient()`.
- virtual `exvector get_free_indices` () const
Return a vector containing the free indices of an expression.
- virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
Add two indexed expressions.
- virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
Multiply an indexed expression with a scalar.
- virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const
Try to contract two indexed expressions that appear in the same product.
- virtual unsigned `return_type` () const
- virtual `return_type_t return_type_tinfo` () const
- virtual `ex conjugate` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const

- `template<class T >`
`void print_dispatch (const print_context &c, unsigned level) const`
Like `print()`, but dispatch to the specified class.
- `void print_dispatch (const registered_class_info &ri, const print_context &c, unsigned level) const`
Like `print()`, but dispatch to the specified class.
- `virtual void archive (archive_node &n) const`
Save (serialize) the object into archive node.
- `virtual void read_archive (const archive_node &n, lst &syms)`
Load (deserialize) the object from an archive node.
- `ex subs_one_level (const exmap &m, unsigned options) const`
Helper function for `subs()`.
- `ex diff (const symbol &s, unsigned nth=1) const`
Default interface of `nth` derivative `ex::diff(s, n)`.
- `int compare (const basic &other) const`
Compare objects syntactically to establish canonical ordering.
- `bool is_equal (const basic &other) const`
Test for syntactic equality.
- `const basic & hold () const`
Stop further evaluation.
- `unsigned gethash () const`
- `const basic & setflag (unsigned f) const`
Set some `status_flags`.
- `const basic & clearflag (unsigned f) const`
Clear some `status_flags`.

Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted () noexcept`
- `unsigned int add_reference () noexcept`
- `unsigned int remove_reference () noexcept`
- `unsigned int get_refcount () const noexcept`
- `void set_refcount (unsigned int r) noexcept`

Protected Member Functions

- `bool match_same_type (const basic &other) const override`
Returns true if the attributes of two objects are similar enough for a match.
- `void do_print (const print_context &c, unsigned level) const`
- `void do_print_latex (const print_latex &c, unsigned level) const`
- `void do_print_tree (const print_tree &c, unsigned level) const`

Protected Member Functions inherited from `GiNaC::varidx`

- `bool match_same_type (const basic &other) const override`
Returns true if the attributes of two objects are similar enough for a match.
- `void do_print (const print_context &c, unsigned level) const`
- `void do_print_tree (const print_tree &c, unsigned level) const`

Protected Member Functions inherited from GiNaC::idx

- `ex derivative` (const `symbol` &s) const override
Implementation of `ex::diff()` for an index always returns 0.
- `bool match_same_type` (const `basic` &other) const override
Returns true if the attributes of two objects are similar enough for a match.
- `unsigned calchash` () const override
Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.
- `void print_index` (const `print_context` &c, unsigned level) const
- `void do_print` (const `print_context` &c, unsigned level) const
- `void do_print_csrf` (const `print_csrf` &c, unsigned level) const
- `void do_print_latex` (const `print_latex` &c, unsigned level) const
- `void do_print_tree` (const `print_tree` &c, unsigned level) const

Protected Member Functions inherited from GiNaC::basic

- `basic` ()
- `virtual ex eval_ncmul` (const `exvector` &v) const
- `virtual bool match_same_type` (const `basic` &other) const
Returns true if the attributes of two objects are similar enough for a match.
- `virtual ex derivative` (const `symbol` &s) const
Default implementation of `ex::diff()`.
- `virtual int compare_same_type` (const `basic` &other) const
Returns order relation between two objects of same type.
- `virtual bool is_equal_same_type` (const `basic` &other) const
Returns true if two objects of same type are equal.
- `virtual unsigned calchash` () const
Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.
- `void ensure_if_modifiable` () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- `void do_print` (const `print_context` &c, unsigned level) const
Default output to stream.
- `void do_print_tree` (const `print_tree` &c, unsigned level) const
Tree output to stream.
- `void do_print_python_repr` (const `print_python_repr` &c, unsigned level) const
Python parsable output to stream.

Protected Attributes

- `bool dotted`

Protected Attributes inherited from GiNaC::varidx

- `bool covariant`
 $x.\mu$, default is contravariant: $x \sim \mu$

Protected Attributes inherited from `GiNaC::idx`

- `ex value`
Expression that constitutes the index (numeric or symbolic name)
- `ex dim`
Dimension of space (can be symbolic or numeric)

Protected Attributes inherited from `GiNaC::basic`

- unsigned `flags`
of type `status_flags`
- unsigned `hashvalue`
hash value

6.156.1 Detailed Description

This class holds a spinor index that can be dotted or undotted and that also has a variance.

This is used in the Weyl-van-der-Waerden formalism where the dot indicates complex conjugation. There is an associated (asymmetric) metric tensor that can be used to raise/lower spinor indices.

6.156.2 Constructor & Destructor Documentation

6.156.2.1 `spinidx()`

```
GiNaC::spinidx::spinidx (
    const ex & v,
    const ex & dim = 2,
    bool covariant = false,
    bool dotted = false )
```

Construct index with given value, dimension, variance and dot.

Parameters

<i>v</i>	Value of index (numeric or symbolic)
<i>dim</i>	Dimension of index space (numeric or symbolic)
<i>covariant</i>	Make covariant index (default is contravariant)
<i>dotted</i>	Make covariant dotted (default is undotted)

6.156.3 Member Function Documentation

6.156.3.1 is_dummy_pair_same_type()

```
bool GiNaC::spinidx::is_dummy_pair_same_type (
    const basic & other ) const [override], [virtual]
```

Check whether the index forms a dummy index pair with another index of the same type.

Reimplemented from [GiNaC::varidx](#).

References [dotted](#).

6.156.3.2 conjugate()

```
ex GiNaC::spinidx::conjugate ( ) const [inline], [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [toggle_dot\(\)](#).

6.156.3.3 archive()

```
void GiNaC::spinidx::archive (
    archive\_node & n ) const [override], [virtual]
```

Save (serialize) the object into archive node.

Archive the object.

Losely speaking, this method turns an expression into a byte stream (which can be saved and restored later on, or sent via network, etc.)

Reimplemented from [GiNaC::varidx](#).

References [dotted](#), and [n](#).

6.156.3.4 read_archive()

```
void GiNaC::spinidx::read_archive (
    const archive\_node & n,
    lst & syms ) [override], [virtual]
```

Load (deserialize) the object from an archive node.

Construct object from [archive_node](#).

Note

This method is essentially a constructor. However, constructors can't be virtual. So, if unarchiving routines are implemented as constructors one would need to define such a constructor in every class, even if all it does is simply calling constructor of a superclass.

Reimplemented from [GiNaC::varidx](#).

References [dotted](#), and [n](#).

6.156.3.5 match_same_type()

```
bool GiNaC::spinidx::match_same_type (
    const basic & other ) const [override], [protected], [virtual]
```

Returns true if the attributes of two objects are similar enough for a match.

This function must not match subexpressions (this is already done by [basic::match\(\)](#)). Only attributes not accessible by [op\(\)](#) should be compared. This is also the reason why this function doesn't take the wildcard replacement list from [match\(\)](#) as an argument: only subexpressions are subject to wildcard matches. Also, this function only needs to be implemented for container classes because [is_equal_same_type\(\)](#) is automatically used instead of [match_same_type\(\)](#) if [nops\(\)](#) == 0.

See also

[basic::match](#)

Reimplemented from [GiNaC::varidx](#).

References [dotted](#), and [GINAC_ASSERT](#).

6.156.3.6 is_dotted()

```
bool GiNaC::spinidx::is_dotted ( ) const [inline]
```

Check whether the index is dotted.

References [dotted](#).

6.156.3.7 is_undotted()

```
bool GiNaC::spinidx::is_undotted ( ) const [inline]
```

Check whether the index is not dotted.

References [dotted](#).

6.156.3.8 toggle_dot()

```
ex GiNaC::spinidx::toggle_dot ( ) const
```

Make a new index with the same value and variance but the opposite dottedness.

References [GiNaC::basic::clearflag\(\)](#), [dotted](#), [GiNaC::basic::duplicate\(\)](#), and [GiNaC::status_flags::hash_calculated](#).

Referenced by [conjugate\(\)](#).

6.156.3.9 toggle_variance_dot()

`ex` `GiNaC::spinidx::toggle_variance_dot () const`

Make a new index with the same value but opposite variance and dottedness.

References [GiNaC::basic::clearflag\(\)](#), [GiNaC::varidx::covariant](#), [dotted](#), [GiNaC::basic::duplicate\(\)](#), and [GiNaC::status_flags::hash_cal](#)

6.156.3.10 do_print()

```
void GiNaC::spinidx::do_print (
    const print\_context & c,
    unsigned level ) const [protected]
```

References [c](#), [GiNaC::varidx::covariant](#), [dotted](#), and [GiNaC::idx::print_index\(\)](#).

6.156.3.11 do_print_latex()

```
void GiNaC::spinidx::do_print_latex (
    const print\_latex & c,
    unsigned level ) const [protected]
```

References [c](#), [dotted](#), and [GiNaC::idx::print_index\(\)](#).

6.156.3.12 do_print_tree()

```
void GiNaC::spinidx::do_print_tree (
    const print\_tree & c,
    unsigned level ) const [protected]
```

References [c](#), [GiNaC::varidx::covariant](#), [GiNaC::idx::dim](#), [dotted](#), [GiNaC::basic::flags](#), [GiNaC::basic::hashvalue](#), [GiNaC::ex::print\(\)](#), and [GiNaC::idx::value](#).

6.156.4 Member Data Documentation

6.156.4.1 dotted

```
bool GiNaC::spinidx::dotted [protected]
```

Referenced by [archive\(\)](#), [do_print\(\)](#), [do_print_latex\(\)](#), [do_print_tree\(\)](#), [is_dotted\(\)](#), [is_dummy_pair_same_type\(\)](#), [is_undotted\(\)](#), [match_same_type\(\)](#), [read_archive\(\)](#), [toggle_dot\(\)](#), and [toggle_variance_dot\(\)](#).

The documentation for this class was generated from the following files:

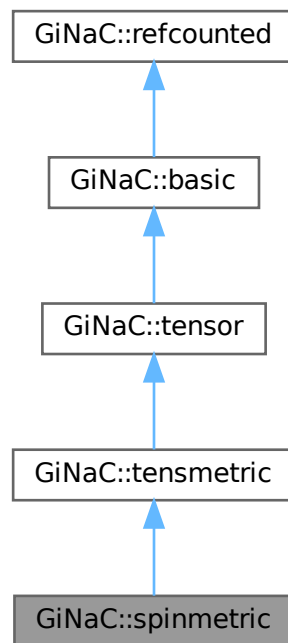
- [idx.h](#)
- [idx.cpp](#)

6.157 GiNaC::spinmetric Class Reference

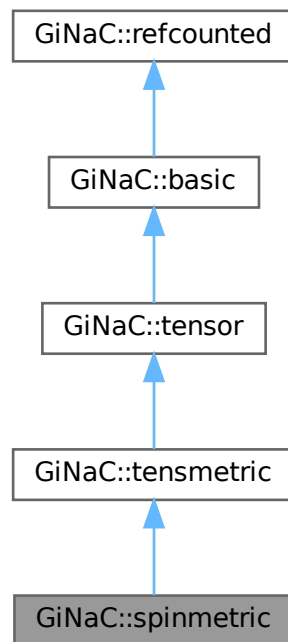
This class represents an antisymmetric spinor metric tensor which can be used to raise/lower indices of 2-component Weyl spinors.

```
#include <tensor.h>
```

Inheritance diagram for GiNaC::spinmetric:



Collaboration diagram for GiNaC::spinmetric:



Public Member Functions

- bool [info](#) (unsigned inf) const override
Information about the object.
 - [ex eval_indexed](#) (const [basic](#) &i) const override
Automatic symbolic evaluation of an indexed metric tensor.
 - bool [contract_with](#) (exvector::iterator self, exvector::iterator other, [exvector](#) &v) const override
Contraction of an indexed spinor metric with something else.
-
- bool [info](#) (unsigned inf) const override
Information about the object.
 - [ex eval_indexed](#) (const [basic](#) &i) const override
Automatic symbolic evaluation of an indexed metric tensor.
 - bool [contract_with](#) (exvector::iterator self, exvector::iterator other, [exvector](#) &v) const override
Contraction of an indexed metric tensor with something else.

Public Member Functions inherited from [GiNaC::tensor](#)

- bool [replace_contr_index](#) (exvector::iterator self, exvector::iterator other) const
Replace dummy index in contracted-with object by the contracting object's second index (used internally for delta and metric tensor contractions).

Public Member Functions inherited from [GiNaC::basic](#)

- virtual [~basic](#) ()
basic destructor, virtual because class ex will delete objects of derived classes via a basic.*
- [basic](#) (const [basic](#) &other)
- const [basic](#) & [operator=](#) (const [basic](#) &other)
basic assignment operator: the other object might be of a derived class.
- virtual [basic](#) * [duplicate](#) () const
Create a clone of this object on the heap.
- virtual [ex eval](#) () const
Perform automatic non-interruptive term rewriting rules.
- virtual [ex evalf](#) () const
Evaluate object numerically.
- virtual [ex evalm](#) () const
Evaluate sums, products and integer powers of matrices.
- virtual [ex eval_integ](#) () const
Evaluate integrals, if result is known.
- virtual [ex eval_indexed](#) (const [basic](#) &i) const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void [print](#) (const [print_context](#) &c, unsigned level=0) const
Output to stream.
- virtual void [dbgprint](#) () const
Little wrapper around print to be called within a debugger.
- virtual void [dbgprinttree](#) () const
Little wrapper around printtree to be called within a debugger.
- virtual unsigned [precedence](#) () const
Return relative operator precedence (for parenthezing output).
- virtual bool [info](#) (unsigned inf) const
Information about the object.
- virtual size_t [nops](#) () const
Number of operands/members.
- virtual [ex op](#) (size_t i) const
Return operand/member at position i.
- virtual [ex operator\[\]](#) (const [ex](#) &index) const
- virtual [ex operator\[\]](#) (size_t i) const
- virtual [ex](#) & [let_op](#) (size_t i)
Return modifiable operand/member at position i.
- virtual [ex](#) & [operator\[\]](#) (const [ex](#) &index)
- virtual [ex](#) & [operator\[\]](#) (size_t i)
- virtual bool [has](#) (const [ex](#) &other, unsigned [options](#)=0) const
Test for occurrence of a pattern.
- virtual bool [match](#) (const [ex](#) &pattern, [exmap](#) &repls) const
Check whether the expression matches a given pattern.
- virtual [ex subs](#) (const [exmap](#) &m, unsigned [options](#)=0) const
Substitute a set of objects by arbitrary expressions.
- virtual [ex map](#) ([map_function](#) &f) const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void [accept](#) ([GiNaC::visitor](#) &v) const
- virtual bool [is_polynomial](#) (const [ex](#) &var) const
Check whether this is a polynomial in the given variables.
- virtual int [degree](#) (const [ex](#) &s) const

- Return degree of highest power in object s.*

 - virtual int [ldegree](#) (const [ex](#) &s) const
- Return degree of lowest power in object s.*

 - virtual [ex coeff](#) (const [ex](#) &s, int n=1) const
- Return coefficient of degree n in object s.*

 - virtual [ex expand](#) (unsigned [options](#)=0) const
- Expand expression, i.e.*

 - virtual [ex collect](#) (const [ex](#) &s, bool distributed=false) const
- Sort expanded expression in terms of powers of some object(s).*

 - virtual [ex series](#) (const [relational](#) &r, int [order](#), unsigned [options](#)=0) const
- Default implementation of [ex::series\(\)](#).*

 - virtual [ex normal](#) ([exmap](#) &repl, [exmap](#) &rev_lookup, [lst](#) &modifier) const
- Default implementation of [ex::normal\(\)](#).*

 - virtual [ex to_rational](#) ([exmap](#) &repl) const
- Default implementation of [ex::to_rational\(\)](#).*

 - virtual [ex to_polynomial](#) ([exmap](#) &repl) const
- virtual [numeric integer_content](#) () const
- virtual [ex smod](#) (const [numeric](#) &xi) const
- Apply symmetric modular homomorphism to an expanded multivariate polynomial.*

 - virtual [numeric max_coefficient](#) () const
- Implementation [ex::max_coefficient\(\)](#).*

 - virtual [exvector get_free_indices](#) () const
- Return a vector containing the free indices of an expression.*

 - virtual [ex add_indexed](#) (const [ex](#) &self, const [ex](#) &other) const
- Add two indexed expressions.*

 - virtual [ex scalar_mul_indexed](#) (const [ex](#) &self, const [numeric](#) &other) const
- Multiply an indexed expression with a scalar.*

 - virtual bool [contract_with](#) (exvector::iterator self, exvector::iterator other, [exvector](#) &v) const
- Try to contract two indexed expressions that appear in the same product.*

 - virtual unsigned [return_type](#) () const
 - virtual [return_type_t](#) [return_type_tinfo](#) () const
 - virtual [ex conjugate](#) () const
 - virtual [ex real_part](#) () const
 - virtual [ex imag_part](#) () const
- template<class T >

 - void [print_dispatch](#) (const [print_context](#) &c, unsigned level) const
- Like [print\(\)](#), but dispatch to the specified class.*

 - void [print_dispatch](#) (const [registered_class_info](#) &ri, const [print_context](#) &c, unsigned level) const
- Like [print\(\)](#), but dispatch to the specified class.*

 - virtual void [archive](#) ([archive_node](#) &n) const
- Save (serialize) the object into archive node.*

 - virtual void [read_archive](#) (const [archive_node](#) &n, [lst](#) &syms)
- Load (deserialize) the object from an archive node.*

 - [ex subs_one_level](#) (const [exmap](#) &m, unsigned [options](#)) const
- Helper function for [subs\(\)](#).*

 - [ex diff](#) (const [symbol](#) &s, unsigned nth=1) const
- Default interface of nth derivative [ex::diff\(s, n\)](#).*

 - int [compare](#) (const [basic](#) &other) const
- Compare objects syntactically to establish canonical ordering.*

 - bool [is_equal](#) (const [basic](#) &other) const
- Test for syntactic equality.*

- const [basic](#) & [hold](#) () const
Stop further evaluation.
- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const
Set some [status_flags](#).
- const [basic](#) & [clearflag](#) (unsigned f) const
Clear some [status_flags](#).

Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add_reference](#) () noexcept
- unsigned int [remove_reference](#) () noexcept
- unsigned int [get_refcount](#) () const noexcept
- void [set_refcount](#) (unsigned int r) noexcept

Protected Member Functions

- void [do_print](#) (const [print_context](#) &c, unsigned level) const
- void [do_print_latex](#) (const [print_latex](#) &c, unsigned level) const

Protected Member Functions inherited from [GiNaC::tensmetric](#)

- unsigned [return_type](#) () const override
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
- unsigned [return_type](#) () const override

Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match_same_type](#) (const [basic](#) &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual [ex derivative](#) (const [symbol](#) &s) const
Default implementation of [ex::diff\(\)](#).
- virtual int [compare_same_type](#) (const [basic](#) &other) const
Returns order relation between two objects of same type.
- virtual bool [is_equal_same_type](#) (const [basic](#) &other) const
Returns true if two objects of same type are equal.
- virtual unsigned [calchash](#) () const
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- void [ensure_if_modifiable](#) () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
Default output to stream.
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
Tree output to stream.
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
Python parsable output to stream.

Additional Inherited Members

Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)
of type [status_flags](#)
- unsigned [hashvalue](#)
hash value

6.157.1 Detailed Description

This class represents an antisymmetric spinor metric tensor which can be used to raise/lower indices of 2-component Weyl spinors.

If indexed, it must have exactly two indices of the same type which must be of class `spinidx` or a subclass and have dimension 2.

6.157.2 Member Function Documentation

6.157.2.1 `info()`

```
bool GiNaC::spinmetric::info (
    unsigned inf ) const [override], [virtual]
```

Information about the object.

See also

class [info_flags](#)

Reimplemented from [GiNaC::tensmetric](#).

References [GiNaC::info_flags::real](#).

6.157.2.2 `eval_indexed()`

```
ex GiNaC::spinmetric::eval_indexed (
    const basic & i ) const [override], [virtual]
```

Automatic symbolic evaluation of an indexed metric tensor.

Reimplemented from [GiNaC::tensmetric](#).

References [GiNaC::_ex0](#), [GiNaC::_ex1](#), [GiNaC::_ex_1](#), [GiNaC::idx::get_value\(\)](#), [GINAC_ASSERT](#), [GiNaC::basic::hold\(\)](#), [GiNaC::info_flags::nonnegint](#), [GiNaC::basic::nops\(\)](#), and [GiNaC::basic::op\(\)](#).

6.157.2.3 `contract_with()`

```
bool GiNaC::spinmetric::contract_with (
    exvector::iterator self,
    exvector::iterator other,
    exvector & v ) const [override], [virtual]
```

Contraction of an indexed spinor metric with something else.

Reimplemented from [GiNaC::tensmetric](#).

References [GiNaC::_ex1](#), [GiNaC::_ex2](#), [GiNaC::_ex_2](#), [GiNaC::delta_tensor\(\)](#), [GINAC_ASSERT](#), [GiNaC::is_dummy_pair\(\)](#), and [GiNaC::idx::is_symbolic\(\)](#).

6.157.2.4 `do_print()`

```
void GiNaC::spinmetric::do_print (
    const print_context & c,
    unsigned level ) const [protected]
```

6.157.2.5 `do_print_latex()`

```
void GiNaC::spinmetric::do_print_latex (
    const print_latex & c,
    unsigned level ) const [protected]
```

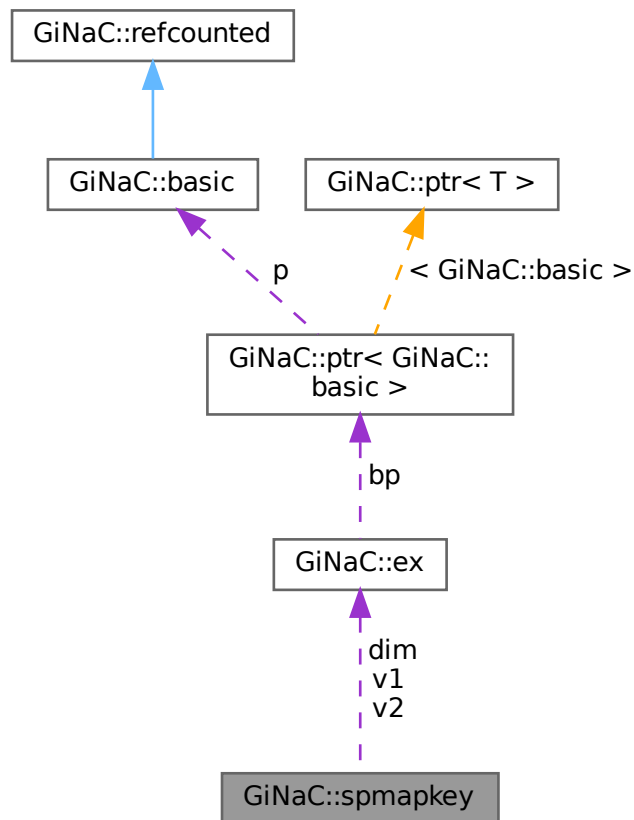
The documentation for this class was generated from the following files:

- [tensor.h](#)
- [tensor.cpp](#)

6.158 GiNaC::spmapkey Class Reference

```
#include <indexed.h>
```

Collaboration diagram for GiNaC::spmapkey:



Public Member Functions

- [spmapkey](#) ()
- [spmapkey](#) (const [ex](#) &[v1](#), const [ex](#) &[v2](#), const [ex](#) &[dim](#)=[wild](#)())
- bool [operator==](#) (const [spmapkey](#) &other) const
- bool [operator<](#) (const [spmapkey](#) &other) const
- void [debugprint](#) () const

Protected Attributes

- [ex](#) [v1](#)
- [ex](#) [v2](#)
- [ex](#) [dim](#)

6.158.1 Constructor & Destructor Documentation

6.158.1.1 `smapkey()` [1/2]

```
GiNaC::smapkey::smapkey ( ) [inline]
```

6.158.1.2 `smapkey()` [2/2]

```
GiNaC::smapkey::smapkey (
    const ex & v1,
    const ex & v2,
    const ex & dim = wild\(\) )
```

References [GiNaC::ex::compare\(\)](#), [GiNaC::ex::op\(\)](#), [v1](#), and [v2](#).

6.158.2 Member Function Documentation

6.158.2.1 `operator==()`

```
bool GiNaC::smapkey::operator== (
    const smapkey & other ) const
```

References [dim](#), [GiNaC::ex::is_equal\(\)](#), [v1](#), and [v2](#).

6.158.2.2 `operator<()`

```
bool GiNaC::smapkey::operator< (
    const smapkey & other ) const
```

References [GiNaC::ex::compare\(\)](#), [dim](#), [v1](#), and [v2](#).

6.158.2.3 `debugprint()`

```
void GiNaC::smapkey::debugprint ( ) const
```

References [dim](#), [v1](#), and [v2](#).

6.158.3 Member Data Documentation

6.158.3.1 v1

`ex` GiNaC::smapkey::v1 [protected]

Referenced by [debugprint\(\)](#), [operator<\(\)](#), [operator==\(\)](#), and [smapkey\(\)](#).

6.158.3.2 v2

`ex` GiNaC::smapkey::v2 [protected]

Referenced by [debugprint\(\)](#), [operator<\(\)](#), [operator==\(\)](#), and [smapkey\(\)](#).

6.158.3.3 dim

`ex` GiNaC::smapkey::dim [protected]

Referenced by [debugprint\(\)](#), [operator<\(\)](#), and [operator==\(\)](#).

The documentation for this class was generated from the following files:

- [indexed.h](#)
- [indexed.cpp](#)

6.159 GiNaC::status_flags Class Reference

Flags to store information about the state of an object.

```
#include <flags.h>
```

Public Types

- enum {
[dynallocated](#) = 0x0001 , [evaluated](#) = 0x0002 , [expanded](#) = 0x0004 , [hash_calculated](#) = 0x0008 ,
[not_shareable](#) = 0x0010 , [has_indices](#) = 0x0020 , [has_no_indices](#) = 0x0040 , [is_positive](#) = 0x0080 ,
[is_negative](#) = 0x0100 , [purely_indefinite](#) = 0x0200 }

6.159.1 Detailed Description

Flags to store information about the state of an object.

See also

[basic::flags](#)

6.159.2 Member Enumeration Documentation

6.159.2.1 anonymous enum

anonymous enum

Enumerator

dynallocated	heap-allocated (i.e. created by new if we want to be clever and bypass the stack, See also ex::construct_from_basic())
evaluated	.eval() has already done its job
expanded	.expand(0) has already done its job (other expand() options ignore this flag)
hash_calculated	.calchash() has already done its job
not_shareable	don't share instances of this object between different expressions unless explicitly asked to (used by ex::compare())
has_indices	
has_no_indices	
is_positive	
is_negative	
purely_indefinite	

The documentation for this class was generated from the following file:

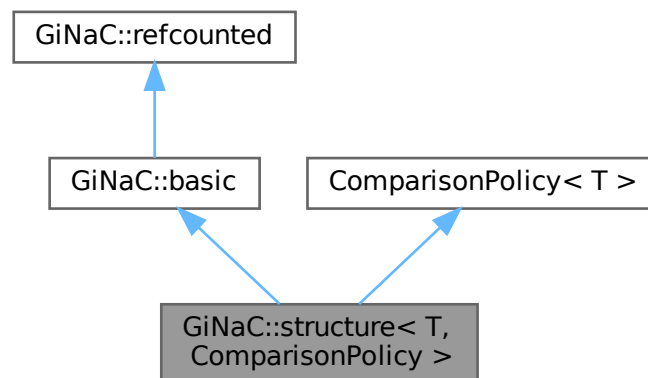
- [flags.h](#)

6.160 GiNaC::structure< T, ComparisonPolicy > Class Template Reference

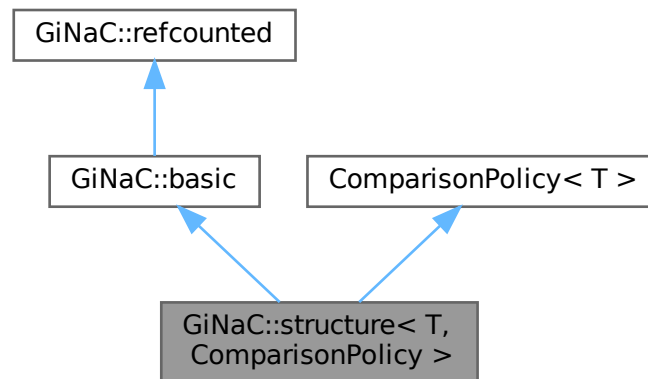
Wrapper template for making [GiNaC](#) classes out of C++ structures.

```
#include <structure.h>
```

Inheritance diagram for GiNaC::structure< T, ComparisonPolicy >:



Collaboration diagram for GiNaC::structure< T, ComparisonPolicy >:



Public Member Functions

- `structure` (const T &t)
Construct structure as a copy of a given C++ structure.
- `ex eval` () const override
Perform automatic non-interruptive term rewriting rules.
- `ex evalm` () const override
Evaluate sums, products and integer powers of matrices.
- `ex eval_indexed` (const `basic` &i) const override
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- void `print` (const `print_context` &c, unsigned level=0) const override
Output to stream.
- unsigned `precedence` () const override
Return relative operator precedence (for parenthesizing output).
- bool `info` (unsigned inf) const override
Information about the object.
- size_t `nops` () const override
Number of operands/members.
- `ex op` (size_t i) const override
Return operand/member at position i.
- `ex operator[]` (const `ex` &index) const override
- `ex operator[]` (size_t i) const override
- `ex & let_op` (size_t i) override
Return modifiable operand/member at position i.
- `ex & operator[]` (const `ex` &index) override
- `ex & operator[]` (size_t i) override
- bool `has` (const `ex` &other, unsigned `options`=0) const override
Test for occurrence of a pattern.
- bool `match` (const `ex` &pattern, `exmap` &repl_lst) const override
Check whether the expression matches a given pattern.
- `ex subs` (const `exmap` &m, unsigned `options`=0) const override

- Substitute a set of objects by arbitrary expressions.*

 - `ex map` (`map_function` &`f`) const override

Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- `int degree` (const `ex` &`s`) const override

Return degree of highest power in object `s`.
- `int ldegree` (const `ex` &`s`) const override

Return degree of lowest power in object `s`.
- `ex coeff` (const `ex` &`s`, int `n=1`) const override

Return coefficient of degree `n` in object `s`.
- `ex expand` (unsigned `options=0`) const override

Expand expression, i.e.
- `ex collect` (const `ex` &`s`, bool `distributed=false`) const override

Sort expanded expression in terms of powers of some object(s).
- `ex series` (const `relational` &`r`, int `order`, unsigned `options=0`) const override

Default implementation of `ex::series()`.
- `ex normal` (`exmap` &`repl`, `exmap` &`rev_lookup`, `lst` &`modifier`) const override

Default implementation of `ex::normal()`.
- `ex to_rational` (`exmap` &`repl`) const override

Default implementation of `ex::to_rational()`.
- `ex to_polynomial` (`exmap` &`repl`) const override
- `numeric integer_content` () const override
- `ex smod` (const `numeric` &`xi`) const override

Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- `numeric max_coefficient` () const override

Implementation `ex::max_coefficient()`.
- `exvector get_free_indices` () const override

Return a vector containing the free indices of an expression.
- `ex add_indexed` (const `ex` &`self`, const `ex` &`other`) const override

Add two indexed expressions.
- `ex scalar_mul_indexed` (const `ex` &`self`, const `numeric` &`other`) const override

Multiply an indexed expression with a scalar.
- `bool contract_with` (`exvector::iterator` `self`, `exvector::iterator` `other`, `exvector` &`v`) const override

Try to contract two indexed expressions that appear in the same product.
- unsigned `return_type` () const override
- `return_type_t` `return_type_tinfo` () const override
- const `T` * `operator->` () const
- `T` & `get_struct` ()
- const `T` & `get_struct` () const

Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()

basic destructor, virtual because class `ex` will delete objects of derived classes via a `basic`.*
- `basic` (const `basic` &`other`)
- const `basic` & `operator=` (const `basic` &`other`)

basic assignment operator: the other object might be of a derived class.
- virtual `basic` * `duplicate` () const

Create a clone of this object on the heap.
- virtual `ex eval` () const

Perform automatic non-interruptive term rewriting rules.
- virtual `ex evalf` () const

- Evaluate object numerically.*
- virtual `ex evalm () const`
- Evaluate sums, products and integer powers of matrices.*
- virtual `ex eval_integ () const`
- Evaluate integrals, if result is known.*
- virtual `ex eval_indexed (const basic &i) const`
- Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.*
- virtual void `print (const print_context &c, unsigned level=0) const`
- Output to stream.*
- virtual void `dbgprint () const`
- Little wrapper around print to be called within a debugger.*
- virtual void `dbgprinttree () const`
- Little wrapper around printtree to be called within a debugger.*
- virtual unsigned `precedence () const`
- Return relative operator precedence (for parenthezing output).*
- virtual bool `info (unsigned inf) const`
- Information about the object.*
- virtual size_t `nops () const`
- Number of operands/members.*
- virtual `ex op (size_t i) const`
- Return operand/member at position i.*
- virtual `ex operator[] (const ex &index) const`
- virtual `ex operator[] (size_t i) const`
- virtual `ex &let_op (size_t i)`
- Return modifiable operand/member at position i.*
- virtual `ex &operator[] (const ex &index)`
- virtual `ex &operator[] (size_t i)`
- virtual bool `has (const ex &other, unsigned options=0) const`
- Test for occurrence of a pattern.*
- virtual bool `match (const ex &pattern, exmap &repls) const`
- Check whether the expression matches a given pattern.*
- virtual `ex subs (const exmap &m, unsigned options=0) const`
- Substitute a set of objects by arbitrary expressions.*
- virtual `ex map (map_function &f) const`
- Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
- virtual void `accept (GiNaC::visitor &v) const`
- virtual bool `is_polynomial (const ex &var) const`
- Check whether this is a polynomial in the given variables.*
- virtual int `degree (const ex &s) const`
- Return degree of highest power in object s.*
- virtual int `ldegree (const ex &s) const`
- Return degree of lowest power in object s.*
- virtual `ex coeff (const ex &s, int n=1) const`
- Return coefficient of degree n in object s.*
- virtual `ex expand (unsigned options=0) const`
- Expand expression, i.e.*
- virtual `ex collect (const ex &s, bool distributed=false) const`
- Sort expanded expression in terms of powers of some object(s).*
- virtual `ex series (const relational &r, int order, unsigned options=0) const`
- Default implementation of ex::series().*
- virtual `ex normal (exmap &repl, exmap &rev_lookup, lst &modifier) const`

- Default implementation of `ex::normal()`.
- virtual `ex to_rational` (`exmap` &repl) const
 - Default implementation of `ex::to_rational()`.
- virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const
 - Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- virtual `numeric max_coefficient` () const
 - Implementation `ex::max_coefficient()`.
- virtual `exvector get_free_indices` () const
 - Return a vector containing the free indices of an expression.
- virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
 - Add two indexed expressions.
- virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
 - Multiply an indexed expression with a scalar.
- virtual bool `contract_with` (`exvector::iterator` self, `exvector::iterator` other, `exvector` &v) const
 - Try to contract two indexed expressions that appear in the same product.
- virtual unsigned `return_type` () const
- virtual `return_type_t return_type_tinfo` () const
- virtual `ex conjugate` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const
- template<class T >
 - void `print_dispatch` (const `print_context` &c, unsigned level) const
 - Like `print()`, but dispatch to the specified class.
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const
 - Like `print()`, but dispatch to the specified class.
- virtual void `archive` (`archive_node` &n) const
 - Save (serialize) the object into archive node.
- virtual void `read_archive` (const `archive_node` &n, `lst` &syms)
 - Load (deserialize) the object from an archive node.
- `ex subs_one_level` (const `exmap` &m, unsigned `options`) const
 - Helper function for `subs()`.
- `ex diff` (const `symbol` &s, unsigned nth=1) const
 - Default interface of nth derivative `ex::diff(s, n)`.
- int `compare` (const `basic` &other) const
 - Compare objects syntactically to establish canonical ordering.
- bool `is_equal` (const `basic` &other) const
 - Test for syntactic equality.
- const `basic` & `hold` () const
 - Stop further evaluation.
- unsigned `gethash` () const
- const `basic` & `setflag` (unsigned f) const
 - Set some `status_flags`.
- const `basic` & `clearflag` (unsigned f) const
 - Clear some `status_flags`.

Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- unsigned int `add_reference` () noexcept
- unsigned int `remove_reference` () noexcept
- unsigned int `get_refcount` () const noexcept
- void `set_refcount` (unsigned int r) noexcept

Protected Member Functions

- `ex eval_ncmul` (const `exvector` &v) const override
- bool `match_same_type` (const `basic` &other) const override
Returns true if the attributes of two objects are similar enough for a match.
- `ex derivative` (const `symbol` &s) const override
Default implementation of `ex::diff()`.
- bool `is_equal_same_type` (const `basic` &other) const override
Returns true if two objects of same type are equal.
- unsigned `calchash` () const override
Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.

Protected Member Functions inherited from `GiNaC::basic`

- `basic` ()
- virtual `ex eval_ncmul` (const `exvector` &v) const
- virtual bool `match_same_type` (const `basic` &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual `ex derivative` (const `symbol` &s) const
Default implementation of `ex::diff()`.
- virtual int `compare_same_type` (const `basic` &other) const
Returns order relation between two objects of same type.
- virtual bool `is_equal_same_type` (const `basic` &other) const
Returns true if two objects of same type are equal.
- virtual unsigned `calchash` () const
Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.
- void `ensure_if_modifiable` () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void `do_print` (const `print_context` &c, unsigned level) const
Default output to stream.
- void `do_print_tree` (const `print_tree` &c, unsigned level) const
Tree output to stream.
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const
Python parsable output to stream.

Static Private Member Functions

- static const char * `get_class_name` ()

Private Attributes

- T `obj`

Additional Inherited Members

Protected Attributes inherited from `GiNaC::basic`

- unsigned `flags`
of type `status_flags`
- unsigned `hashvalue`
hash value

6.160.1 Detailed Description

```
template<class T, template< class > class ComparisonPolicy>
class GiNaC::structure< T, ComparisonPolicy >
```

Wrapper template for making [GiNaC](#) classes out of C++ structures.

6.160.2 Constructor & Destructor Documentation

6.160.2.1 structure()

```
template<class T , template< class > class ComparisonPolicy>
GiNaC::structure< T, CP >::structure (
    const T & t ) [inline]
```

Construct structure as a copy of a given C++ structure.

Default constructor.

6.160.3 Member Function Documentation

6.160.3.1 get_class_name()

```
template<class T , template< class > class ComparisonPolicy>
static const char * GiNaC::structure< T, ComparisonPolicy >::get_class_name ( ) [inline],
[static], [private]
```

6.160.3.2 eval()

```
template<class T , template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::eval ( ) const [inline], [override], [virtual]
```

Perform automatic non-interruptive term rewriting rules.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::hold\(\)](#).

6.160.3.3 evalm()

```
template<class T , template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::evalm ( ) const [inline], [override], [virtual]
```

Evaluate sums, products and integer powers of matrices.

Reimplemented from [GiNaC::basic](#).

6.160.3.4 eval_ncmul()

```
template<class T , template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::eval_ncmul (
    const exvector & v ) const [inline], [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::hold_ncmul\(\)](#).

6.160.3.5 eval_indexed()

```
template<class T , template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::eval_indexed (
    const basic & i ) const [inline], [override], [virtual]
```

Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::hold\(\)](#).

6.160.3.6 print()

```
template<class T , template< class > class ComparisonPolicy>
void GiNaC::structure< T, ComparisonPolicy >::print (
    const print_context & c,
    unsigned level = 0 ) const [inline], [override], [virtual]
```

Output to stream.

This performs double dispatch on the dynamic type of *this and the dynamic type of the supplied print context.

Parameters

<i>c</i>	print context object that describes the output formatting
<i>level</i>	value that is used to identify the precedence or indentation level for placing parentheses and formatting

Reimplemented from [GiNaC::basic](#).

References [c](#).

6.160.3.7 precedence()

```
template<class T , template< class > class ComparisonPolicy>
unsigned GiNaC::structure< T, ComparisonPolicy >::precedence ( ) const [inline], [override],
[virtual]
```

Return relative operator precedence (for parenthezing output).

Reimplemented from [GiNaC::basic](#).

6.160.3.8 info()

```
template<class T , template< class > class ComparisonPolicy>
bool GiNaC::structure< T, ComparisonPolicy >::info (
    unsigned inf ) const [inline], [override], [virtual]
```

Information about the object.

See also

class [info_flags](#)

Reimplemented from [GiNaC::basic](#).

6.160.3.9 nops()

```
template<class T , template< class > class ComparisonPolicy>
size_t GiNaC::structure< T, ComparisonPolicy >::nops ( ) const [inline], [override], [virtual]
```

Number of operands/members.

Reimplemented from [GiNaC::basic](#).

6.160.3.10 op()

```
template<class T , template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::op (
    size_t i ) const [inline], [override], [virtual]
```

Return operand/member at position *i*.

Reimplemented from [GiNaC::basic](#).

6.160.3.11 operator[]() [1/4]

```
template<class T , template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::operator[] (
    const ex & index ) const [inline], [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

6.160.3.12 operator[]() [2/4]

```
template<class T , template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::operator[] (
    size_t i ) const [inline], [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

6.160.3.13 let_op()

```
template<class T , template< class > class ComparisonPolicy>
ex & GiNaC::structure< T, ComparisonPolicy >::let_op (
    size_t i ) [inline], [override], [virtual]
```

Return modifiable operand/member at position i.

Reimplemented from [GiNaC::basic](#).

6.160.3.14 operator[]() [3/4]

```
template<class T , template< class > class ComparisonPolicy>
ex & GiNaC::structure< T, ComparisonPolicy >::operator[] (
    const ex & index ) [inline], [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

6.160.3.15 operator[]() [4/4]

```
template<class T , template< class > class ComparisonPolicy>
ex & GiNaC::structure< T, ComparisonPolicy >::operator[] (
    size_t i ) [inline], [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

6.160.3.16 has()

```
template<class T , template< class > class ComparisonPolicy>
bool GiNaC::structure< T, ComparisonPolicy >::has (
    const ex & pattern,
    unsigned options = 0 ) const [inline], [override], [virtual]
```

Test for occurrence of a pattern.

An object 'has' a pattern if it matches the pattern itself or one of the children 'has' it. As a consequence (according to the definition of children) given $e=x+y+z$, $e.has(x)$ is true but $e.has(x+y)$ is false.

Reimplemented from [GiNaC::basic](#).

References [options](#).

6.160.3.17 match()

```
template<class T , template< class > class ComparisonPolicy>
bool GiNaC::structure< T, ComparisonPolicy >::match (
    const ex & pattern,
    exmap & repl_lst ) const [inline], [override], [virtual]
```

Check whether the expression matches a given pattern.

For every wildcard object in the pattern, a pair with the wildcard as a key and matching expression as a value is added to `repl_lst`.

Reimplemented from [GiNaC::basic](#).

6.160.3.18 match_same_type()

```
template<class T , template< class > class ComparisonPolicy>
bool GiNaC::structure< T, ComparisonPolicy >::match_same_type (
    const basic & other ) const [inline], [override], [protected], [virtual]
```

Returns true if the attributes of two objects are similar enough for a match.

This function must not match subexpressions (this is already done by [basic::match\(\)](#)). Only attributes not accessible by [op\(\)](#) should be compared. This is also the reason why this function doesn't take the wildcard replacement list from [match\(\)](#) as an argument: only subexpressions are subject to wildcard matches. Also, this function only needs to be implemented for container classes because [is_equal_same_type\(\)](#) is automatically used instead of [match_same_type\(\)](#) if [nops\(\)](#) == 0.

See also

[basic::match](#)

Reimplemented from [GiNaC::basic](#).

6.160.3.19 subs()

```
template<class T , template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::subs (
    const exmap & m,
    unsigned options = 0 ) const [inline], [override], [virtual]
```

Substitute a set of objects by arbitrary expressions.

The ex returned will already be evaluated.

Reimplemented from [GiNaC::basic](#).

References [m](#), and [options](#).

6.160.3.20 map()

```
template<class T , template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::map (
    map_function & f ) const [inline], [override], [virtual]
```

Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).

Reimplemented from [GiNaC::basic](#).

6.160.3.21 degree()

```
template<class T , template< class > class ComparisonPolicy>
int GiNaC::structure< T, ComparisonPolicy >::degree (
    const ex & s ) const [inline], [override], [virtual]
```

Return degree of highest power in object s.

Reimplemented from [GiNaC::basic](#).

6.160.3.22 ldegree()

```
template<class T , template< class > class ComparisonPolicy>
int GiNaC::structure< T, ComparisonPolicy >::ldegree (
    const ex & s ) const [inline], [override], [virtual]
```

Return degree of lowest power in object s.

Reimplemented from [GiNaC::basic](#).

6.160.3.23 coeff()

```
template<class T , template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::coeff (
    const ex & s,
    int n = 1 ) const [inline], [override], [virtual]
```

Return coefficient of degree n in object s.

Reimplemented from [GiNaC::basic](#).

References [n](#).

6.160.3.24 expand()

```
template<class T , template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::expand (
    unsigned options = 0 ) const [inline], [override], [virtual]
```

Expand expression, i.e.

multiply it out and return the result as a new expression.

Reimplemented from [GiNaC::basic](#).

References [options](#).

6.160.3.25 collect()

```
template<class T , template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::collect (
    const ex & s,
    bool distributed = false ) const [inline], [override], [virtual]
```

Sort expanded expression in terms of powers of some object(s).

Parameters

<i>s</i>	object(s) to sort in
<i>distributed</i>	recursive or distributed form (only used when s is a list)

Reimplemented from [GiNaC::basic](#).

6.160.3.26 derivative()

```
template<class T , template< class > class ComparisonPolicy>
```

```
ex GiNaC::structure< T, ComparisonPolicy >::derivative (
    const symbol & s ) const [inline], [override], [protected], [virtual]
```

Default implementation of [ex::diff\(\)](#).

It maps the operation on the operands (or returns 0 when the object has no operands).

See also

[ex::diff](#)

Reimplemented from [GiNaC::basic](#).

6.160.3.27 series()

```
template<class T , template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::series (
    const relational & r,
    int order,
    unsigned options = 0 ) const [inline], [override], [virtual]
```

Default implementation of [ex::series\(\)](#).

This performs Taylor expansion.

See also

[ex::series](#)

Reimplemented from [GiNaC::basic](#).

References [options](#), [order](#), and [r](#).

6.160.3.28 normal()

```
template<class T , template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::normal (
    exmap & repl,
    exmap & rev_lookup,
    lst & modifier ) const [inline], [override], [virtual]
```

Default implementation of [ex::normal\(\)](#).

It normalizes the children and replaces the object with a temporary symbol.

See also

[ex::normal](#)

Reimplemented from [GiNaC::basic](#).

6.160.3.29 to_rational()

```
template<class T , template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::to_rational (
    exmap & repl ) const [inline], [override], [virtual]
```

Default implementation of [ex::to_rational\(\)](#).

This replaces the object with a temporary symbol.

Reimplemented from [GiNaC::basic](#).

6.160.3.30 to_polynomial()

```
template<class T , template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::to_polynomial (
    exmap & repl ) const [inline], [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

6.160.3.31 integer_content()

```
template<class T , template< class > class ComparisonPolicy>
numeric GiNaC::structure< T, ComparisonPolicy >::integer_content ( ) const [inline], [override],
[virtual]
```

Reimplemented from [GiNaC::basic](#).

6.160.3.32 smod()

```
template<class T , template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::smod (
    const numeric & xi ) const [inline], [override], [virtual]
```

Apply symmetric modular homomorphism to an expanded multivariate polynomial.

This function is usually used internally by [heur_gcd\(\)](#).

Parameters

xi	modulus
------	---------

Returns

mapped polynomial

See also

[heur_gcd](#)

Reimplemented from [GiNaC::basic](#).

6.160.3.33 max_coefficient()

```
template<class T , template< class > class ComparisonPolicy>
numeric GiNaC::structure< T, ComparisonPolicy >::max_coefficient ( ) const [inline], [override],
[virtual]
```

Implementation [ex::max_coefficient\(\)](#).

See also

[heur_gcd](#)

Reimplemented from [GiNaC::basic](#).

6.160.3.34 get_free_indices()

```
template<class T , template< class > class ComparisonPolicy>
exvector GiNaC::structure< T, ComparisonPolicy >::get_free_indices ( ) const [inline], [override],
[virtual]
```

Return a vector containing the free indices of an expression.

Reimplemented from [GiNaC::basic](#).

6.160.3.35 add_indexed()

```
template<class T , template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::add_indexed (
    const ex & self,
    const ex & other ) const [inline], [override], [virtual]
```

Add two indexed expressions.

They are guaranteed to be of class indexed (or a subclass) and their indices are compatible. This function is used internally by [simplify_indexed\(\)](#).

Parameters

<i>self</i>	First indexed expression; its base object is *this
<i>other</i>	Second indexed expression

Returns

sum of self and other

See also

[ex::simplify_indexed\(\)](#)

Reimplemented from [GiNaC::basic](#).

6.160.3.36 scalar_mul_indexed()

```
template<class T , template< class > class ComparisonPolicy>
ex GiNaC::structure< T, ComparisonPolicy >::scalar_mul_indexed (
    const ex & self,
    const numeric & other ) const [inline], [override], [virtual]
```

Multiply an indexed expression with a scalar.

This function is used internally by [simplify_indexed\(\)](#).

Parameters

<i>self</i>	Indexed expression; its base object is *this
<i>other</i>	Numeric value

Returns

product of self and other

See also

[ex::simplify_indexed\(\)](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ex](#).

6.160.3.37 contract_with()

```
template<class T , template< class > class ComparisonPolicy>
bool GiNaC::structure< T, ComparisonPolicy >::contract_with (
    exvector::iterator self,
    exvector::iterator other,
    exvector & v ) const [inline], [override], [virtual]
```

Try to contract two indexed expressions that appear in the same product.

If a contraction exists, the function overwrites one or both of the expressions and returns true. Otherwise it returns false. It is guaranteed that both expressions are of class indexed (or a subclass) and that at least one dummy index has been found. This functions is used internally by [simplify_indexed\(\)](#).

Parameters

<i>self</i>	Pointer to first indexed expression; its base object is *this
<i>other</i>	Pointer to second indexed expression
<i>v</i>	The complete vector of factors

Returns

true if the contraction was successful, false otherwise

See also

[ex::simplify_indexed\(\)](#)

Reimplemented from [GiNaC::basic](#).

6.160.3.38 return_type()

```
template<class T , template< class > class ComparisonPolicy>
unsigned GiNaC::structure< T, ComparisonPolicy >::return_type ( ) const [inline], [override],
[virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::return_types::commutative](#).

6.160.3.39 return_type_tinfo()

```
template<class T , template< class > class ComparisonPolicy>
return_type_t GiNaC::structure< T, ComparisonPolicy >::return_type_tinfo ( ) const [inline],
[override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [r](#).

6.160.3.40 is_equal_same_type()

```
template<class T , template< class > class ComparisonPolicy>
bool GiNaC::structure< T, ComparisonPolicy >::is_equal_same_type (
    const basic & other ) const [inline], [override], [protected], [virtual]
```

Returns true if two objects of same type are equal.

Normally needs not be reimplemented as long as it wasn't overwritten by some parent class, since it just calls [compare_same_type\(\)](#). The reason why this function exists is that sometimes it is easier to determine equality than an order relation and then it can be overridden.

Reimplemented from [GiNaC::basic](#).

References [GINAC_ASSERT](#), and [GiNaC::structure< T, ComparisonPolicy >::obj](#).

6.160.3.41 calchash()

```
template<class T , template< class > class ComparisonPolicy>
unsigned GiNaC::structure< T, ComparisonPolicy >::calchash ( ) const [inline], [override],
[protected], [virtual]
```

Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.

The method inherited from class basic computes a hash value based on the type and hash values of possible members. For this reason it is well suited for container classes but atomic classes should override this implementation because otherwise they would all end up with the same hashvalue.

Reimplemented from [GiNaC::basic](#).

6.160.3.42 operator->()

```
template<class T , template< class > class ComparisonPolicy>
const T * GiNaC::structure< T, ComparisonPolicy >::operator-> ( ) const [inline]
```

References [GiNaC::structure< T, ComparisonPolicy >::obj](#).

6.160.3.43 get_struct() [1/2]

```
template<class T , template< class > class ComparisonPolicy>
T & GiNaC::structure< T, ComparisonPolicy >::get_struct ( ) [inline]
```

References [GiNaC::structure< T, ComparisonPolicy >::obj](#).

6.160.3.44 `get_struct()` [2/2]

```
template<class T , template< class > class ComparisonPolicy>
const T & GiNaC::structure< T, ComparisonPolicy >::get_struct ( ) const [inline]
```

References [GiNaC::structure< T, ComparisonPolicy >::obj](#).

6.160.4 Member Data Documentation**6.160.4.1** `obj`

```
template<class T , template< class > class ComparisonPolicy>
T GiNaC::structure< T, ComparisonPolicy >::obj [private]
```

Referenced by [GiNaC::structure< T, ComparisonPolicy >::get_struct\(\)](#), [GiNaC::structure< T, ComparisonPolicy >::is_equal_same_t](#) and [GiNaC::structure< T, ComparisonPolicy >::operator->\(\)](#).

The documentation for this class was generated from the following file:

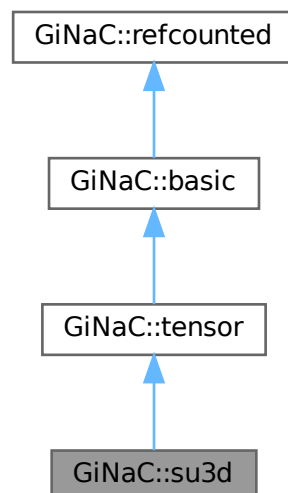
- [structure.h](#)

6.161 **GiNaC::su3d** Class Reference

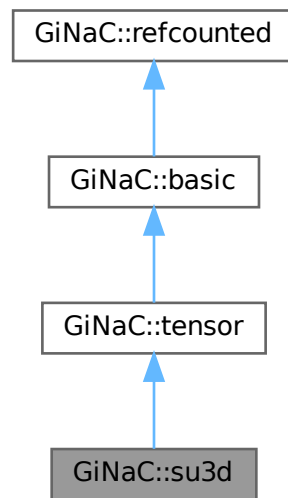
This class represents the tensor of symmetric su(3) structure constants.

```
#include <color.h>
```

Inheritance diagram for GiNaC::su3d:



Collaboration diagram for `GiNaC::su3d`:



Public Member Functions

- `ex eval_indexed` (const `basic` &i) const override
Automatic symbolic evaluation of indexed symmetric structure constant.
- bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const override
Contraction of an indexed symmetric structure constant with something else.

Public Member Functions inherited from `GiNaC::tensor`

- bool `replace_contr_index` (exvector::iterator self, exvector::iterator other) const
Replace dummy index in contracted-with object by the contracting object's second index (used internally for delta and metric tensor contractions).

Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()
basic destructor, virtual because class `ex` will delete objects of derived classes via a `basic`.*
- `basic` (const `basic` &other)
- const `basic` & `operator=` (const `basic` &other)
basic assignment operator: the other object might be of a derived class.
- virtual `basic * duplicate` () const
Create a clone of this object on the heap.
- virtual `ex eval` () const
Perform automatic non-interruptive term rewriting rules.
- virtual `ex evalf` () const
Evaluate object numerically.

- virtual `ex evalm ()` const
Evaluate sums, products and integer powers of matrices.
- virtual `ex eval_integ ()` const
Evaluate integrals, if result is known.
- virtual `ex eval_indexed (const basic &i)` const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void `print (const print_context &c, unsigned level=0)` const
Output to stream.
- virtual void `dbgprint ()` const
Little wrapper around print to be called within a debugger.
- virtual void `dbgprintree ()` const
Little wrapper around printree to be called within a debugger.
- virtual unsigned `precedence ()` const
Return relative operator precedence (for parenthezing output).
- virtual bool `info (unsigned inf)` const
Information about the object.
- virtual size_t `nops ()` const
Number of operands/members.
- virtual `ex op (size_t i)` const
Return operand/member at position i.
- virtual `ex operator[] (const ex &index)` const
- virtual `ex operator[] (size_t i)` const
- virtual `ex & let_op (size_t i)`
Return modifiable operand/member at position i.
- virtual `ex & operator[] (const ex &index)`
- virtual `ex & operator[] (size_t i)`
- virtual bool `has (const ex &other, unsigned options=0)` const
Test for occurrence of a pattern.
- virtual bool `match (const ex &pattern, exmap &repls)` const
Check whether the expression matches a given pattern.
- virtual `ex subs (const exmap &m, unsigned options=0)` const
Substitute a set of objects by arbitrary expressions.
- virtual `ex map (map_function &f)` const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void `accept (GiNaC::visitor &v)` const
- virtual bool `is_polynomial (const ex &var)` const
Check whether this is a polynomial in the given variables.
- virtual int `degree (const ex &s)` const
Return degree of highest power in object s.
- virtual int `ldegree (const ex &s)` const
Return degree of lowest power in object s.
- virtual `ex coeff (const ex &s, int n=1)` const
Return coefficient of degree n in object s.
- virtual `ex expand (unsigned options=0)` const
Expand expression, i.e.
- virtual `ex collect (const ex &s, bool distributed=false)` const
Sort expanded expression in terms of powers of some object(s).
- virtual `ex series (const relational &r, int order, unsigned options=0)` const
Default implementation of `ex::series()`.
- virtual `ex normal (exmap &repl, exmap &rev_lookup, lst &modifier)` const
Default implementation of `ex::normal()`.

- virtual [ex to_rational](#) ([exmap](#) &repl) const
Default implementation of [ex::to_rational\(\)](#).
- virtual [ex to_polynomial](#) ([exmap](#) &repl) const
- virtual [numeric integer_content](#) () const
- virtual [ex smod](#) (const [numeric](#) &xi) const
Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- virtual [numeric max_coefficient](#) () const
Implementation [ex::max_coefficient\(\)](#).
- virtual [exvector get_free_indices](#) () const
Return a vector containing the free indices of an expression.
- virtual [ex add_indexed](#) (const [ex](#) &self, const [ex](#) &other) const
Add two indexed expressions.
- virtual [ex scalar_mul_indexed](#) (const [ex](#) &self, const [numeric](#) &other) const
Multiply an indexed expression with a scalar.
- virtual bool [contract_with](#) (exvector::iterator self, exvector::iterator other, [exvector](#) &v) const
Try to contract two indexed expressions that appear in the same product.
- virtual unsigned [return_type](#) () const
- virtual [return_type_t](#) [return_type_tinfo](#) () const
- virtual [ex conjugate](#) () const
- virtual [ex real_part](#) () const
- virtual [ex imag_part](#) () const
- template<class T >
void [print_dispatch](#) (const [print_context](#) &c, unsigned level) const
Like [print\(\)](#), but dispatch to the specified class.
- void [print_dispatch](#) (const [registered_class_info](#) &ri, const [print_context](#) &c, unsigned level) const
Like [print\(\)](#), but dispatch to the specified class.
- virtual void [archive](#) ([archive_node](#) &n) const
Save (serialize) the object into archive node.
- virtual void [read_archive](#) (const [archive_node](#) &n, [lst](#) &syms)
Load (deserialize) the object from an archive node.
- [ex subs_one_level](#) (const [exmap](#) &m, unsigned [options](#)) const
Helper function for [subs\(\)](#).
- [ex diff](#) (const [symbol](#) &s, unsigned nth=1) const
Default interface of nth derivative [ex::diff\(s, n\)](#).
- int [compare](#) (const [basic](#) &other) const
Compare objects syntactically to establish canonical ordering.
- bool [is_equal](#) (const [basic](#) &other) const
Test for syntactic equality.
- const [basic](#) & [hold](#) () const
Stop further evaluation.
- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const
Set some [status_flags](#).
- const [basic](#) & [clearflag](#) (unsigned f) const
Clear some [status_flags](#).

Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add_reference](#) () noexcept
- unsigned int [remove_reference](#) () noexcept
- unsigned int [get_refcount](#) () const noexcept
- void [set_refcount](#) (unsigned int r) noexcept

Protected Member Functions

- unsigned [return_type](#) () const override
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
- void [do_print_latex](#) (const [print_latex](#) &c, unsigned level) const

Protected Member Functions inherited from [GiNaC::tensor](#)

- unsigned [return_type](#) () const override

Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match_same_type](#) (const [basic](#) &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual [ex derivative](#) (const [symbol](#) &s) const
Default implementation of [ex::diff\(\)](#).
- virtual int [compare_same_type](#) (const [basic](#) &other) const
Returns order relation between two objects of same type.
- virtual bool [is_equal_same_type](#) (const [basic](#) &other) const
Returns true if two objects of same type are equal.
- virtual unsigned [calchash](#) () const
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- void [ensure_if_modifiable](#) () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
Default output to stream.
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
Tree output to stream.
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
Python parsable output to stream.

Additional Inherited Members

Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)
of type [status_flags](#)
- unsigned [hashvalue](#)
hash value

6.161.1 Detailed Description

This class represents the tensor of symmetric su(3) structure constants.

6.161.2 Member Function Documentation

6.161.2.1 eval_indexed()

```
ex GiNaC::su3d::eval_indexed (
    const basic & i ) const [override], [virtual]
```

Automatic symbolic evaluation of indexed symmetric structure constant.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex0](#), [GiNaC::_ex1_2](#), [GiNaC::_ex1_3](#), [GiNaC::_ex3](#), [GiNaC::_ex_1_2](#), [GiNaC::_ex_1_3](#), [GiNaC::_ex_6](#), [CMPINDICES](#), [GINAC_ASSERT](#), [GiNaC::basic::hold\(\)](#), [GiNaC::info_flags::nonnegint](#), [GiNaC::basic::nops\(\)](#), [GiNaC::basic::op\(\)](#), [GiNaC::sqrt\(\)](#), and [std::swap\(\)](#).

6.161.2.2 contract_with()

```
bool GiNaC::su3d::contract_with (
    exvector::iterator self,
    exvector::iterator other,
    exvector & v ) const [override], [virtual]
```

Contraction of an indexed symmetric structure constant with something else.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex1](#), [GiNaC::color_T\(\)](#), [GiNaC::delta_tensor\(\)](#), [GiNaC::find_free_and_dummy\(\)](#), [GiNaC::get_representation_label\(\)](#), [GINAC_ASSERT](#), [GiNaC::ex::op\(\)](#), and [GiNaC::permute_free_index_to_front\(\)](#).

6.161.2.3 return_type()

```
unsigned GiNaC::su3d::return_type ( ) const [inline], [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::return_types::commutative](#).

6.161.2.4 do_print()

```
void GiNaC::su3d::do_print (
    const print_context & c,
    unsigned level ) const [protected]
```

6.161.2.5 do_print_latex()

```
void GiNaC::su3d::do_print_latex (
    const print\_latex & c,
    unsigned level ) const [protected]
```

The documentation for this class was generated from the following files:

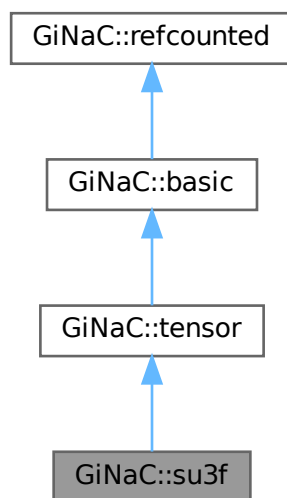
- [color.h](#)
- [color.cpp](#)

6.162 GiNaC::su3f Class Reference

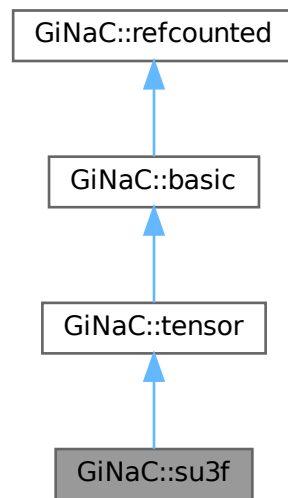
This class represents the tensor of antisymmetric su(3) structure constants.

```
#include <color.h>
```

Inheritance diagram for GiNaC::su3f:



Collaboration diagram for `GiNaC::su3f`:



Public Member Functions

- `ex eval_indexed` (const `basic` &i) const override
Automatic symbolic evaluation of indexed antisymmetric structure constant.
- `bool contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const override
Contraction of an indexed antisymmetric structure constant with something else.

Public Member Functions inherited from `GiNaC::tensor`

- `bool replace_contr_index` (exvector::iterator self, exvector::iterator other) const
Replace dummy index in contracted-with object by the contracting object's second index (used internally for delta and metric tensor contractions).

Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()
basic destructor, virtual because class `ex` will delete objects of derived classes via a `basic`.*
- `basic` (const `basic` &other)
- const `basic` & `operator=` (const `basic` &other)
basic assignment operator: the other object might be of a derived class.
- virtual `basic * duplicate` () const
Create a clone of this object on the heap.
- virtual `ex eval` () const
Perform automatic non-interruptive term rewriting rules.
- virtual `ex evalf` () const
Evaluate object numerically.

- virtual `ex evalm` () const
Evaluate sums, products and integer powers of matrices.
- virtual `ex eval_integ` () const
Evaluate integrals, if result is known.
- virtual `ex eval_indexed` (const `basic` &i) const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void `print` (const `print_context` &c, unsigned level=0) const
Output to stream.
- virtual void `dbgprint` () const
Little wrapper around print to be called within a debugger.
- virtual void `dbgprintree` () const
Little wrapper around printree to be called within a debugger.
- virtual unsigned `precedence` () const
Return relative operator precedence (for parenthezing output).
- virtual bool `info` (unsigned inf) const
Information about the object.
- virtual size_t `nops` () const
Number of operands/members.
- virtual `ex op` (size_t i) const
Return operand/member at position i.
- virtual `ex operator[]` (const `ex` &index) const
- virtual `ex operator[]` (size_t i) const
- virtual `ex & let_op` (size_t i)
Return modifiable operand/member at position i.
- virtual `ex & operator[]` (const `ex` &index)
- virtual `ex & operator[]` (size_t i)
- virtual bool `has` (const `ex` &other, unsigned `options`=0) const
Test for occurrence of a pattern.
- virtual bool `match` (const `ex` &pattern, `exmap` &repls) const
Check whether the expression matches a given pattern.
- virtual `ex subs` (const `exmap` &m, unsigned `options`=0) const
Substitute a set of objects by arbitrary expressions.
- virtual `ex map` (`map_function` &f) const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void `accept` (GiNaC::visitor &v) const
- virtual bool `is_polynomial` (const `ex` &var) const
Check whether this is a polynomial in the given variables.
- virtual int `degree` (const `ex` &s) const
Return degree of highest power in object s.
- virtual int `ldegree` (const `ex` &s) const
Return degree of lowest power in object s.
- virtual `ex coeff` (const `ex` &s, int n=1) const
Return coefficient of degree n in object s.
- virtual `ex expand` (unsigned `options`=0) const
Expand expression, i.e.
- virtual `ex collect` (const `ex` &s, bool distributed=false) const
Sort expanded expression in terms of powers of some object(s).
- virtual `ex series` (const `relational` &r, int `order`, unsigned `options`=0) const
Default implementation of `ex::series()`.
- virtual `ex normal` (`exmap` &repl, `exmap` &rev_lookup, `lst` &modifier) const
Default implementation of `ex::normal()`.

- virtual [ex to_rational](#) ([exmap](#) &repl) const
Default implementation of [ex::to_rational\(\)](#).
- virtual [ex to_polynomial](#) ([exmap](#) &repl) const
- virtual [numeric integer_content](#) () const
- virtual [ex smod](#) (const [numeric](#) &xi) const
Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- virtual [numeric max_coefficient](#) () const
Implementation [ex::max_coefficient\(\)](#).
- virtual [exvector get_free_indices](#) () const
Return a vector containing the free indices of an expression.
- virtual [ex add_indexed](#) (const [ex](#) &self, const [ex](#) &other) const
Add two indexed expressions.
- virtual [ex scalar_mul_indexed](#) (const [ex](#) &self, const [numeric](#) &other) const
Multiply an indexed expression with a scalar.
- virtual bool [contract_with](#) (exvector::iterator self, exvector::iterator other, [exvector](#) &v) const
Try to contract two indexed expressions that appear in the same product.
- virtual unsigned [return_type](#) () const
- virtual [return_type_t](#) [return_type_tinfo](#) () const
- virtual [ex conjugate](#) () const
- virtual [ex real_part](#) () const
- virtual [ex imag_part](#) () const
- template<class T >
void [print_dispatch](#) (const [print_context](#) &c, unsigned level) const
Like [print\(\)](#), but dispatch to the specified class.
- void [print_dispatch](#) (const [registered_class_info](#) &ri, const [print_context](#) &c, unsigned level) const
Like [print\(\)](#), but dispatch to the specified class.
- virtual void [archive](#) ([archive_node](#) &n) const
Save (serialize) the object into archive node.
- virtual void [read_archive](#) (const [archive_node](#) &n, [lst](#) &syms)
Load (deserialize) the object from an archive node.
- [ex subs_one_level](#) (const [exmap](#) &m, unsigned [options](#)) const
Helper function for [subs\(\)](#).
- [ex diff](#) (const [symbol](#) &s, unsigned nth=1) const
Default interface of nth derivative [ex::diff\(s, n\)](#).
- int [compare](#) (const [basic](#) &other) const
Compare objects syntactically to establish canonical ordering.
- bool [is_equal](#) (const [basic](#) &other) const
Test for syntactic equality.
- const [basic](#) & [hold](#) () const
Stop further evaluation.
- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const
Set some [status_flags](#).
- const [basic](#) & [clearflag](#) (unsigned f) const
Clear some [status_flags](#).

Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add_reference](#) () noexcept
- unsigned int [remove_reference](#) () noexcept
- unsigned int [get_refcount](#) () const noexcept
- void [set_refcount](#) (unsigned int r) noexcept

Protected Member Functions

- unsigned `return_type` () const override
- void `do_print` (const `print_context` &c, unsigned level) const
- void `do_print_latex` (const `print_latex` &c, unsigned level) const

Protected Member Functions inherited from `GiNaC::tensor`

- unsigned `return_type` () const override

Protected Member Functions inherited from `GiNaC::basic`

- `basic` ()
- virtual `ex eval_ncmul` (const `exvector` &v) const
- virtual bool `match_same_type` (const `basic` &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual `ex derivative` (const `symbol` &s) const
Default implementation of `ex::diff()`.
- virtual int `compare_same_type` (const `basic` &other) const
Returns order relation between two objects of same type.
- virtual bool `is_equal_same_type` (const `basic` &other) const
Returns true if two objects of same type are equal.
- virtual unsigned `calchash` () const
Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.
- void `ensure_if_modifiable` () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void `do_print` (const `print_context` &c, unsigned level) const
Default output to stream.
- void `do_print_tree` (const `print_tree` &c, unsigned level) const
Tree output to stream.
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const
Python parsable output to stream.

Additional Inherited Members

Protected Attributes inherited from `GiNaC::basic`

- unsigned `flags`
of type `status_flags`
- unsigned `hashvalue`
hash value

6.162.1 Detailed Description

This class represents the tensor of antisymmetric su(3) structure constants.

6.162.2 Member Function Documentation

6.162.2.1 `eval_indexed()`

```
ex GiNaC::su3f::eval_indexed (
    const basic & i ) const [override], [virtual]
```

Automatic symbolic evaluation of indexed antisymmetric structure constant.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex0](#), [GiNaC::_ex1_2](#), [GiNaC::_ex3](#), [GiNaC::_ex_1_2](#), [CMPINDICES](#), [GINAC_ASSERT](#), [GiNaC::basic::hold\(\)](#), [GiNaC::info_flags::nonnegint](#), [GiNaC::basic::nops\(\)](#), [GiNaC::basic::op\(\)](#), [GiNaC::sqrt\(\)](#), and [std::swap\(\)](#).

6.162.2.2 `contract_with()`

```
bool GiNaC::su3f::contract_with (
    exvector::iterator self,
    exvector::iterator other,
    exvector & v ) const [override], [virtual]
```

Contraction of an indexed antisymmetric structure constant with something else.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex1](#), [GiNaC::color_T\(\)](#), [GiNaC::delta_tensor\(\)](#), [GiNaC::get_representation_label\(\)](#), [GINAC_ASSERT](#), [GiNaC::l](#), [GiNaC::ex::op\(\)](#), and [GiNaC::permute_free_index_to_front\(\)](#).

6.162.2.3 `return_type()`

```
unsigned GiNaC::su3f::return_type ( ) const [inline], [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

References [GiNaC::return_types::commutative](#).

6.162.2.4 `do_print()`

```
void GiNaC::su3f::do_print (
    const print_context & c,
    unsigned level ) const [protected]
```


6.162.2.5 do_print_latex()

```
void GiNaC::su3f::do_print_latex (
    const print\_latex & c,
    unsigned level ) const [protected]
```

The documentation for this class was generated from the following files:

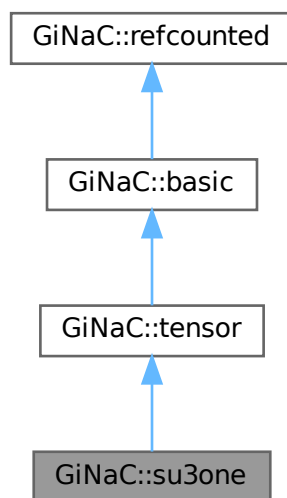
- [color.h](#)
- [color.cpp](#)

6.163 GiNaC::su3one Class Reference

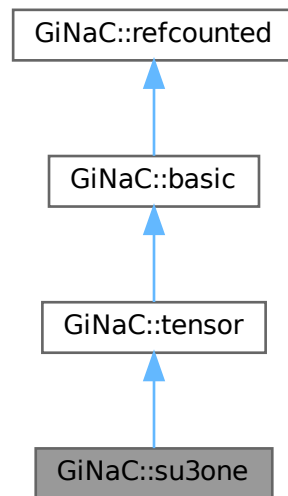
This class represents the su(3) unity element.

```
#include <color.h>
```

Inheritance diagram for GiNaC::su3one:



Collaboration diagram for `GiNaC::su3one`:



Protected Member Functions

- void `do_print` (const `print_context` &c, unsigned level) const
- void `do_print_latex` (const `print_latex` &c, unsigned level) const

Protected Member Functions inherited from `GiNaC::tensor`

- unsigned `return_type` () const override

Protected Member Functions inherited from `GiNaC::basic`

- `basic` ()
- virtual `ex eval_ncmul` (const `exvector` &v) const
- virtual bool `match_same_type` (const `basic` &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual `ex derivative` (const `symbol` &s) const
Default implementation of `ex::diff()`.
- virtual int `compare_same_type` (const `basic` &other) const
Returns order relation between two objects of same type.
- virtual bool `is_equal_same_type` (const `basic` &other) const
Returns true if two objects of same type are equal.
- virtual unsigned `calchash` () const
Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.
- void `ensure_if_modifiable` () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void `do_print` (const `print_context` &c, unsigned level) const
Default output to stream.
- void `do_print_tree` (const `print_tree` &c, unsigned level) const
Tree output to stream.
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const
Python parsable output to stream.

Additional Inherited Members

Public Member Functions inherited from [GiNaC::tensor](#)

- bool [replace_contr_index](#) (exvector::iterator self, exvector::iterator other) const
Replace dummy index in contracted-with object by the contracting object's second index (used internally for delta and metric tensor contractions).

Public Member Functions inherited from [GiNaC::basic](#)

- virtual [~basic](#) ()
basic destructor, virtual because class ex will delete objects of derived classes via a basic.*
- [basic](#) (const [basic](#) &other)
- const [basic](#) & [operator=](#) (const [basic](#) &other)
basic assignment operator: the other object might be of a derived class.
- virtual [basic](#) * [duplicate](#) () const
Create a clone of this object on the heap.
- virtual [ex eval](#) () const
Perform automatic non-interruptive term rewriting rules.
- virtual [ex evalf](#) () const
Evaluate object numerically.
- virtual [ex evalm](#) () const
Evaluate sums, products and integer powers of matrices.
- virtual [ex eval_integ](#) () const
Evaluate integrals, if result is known.
- virtual [ex eval_indexed](#) (const [basic](#) &i) const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void [print](#) (const [print_context](#) &c, unsigned level=0) const
Output to stream.
- virtual void [dbgprint](#) () const
Little wrapper around print to be called within a debugger.
- virtual void [dbgprinttree](#) () const
Little wrapper around printtree to be called within a debugger.
- virtual unsigned [precedence](#) () const
Return relative operator precedence (for parenthezing output).
- virtual bool [info](#) (unsigned inf) const
Information about the object.
- virtual size_t [nops](#) () const
Number of operands/members.
- virtual [ex op](#) (size_t i) const
Return operand/member at position i.
- virtual [ex operator\[\]](#) (const [ex](#) &index) const
- virtual [ex operator\[\]](#) (size_t i) const
- virtual [ex](#) & [let_op](#) (size_t i)
Return modifiable operand/member at position i.
- virtual [ex](#) & [operator\[\]](#) (const [ex](#) &index)
- virtual [ex](#) & [operator\[\]](#) (size_t i)
- virtual bool [has](#) (const [ex](#) &other, unsigned [options](#)=0) const
Test for occurrence of a pattern.
- virtual bool [match](#) (const [ex](#) &pattern, [exmap](#) &repls) const
Check whether the expression matches a given pattern.

- virtual `ex subs` (const `exmap` &m, unsigned `options`=0) const
Substitute a set of objects by arbitrary expressions.
- virtual `ex map` (`map_function` &f) const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void `accept` (`GiNaC::visitor` &v) const
- virtual bool `is_polynomial` (const `ex` &var) const
Check whether this is a polynomial in the given variables.
- virtual int `degree` (const `ex` &s) const
Return degree of highest power in object s.
- virtual int `ldegree` (const `ex` &s) const
Return degree of lowest power in object s.
- virtual `ex coeff` (const `ex` &s, int `n`=1) const
Return coefficient of degree n in object s.
- virtual `ex expand` (unsigned `options`=0) const
Expand expression, i.e.
- virtual `ex collect` (const `ex` &s, bool `distributed`=false) const
Sort expanded expression in terms of powers of some object(s).
- virtual `ex series` (const `relational` &r, int `order`, unsigned `options`=0) const
Default implementation of `ex::series()`.
- virtual `ex normal` (`exmap` &repl, `exmap` &rev_lookup, `lst` &modifier) const
Default implementation of `ex::normal()`.
- virtual `ex to_rational` (`exmap` &repl) const
Default implementation of `ex::to_rational()`.
- virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const
Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- virtual `numeric max_coefficient` () const
Implementation `ex::max_coefficient()`.
- virtual `exvector get_free_indices` () const
Return a vector containing the free indices of an expression.
- virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
Add two indexed expressions.
- virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
Multiply an indexed expression with a scalar.
- virtual bool `contract_with` (`exvector::iterator` self, `exvector::iterator` other, `exvector` &v) const
Try to contract two indexed expressions that appear in the same product.
- virtual unsigned `return_type` () const
- virtual `return_type_t return_type_tinfo` () const
- virtual `ex conjugate` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const
- template<class T >
void `print_dispatch` (const `print_context` &c, unsigned level) const
Like `print()`, but dispatch to the specified class.
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const
Like `print()`, but dispatch to the specified class.
- virtual void `archive` (`archive_node` &n) const
Save (serialize) the object into archive node.
- virtual void `read_archive` (const `archive_node` &n, `lst` &syms)
Load (deserialize) the object from an archive node.

- `ex subs_one_level` (const `exmap` &`m`, unsigned `options`) const
Helper function for `subs()`.
- `ex diff` (const `symbol` &`s`, unsigned `nth=1`) const
Default interface of `nth` derivative `ex::diff(s, n)`.
- `int compare` (const `basic` &`other`) const
Compare objects syntactically to establish canonical ordering.
- `bool is_equal` (const `basic` &`other`) const
Test for syntactic equality.
- `const basic & hold` () const
Stop further evaluation.
- unsigned `gethash` () const
- `const basic & setflag` (unsigned `f`) const
Set some `status_flags`.
- `const basic & clearflag` (unsigned `f`) const
Clear some `status_flags`.

Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted` () noexcept
- unsigned `int add_reference` () noexcept
- unsigned `int remove_reference` () noexcept
- unsigned `int get_refcount` () const noexcept
- void `set_refcount` (unsigned `int r`) noexcept

Protected Attributes inherited from `GiNaC::basic`

- unsigned `flags`
of type `status_flags`
- unsigned `hashvalue`
hash value

6.163.1 Detailed Description

This class represents the $su(3)$ unity element.

6.163.2 Member Function Documentation

6.163.2.1 `do_print()`

```
void GiNaC::su3one::do_print (
    const print_context & c,
    unsigned level ) const [protected]
```

6.163.2.2 do_print_latex()

```
void GiNaC::su3one::do_print_latex (
    const print\_latex & c,
    unsigned level ) const [protected]
```

The documentation for this class was generated from the following file:

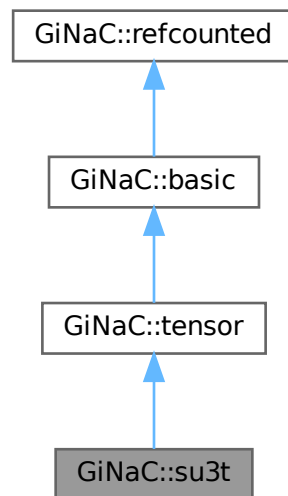
- [color.h](#)

6.164 GiNaC::su3t Class Reference

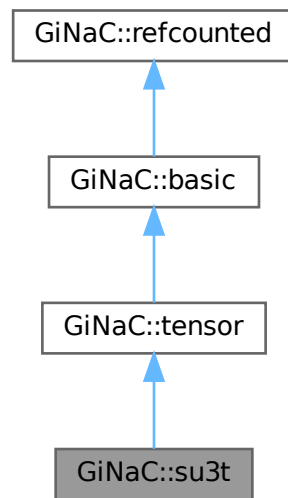
This class represents an su(3) generator.

```
#include <color.h>
```

Inheritance diagram for GiNaC::su3t:



Collaboration diagram for GiNaC::su3t:



Public Member Functions

- bool [contract_with](#) (exvector::iterator self, exvector::iterator other, [exvector](#) &v) const override
Contraction of generator with something else.

Public Member Functions inherited from [GiNaC::tensor](#)

- bool [replace_contr_index](#) (exvector::iterator self, exvector::iterator other) const
Replace dummy index in contracted-with object by the contracting object's second index (used internally for delta and metric tensor contractions).

Public Member Functions inherited from [GiNaC::basic](#)

- virtual [~basic](#) ()
basic destructor, virtual because class ex will delete objects of derived classes via a basic.*
- [basic](#) (const [basic](#) &other)
- const [basic](#) & [operator=](#) (const [basic](#) &other)
basic assignment operator: the other object might be of a derived class.
- virtual [basic](#) * [duplicate](#) () const
Create a clone of this object on the heap.
- virtual [ex eval](#) () const
Perform automatic non-interruptive term rewriting rules.
- virtual [ex evalf](#) () const
Evaluate object numerically.
- virtual [ex evalm](#) () const
Evaluate sums, products and integer powers of matrices.

- virtual `ex eval_integ ()` const
Evaluate integrals, if result is known.
- virtual `ex eval_indexed (const basic &i)` const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void `print (const print_context &c, unsigned level=0)` const
Output to stream.
- virtual void `dbgprint ()` const
Little wrapper around print to be called within a debugger.
- virtual void `dbgprinttree ()` const
Little wrapper around printtree to be called within a debugger.
- virtual unsigned `precedence ()` const
Return relative operator precedence (for parenthezing output).
- virtual bool `info (unsigned inf)` const
Information about the object.
- virtual size_t `nops ()` const
Number of operands/members.
- virtual `ex op (size_t i)` const
Return operand/member at position i.
- virtual `ex operator[] (const ex &index)` const
- virtual `ex operator[] (size_t i)` const
- virtual `ex &let_op (size_t i)`
Return modifiable operand/member at position i.
- virtual `ex &operator[] (const ex &index)`
- virtual `ex &operator[] (size_t i)`
- virtual bool `has (const ex &other, unsigned options=0)` const
Test for occurrence of a pattern.
- virtual bool `match (const ex &pattern, exmap &repls)` const
Check whether the expression matches a given pattern.
- virtual `ex subs (const exmap &m, unsigned options=0)` const
Substitute a set of objects by arbitrary expressions.
- virtual `ex map (map_function &f)` const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void `accept (GiNaC::visitor &v)` const
- virtual bool `is_polynomial (const ex &var)` const
Check whether this is a polynomial in the given variables.
- virtual int `degree (const ex &s)` const
Return degree of highest power in object s.
- virtual int `ldegree (const ex &s)` const
Return degree of lowest power in object s.
- virtual `ex coeff (const ex &s, int n=1)` const
Return coefficient of degree n in object s.
- virtual `ex expand (unsigned options=0)` const
Expand expression, i.e.
- virtual `ex collect (const ex &s, bool distributed=false)` const
Sort expanded expression in terms of powers of some object(s).
- virtual `ex series (const relational &r, int order, unsigned options=0)` const
Default implementation of `ex::series()`.
- virtual `ex normal (exmap &repl, exmap &rev_lookup, lst &modifier)` const
Default implementation of `ex::normal()`.
- virtual `ex to_rational (exmap &repl)` const
Default implementation of `ex::to_rational()`.

- virtual [ex to_polynomial](#) ([exmap](#) &repl) const
- virtual [numeric integer_content](#) () const
- virtual [ex smod](#) (const [numeric](#) &xi) const
Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- virtual [numeric max_coefficient](#) () const
Implementation [ex::max_coefficient\(\)](#).
- virtual [exvector get_free_indices](#) () const
Return a vector containing the free indices of an expression.
- virtual [ex add_indexed](#) (const [ex](#) &self, const [ex](#) &other) const
Add two indexed expressions.
- virtual [ex scalar_mul_indexed](#) (const [ex](#) &self, const [numeric](#) &other) const
Multiply an indexed expression with a scalar.
- virtual bool [contract_with](#) ([exvector::iterator](#) self, [exvector::iterator](#) other, [exvector](#) &v) const
Try to contract two indexed expressions that appear in the same product.
- virtual unsigned [return_type](#) () const
- virtual [return_type_t](#) [return_type_tinfo](#) () const
- virtual [ex conjugate](#) () const
- virtual [ex real_part](#) () const
- virtual [ex imag_part](#) () const
- template<class T >
void [print_dispatch](#) (const [print_context](#) &c, unsigned level) const
Like [print\(\)](#), but dispatch to the specified class.
- void [print_dispatch](#) (const [registered_class_info](#) &ri, const [print_context](#) &c, unsigned level) const
Like [print\(\)](#), but dispatch to the specified class.
- virtual void [archive](#) ([archive_node](#) &n) const
Save (serialize) the object into archive node.
- virtual void [read_archive](#) (const [archive_node](#) &n, [lst](#) &syms)
Load (deserialize) the object from an archive node.
- [ex subs_one_level](#) (const [exmap](#) &m, unsigned [options](#)) const
Helper function for [subs\(\)](#).
- [ex diff](#) (const [symbol](#) &s, unsigned nth=1) const
Default interface of nth derivative [ex::diff\(s, n\)](#).
- int [compare](#) (const [basic](#) &other) const
Compare objects syntactically to establish canonical ordering.
- bool [is_equal](#) (const [basic](#) &other) const
Test for syntactic equality.
- const [basic](#) & [hold](#) () const
Stop further evaluation.
- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const
Set some [status_flags](#).
- const [basic](#) & [clearflag](#) (unsigned f) const
Clear some [status_flags](#).

Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add_reference](#) () noexcept
- unsigned int [remove_reference](#) () noexcept
- unsigned int [get_refcount](#) () const noexcept
- void [set_refcount](#) (unsigned int r) noexcept

Protected Member Functions

- void `do_print` (const `print_context` &c, unsigned level) const
- void `do_print_latex` (const `print_latex` &c, unsigned level) const

Protected Member Functions inherited from `GiNaC::tensor`

- unsigned `return_type` () const override

Protected Member Functions inherited from `GiNaC::basic`

- `basic` ()
- virtual `ex eval_ncmul` (const `exvector` &v) const
- virtual bool `match_same_type` (const `basic` &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual `ex derivative` (const `symbol` &s) const
Default implementation of `ex::diff()`.
- virtual int `compare_same_type` (const `basic` &other) const
Returns order relation between two objects of same type.
- virtual bool `is_equal_same_type` (const `basic` &other) const
Returns true if two objects of same type are equal.
- virtual unsigned `calchash` () const
Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.
- void `ensure_if_modifiable` () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void `do_print` (const `print_context` &c, unsigned level) const
Default output to stream.
- void `do_print_tree` (const `print_tree` &c, unsigned level) const
Tree output to stream.
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const
Python parsable output to stream.

Additional Inherited Members

Protected Attributes inherited from `GiNaC::basic`

- unsigned `flags`
of type `status_flags`
- unsigned `hashvalue`
hash value

6.164.1 Detailed Description

This class represents an $su(3)$ generator.

6.164.2 Member Function Documentation

6.164.2.1 contract_with()

```
bool GiNaC::su3t::contract_with (
    exvector::iterator self,
    exvector::iterator other,
    exvector & v ) const [override], [virtual]
```

Contraction of generator with something else.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex1](#), [GiNaC::color_ONE\(\)](#), [GiNaC::color_trace\(\)](#), and [GINAC_ASSERT](#).

6.164.2.2 do_print()

```
void GiNaC::su3t::do_print (
    const print_context & c,
    unsigned level ) const [protected]
```

6.164.2.3 do_print_latex()

```
void GiNaC::su3t::do_print_latex (
    const print_latex & c,
    unsigned level ) const [protected]
```

The documentation for this class was generated from the following files:

- [color.h](#)
- [color.cpp](#)

6.165 GiNaC::subs_options Class Reference

Flags to control the behavior of [subs\(\)](#).

```
#include <flags.h>
```

Public Types

- enum {
[no_pattern](#) = 0x0001 , [subs_no_pattern](#) = 0x0001 , [algebraic](#) = 0x0002 , [subs_algebraic](#) = 0x0002 ,
[pattern_is_product](#) = 0x0004 , [pattern_is_not_product](#) = 0x0008 , [no_index_renaming](#) = 0x0010 ,
[really_subs_idx](#) = 0x0020 }

6.165.1 Detailed Description

Flags to control the behavior of [subs\(\)](#).

6.165.2 Member Enumeration Documentation

6.165.2.1 anonymous enum

```
anonymous enum
```

Enumerator

no_pattern	disable pattern matching
subs_no_pattern	
algebraic	enable algebraic substitutions
subs_algebraic	
pattern_is_product	used internally by expairseq::subschildren()
pattern_is_not_product	used internally by expairseq::subschildren()
no_index_renaming	
really_subs_idx	

The documentation for this class was generated from the following file:

- [flags.h](#)

6.166 GiNaC::sy_is_less Class Reference

Public Member Functions

- [sy_is_less](#) (exvector::iterator v_)
- bool [operator\(\)](#) (const [ex](#) &lh, const [ex](#) &rh) const

Private Attributes

- exvector::iterator [v](#)

6.166.1 Constructor & Destructor Documentation

6.166.1.1 sy_is_less()

```
GiNaC::sy_is_less::sy_is_less (
    exvector::iterator v_ ) [inline]
```

6.166.2 Member Function Documentation

6.166.2.1 operator>()

```
bool GiNaC::sy_is_less::operator() (
    const ex & lh,
    const ex & rh ) const [inline]
```

References [GINAC_ASSERT](#), and [v](#).

6.166.3 Member Data Documentation

6.166.3.1 v

`exvector::iterator GiNaC::sy_is_less::v` [private]

Referenced by [operator\(\)\(\)](#).

The documentation for this class was generated from the following file:

- [symmetry.cpp](#)

6.167 GiNaC::sy_swap Class Reference

Public Member Functions

- [sy_swap](#) (`exvector::iterator v_`, `bool &s`)
- `void` [operator\(\)](#) (`const` [ex](#) &lh, `const` [ex](#) &rh)

Public Attributes

- `bool` & [swapped](#)

Private Attributes

- `exvector::iterator` [v](#)

6.167.1 Constructor & Destructor Documentation

6.167.1.1 sy_swap()

```
GiNaC::sy_swap::sy_swap (  
    exvector::iterator v_,  
    bool & s ) [inline]
```

6.167.2 Member Function Documentation

6.167.2.1 `operator()`

```
void GiNaC::sy_swap::operator() (
    const ex & lh,
    const ex & rh ) [inline]
```

References [GINAC_ASSERT](#), [swapped](#), and [v](#).

6.167.3 Member Data Documentation

6.167.3.1 `v`

```
exvector::iterator GiNaC::sy_swap::v [private]
```

Referenced by [operator\(\)](#).

6.167.3.2 `swapped`

```
bool& GiNaC::sy_swap::swapped
```

Referenced by [operator\(\)](#).

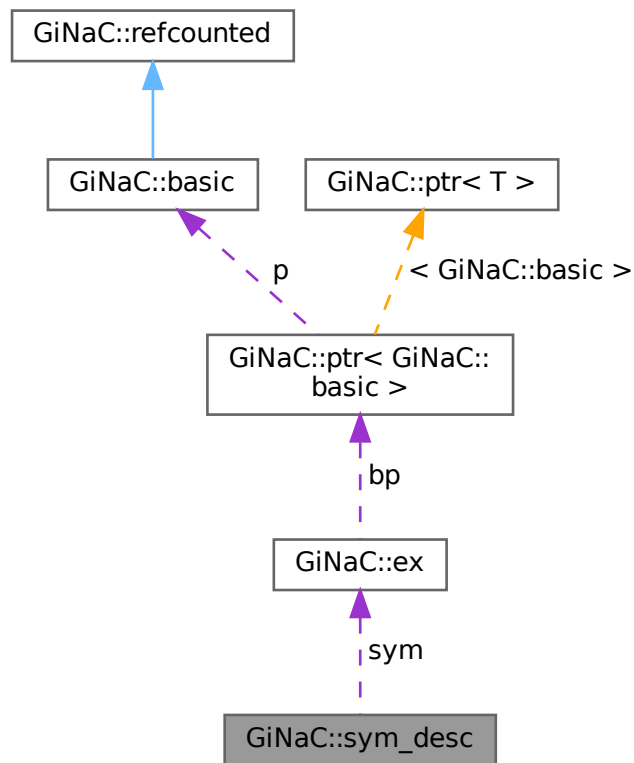
The documentation for this class was generated from the following file:

- [symmetry.cpp](#)

6.168 GiNaC::sym_desc Struct Reference

This structure holds information about the highest and lowest degrees in which a symbol appears in two multivariate polynomials "a" and "b".

Collaboration diagram for GiNaC::sym_desc:



Public Member Functions

- `sym_desc` (const `ex` &s)
Initialize symbol, leave other variables uninitialized.
- `bool operator<` (const `sym_desc` &x) const
Comparison operator for sorting.

Public Attributes

- `ex sym`
Reference to symbol.
- `int deg_a`
Highest degree of symbol in polynomial "a".
- `int deg_b`
Highest degree of symbol in polynomial "b".
- `int ldeg_a`
Lowest degree of symbol in polynomial "a".
- `int ldeg_b`
Lowest degree of symbol in polynomial "b".

- int [max_deg](#)
Maximum of `deg_a` and `deg_b` (Used for sorting)
- size_t [max_lcnops](#)
Maximum number of terms of leading coefficient of symbol in both polynomials.

6.168.1 Detailed Description

This structure holds information about the highest and lowest degrees in which a symbol appears in two multivariate polynomials "a" and "b".

A vector of these structures with information about all symbols in two polynomials can be created with the function [get_symbol_stats\(\)](#).

See also

[get_symbol_stats](#)

6.168.2 Constructor & Destructor Documentation

6.168.2.1 `sym_desc()`

```
GiNaC::sym_desc::sym_desc (
    const ex & s ) [inline]
```

Initialize symbol, leave other variables uninitialized.

6.168.3 Member Function Documentation

6.168.3.1 `operator<()`

```
bool GiNaC::sym_desc::operator< (
    const sym\_desc & x ) const [inline]
```

Comparison operator for sorting.

References [max_deg](#), [max_lcnops](#), and `x`.

6.168.4 Member Data Documentation

6.168.4.1 sym

`ex` `GiNaC::sym_desc::sym`

Reference to symbol.

6.168.4.2 deg_a

`int` `GiNaC::sym_desc::deg_a`

Highest degree of symbol in polynomial "a".

6.168.4.3 deg_b

`int` `GiNaC::sym_desc::deg_b`

Highest degree of symbol in polynomial "b".

6.168.4.4 ldeg_a

`int` `GiNaC::sym_desc::ldeg_a`

Lowest degree of symbol in polynomial "a".

6.168.4.5 ldeg_b

`int` `GiNaC::sym_desc::ldeg_b`

Lowest degree of symbol in polynomial "b".

6.168.4.6 max_deg

`int` `GiNaC::sym_desc::max_deg`

Maximum of `deg_a` and `deg_b` (Used for sorting)

Referenced by [operator<\(\)](#).

6.168.4.7 max_lcnops

```
size_t GiNaC::sym_desc::max_lcnops
```

Maximum number of terms of leading coefficient of symbol in both polynomials.

Referenced by [operator<\(\)](#).

The documentation for this struct was generated from the following file:

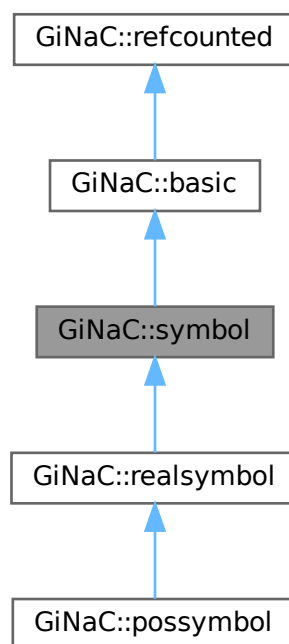
- [normal.cpp](#)

6.169 GiNaC::symbol Class Reference

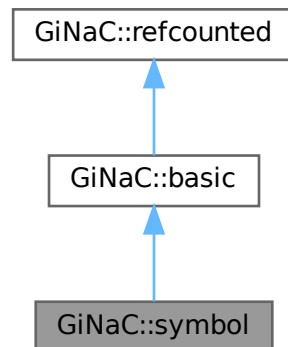
Basic CAS symbol.

```
#include <symbol.h>
```

Inheritance diagram for GiNaC::symbol:



Collaboration diagram for GiNaC::symbol:



Public Member Functions

- [symbol](#) (const std::string &initname)
- [symbol](#) (const std::string &initname, const std::string &texname)
- bool [info](#) (unsigned inf) const override
Information about the object.
- [ex eval](#) () const override
Perform automatic non-interruptive term rewriting rules.
- [ex evalf](#) () const override
Evaluate object numerically.
- [ex series](#) (const [relational](#) &s, int [order](#), unsigned [options](#)=0) const override
Implementation of [ex::series\(\)](#) for symbols.
- [ex subs](#) (const [exmap](#) &m, unsigned [options](#)=0) const override
Substitute a set of objects by arbitrary expressions.
- [ex normal](#) ([exmap](#) &repl, [exmap](#) &rev_lookup, [lst](#) &modifier) const override
Implementation of [ex::normal\(\)](#) for symbols.
- [ex to_rational](#) ([exmap](#) &repl) const override
Implementation of [ex::to_rational\(\)](#) for symbols.
- [ex to_polynomial](#) ([exmap](#) &repl) const override
Implementation of [ex::to_polynomial\(\)](#) for symbols.
- [ex conjugate](#) () const override
- [ex real_part](#) () const override
- [ex imag_part](#) () const override
- bool [is_polynomial](#) (const [ex](#) &var) const override
Check whether this is a polynomial in the given variables.
- void [archive](#) ([archive_node](#) &n) const override
Save (a.k.a.
- void [read_archive](#) (const [archive_node](#) &n, [lst](#) &syms) override
Read (a.k.a.
- virtual unsigned [get_domain](#) () const
- void [set_name](#) (const std::string &n)
- void [set_TeX_name](#) (const std::string &n)
- std::string [get_name](#) () const
- std::string [get_TeX_name](#) () const

Public Member Functions inherited from [GiNaC::basic](#)

- virtual [~basic](#) ()
basic destructor, virtual because class ex will delete objects of derived classes via a basic.*
- [basic](#) (const [basic](#) &other)
- const [basic](#) & [operator=](#) (const [basic](#) &other)
basic assignment operator: the other object might be of a derived class.
- virtual [basic](#) * [duplicate](#) () const
Create a clone of this object on the heap.
- virtual [ex eval](#) () const
Perform automatic non-interruptive term rewriting rules.
- virtual [ex evalf](#) () const
Evaluate object numerically.
- virtual [ex evalm](#) () const
Evaluate sums, products and integer powers of matrices.
- virtual [ex eval_integ](#) () const
Evaluate integrals, if result is known.
- virtual [ex eval_indexed](#) (const [basic](#) &i) const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void [print](#) (const [print_context](#) &c, unsigned level=0) const
Output to stream.
- virtual void [dbgprint](#) () const
Little wrapper around print to be called within a debugger.
- virtual void [dbgprinttree](#) () const
Little wrapper around printtree to be called within a debugger.
- virtual unsigned [precedence](#) () const
Return relative operator precedence (for parenthezing output).
- virtual bool [info](#) (unsigned inf) const
Information about the object.
- virtual size_t [nops](#) () const
Number of operands/members.
- virtual [ex op](#) (size_t i) const
Return operand/member at position i.
- virtual [ex operator\[\]](#) (const [ex](#) &index) const
- virtual [ex operator\[\]](#) (size_t i) const
- virtual [ex](#) & [let_op](#) (size_t i)
Return modifiable operand/member at position i.
- virtual [ex](#) & [operator\[\]](#) (const [ex](#) &index)
- virtual [ex](#) & [operator\[\]](#) (size_t i)
- virtual bool [has](#) (const [ex](#) &other, unsigned [options](#)=0) const
Test for occurrence of a pattern.
- virtual bool [match](#) (const [ex](#) &pattern, [exmap](#) &repls) const
Check whether the expression matches a given pattern.
- virtual [ex subs](#) (const [exmap](#) &m, unsigned [options](#)=0) const
Substitute a set of objects by arbitrary expressions.
- virtual [ex map](#) ([map_function](#) &f) const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void [accept](#) ([GiNaC::visitor](#) &v) const
- virtual bool [is_polynomial](#) (const [ex](#) &var) const
Check whether this is a polynomial in the given variables.
- virtual int [degree](#) (const [ex](#) &s) const

- Return degree of highest power in object s.*
- virtual int [ldegree](#) (const [ex](#) &s) const
- Return degree of lowest power in object s.*
- virtual [ex coeff](#) (const [ex](#) &s, int [n](#)=1) const
- Return coefficient of degree n in object s.*
- virtual [ex expand](#) (unsigned [options](#)=0) const
- Expand expression, i.e.*
- virtual [ex collect](#) (const [ex](#) &s, bool [distributed](#)=false) const
- Sort expanded expression in terms of powers of some object(s).*
- virtual [ex series](#) (const [relational](#) &r, int [order](#), unsigned [options](#)=0) const
- Default implementation of [ex::series\(\)](#).*
- virtual [ex normal](#) ([exmap](#) &repl, [exmap](#) &rev_lookup, [lst](#) &modifier) const
- Default implementation of [ex::normal\(\)](#).*
- virtual [ex to_rational](#) ([exmap](#) &repl) const
- Default implementation of [ex::to_rational\(\)](#).*
- virtual [ex to_polynomial](#) ([exmap](#) &repl) const
- virtual [numeric integer_content](#) () const
- virtual [ex smod](#) (const [numeric](#) &xi) const
- Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
- virtual [numeric max_coefficient](#) () const
- Implementation [ex::max_coefficient\(\)](#).*
- virtual [exvector get_free_indices](#) () const
- Return a vector containing the free indices of an expression.*
- virtual [ex add_indexed](#) (const [ex](#) &self, const [ex](#) &other) const
- Add two indexed expressions.*
- virtual [ex scalar_mul_indexed](#) (const [ex](#) &self, const [numeric](#) &other) const
- Multiply an indexed expression with a scalar.*
- virtual bool [contract_with](#) (exvector::iterator self, exvector::iterator other, [exvector](#) &v) const
- Try to contract two indexed expressions that appear in the same product.*
- virtual unsigned [return_type](#) () const
- virtual [return_type_t return_type_tinfo](#) () const
- virtual [ex conjugate](#) () const
- virtual [ex real_part](#) () const
- virtual [ex imag_part](#) () const
- template<class T >
void [print_dispatch](#) (const [print_context](#) &c, unsigned [level](#)) const
- Like [print\(\)](#), but dispatch to the specified class.*
- void [print_dispatch](#) (const [registered_class_info](#) &ri, const [print_context](#) &c, unsigned [level](#)) const
- Like [print\(\)](#), but dispatch to the specified class.*
- virtual void [archive](#) ([archive_node](#) &n) const
- Save (serialize) the object into archive node.*
- virtual void [read_archive](#) (const [archive_node](#) &n, [lst](#) &syms)
- Load (deserialize) the object from an archive node.*
- [ex subs_one_level](#) (const [exmap](#) &m, unsigned [options](#)) const
- Helper function for [subs\(\)](#).*
- [ex diff](#) (const [symbol](#) &s, unsigned [nth](#)=1) const
- Default interface of nth derivative [ex::diff\(s, n\)](#).*
- int [compare](#) (const [basic](#) &other) const
- Compare objects syntactically to establish canonical ordering.*
- bool [is_equal](#) (const [basic](#) &other) const
- Test for syntactic equality.*

- const [basic](#) & [hold](#) () const
Stop further evaluation.
- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const
Set some [status_flags](#).
- const [basic](#) & [clearflag](#) (unsigned f) const
Clear some [status_flags](#).

Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add_reference](#) () noexcept
- unsigned int [remove_reference](#) () noexcept
- unsigned int [get_refcount](#) () const noexcept
- void [set_refcount](#) (unsigned int r) noexcept

Protected Member Functions

- [ex_derivative](#) (const [symbol](#) &s) const override
Implementation of [ex::diff\(\)](#) for single differentiation of a symbol.
- bool [is_equal_same_type](#) (const [basic](#) &other) const override
Returns true if two objects of same type are equal.
- unsigned [calchash](#) () const override
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
- void [do_print_latex](#) (const [print_latex](#) &c, unsigned level) const
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const

Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match_same_type](#) (const [basic](#) &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual [ex_derivative](#) (const [symbol](#) &s) const
Default implementation of [ex::diff\(\)](#).
- virtual int [compare_same_type](#) (const [basic](#) &other) const
Returns order relation between two objects of same type.
- virtual bool [is_equal_same_type](#) (const [basic](#) &other) const
Returns true if two objects of same type are equal.
- virtual unsigned [calchash](#) () const
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- void [ensure_if_modifiable](#) () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
Default output to stream.
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
Tree output to stream.
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
Python parsable output to stream.

Protected Attributes

- unsigned [serial](#)
unique serial number for comparison
- std::string [name](#)
printname of this symbol
- std::string [TeX_name](#)
LaTeX name of this symbol.

Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)
of type [status_flags](#)
- unsigned [hashvalue](#)
hash value

Static Private Attributes

- static unsigned [next_serial](#) = 0

6.169.1 Detailed Description

Basic CAS symbol.

It has a name because it must know how to output itself.

6.169.2 Constructor & Destructor Documentation

6.169.2.1 [symbol\(\)](#) [1/2]

```
GiNaC::symbol::symbol (  
    const std::string & initname ) [explicit]
```

References [GiNaC::status_flags::evaluated](#), [GiNaC::status_flags::expanded](#), and [GiNaC::basic::setflag\(\)](#).

6.169.2.2 [symbol\(\)](#) [2/2]

```
GiNaC::symbol::symbol (  
    const std::string & initname,  
    const std::string & texname )
```

References [GiNaC::status_flags::evaluated](#), [GiNaC::status_flags::expanded](#), and [GiNaC::basic::setflag\(\)](#).

6.169.3 Member Function Documentation

6.169.3.1 info()

```
bool GiNaC::symbol::info (
    unsigned inf ) const [override], [virtual]
```

Information about the object.

See also

class [info_flags](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::info_flags::cinteger_polynomial](#), [GiNaC::info_flags::crational_polynomial](#), [GiNaC::info_flags::expanded](#), [get_domain\(\)](#), [GiNaC::info_flags::has_indices](#), [GiNaC::info_flags::integer_polynomial](#), [GiNaC::info_flags::nonnegative](#), [GiNaC::info_flags::polynomial](#), [GiNaC::domain::positive](#), [GiNaC::info_flags::positive](#), [GiNaC::info_flags::rational_function](#), [GiNaC::info_flags::rational_polynomial](#), [GiNaC::domain::real](#), [GiNaC::info_flags::real](#), and [GiNaC::info_flags::symbol](#).

Referenced by [GiNaC::conjugate_expl_derivative\(\)](#), [GiNaC::imag_part_expl_derivative\(\)](#), and [GiNaC::real_part_expl_derivative\(\)](#).

6.169.3.2 eval()

```
ex GiNaC::symbol::eval ( ) const [inline], [override], [virtual]
```

Perform automatic non-interruptive term rewriting rules.

Reimplemented from [GiNaC::basic](#).

6.169.3.3 evalf()

```
ex GiNaC::symbol::evalf ( ) const [inline], [override], [virtual]
```

Evaluate object numerically.

Reimplemented from [GiNaC::basic](#).

6.169.3.4 series()

```
ex GiNaC::symbol::series (
    const relational & r,
    int order,
    unsigned options = 0 ) const [override], [virtual]
```

Implementation of [ex::series\(\)](#) for symbols.

See also

[ex::series](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex0](#), [GiNaC::_ex1](#), [GINAC_ASSERT](#), [is_equal_same_type\(\)](#), [GiNaC::ex::is_zero\(\)](#), [order](#), and [r](#).

6.169.3.5 subs()

```
ex GiNaC::symbol::subs (
    const exmap & m,
    unsigned options = 0 ) const [inline], [override], [virtual]
```

Substitute a set of objects by arbitrary expressions.

The ex returned will already be evaluated.

Reimplemented from [GiNaC::basic](#).

References [m](#), [options](#), and [GiNaC::basic::subs_one_level\(\)](#).

6.169.3.6 normal()

```
ex GiNaC::symbol::normal (
    exmap & repl,
    exmap & rev_lookup,
    lst & modifier ) const [override], [virtual]
```

Implementation of [ex::normal\(\)](#) for symbols.

This returns the unmodified symbol.

See also

[ex::normal](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex1](#).

6.169.3.7 to_rational()

```
ex GiNaC::symbol::to_rational (
    exmap & repl ) const [override], [virtual]
```

Implementation of [ex::to_rational\(\)](#) for symbols.

This returns the unmodified symbol.

Reimplemented from [GiNaC::basic](#).

6.169.3.8 to_polynomial()

```
ex GiNaC::symbol::to_polynomial (
    exmap & repl ) const [override], [virtual]
```

Implementation of [ex::to_polynomial\(\)](#) for symbols.

This returns the unmodified symbol.

Reimplemented from [GiNaC::basic](#).

6.169.3.9 conjugate()

```
ex GiNaC::symbol::conjugate ( ) const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::realsymbol](#).

6.169.3.10 real_part()

```
ex GiNaC::symbol::real_part ( ) const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::realsymbol](#).

6.169.3.11 imag_part()

```
ex GiNaC::symbol::imag_part ( ) const [override], [virtual]
```

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::realsymbol](#).

6.169.3.12 is_polynomial()

```
bool GiNaC::symbol::is_polynomial (
    const ex & var ) const [override], [virtual]
```

Check whether this is a polynomial in the given variables.

Reimplemented from [GiNaC::basic](#).

6.169.3.13 archive()

```
void GiNaC::symbol::archive (
    archive\_node & n ) const [override], [virtual]
```

Save (a.k.a.

Archive the object.

serialize) object into archive.

Reimplemented from [GiNaC::basic](#).

References [n](#), [name](#), and [TeX_name](#).

6.169.3.14 read_archive()

```
void GiNaC::symbol::read_archive (
    const archive\_node & n,
    lst & syms ) [override], [virtual]
```

Read (a.k.a.

Read object from [archive_node](#).

deserialize) object from archive.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::container< C >::append\(\)](#), [GiNaC::status_flags::dynallocated](#), [GiNaC::status_flags::evaluated](#), [GiNaC::status_flags::expanded](#), [n](#), [name](#), [next_serial](#), [serial](#), [GiNaC::basic::setflag\(\)](#), and [TeX_name](#).

6.169.3.15 derivative()

```
ex GiNaC::symbol::derivative (
    const symbol & s ) const [override], [protected], [virtual]
```

Implementation of [ex::diff\(\)](#) for single differentiation of a symbol.

It returns 1 or 0.

See also

[ex::diff](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex0](#), [GiNaC::_ex1](#), and [GiNaC::basic::compare_same_type\(\)](#).

6.169.3.16 is_equal_same_type()

```
bool GiNaC::symbol::is_equal_same_type (
    const basic & other ) const [override], [protected], [virtual]
```

Returns true if two objects of same type are equal.

Normally needs not be reimplemented as long as it wasn't overwritten by some parent class, since it just calls [compare_same_type\(\)](#). The reason why this function exists is that sometimes it is easier to determine equality than an order relation and then it can be overridden.

Reimplemented from [GiNaC::basic](#).

References [GINAC_ASSERT](#), and [serial](#).

Referenced by [series\(\)](#).

6.169.3.17 calchash()

```
unsigned GiNaC::symbol::calchash ( ) const [override], [protected], [virtual]
```

Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.

The method inherited from class basic computes a hash value based on the type and hash values of possible members. For this reason it is well suited for container classes but atomic classes should override this implementation because otherwise they would all end up with the same hashvalue.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::golden_ratio_hash\(\)](#), [GiNaC::status_flags::hash_calculated](#), [GiNaC::basic::hashvalue](#), [GiNaC::make_hash_seed\(\)](#), [serial](#), and [GiNaC::basic::setflag\(\)](#).

6.169.3.18 `get_domain()`

```
virtual unsigned GiNaC::symbol::get_domain ( ) const [inline], [virtual]
```

Reimplemented in [GiNaC::realsymbol](#), and [GiNaC::possymbol](#).

References [GiNaC::domain::complex](#).

Referenced by [do_print_tree\(\)](#), and [info\(\)](#).

6.169.3.19 `set_name()`

```
void GiNaC::symbol::set_name (
    const std::string & n ) [inline]
```

References [n](#), and [name](#).

6.169.3.20 `set_TeX_name()`

```
void GiNaC::symbol::set_TeX_name (
    const std::string & n ) [inline]
```

References [n](#), and [TeX_name](#).

6.169.3.21 `get_name()`

```
std::string GiNaC::symbol::get_name ( ) const
```

References [name](#), and [serial](#).

Referenced by [do_print\(\)](#), and [get_TeX_name\(\)](#).

6.169.3.22 `get_TeX_name()`

```
std::string GiNaC::symbol::get_TeX_name ( ) const
```

References [GiNaC::get_default_TeX_name\(\)](#), [get_name\(\)](#), and [TeX_name](#).

6.169.3.23 do_print()

```
void GiNaC::symbol::do_print (
    const print\_context & c,
    unsigned level ) const [protected]
```

References [c](#), and [get_name\(\)](#).

6.169.3.24 do_print_latex()

```
void GiNaC::symbol::do_print_latex (
    const print\_latex & c,
    unsigned level ) const [protected]
```

References [c](#), [GiNaC::get_default_TeX_name\(\)](#), [name](#), [serial](#), and [TeX_name](#).

6.169.3.25 do_print_tree()

```
void GiNaC::symbol::do_print_tree (
    const print\_tree & c,
    unsigned level ) const [protected]
```

References [c](#), [GiNaC::basic::flags](#), [get_domain\(\)](#), [GiNaC::basic::hashvalue](#), [name](#), and [serial](#).

6.169.3.26 do_print_python_repr()

```
void GiNaC::symbol::do_print_python_repr (
    const print\_python\_repr & c,
    unsigned level ) const [protected]
```

References [c](#), [name](#), [serial](#), and [TeX_name](#).

6.169.4 Member Data Documentation

6.169.4.1 serial

```
unsigned GiNaC::symbol::serial [protected]
```

unique serial number for comparison

Referenced by [calchash\(\)](#), [do_print_latex\(\)](#), [do_print_python_repr\(\)](#), [do_print_tree\(\)](#), [get_name\(\)](#), [is_equal_same_type\(\)](#), and [read_archive\(\)](#).

6.169.4.2 name

```
std::string GiNaC::symbol::name [mutable], [protected]
```

printname of this symbol

Referenced by [archive\(\)](#), [do_print_latex\(\)](#), [do_print_python_repr\(\)](#), [do_print_tree\(\)](#), [get_name\(\)](#), [read_archive\(\)](#), and [set_name\(\)](#).

6.169.4.3 TeX_name

```
std::string GiNaC::symbol::TeX_name [protected]
```

LaTeX name of this symbol.

Referenced by [archive\(\)](#), [do_print_latex\(\)](#), [do_print_python_repr\(\)](#), [get_TeX_name\(\)](#), [read_archive\(\)](#), and [set_TeX_name\(\)](#).

6.169.4.4 next_serial

```
unsigned GiNaC::symbol::next_serial = 0 [static], [private]
```

Referenced by [read_archive\(\)](#).

The documentation for this class was generated from the following files:

- [symbol.h](#)
- [normal.cpp](#)
- [pseries.cpp](#)
- [symbol.cpp](#)

6.170 GiNaC::symbolset Class Reference

Public Member Functions

- [symbolset](#) (const [ex](#) &e)
- bool [has](#) (const [ex](#) &e) const

Private Member Functions

- void [insert_symbols](#) (const [ex](#) &e)

Private Attributes

- [exset s](#)

6.170.1 Constructor & Destructor Documentation

6.170.1.1 symbolset()

```
GiNaC::symbolset::symbolset (  
    const ex & e ) [inline], [explicit]
```

References [insert_symbols\(\)](#).

6.170.2 Member Function Documentation

6.170.2.1 insert_symbols()

```
void GiNaC::symbolset::insert_symbols (  
    const ex & e ) [inline], [private]
```

References [insert_symbols\(\)](#), and [s](#).

Referenced by [insert_symbols\(\)](#), and [symbolset\(\)](#).

6.170.2.2 has()

```
bool GiNaC::symbolset::has (  
    const ex & e ) const [inline]
```

References [s](#).

Referenced by [GiNaC::lsolve\(\)](#).

6.170.3 Member Data Documentation

6.170.3.1 s

```
exset GiNaC::symbolset::s [private]
```

Referenced by [has\(\)](#), and [insert_symbols\(\)](#).

The documentation for this class was generated from the following file:

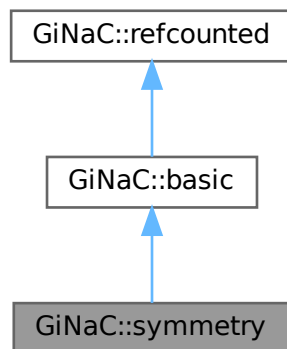
- [inifcns.cpp](#)

6.171 GiNaC::symmetry Class Reference

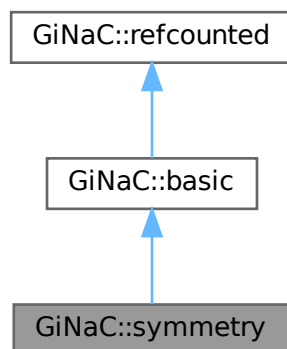
This class describes the symmetry of a group of indices.

```
#include <symmetry.h>
```

Inheritance diagram for GiNaC::symmetry:



Collaboration diagram for GiNaC::symmetry:



Public Types

- enum `symmetry_type` { `none` , `symmetric` , `antisymmetric` , `cyclic` }
- Type of symmetry.*

Public Member Functions

- `symmetry` (unsigned i)
Create leaf node that represents one index.
- `symmetry` (`symmetry_type` t, const `symmetry` &c1, const `symmetry` &c2)
Create node with two children.
- void `archive` (`archive_node` &n) const override
Save (a.k.a.
- void `read_archive` (const `archive_node` &n, `lst` &syms) override
Read (a.k.a.
- `symmetry_type` `get_type` () const
Get symmetry type.
- void `set_type` (`symmetry_type` t)
Set symmetry type.
- `symmetry` & `add` (const `symmetry` &c)
Add child node, check index sets for consistency.
- void `validate` (unsigned n)
Verify that all indices of this node are in the range [0..n-1].
- bool `has_symmetry` () const
Check whether this node actually represents any kind of symmetry.
- bool `has_nonsymmetric` () const
Check whether this node involves anything non symmetric.
- bool `has_cyclic` () const
Check whether this node involves a cyclic symmetry.

Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()
basic destructor, virtual because class `ex` will delete objects of derived classes via a `basic`.*
- `basic` (const `basic` &other)
- const `basic` & `operator=` (const `basic` &other)
basic assignment operator: the other object might be of a derived class.
- virtual `basic` * `duplicate` () const
Create a clone of this object on the heap.
- virtual `ex` `eval` () const
Perform automatic non-interruptive term rewriting rules.
- virtual `ex` `evalf` () const
Evaluate object numerically.
- virtual `ex` `evalm` () const
Evaluate sums, products and integer powers of matrices.
- virtual `ex` `eval_integ` () const
Evaluate integrals, if result is known.
- virtual `ex` `eval_indexed` (const `basic` &i) const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void `print` (const `print_context` &c, unsigned level=0) const

- *Output to stream.*
virtual void [dbgprint](#) () const
- *Little wrapper around print to be called within a debugger.*
virtual void [dbgprinttree](#) () const
- *Little wrapper around printtree to be called within a debugger.*
virtual unsigned [precedence](#) () const
- *Return relative operator precedence (for parenthezing output).*
virtual bool [info](#) (unsigned inf) const
- *Information about the object.*
virtual size_t [nops](#) () const
- *Number of operands/members.*
virtual [ex op](#) (size_t i) const
- *Return operand/member at position i.*
virtual [ex operator\[\]](#) (const [ex](#) &index) const
- virtual [ex operator\[\]](#) (size_t i) const
- virtual [ex & let_op](#) (size_t i)
- *Return modifiable operand/member at position i.*
virtual [ex & operator\[\]](#) (const [ex](#) &index)
- virtual [ex & operator\[\]](#) (size_t i)
- virtual bool [has](#) (const [ex](#) &other, unsigned [options](#)=0) const
- *Test for occurrence of a pattern.*
virtual bool [match](#) (const [ex](#) &pattern, [exmap](#) &repls) const
- *Check whether the expression matches a given pattern.*
virtual [ex subs](#) (const [exmap](#) &m, unsigned [options](#)=0) const
- *Substitute a set of objects by arbitrary expressions.*
virtual [ex map](#) ([map_function](#) &f) const
- *Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).*
virtual void [accept](#) ([GiNaC::visitor](#) &v) const
- virtual bool [is_polynomial](#) (const [ex](#) &var) const
- *Check whether this is a polynomial in the given variables.*
virtual int [degree](#) (const [ex](#) &s) const
- *Return degree of highest power in object s.*
virtual int [ldegree](#) (const [ex](#) &s) const
- *Return degree of lowest power in object s.*
virtual [ex coeff](#) (const [ex](#) &s, int n=1) const
- *Return coefficient of degree n in object s.*
virtual [ex expand](#) (unsigned [options](#)=0) const
- *Expand expression, i.e.*
virtual [ex collect](#) (const [ex](#) &s, bool distributed=false) const
- *Sort expanded expression in terms of powers of some object(s).*
virtual [ex series](#) (const [relational](#) &r, int [order](#), unsigned [options](#)=0) const
- *Default implementation of [ex::series\(\)](#).*
virtual [ex normal](#) ([exmap](#) &repl, [exmap](#) &rev_lookup, [lst](#) &modifier) const
- *Default implementation of [ex::normal\(\)](#).*
virtual [ex to_rational](#) ([exmap](#) &repl) const
- *Default implementation of [ex::to_rational\(\)](#).*
virtual [ex to_polynomial](#) ([exmap](#) &repl) const
- virtual [numeric integer_content](#) () const
- virtual [ex smod](#) (const [numeric](#) &xi) const
- *Apply symmetric modular homomorphism to an expanded multivariate polynomial.*
virtual [numeric max_coefficient](#) () const

- Implementation *ex::max_coefficient()*.
- virtual `exvector get_free_indices ()` const
 - Return a vector containing the free indices of an expression.
- virtual `ex add_indexed (const ex &self, const ex &other)` const
 - Add two indexed expressions.
- virtual `ex scalar_mul_indexed (const ex &self, const numeric &other)` const
 - Multiply an indexed expression with a scalar.
- virtual `bool contract_with (exvector::iterator self, exvector::iterator other, exvector &v)` const
 - Try to contract two indexed expressions that appear in the same product.
- virtual `unsigned return_type ()` const
- virtual `return_type_t return_type_tinfo ()` const
- virtual `ex conjugate ()` const
- virtual `ex real_part ()` const
- virtual `ex imag_part ()` const
- template<class T >
 - void `print_dispatch (const print_context &c, unsigned level)` const
 - Like `print()`, but dispatch to the specified class.
- void `print_dispatch (const registered_class_info &ri, const print_context &c, unsigned level)` const
 - Like `print()`, but dispatch to the specified class.
- virtual void `archive (archive_node &n)` const
 - Save (serialize) the object into archive node.
- virtual void `read_archive (const archive_node &n, lst &syms)`
 - Load (deserialize) the object from an archive node.
- `ex subs_one_level (const exmap &m, unsigned options)` const
 - Helper function for `subs()`.
- `ex diff (const symbol &s, unsigned nth=1)` const
 - Default interface of `nth` derivative `ex::diff(s, n)`.
- int `compare (const basic &other)` const
 - Compare objects syntactically to establish canonical ordering.
- bool `is_equal (const basic &other)` const
 - Test for syntactic equality.
- const `basic & hold ()` const
 - Stop further evaluation.
- unsigned `gethash ()` const
- const `basic & setflag (unsigned f)` const
 - Set some `status_flags`.
- const `basic & clearflag (unsigned f)` const
 - Clear some `status_flags`.

Public Member Functions inherited from `GiNaC::refcounted`

- `refcounted ()` noexcept
- unsigned int `add_reference ()` noexcept
- unsigned int `remove_reference ()` noexcept
- unsigned int `get_refcount ()` const noexcept
- void `set_refcount (unsigned int r)` noexcept

Protected Member Functions

- unsigned `calchash ()` const override
 - Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.
- void `do_print (const print_context &c, unsigned level)` const
- void `do_print_tree (const print_tree &c, unsigned level)` const

Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match_same_type](#) (const [basic](#) &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual [ex derivative](#) (const [symbol](#) &s) const
Default implementation of [ex::diff\(\)](#).
- virtual int [compare_same_type](#) (const [basic](#) &other) const
Returns order relation between two objects of same type.
- virtual bool [is_equal_same_type](#) (const [basic](#) &other) const
Returns true if two objects of same type are equal.
- virtual unsigned [calchash](#) () const
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- void [ensure_if_modifiable](#) () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
Default output to stream.
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
Tree output to stream.
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
Python parsable output to stream.

Private Attributes

- [symmetry_type](#) type
Type of symmetry described by this node.
- std::set< unsigned > [indices](#)
Sorted union set of all indices handled by this node.
- [exvector children](#)
Vector of child nodes.

Friends

- class [sy_is_less](#)
- class [sy_swap](#)
- int [canonicalize](#) ([exvector::iterator](#) v, const [symmetry](#) &symm)
Canonicalize the order of elements of an expression vector, according to the symmetry properties defined in a symmetry tree.

Additional Inherited Members

Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)
of type [status_flags](#)
- unsigned [hashvalue](#)
hash value

6.171.1 Detailed Description

This class describes the symmetry of a group of indices.

These objects can be grouped into a tree to form complex mixed symmetries.

6.171.2 Member Enumeration Documentation

6.171.2.1 symmetry_type

```
enum GiNaC::symmetry::symmetry_type
```

Type of symmetry.

Enumerator

none	no symmetry properties
symmetric	totally symmetric
antisymmetric	totally antisymmetric
cyclic	cyclic symmetry

6.171.3 Constructor & Destructor Documentation

6.171.3.1 symmetry() [1/2]

```
GiNaC::symmetry::symmetry (
    unsigned i )
```

Create leaf node that represents one index.

References [GiNaC::status_flags::evaluated](#), [GiNaC::status_flags::expanded](#), [indices](#), and [GiNaC::basic::setflag\(\)](#).

6.171.3.2 symmetry() [2/2]

```
GiNaC::symmetry::symmetry (
    symmetry_type t,
    const symmetry & c1,
    const symmetry & c2 )
```

Create node with two children.

References [GiNaC::status_flags::evaluated](#), [GiNaC::status_flags::expanded](#), and [GiNaC::basic::setflag\(\)](#).

6.171.4 Member Function Documentation

6.171.4.1 archive()

```
void GiNaC::symmetry::archive (
    archive_node & n ) const [override], [virtual]
```

Save (a.k.a.

Archive the object.

serialize) object into archive.

Reimplemented from [GiNaC::basic](#).

References [children](#), [indices](#), [n](#), and [type](#).

6.171.4.2 read_archive()

```
void GiNaC::symmetry::read_archive (
    const archive_node & n,
    lst & syms ) [override], [virtual]
```

Read (a.k.a.

Construct object from [archive_node](#).

deserialize) object from archive.

Reimplemented from [GiNaC::basic](#).

References [indices](#), [n](#), and [type](#).

6.171.4.3 calchash()

```
unsigned GiNaC::symmetry::calchash ( ) const [override], [protected], [virtual]
```

Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.

The method inherited from class basic computes a hash value based on the type and hash values of possible members. For this reason it is well suited for container classes but atomic classes should override this implementation because otherwise they would all end up with the same hashvalue.

Reimplemented from [GiNaC::basic](#).

References [children](#), [GiNaC::status_flags::evaluated](#), [GiNaC::basic::flags](#), [GiNaC::status_flags::hash_calculated](#), [GiNaC::basic::hashvalue](#), [indices](#), [GiNaC::make_hash_seed\(\)](#), [none](#), [GiNaC::rotate_left\(\)](#), [GiNaC::basic::setflag\(\)](#), and [type](#).

6.171.4.4 `get_type()`

```
symmetry_type GiNaC::symmetry::get_type ( ) const [inline]
```

Get symmetry type.

References [type](#).

6.171.4.5 `set_type()`

```
void GiNaC::symmetry::set_type (
    symmetry_type t ) [inline]
```

Set symmetry type.

References [type](#).

Referenced by [GiNaC::sy_anti\(\)](#), [GiNaC::sy_cycl\(\)](#), and [GiNaC::sy_symm\(\)](#).

6.171.4.6 `add()`

```
symmetry & GiNaC::symmetry::add (
    const symmetry & c )
```

Add child node, check index sets for consistency.

References [c](#), [children](#), [GINAC_ASSERT](#), [indices](#), [none](#), and [type](#).

Referenced by [GiNaC::sy_anti\(\)](#), [GiNaC::sy_cycl\(\)](#), [GiNaC::sy_none\(\)](#), and [GiNaC::sy_symm\(\)](#).

6.171.4.7 `validate()`

```
void GiNaC::symmetry::validate (
    unsigned n )
```

Verify that all indices of this node are in the range [0..n-1].

This function throws an exception if the verification fails. If the top node has a type != none and no children, add all indices in the range [0..n-1] as children.

References [indices](#), [n](#), [none](#), and [type](#).

6.171.4.8 has_symmetry()

```
bool GiNaC::symmetry::has_symmetry ( ) const [inline]
```

Check whether this node actually represents any kind of symmetry.

References [children](#), [none](#), and [type](#).

6.171.4.9 has_nonsymmetric()

```
bool GiNaC::symmetry::has_nonsymmetric ( ) const
```

Check whether this node involves anything non symmetric.

References [antisymmetric](#), [children](#), [cyclic](#), [has_nonsymmetric\(\)](#), and [type](#).

Referenced by [has_nonsymmetric\(\)](#).

6.171.4.10 has_cyclic()

```
bool GiNaC::symmetry::has_cyclic ( ) const
```

Check whether this node involves a cyclic symmetry.

References [children](#), [cyclic](#), [has_cyclic\(\)](#), and [type](#).

Referenced by [has_cyclic\(\)](#).

6.171.4.11 do_print()

```
void GiNaC::symmetry::do_print (
    const print\_context & c,
    unsigned level ) const [protected]
```

References [antisymmetric](#), [c](#), [children](#), [cyclic](#), [indices](#), [none](#), [symmetric](#), and [type](#).

6.171.4.12 do_print_tree()

```
void GiNaC::symmetry::do_print_tree (
    const print\_tree & c,
    unsigned level ) const [protected]
```

References [antisymmetric](#), [c](#), [children](#), [cyclic](#), [GiNaC::basic::flags](#), [GiNaC::basic::hashvalue](#), [indices](#), [none](#), [symmetric](#), and [type](#).

6.171.5 Friends And Related Function Documentation

6.171.5.1 `sy_is_less`

```
friend class sy_is_less [friend]
```

6.171.5.2 `sy_swap`

```
friend class sy_swap [friend]
```

6.171.5.3 `canonicalize`

```
int canonicalize (
    exvector::iterator v,
    const symmetry & symm ) [friend]
```

Canonicalize the order of elements of an expression vector, according to the symmetry properties defined in a symmetry tree.

Parameters

<i>v</i>	Start of expression vector
<i>symm</i>	Root node of symmetry tree

Returns

the overall sign introduced by the reordering (+1, -1 or 0) or `numeric_limits<int>::max()` if nothing changed

6.171.6 Member Data Documentation

6.171.6.1 `type`

```
symmetry_type GiNaC::symmetry::type [private]
```

Type of symmetry described by this node.

Referenced by [add\(\)](#), [archive\(\)](#), [calchash\(\)](#), [do_print\(\)](#), [do_print_tree\(\)](#), [get_type\(\)](#), [has_cyclic\(\)](#), [has_nonsymmetric\(\)](#), [has_symmetry\(\)](#), [read_archive\(\)](#), [set_type\(\)](#), and [validate\(\)](#).

6.171.6.2 indices

```
std::set<unsigned> GiNaC::symmetry::indices [private]
```

Sorted union set of all indices handled by this node.

Referenced by [add\(\)](#), [archive\(\)](#), [calchash\(\)](#), [do_print\(\)](#), [do_print_tree\(\)](#), [read_archive\(\)](#), [symmetry\(\)](#), and [validate\(\)](#).

6.171.6.3 children

```
exvector GiNaC::symmetry::children [private]
```

Vector of child nodes.

Referenced by [add\(\)](#), [archive\(\)](#), [calchash\(\)](#), [do_print\(\)](#), [do_print_tree\(\)](#), [has_cyclic\(\)](#), [has_nonsymmetric\(\)](#), and [has_symmetry\(\)](#).

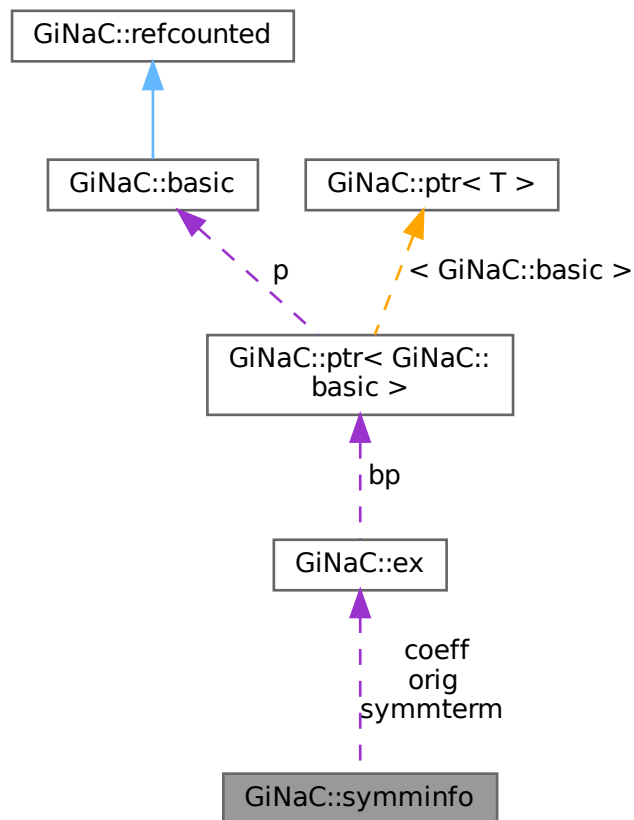
The documentation for this class was generated from the following files:

- [symmetry.h](#)
- [symmetry.cpp](#)

6.172 GiNaC::symminfo Class Reference

This structure stores the individual symmetrized terms obtained during the simplification of sums.

Collaboration diagram for `GiNaC::symminfo`:



Public Member Functions

- `symminfo()`
- `symminfo(const ex &symmterm_, const ex &orig_, size_t num_)`

Public Attributes

- `ex symmterm`
symmetrized term
- `ex coeff`
coefficient of symmetrized term
- `ex orig`
original term
- `size_t num`
how many symmetrized terms resulted from the original term

6.172.1 Detailed Description

This structure stores the individual symmetrized terms obtained during the simplification of sums.

6.172.2 Constructor & Destructor Documentation

6.172.2.1 symminfo() [1/2]

```
GiNaC::symminfo::symminfo ( ) [inline]
```

6.172.2.2 symminfo() [2/2]

```
GiNaC::symminfo::symminfo (
    const ex & symmterm_,
    const ex & orig_,
    size_t num_ ) [inline]
```

References [coeff](#), [GiNaC::ex::nops\(\)](#), [GiNaC::ex::op\(\)](#), and [symmterm](#).

6.172.3 Member Data Documentation

6.172.3.1 symmterm

```
ex GiNaC::symminfo::symmterm
```

symmetrized term

Referenced by [GiNaC::symminfo_is_less_by_symmterm::operator\(\)\(\)](#), and [symminfo\(\)](#).

6.172.3.2 coeff

```
ex GiNaC::symminfo::coeff
```

coefficient of symmetrized term

Referenced by [symminfo\(\)](#).

6.172.3.3 orig

`ex` `GiNaC::symminfo::orig`

original term

Referenced by `GiNaC::symminfo_is_less_by_orig::operator()()`.

6.172.3.4 num

`size_t` `GiNaC::symminfo::num`

how many symmetrized terms resulted from the original term

The documentation for this class was generated from the following file:

- `indexed.cpp`

6.173 GiNaC::symminfo_is_less_by_orig Class Reference

Public Member Functions

- `bool operator()` (const `symminfo` &si1, const `symminfo` &si2) const

6.173.1 Member Function Documentation

6.173.1.1 operator()()

```
bool GiNaC::symminfo_is_less_by_orig::operator() (
    const symminfo & si1,
    const symminfo & si2 ) const [inline]
```

References `GiNaC::ex::compare()`, and `GiNaC::symminfo::orig`.

The documentation for this class was generated from the following file:

- `indexed.cpp`

6.174 GiNaC::symminfo_is_less_by_symmterm Class Reference

Public Member Functions

- `bool operator()` (const `symminfo` &si1, const `symminfo` &si2) const

6.174.1 Member Function Documentation

6.174.1.1 operator>()

```
bool GiNaC::symminfo_is_less_by_symmterm::operator() (
    const symminfo & si1,
    const symminfo & si2 ) const [inline]
```

References [GiNaC::ex::compare\(\)](#), and [GiNaC::symminfo::symmterm](#).

The documentation for this class was generated from the following file:

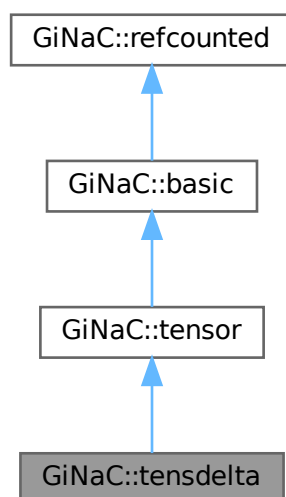
- [indexed.cpp](#)

6.175 GiNaC::tensdelta Class Reference

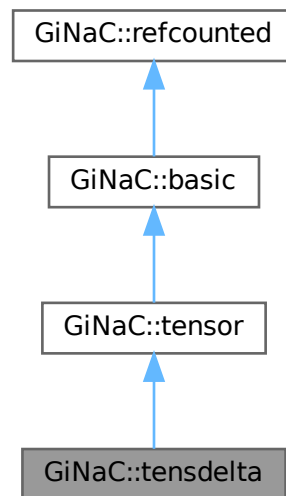
This class represents the delta tensor.

```
#include <tensor.h>
```

Inheritance diagram for GiNaC::tensdelta:



Collaboration diagram for `GiNaC::tensdelta`:



Public Member Functions

- `bool info` (unsigned inf) const override
Information about the object.
- `ex eval_indexed` (const `basic` &i) const override
Automatic symbolic evaluation of an indexed delta tensor.
- `bool contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const override
Contraction of an indexed delta tensor with something else.

Public Member Functions inherited from `GiNaC::tensor`

- `bool replace_contr_index` (exvector::iterator self, exvector::iterator other) const
Replace dummy index in contracted-with object by the contracting object's second index (used internally for delta and metric tensor contractions).

Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()
basic destructor, virtual because class ex will delete objects of derived classes via a basic.*
- `basic` (const `basic` &other)
- const `basic` & `operator=` (const `basic` &other)
basic assignment operator: the other object might be of a derived class.
- virtual `basic * duplicate` () const
Create a clone of this object on the heap.
- virtual `ex eval` () const
Perform automatic non-interruptive term rewriting rules.

- virtual [ex evalf](#) () const
Evaluate object numerically.
- virtual [ex evalm](#) () const
Evaluate sums, products and integer powers of matrices.
- virtual [ex eval_integ](#) () const
Evaluate integrals, if result is known.
- virtual [ex eval_indexed](#) (const [basic](#) &i) const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void [print](#) (const [print_context](#) &c, unsigned level=0) const
Output to stream.
- virtual void [dbgprint](#) () const
Little wrapper around print to be called within a debugger.
- virtual void [dbgprinttree](#) () const
Little wrapper around printtree to be called within a debugger.
- virtual unsigned [precedence](#) () const
Return relative operator precedence (for parenthezing output).
- virtual bool [info](#) (unsigned inf) const
Information about the object.
- virtual size_t [nops](#) () const
Number of operands/members.
- virtual [ex op](#) (size_t i) const
Return operand/member at position i.
- virtual [ex operator\[\]](#) (const [ex](#) &index) const
- virtual [ex operator\[\]](#) (size_t i) const
- virtual [ex](#) & [let_op](#) (size_t i)
Return modifiable operand/member at position i.
- virtual [ex](#) & [operator\[\]](#) (const [ex](#) &index)
- virtual [ex](#) & [operator\[\]](#) (size_t i)
- virtual bool [has](#) (const [ex](#) &other, unsigned [options](#)=0) const
Test for occurrence of a pattern.
- virtual bool [match](#) (const [ex](#) &pattern, [exmap](#) &repls) const
Check whether the expression matches a given pattern.
- virtual [ex subs](#) (const [exmap](#) &m, unsigned [options](#)=0) const
Substitute a set of objects by arbitrary expressions.
- virtual [ex map](#) ([map_function](#) &f) const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void [accept](#) ([GiNaC::visitor](#) &v) const
- virtual bool [is_polynomial](#) (const [ex](#) &var) const
Check whether this is a polynomial in the given variables.
- virtual int [degree](#) (const [ex](#) &s) const
Return degree of highest power in object s.
- virtual int [ldegree](#) (const [ex](#) &s) const
Return degree of lowest power in object s.
- virtual [ex coeff](#) (const [ex](#) &s, int n=1) const
Return coefficient of degree n in object s.
- virtual [ex expand](#) (unsigned [options](#)=0) const
Expand expression, i.e.
- virtual [ex collect](#) (const [ex](#) &s, bool distributed=false) const
Sort expanded expression in terms of powers of some object(s).
- virtual [ex series](#) (const [relational](#) &r, int [order](#), unsigned [options](#)=0) const
Default implementation of [ex::series\(\)](#).

- virtual `ex normal` (`exmap` &repl, `exmap` &rev_lookup, `lst` &modifier) const
Default implementation of `ex::normal()`.
- virtual `ex to_rational` (`exmap` &repl) const
Default implementation of `ex::to_rational()`.
- virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const
Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- virtual `numeric max_coefficient` () const
Implementation `ex::max_coefficient()`.
- virtual `exvector get_free_indices` () const
Return a vector containing the free indices of an expression.
- virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
Add two indexed expressions.
- virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
Multiply an indexed expression with a scalar.
- virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const
Try to contract two indexed expressions that appear in the same product.
- virtual unsigned `return_type` () const
- virtual `return_type_t return_type_tinfo` () const
- virtual `ex conjugate` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const
- template<class T >
void `print_dispatch` (const `print_context` &c, unsigned level) const
Like `print()`, but dispatch to the specified class.
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const
Like `print()`, but dispatch to the specified class.
- virtual void `archive` (`archive_node` &n) const
Save (serialize) the object into archive node.
- virtual void `read_archive` (const `archive_node` &n, `lst` &syms)
Load (deserialize) the object from an archive node.
- `ex subs_one_level` (const `exmap` &m, unsigned `options`) const
Helper function for `subs()`.
- `ex diff` (const `symbol` &s, unsigned nth=1) const
Default interface of nth derivative `ex::diff(s, n)`.
- int `compare` (const `basic` &other) const
Compare objects syntactically to establish canonical ordering.
- bool `is_equal` (const `basic` &other) const
Test for syntactic equality.
- const `basic` & `hold` () const
Stop further evaluation.
- unsigned `gethash` () const
- const `basic` & `setflag` (unsigned f) const
Set some `status_flags`.
- const `basic` & `clearflag` (unsigned f) const
Clear some `status_flags`.

Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add_reference](#) () noexcept
- unsigned int [remove_reference](#) () noexcept
- unsigned int [get_refcount](#) () const noexcept
- void [set_refcount](#) (unsigned int r) noexcept

Protected Member Functions

- unsigned [return_type](#) () const override
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
- void [do_print_latex](#) (const [print_latex](#) &c, unsigned level) const
- unsigned [return_type](#) () const override

Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match_same_type](#) (const [basic](#) &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual [ex derivative](#) (const [symbol](#) &s) const
Default implementation of [ex::diff\(\)](#).
- virtual int [compare_same_type](#) (const [basic](#) &other) const
Returns order relation between two objects of same type.
- virtual bool [is_equal_same_type](#) (const [basic](#) &other) const
Returns true if two objects of same type are equal.
- virtual unsigned [calchash](#) () const
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- void [ensure_if_modifiable](#) () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
Default output to stream.
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
Tree output to stream.
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
Python parsable output to stream.

Additional Inherited Members**Protected Attributes inherited from [GiNaC::basic](#)**

- unsigned [flags](#)
of type [status_flags](#)
- unsigned [hashvalue](#)
hash value

6.175.1 Detailed Description

This class represents the delta tensor.

If indexed, it must have exactly two indices of the same type.

6.175.2 Member Function Documentation

6.175.2.1 info()

```
bool GiNaC::tensdelta::info (
    unsigned int ) const [override], [virtual]
```

Information about the object.

See also

class [info_flags](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::info_flags::real](#).

6.175.2.2 eval_indexed()

```
ex GiNaC::tensdelta::eval_indexed (
    const basic & i ) const [override], [virtual]
```

Automatic symbolic evaluation of an indexed delta tensor.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex0](#), [GiNaC::_ex1](#), [GiNaC::idx::get_dim\(\)](#), [GiNaC::idx::get_value\(\)](#), [GINAC_ASSERT](#), [GiNaC::info_flags::integer](#), [GiNaC::is_dummy_pair\(\)](#), [GiNaC::ex::is_equal\(\)](#), [m](#), [GiNaC::idx::minimal_dim\(\)](#), [GiNaC::subs_options::no_pattern](#), [GiNaC::idx::replace_dim\(\)](#), and [GiNaC::ex::subs\(\)](#).

6.175.2.3 contract_with()

```
bool GiNaC::tensdelta::contract_with (
    exvector::iterator self,
    exvector::iterator other,
    exvector & v ) const [override], [virtual]
```

Contraction of an indexed delta tensor with something else.

Reimplemented from [GiNaC::basic](#).

References [GINAC_ASSERT](#), and [GiNaC::tensor::replace_contr_index\(\)](#).

6.175.2.4 return_type()

```
unsigned GiNaC::tensdelta::return_type ( ) const [inline], [override], [protected], [virtual]
```

Reimplemented from [GiNaC::tensor](#).

References [GiNaC::return_types::commutative](#).

6.175.2.5 do_print()

```
void GiNaC::tensdelta::do_print (
    const print\_context & c,
    unsigned level ) const [protected]
```

6.175.2.6 do_print_latex()

```
void GiNaC::tensdelta::do_print_latex (
    const print\_latex & c,
    unsigned level ) const [protected]
```

The documentation for this class was generated from the following files:

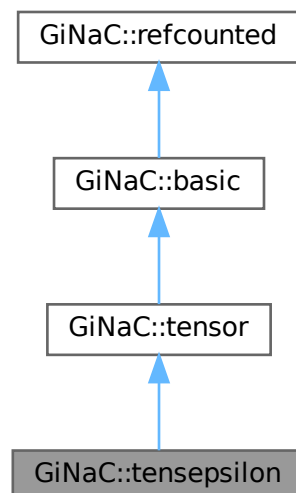
- [tensor.h](#)
- [tensor.cpp](#)

6.176 GiNaC::tensepsilon Class Reference

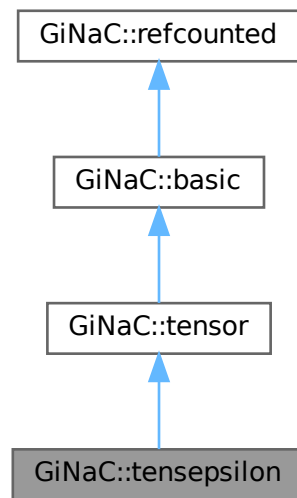
This class represents the totally antisymmetric epsilon tensor.

```
#include <tensor.h>
```

Inheritance diagram for GiNaC::tensepsilon:



Collaboration diagram for GiNaC::tensepsilon:



Public Member Functions

- [tensepsilon](#) (bool [minkowski](#), bool [pos_sig](#))
- bool [info](#) (unsigned inf) const override
Information about the object.
- [ex eval_indexed](#) (const [basic](#) &i) const override
Automatic symbolic evaluation of an indexed epsilon tensor.
- bool [contract_with](#) (exvector::iterator self, exvector::iterator other, [exvector](#) &v) const override
Contraction of epsilon tensor with something else.
- void [archive](#) ([archive_node](#) &n) const override
Save (a.k.a.
- void [read_archive](#) (const [archive_node](#) &n, [lst](#) &[syms](#)) override
Read (a.k.a.

Public Member Functions inherited from [GiNaC::tensor](#)

- bool [replace_contr_index](#) (exvector::iterator self, exvector::iterator other) const
Replace dummy index in contracted-with object by the contracting object's second index (used internally for delta and metric tensor contractions.

Public Member Functions inherited from [GiNaC::basic](#)

- virtual [~basic](#) ()
basic destructor, virtual because class ex will delete objects of derived classes via a basic.*
- [basic](#) (const [basic](#) &other)
- const [basic](#) & [operator=](#) (const [basic](#) &other)

- basic assignment operator: the other object might be of a derived class.*
- virtual `basic * duplicate () const`
Create a clone of this object on the heap.
- virtual `ex eval () const`
Perform automatic non-interruptive term rewriting rules.
- virtual `ex evalf () const`
Evaluate object numerically.
- virtual `ex evalm () const`
Evaluate sums, products and integer powers of matrices.
- virtual `ex eval_integ () const`
Evaluate integrals, if result is known.
- virtual `ex eval_indexed (const basic &i) const`
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual `void print (const print_context &c, unsigned level=0) const`
Output to stream.
- virtual `void dbgprint () const`
Little wrapper around print to be called within a debugger.
- virtual `void dbgprinttree () const`
Little wrapper around printtree to be called within a debugger.
- virtual `unsigned precedence () const`
Return relative operator precedence (for parenthezing output).
- virtual `bool info (unsigned inf) const`
Information about the object.
- virtual `size_t nops () const`
Number of operands/members.
- virtual `ex op (size_t i) const`
Return operand/member at position i.
- virtual `ex operator[] (const ex &index) const`
- virtual `ex operator[] (size_t i) const`
- virtual `ex & let_op (size_t i)`
Return modifiable operand/member at position i.
- virtual `ex & operator[] (const ex &index)`
- virtual `ex & operator[] (size_t i)`
- virtual `bool has (const ex &other, unsigned options=0) const`
Test for occurrence of a pattern.
- virtual `bool match (const ex &pattern, exmap &repls) const`
Check whether the expression matches a given pattern.
- virtual `ex subs (const exmap &m, unsigned options=0) const`
Substitute a set of objects by arbitrary expressions.
- virtual `ex map (map_function &f) const`
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual `void accept (GiNaC::visitor &v) const`
- virtual `bool is_polynomial (const ex &var) const`
Check whether this is a polynomial in the given variables.
- virtual `int degree (const ex &s) const`
Return degree of highest power in object s.
- virtual `int ldegree (const ex &s) const`
Return degree of lowest power in object s.
- virtual `ex coeff (const ex &s, int n=1) const`
Return coefficient of degree n in object s.
- virtual `ex expand (unsigned options=0) const`

- Expand expression, i.e.*

 - virtual `ex collect` (const `ex` &s, bool distributed=false) const

Sort expanded expression in terms of powers of some object(s).

 - virtual `ex series` (const `relational` &r, int `order`, unsigned `options`=0) const

Default implementation of `ex::series()`.

 - virtual `ex normal` (`exmap` &repl, `exmap` &rev_lookup, `lst` &modifier) const

Default implementation of `ex::normal()`.

 - virtual `ex to_rational` (`exmap` &repl) const

Default implementation of `ex::to_rational()`.

 - virtual `ex to_polynomial` (`exmap` &repl) const
 - virtual `numeric integer_content` () const
 - virtual `ex smod` (const `numeric` &xi) const

Apply symmetric modular homomorphism to an expanded multivariate polynomial.

 - virtual `numeric max_coefficient` () const

Implementation `ex::max_coefficient()`.

 - virtual `exvector get_free_indices` () const

Return a vector containing the free indices of an expression.

 - virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const

Add two indexed expressions.

 - virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const

Multiply an indexed expression with a scalar.

 - virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const

Try to contract two indexed expressions that appear in the same product.

 - virtual unsigned `return_type` () const
 - virtual `return_type_t return_type_tinfo` () const
 - virtual `ex conjugate` () const
 - virtual `ex real_part` () const
 - virtual `ex imag_part` () const
 - template<class T >
 - void `print_dispatch` (const `print_context` &c, unsigned level) const

Like `print()`, but dispatch to the specified class.

 - void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const

Like `print()`, but dispatch to the specified class.

 - virtual void `archive` (`archive_node` &n) const

Save (serialize) the object into archive node.

 - virtual void `read_archive` (const `archive_node` &n, `lst` &syms)

Load (deserialize) the object from an archive node.

 - `ex subs_one_level` (const `exmap` &m, unsigned `options`) const

Helper function for `subs()`.

 - `ex diff` (const `symbol` &s, unsigned nth=1) const

Default interface of nth derivative `ex::diff(s, n)`.

 - int `compare` (const `basic` &other) const

Compare objects syntactically to establish canonical ordering.

 - bool `is_equal` (const `basic` &other) const

Test for syntactic equality.

 - const `basic` & `hold` () const

Stop further evaluation.

 - unsigned `gethash` () const
 - const `basic` & `setflag` (unsigned f) const

Set some `status_flags`.

 - const `basic` & `clearflag` (unsigned f) const

Clear some `status_flags`.

Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add_reference](#) () noexcept
- unsigned int [remove_reference](#) () noexcept
- unsigned int [get_refcount](#) () const noexcept
- void [set_refcount](#) (unsigned int r) noexcept

Protected Member Functions

- unsigned [return_type](#) () const override
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
- void [do_print_latex](#) (const [print_latex](#) &c, unsigned level) const
- unsigned [return_type](#) () const override

Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match_same_type](#) (const [basic](#) &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual [ex derivative](#) (const [symbol](#) &s) const
Default implementation of [ex::diff\(\)](#).
- virtual int [compare_same_type](#) (const [basic](#) &other) const
Returns order relation between two objects of same type.
- virtual bool [is_equal_same_type](#) (const [basic](#) &other) const
Returns true if two objects of same type are equal.
- virtual unsigned [calchash](#) () const
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- void [ensure_if_modifiable](#) () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
Default output to stream.
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
Tree output to stream.
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
Python parsable output to stream.

Private Attributes

- bool [minkowski](#)
If true, tensor is in Minkowski-type space.
- bool [pos_sig](#)
If true, the metric is assumed to be $\text{diag}(-1, 1, 1 \dots)$.

Additional Inherited Members

Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)
of type [status_flags](#)
- unsigned [hashvalue](#)
hash value

6.176.1 Detailed Description

This class represents the totally antisymmetric epsilon tensor.

If indexed, all indices must be of the same type and their number must be equal to the dimension of the index space.

6.176.2 Constructor & Destructor Documentation

6.176.2.1 `tensepsilon()`

```
GiNaC::tensepsilon::tensepsilon (
    bool minkowski,
    bool pos_sig )
```

6.176.3 Member Function Documentation

6.176.3.1 `info()`

```
bool GiNaC::tensepsilon::info (
    unsigned inf ) const [override], [virtual]
```

Information about the object.

See also

class [info_flags](#)

Reimplemented from [GiNaC::basic](#).

References [GiNaC::info_flags::real](#).

6.176.3.2 eval_indexed()

```
ex GiNaC::tensepsilon::eval_indexed (
    const basic & i ) const [override], [virtual]
```

Automatic symbolic evaluation of an indexed epsilon tensor.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex0](#), [GINAC_ASSERT](#), [GiNaC::basic::hold\(\)](#), [GiNaC::is_zero\(\)](#), [minkowski](#), [GiNaC::info_flags::nonnegint](#), [GiNaC::basic::nops\(\)](#), [GiNaC::basic::op\(\)](#), [GiNaC::permutation_sign\(\)](#), [pos_sig](#), and [x](#).

6.176.3.3 contract_with()

```
bool GiNaC::tensepsilon::contract_with (
    exvector::iterator self,
    exvector::iterator other,
    exvector & v ) const [override], [virtual]
```

Contraction of epsilon tensor with something else.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::_ex1](#), [GiNaC::delta_tensor\(\)](#), [GiNaC::matrix::determinant\(\)](#), [GINAC_ASSERT](#), [GiNaC::lorentz_g\(\)](#), [GiNaC::metric_tensor\(\)](#), [minkowski](#), [pos_sig](#), and [GiNaC::ex::simplify_indexed\(\)](#).

6.176.3.4 archive()

```
void GiNaC::tensepsilon::archive (
    archive_node & n ) const [override], [virtual]
```

Save (a.k.a.

serialize) object into archive.

Reimplemented from [GiNaC::basic](#).

References [minkowski](#), [n](#), and [pos_sig](#).

6.176.3.5 read_archive()

```
void GiNaC::tensepsilon::read_archive (
    const archive_node & n,
    lst & syms ) [override], [virtual]
```

Read (a.k.a.

deserialize) object from archive.

Reimplemented from [GiNaC::basic](#).

References [minkowski](#), [n](#), and [pos_sig](#).

6.176.3.6 return_type()

```
unsigned GiNaC::tensepsilon::return_type ( ) const [inline], [override], [protected], [virtual]
```

Reimplemented from [GiNaC::tensor](#).

References [GiNaC::return_types::commutative](#).

6.176.3.7 do_print()

```
void GiNaC::tensepsilon::do_print (
    const print\_context & c,
    unsigned level ) const [protected]
```

6.176.3.8 do_print_latex()

```
void GiNaC::tensepsilon::do_print_latex (
    const print\_latex & c,
    unsigned level ) const [protected]
```

6.176.4 Member Data Documentation

6.176.4.1 minkowski

```
bool GiNaC::tensepsilon::minkowski [private]
```

If true, tensor is in Minkowski-type space.

Otherwise it is in a Euclidean space.

Referenced by [archive\(\)](#), [contract_with\(\)](#), [eval_indexed\(\)](#), and [read_archive\(\)](#).

6.176.4.2 pos_sig

```
bool GiNaC::tensepsilon::pos_sig [private]
```

If true, the metric is assumed to be $\text{diag}(-1, 1, 1, \dots)$.

Otherwise it is $\text{diag}(1, -1, -1, \dots)$. This is only relevant if `minkowski = true`.

Referenced by [archive\(\)](#), [contract_with\(\)](#), [eval_indexed\(\)](#), and [read_archive\(\)](#).

The documentation for this class was generated from the following files:

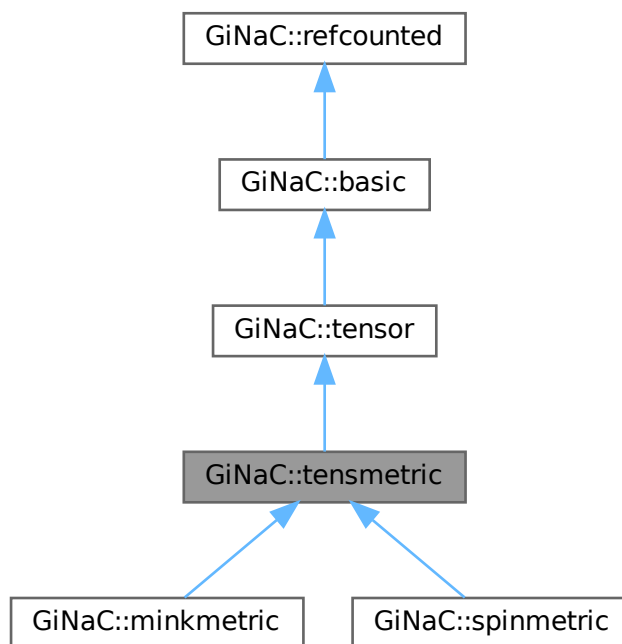
- [tensor.h](#)
- [tensor.cpp](#)

6.177 GiNaC::tensmetric Class Reference

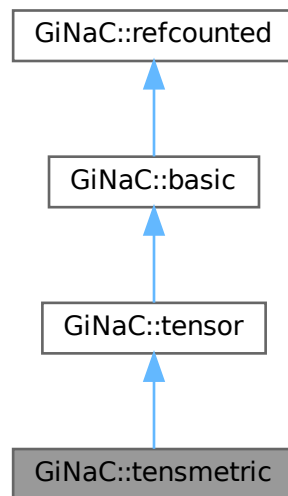
This class represents a general metric tensor which can be used to raise/lower indices.

```
#include <tensor.h>
```

Inheritance diagram for GiNaC::tensmetric:



Collaboration diagram for `GiNaC::tensmetric`:



Public Member Functions

- `bool info` (unsigned inf) const override
Information about the object.
- `ex eval_indexed` (const `basic` &i) const override
Automatic symbolic evaluation of an indexed metric tensor.
- `bool contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const override
Contraction of an indexed metric tensor with something else.

Public Member Functions inherited from `GiNaC::tensor`

- `bool replace_contr_index` (exvector::iterator self, exvector::iterator other) const
Replace dummy index in contracted-with object by the contracting object's second index (used internally for delta and metric tensor contractions).

Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()
basic destructor, virtual because class ex will delete objects of derived classes via a basic.*
- `basic` (const `basic` &other)
- const `basic` & `operator=` (const `basic` &other)
basic assignment operator: the other object might be of a derived class.
- virtual `basic * duplicate` () const
Create a clone of this object on the heap.
- virtual `ex eval` () const
Perform automatic non-interruptive term rewriting rules.

- virtual `ex evalf ()` const
Evaluate object numerically.
- virtual `ex evalm ()` const
Evaluate sums, products and integer powers of matrices.
- virtual `ex eval_integ ()` const
Evaluate integrals, if result is known.
- virtual `ex eval_indexed (const basic &i)` const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void `print (const print_context &c, unsigned level=0)` const
Output to stream.
- virtual void `dbgprint ()` const
Little wrapper around print to be called within a debugger.
- virtual void `dbgprinttree ()` const
Little wrapper around printtree to be called within a debugger.
- virtual unsigned `precedence ()` const
Return relative operator precedence (for parenthezing output).
- virtual bool `info (unsigned inf)` const
Information about the object.
- virtual size_t `nops ()` const
Number of operands/members.
- virtual `ex op (size_t i)` const
Return operand/member at position i.
- virtual `ex operator[] (const ex &index)` const
- virtual `ex operator[] (size_t i)` const
- virtual `ex & let_op (size_t i)`
Return modifiable operand/member at position i.
- virtual `ex & operator[] (const ex &index)`
- virtual `ex & operator[] (size_t i)`
- virtual bool `has (const ex &other, unsigned options=0)` const
Test for occurrence of a pattern.
- virtual bool `match (const ex &pattern, exmap &repls)` const
Check whether the expression matches a given pattern.
- virtual `ex subs (const exmap &m, unsigned options=0)` const
Substitute a set of objects by arbitrary expressions.
- virtual `ex map (map_function &f)` const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void `accept (GiNaC::visitor &v)` const
- virtual bool `is_polynomial (const ex &var)` const
Check whether this is a polynomial in the given variables.
- virtual int `degree (const ex &s)` const
Return degree of highest power in object s.
- virtual int `ldegree (const ex &s)` const
Return degree of lowest power in object s.
- virtual `ex coeff (const ex &s, int n=1)` const
Return coefficient of degree n in object s.
- virtual `ex expand (unsigned options=0)` const
Expand expression, i.e.
- virtual `ex collect (const ex &s, bool distributed=false)` const
Sort expanded expression in terms of powers of some object(s).
- virtual `ex series (const relational &r, int order, unsigned options=0)` const
Default implementation of `ex::series()`.

- virtual `ex normal` (`exmap` &repl, `exmap` &rev_lookup, `lst` &modifier) const
Default implementation of `ex::normal()`.
- virtual `ex to_rational` (`exmap` &repl) const
Default implementation of `ex::to_rational()`.
- virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const
Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- virtual `numeric max_coefficient` () const
Implementation `ex::max_coefficient()`.
- virtual `exvector get_free_indices` () const
Return a vector containing the free indices of an expression.
- virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
Add two indexed expressions.
- virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
Multiply an indexed expression with a scalar.
- virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const
Try to contract two indexed expressions that appear in the same product.
- virtual unsigned `return_type` () const
- virtual `return_type_t return_type_tinfo` () const
- virtual `ex conjugate` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const
- template<class T >
void `print_dispatch` (const `print_context` &c, unsigned level) const
Like `print()`, but dispatch to the specified class.
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const
Like `print()`, but dispatch to the specified class.
- virtual void `archive` (`archive_node` &n) const
Save (serialize) the object into archive node.
- virtual void `read_archive` (const `archive_node` &n, `lst` &syms)
Load (deserialize) the object from an archive node.
- `ex subs_one_level` (const `exmap` &m, unsigned `options`) const
Helper function for `subs()`.
- `ex diff` (const `symbol` &s, unsigned nth=1) const
Default interface of `nth` derivative `ex::diff(s, n)`.
- int `compare` (const `basic` &other) const
Compare objects syntactically to establish canonical ordering.
- bool `is_equal` (const `basic` &other) const
Test for syntactic equality.
- const `basic` & `hold` () const
Stop further evaluation.
- unsigned `gethash` () const
- const `basic` & `setflag` (unsigned f) const
Set some `status_flags`.
- const `basic` & `clearflag` (unsigned f) const
Clear some `status_flags`.

Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add_reference](#) () noexcept
- unsigned int [remove_reference](#) () noexcept
- unsigned int [get_refcount](#) () const noexcept
- void [set_refcount](#) (unsigned int r) noexcept

Protected Member Functions

- unsigned [return_type](#) () const override
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
- unsigned [return_type](#) () const override

Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match_same_type](#) (const [basic](#) &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual [ex derivative](#) (const [symbol](#) &s) const
Default implementation of [ex::diff\(\)](#).
- virtual int [compare_same_type](#) (const [basic](#) &other) const
Returns order relation between two objects of same type.
- virtual bool [is_equal_same_type](#) (const [basic](#) &other) const
Returns true if two objects of same type are equal.
- virtual unsigned [calchash](#) () const
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- void [ensure_if_modifiable](#) () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
Default output to stream.
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
Tree output to stream.
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
Python parsable output to stream.

Additional Inherited Members**Protected Attributes inherited from [GiNaC::basic](#)**

- unsigned [flags](#)
of type [status_flags](#)
- unsigned [hashvalue](#)
hash value

6.177.1 Detailed Description

This class represents a general metric tensor which can be used to raise/lower indices.

If indexed, it must have exactly two indices of the same type which must be of class `varidx` or a subclass.

6.177.2 Member Function Documentation

6.177.2.1 `info()`

```
bool GiNaC::tensmetric::info (
    unsigned inf ) const [override], [virtual]
```

Information about the object.

See also

class [info_flags](#)

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::minkmetric](#), and [GiNaC::spinmetric](#).

References [GiNaC::info_flags::real](#).

6.177.2.2 `eval_indexed()`

```
ex GiNaC::tensmetric::eval_indexed (
    const basic & i ) const [override], [virtual]
```

Automatic symbolic evaluation of an indexed metric tensor.

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::minkmetric](#), and [GiNaC::spinmetric](#).

References [GiNaC::delta_tensor\(\)](#), [GiNaC::idx::get_dim\(\)](#), [GINAC_ASSERT](#), [GiNaC::basic::hold\(\)](#), [GiNaC::varidx::is_covariant\(\)](#), [GiNaC::ex::is_equal\(\)](#), [m](#), [GiNaC::idx::minimal_dim\(\)](#), [GiNaC::subs_options::no_pattern](#), [GiNaC::basic::nops\(\)](#), [GiNaC::basic::op\(\)](#), [GiNaC::idx::replace_dim\(\)](#), and [GiNaC::basic::subs\(\)](#).

6.177.2.3 contract_with()

```
bool GiNaC::tensmetric::contract_with (
    exvector::iterator self,
    exvector::iterator other,
    exvector & v ) const [override], [virtual]
```

Contraction of an indexed metric tensor with something else.

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::spinmetric](#).

References [GINAC_ASSERT](#), and [GiNaC::tensor::replace_contr_index\(\)](#).

6.177.2.4 return_type()

```
unsigned GiNaC::tensmetric::return_type ( ) const [inline], [override], [protected], [virtual]
```

Reimplemented from [GiNaC::tensor](#).

Reimplemented in [GiNaC::minkmetric](#).

References [GiNaC::return_types::commutative](#).

6.177.2.5 do_print()

```
void GiNaC::tensmetric::do_print (
    const print_context & c,
    unsigned level ) const [protected]
```

The documentation for this class was generated from the following files:

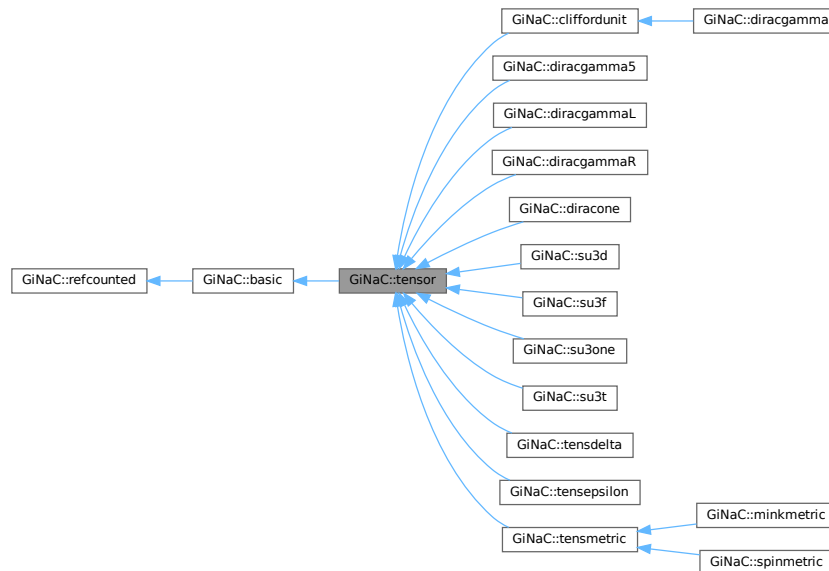
- [tensor.h](#)
- [tensor.cpp](#)

6.178 GiNaC::tensor Class Reference

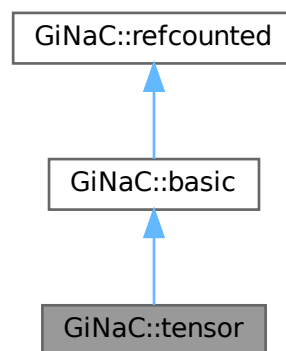
This class holds one of [GiNaC](#)'s predefined special tensors such as the delta and the metric tensors.

```
#include <tensor.h>
```

Inheritance diagram for GiNaC::tensor:



Collaboration diagram for GiNaC::tensor:



Public Member Functions

- bool [replace_contr_index](#) (exvector::iterator self, exvector::iterator other) const
Replace dummy index in contracted-with object by the contracting object's second index (used internally for delta and metric tensor contractions).

Public Member Functions inherited from [GiNaC::basic](#)

- virtual [~basic](#) ()
basic destructor, virtual because class ex will delete objects of derived classes via a basic.*
- [basic](#) (const [basic](#) &other)
- const [basic](#) & [operator=](#) (const [basic](#) &other)
basic assignment operator: the other object might be of a derived class.
- virtual [basic](#) * [duplicate](#) () const
Create a clone of this object on the heap.
- virtual [ex eval](#) () const
Perform automatic non-interruptive term rewriting rules.
- virtual [ex evalf](#) () const
Evaluate object numerically.
- virtual [ex evalm](#) () const
Evaluate sums, products and integer powers of matrices.
- virtual [ex eval_integ](#) () const
Evaluate integrals, if result is known.
- virtual [ex eval_indexed](#) (const [basic](#) &i) const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void [print](#) (const [print_context](#) &c, unsigned level=0) const
Output to stream.
- virtual void [dbgprint](#) () const
Little wrapper around print to be called within a debugger.
- virtual void [dbgprinttree](#) () const
Little wrapper around printtree to be called within a debugger.
- virtual unsigned [precedence](#) () const
Return relative operator precedence (for parenthezing output).
- virtual bool [info](#) (unsigned inf) const
Information about the object.
- virtual size_t [nops](#) () const
Number of operands/members.
- virtual [ex op](#) (size_t i) const
Return operand/member at position i.
- virtual [ex operator\[\]](#) (const [ex](#) &index) const
- virtual [ex operator\[\]](#) (size_t i) const
- virtual [ex](#) & [let_op](#) (size_t i)
Return modifiable operand/member at position i.
- virtual [ex](#) & [operator\[\]](#) (const [ex](#) &index)
- virtual [ex](#) & [operator\[\]](#) (size_t i)
- virtual bool [has](#) (const [ex](#) &other, unsigned [options](#)=0) const
Test for occurrence of a pattern.
- virtual bool [match](#) (const [ex](#) &pattern, [exmap](#) &repls) const
Check whether the expression matches a given pattern.
- virtual [ex subs](#) (const [exmap](#) &m, unsigned [options](#)=0) const
Substitute a set of objects by arbitrary expressions.
- virtual [ex map](#) ([map_function](#) &f) const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void [accept](#) ([GiNaC::visitor](#) &v) const
- virtual bool [is_polynomial](#) (const [ex](#) &var) const
Check whether this is a polynomial in the given variables.
- virtual int [degree](#) (const [ex](#) &s) const

- Return degree of highest power in object s.*

 - virtual int `ldegree` (const `ex` &s) const
- Return degree of lowest power in object s.*

 - virtual `ex coeff` (const `ex` &s, int `n`=1) const
- Return coefficient of degree n in object s.*

 - virtual `ex expand` (unsigned `options`=0) const
- Expand expression, i.e.*

 - virtual `ex collect` (const `ex` &s, bool `distributed`=false) const
- Sort expanded expression in terms of powers of some object(s).*

 - virtual `ex series` (const `relational` &r, int `order`, unsigned `options`=0) const
- Default implementation of `ex::series()`.*

 - virtual `ex normal` (`exmap` &repl, `exmap` &rev_lookup, `lst` &modifier) const
- Default implementation of `ex::normal()`.*

 - virtual `ex to_rational` (`exmap` &repl) const
- Default implementation of `ex::to_rational()`.*

 - virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const*

 - virtual `ex smod` (const `numeric` &xi) const
- Apply symmetric modular homomorphism to an expanded multivariate polynomial.*

 - virtual `numeric max_coefficient` () const
- Implementation `ex::max_coefficient()`.*

 - virtual `exvector get_free_indices` () const
- Return a vector containing the free indices of an expression.*

 - virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
- Add two indexed expressions.*

 - virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
- Multiply an indexed expression with a scalar.*

 - virtual bool `contract_with` (exvector::iterator self, exvector::iterator other, `exvector` &v) const
- Try to contract two indexed expressions that appear in the same product.*

 - virtual unsigned `return_type` () const
 - virtual `return_type_t return_type_tinfo` () const
 - virtual `ex conjugate` () const
 - virtual `ex real_part` () const
 - virtual `ex imag_part` () const
- template<class T >

 - void `print_dispatch` (const `print_context` &c, unsigned level) const
- Like `print()`, but dispatch to the specified class.*

 - void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const
- Like `print()`, but dispatch to the specified class.*

 - virtual void `archive` (`archive_node` &n) const
- Save (serialize) the object into archive node.*

 - virtual void `read_archive` (const `archive_node` &n, `lst` &syms)
- Load (deserialize) the object from an archive node.*

 - `ex subs_one_level` (const `exmap` &m, unsigned `options`) const
- Helper function for `subs()`.*

 - `ex diff` (const `symbol` &s, unsigned `nth`=1) const
- Default interface of nth derivative `ex::diff(s, n)`.*

 - int `compare` (const `basic` &other) const
- Compare objects syntactically to establish canonical ordering.*

 - bool `is_equal` (const `basic` &other) const
- Test for syntactic equality.*

- const [basic](#) & [hold](#) () const
Stop further evaluation.
- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const
Set some [status_flags](#).
- const [basic](#) & [clearflag](#) (unsigned f) const
Clear some [status_flags](#).

Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add_reference](#) () noexcept
- unsigned int [remove_reference](#) () noexcept
- unsigned int [get_refcount](#) () const noexcept
- void [set_refcount](#) (unsigned int r) noexcept

Protected Member Functions

- unsigned [return_type](#) () const override

Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match_same_type](#) (const [basic](#) &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual [ex derivative](#) (const [symbol](#) &s) const
Default implementation of [ex::diff\(\)](#).
- virtual int [compare_same_type](#) (const [basic](#) &other) const
Returns order relation between two objects of same type.
- virtual bool [is_equal_same_type](#) (const [basic](#) &other) const
Returns true if two objects of same type are equal.
- virtual unsigned [calchash](#) () const
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- void [ensure_if_modifiable](#) () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
Default output to stream.
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
Tree output to stream.
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
Python parsable output to stream.

Additional Inherited Members

Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)
of type [status_flags](#)
- unsigned [hashvalue](#)
hash value

6.178.1 Detailed Description

This class holds one of [GiNaC](#)'s predefined special tensors such as the delta and the metric tensors.

They are represented without indices. To attach indices to them, wrap them in an object of class [indexed](#).

6.178.2 Member Function Documentation

6.178.2.1 `return_type()`

```
unsigned GiNaC::tensor::return_type ( ) const [inline], [override], [protected], [virtual]
```

Reimplemented from [GiNaC::basic](#).

Reimplemented in [GiNaC::tensdelta](#), [GiNaC::tensmetric](#), [GiNaC::minkmetric](#), and [GiNaC::tensepsilon](#).

References [GiNaC::return_types::noncommutative_composite](#).

6.178.2.2 `replace_contr_index()`

```
bool GiNaC::tensor::replace_contr_index (
    exvector::iterator self,
    exvector::iterator other ) const
```

Replace dummy index in contracted-with object by the contracting object's second index (used internally for delta and metric tensor contractions).

References [GiNaC::_ex1](#), [GiNaC::is_dummy_pair\(\)](#), [GiNaC::idx::is_symbolic\(\)](#), [GiNaC::idx::minimal_dim\(\)](#), [GiNaC::idx::replace_dim\(\)](#), and [GiNaC::ex::subs\(\)](#).

Referenced by [GiNaC::tensdelta::contract_with\(\)](#), and [GiNaC::tensmetric::contract_with\(\)](#).

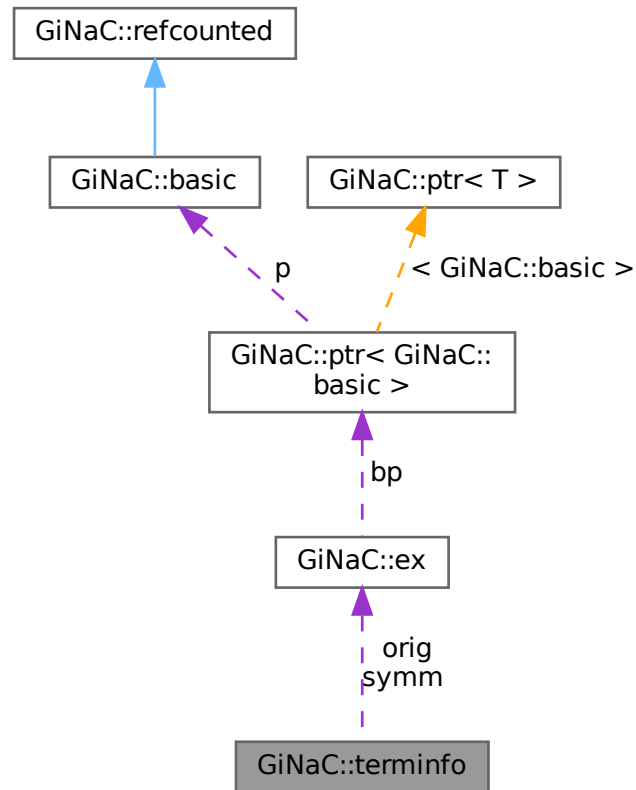
The documentation for this class was generated from the following files:

- [tensor.h](#)
- [tensor.cpp](#)

6.179 GiNaC::terminfo Class Reference

This structure stores the original and symmetrized versions of terms obtained during the simplification of sums.

Collaboration diagram for GiNaC::terminfo:



Public Member Functions

- [terminfo](#) (const [ex](#) &orig_, const [ex](#) &symm_)

Public Attributes

- [ex orig](#)
original term
- [ex symm](#)
symmetrized term

6.179.1 Detailed Description

This structure stores the original and symmetrized versions of terms obtained during the simplification of sums.

6.179.2 Constructor & Destructor Documentation

6.179.2.1 `terminfo()`

```
GiNaC::terminfo::terminfo (
    const ex & orig_,
    const ex & symm_ ) [inline]
```

6.179.3 Member Data Documentation

6.179.3.1 `orig`

[ex](#) `GiNaC::terminfo::orig`

original term

6.179.3.2 `symm`

[ex](#) `GiNaC::terminfo::symm`

symmetrized term

Referenced by [GiNaC::terminfo_is_less::operator\(\)\(\)](#).

The documentation for this class was generated from the following file:

- [indexed.cpp](#)

6.180 `GiNaC::terminfo_is_less` Class Reference

Public Member Functions

- bool [operator\(\)](#) (const [terminfo](#) &ti1, const [terminfo](#) &ti2) const

6.180.1 Member Function Documentation

6.180.1.1 operator>()

```
bool GiNaC::terminfo_is_less::operator() (
    const terminfo & ti1,
    const terminfo & ti2 ) const [inline]
```

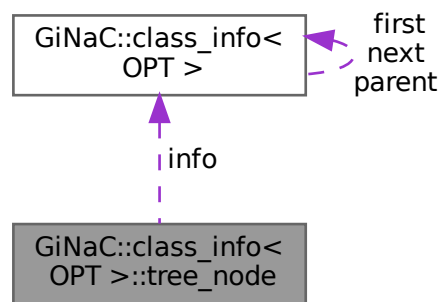
References [GiNaC::ex::compare\(\)](#), and [GiNaC::terminfo::symm](#).

The documentation for this class was generated from the following file:

- [indexed.cpp](#)

6.181 GiNaC::class_info< OPT >::tree_node Struct Reference

Collaboration diagram for GiNaC::class_info< OPT >::tree_node:



Public Member Functions

- [tree_node](#) ([class_info](#) *)
- void [add_child](#) ([tree_node](#) *n)

Public Attributes

- std::vector< [tree_node](#) * > [children](#)
- [class_info](#) * [info](#)

6.181.1 Constructor & Destructor Documentation

6.181.1.1 `tree_node()`

```
template<class OPT >
GiNaC::class_info< OPT >::tree_node::tree_node (
    class_info * i ) [inline]
```

6.181.2 Member Function Documentation

6.181.2.1 `add_child()`

```
template<class OPT >
void GiNaC::class_info< OPT >::tree_node::add_child (
    tree_node * n ) [inline]
```

References [GiNaC::class_info< OPT >::tree_node::children](#), and [n](#).

6.181.3 Member Data Documentation

6.181.3.1 `children`

```
template<class OPT >
std::vector<tree_node *> GiNaC::class_info< OPT >::tree_node::children
```

Referenced by [GiNaC::class_info< OPT >::tree_node::add_child\(\)](#).

6.181.3.2 `info`

```
template<class OPT >
class_info* GiNaC::class_info< OPT >::tree_node::info
```

The documentation for this struct was generated from the following file:

- [class_info.h](#)

6.182 GiNaC::unarchive_table_t Class Reference

```
#include <archive.h>
```

Public Member Functions

- [unarchive_table_t](#) ()
- [~unarchive_table_t](#) ()
- [synthesize_func](#) [find](#) (const std::string &classname) const
- void [insert](#) (const std::string &classname, [synthesize_func](#) f)

Static Private Attributes

- static int [usecount](#) = 0
- static [unarchive_map_t](#) * [unarch_map](#) = nullptr

6.182.1 Constructor & Destructor Documentation

6.182.1.1 unarchive_table_t()

GiNaC::unarchive_table_t::unarchive_table_t ()

References [unarch_map](#), and [usecount](#).

6.182.1.2 ~unarchive_table_t()

GiNaC::unarchive_table_t::~~unarchive_table_t ()

References [unarch_map](#), and [usecount](#).

6.182.2 Member Function Documentation

6.182.2.1 find()

[synthesize_func](#) GiNaC::unarchive_table_t::find (
const std::string & *classname*) const

References [unarch_map](#).

Referenced by [GiNaC::find_factory_fcn](#)().

6.182.2.2 insert()

```
void GiNaC::unarchive_table_t::insert (
    const std::string & classname,
    synthesize_func f )
```

References [unarch_map](#).

6.182.3 Member Data Documentation

6.182.3.1 usecount

```
int GiNaC::unarchive_table_t::usecount = 0 [static], [private]
```

Referenced by [unarchive_table_t\(\)](#), and [~unarchive_table_t\(\)](#).

6.182.3.2 unarch_map

```
unarchive\_map\_t * GiNaC::unarchive_table_t::unarch_map = nullptr [static], [private]
```

Referenced by [find\(\)](#), [insert\(\)](#), [unarchive_table_t\(\)](#), and [~unarchive_table_t\(\)](#).

The documentation for this class was generated from the following files:

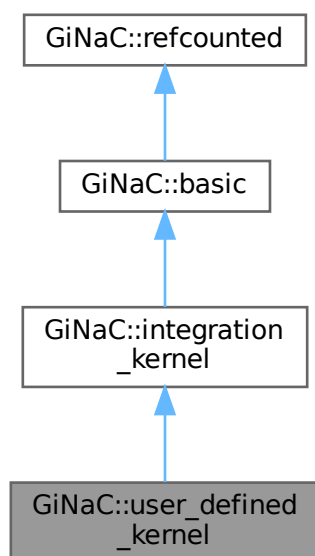
- [archive.h](#)
- [archive.cpp](#)

6.183 GiNaC::user_defined_kernel Class Reference

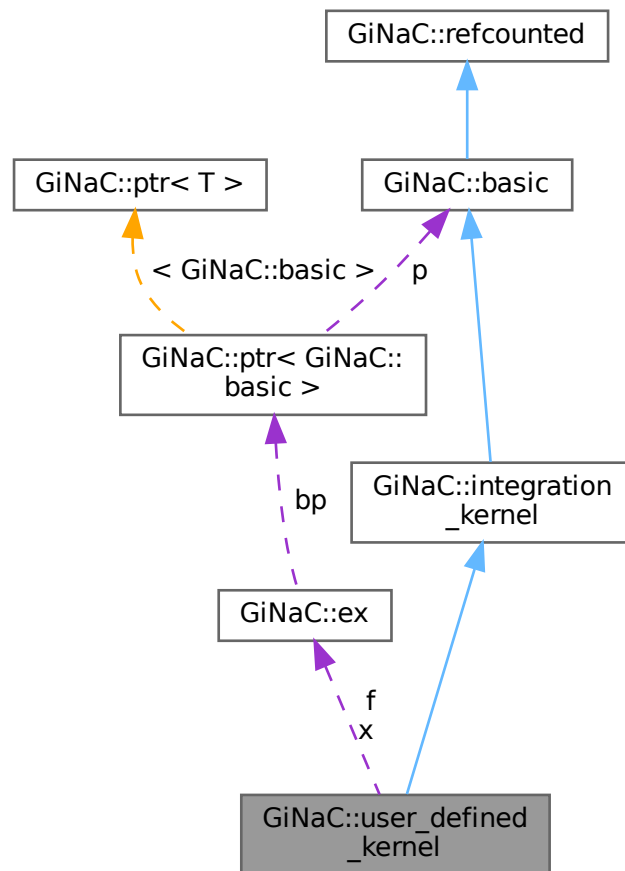
A user-defined integration kernel.

```
#include <integration_kernel.h>
```

Inheritance diagram for GiNaC::user_defined_kernel:



Collaboration diagram for `GiNaC::user_defined_kernel`:



Public Member Functions

- `user_defined_kernel` (const `ex` &`f`, const `ex` &`x`)
- `size_t nops` () const override
Number of operands/members.
- `ex op` (size_t `i`) const override
Return operand/member at position `i`.
- `ex & let_op` (size_t `i`) override
Return modifiable operand/member at position `i`.
- `bool is_numeric` (void) const override
This routine returns true, if the integration kernel can be evaluated numerically.
- `ex Laurent_series` (const `ex` &`x`, int `order`) const override
Returns the Laurent series, starting possibly with the pole term.

Public Member Functions inherited from [GiNaC::integration_kernel](#)

- [ex series](#) (const [relational](#) &r, int [order](#), unsigned [options](#)=0) const override
Default implementation of [ex::series\(\)](#).
- virtual bool [has_trailing_zero](#) (void) const
This routine returns true, if the integration kernel has a trailing zero.
- virtual bool [is_numeric](#) (void) const
This routine returns true, if the integration kernel can be evaluated numerically.
- virtual [ex Laurent_series](#) (const [ex](#) &x, int [order](#)) const
Returns the Laurent series, starting possibly with the pole term.
- virtual [ex get_numerical_value](#) (const [ex](#) &lambda, int N_trunc=0) const
Evaluates the integrand at lambda.
- size_t [get_cache_size](#) (void) const
Returns the current size of the cache.
- void [set_cache_step](#) (int cache_steps) const
Sets the step size by which the cache is increased.
- [ex get_series_coeff](#) (int i) const
Wrapper around [series_coeff\(i\)](#), converts [cl_N](#) to numeric.
- [cln::cl_N series_coeff](#) (int i) const
Subclasses have either to implement [series_coeff_impl](#) or the two methods [Laurent_series](#) and [uses_Laurent_series](#).

Public Member Functions inherited from [GiNaC::basic](#)

- virtual [~basic](#) ()
basic destructor, virtual because class [ex](#) will delete objects of derived classes via a [basic](#).*
- [basic](#) (const [basic](#) &other)
- const [basic](#) & [operator=](#) (const [basic](#) &other)
basic assignment operator: the other object might be of a derived class.
- virtual [basic * duplicate](#) () const
Create a clone of this object on the heap.
- virtual [ex eval](#) () const
Perform automatic non-interruptive term rewriting rules.
- virtual [ex evalf](#) () const
Evaluate object numerically.
- virtual [ex evalm](#) () const
Evaluate sums, products and integer powers of matrices.
- virtual [ex eval_integ](#) () const
Evaluate integrals, if result is known.
- virtual [ex eval_indexed](#) (const [basic](#) &i) const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void [print](#) (const [print_context](#) &c, unsigned level=0) const
Output to stream.
- virtual void [dbgprint](#) () const
Little wrapper around [print](#) to be called within a debugger.
- virtual void [dbgprinttree](#) () const
Little wrapper around [printtree](#) to be called within a debugger.
- virtual unsigned [precedence](#) () const
Return relative operator precedence (for parenthezing output).
- virtual bool [info](#) (unsigned inf) const
Information about the object.

- virtual `size_t nops ()` const
Number of operands/members.
- virtual `ex op (size_t i)` const
Return operand/member at position i.
- virtual `ex operator[] (const ex &index)` const
- virtual `ex operator[] (size_t i)` const
- virtual `ex & let_op (size_t i)`
Return modifiable operand/member at position i.
- virtual `ex & operator[] (const ex &index)`
- virtual `ex & operator[] (size_t i)`
- virtual `bool has (const ex &other, unsigned options=0)` const
Test for occurrence of a pattern.
- virtual `bool match (const ex &pattern, exmap &repls)` const
Check whether the expression matches a given pattern.
- virtual `ex subs (const exmap &m, unsigned options=0)` const
Substitute a set of objects by arbitrary expressions.
- virtual `ex map (map_function &f)` const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual `void accept (GiNaC::visitor &v)` const
- virtual `bool is_polynomial (const ex &var)` const
Check whether this is a polynomial in the given variables.
- virtual `int degree (const ex &s)` const
Return degree of highest power in object s.
- virtual `int ldegree (const ex &s)` const
Return degree of lowest power in object s.
- virtual `ex coeff (const ex &s, int n=1)` const
Return coefficient of degree n in object s.
- virtual `ex expand (unsigned options=0)` const
Expand expression, i.e.
- virtual `ex collect (const ex &s, bool distributed=false)` const
Sort expanded expression in terms of powers of some object(s).
- virtual `ex series (const relational &r, int order, unsigned options=0)` const
Default implementation of `ex::series()`.
- virtual `ex normal (exmap &repl, exmap &rev_lookup, lst &modifier)` const
Default implementation of `ex::normal()`.
- virtual `ex to_rational (exmap &repl)` const
Default implementation of `ex::to_rational()`.
- virtual `ex to_polynomial (exmap &repl)` const
- virtual `numeric integer_content ()` const
- virtual `ex smod (const numeric &xi)` const
Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- virtual `numeric max_coefficient ()` const
Implementation `ex::max_coefficient()`.
- virtual `exvector get_free_indices ()` const
Return a vector containing the free indices of an expression.
- virtual `ex add_indexed (const ex &self, const ex &other)` const
Add two indexed expressions.
- virtual `ex scalar_mul_indexed (const ex &self, const numeric &other)` const
Multiply an indexed expression with a scalar.
- virtual `bool contract_with (exvector::iterator self, exvector::iterator other, exvector &v)` const
Try to contract two indexed expressions that appear in the same product.

- virtual unsigned [return_type](#) () const
- virtual [return_type_t](#) [return_type_tinfo](#) () const
- virtual [ex conjugate](#) () const
- virtual [ex real_part](#) () const
- virtual [ex imag_part](#) () const
- template<class T >
void [print_dispatch](#) (const [print_context](#) &c, unsigned level) const
Like [print\(\)](#), but dispatch to the specified class.
- void [print_dispatch](#) (const [registered_class_info](#) &ri, const [print_context](#) &c, unsigned level) const
Like [print\(\)](#), but dispatch to the specified class.
- virtual void [archive](#) ([archive_node](#) &n) const
Save (serialize) the object into archive node.
- virtual void [read_archive](#) (const [archive_node](#) &n, [lst](#) &[syms](#))
Load (deserialize) the object from an archive node.
- [ex subs_one_level](#) (const [exmap](#) &m, unsigned [options](#)) const
Helper function for [subs\(\)](#).
- [ex diff](#) (const [symbol](#) &s, unsigned nth=1) const
Default interface of nth derivative [ex::diff\(s, n\)](#).
- int [compare](#) (const [basic](#) &other) const
Compare objects syntactically to establish canonical ordering.
- bool [is_equal](#) (const [basic](#) &other) const
Test for syntactic equality.
- const [basic](#) & [hold](#) () const
Stop further evaluation.
- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const
Set some [status_flags](#).
- const [basic](#) & [clearflag](#) (unsigned f) const
Clear some [status_flags](#).

Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add_reference](#) () noexcept
- unsigned int [remove_reference](#) () noexcept
- unsigned int [get_refcount](#) () const noexcept
- void [set_refcount](#) (unsigned int r) noexcept

Protected Member Functions

- bool [uses_Laurent_series](#) () const override
Returns true, if the coefficients are computed from the Laurent series (in which case the method [Laurent_series](#) needs to be implemented).
- void [do_print](#) (const [print_context](#) &c, unsigned level) const

Protected Member Functions inherited from [GiNaC::integration_kernel](#)

- virtual bool [uses_Laurent_series](#) () const
Returns true, if the coefficients are computed from the Laurent series (in which case the method `Laurent_series` needs to be implemented).
- virtual `cln::cl_N` [series_coeff_impl](#) (int i) const
For $\omega = d\lambda$ only the coefficient of λ^0 is non-zero.
- [ex_get_numerical_value_impl](#) (const [ex](#) &lambda, const [ex](#) &pre, int shift, int N_trunc) const
The actual implementation for computing a numerical value for the integrand.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const

Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match_same_type](#) (const [basic](#) &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual [ex derivative](#) (const [symbol](#) &s) const
Default implementation of `ex::diff()`.
- virtual int [compare_same_type](#) (const [basic](#) &other) const
Returns order relation between two objects of same type.
- virtual bool [is_equal_same_type](#) (const [basic](#) &other) const
Returns true if two objects of same type are equal.
- virtual unsigned [calchash](#) () const
Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.
- void [ensure_if_modifiable](#) () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
Default output to stream.
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
Tree output to stream.
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
Python parsable output to stream.

Protected Attributes

- [ex f](#)
- [ex x](#)

Protected Attributes inherited from [GiNaC::integration_kernel](#)

- int [cache_step_size](#)
- `std::vector< cln::cl_N >` [series_vec](#)

Protected Attributes inherited from [GiNaC::basic](#)

- unsigned [flags](#)
of type `status_flags`
- unsigned [hashvalue](#)
hash value

6.183.1 Detailed Description

A user-defined integration kernel.

The input is an expression f , depending on a variable x . It is assumed that f has a Laurent expansion around $x = 0$ and maximally a simple pole at $x = 0$.

6.183.2 Constructor & Destructor Documentation

6.183.2.1 user_defined_kernel()

```
GiNaC::user_defined_kernel::user_defined_kernel (
    const ex & f,
    const ex & x )
```

6.183.3 Member Function Documentation

6.183.3.1 nops()

```
size_t GiNaC::user_defined_kernel::nops ( ) const [override], [virtual]
```

Number of operands/members.

Reimplemented from [GiNaC::basic](#).

6.183.3.2 op()

```
ex GiNaC::user_defined_kernel::op (
    size_t i ) const [override], [virtual]
```

Return operand/member at position *i*.

Reimplemented from [GiNaC::basic](#).

References [f](#), and [x](#).

6.183.3.3 let_op()

```
ex & GiNaC::user_defined_kernel::let_op (
    size_t i ) [override], [virtual]
```

Return modifiable operand/member at position i.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::ensure_if_modifiable\(\)](#), [f](#), and [x](#).

6.183.3.4 is_numeric()

```
bool GiNaC::user_defined_kernel::is_numeric (
    void ) const [override], [virtual]
```

This routine returns true, if the integration kernel can be evaluated numerically.

Reimplemented from [GiNaC::integration_kernel](#).

References [GiNaC::ex::evalf\(\)](#), [f](#), [GiNaC::ex::info\(\)](#), [GiNaC::info_flags::numeric](#), [GiNaC::ex::subs\(\)](#), and [x](#).

6.183.3.5 Laurent_series()

```
ex GiNaC::user_defined_kernel::Laurent_series (
    const ex & x,
    int order ) const [override], [virtual]
```

Returns the Laurent series, starting possibly with the pole term.

Neglected terms are of order $O(x^{order})$.

Reimplemented from [GiNaC::integration_kernel](#).

References [f](#), [order](#), [GiNaC::ex::series\(\)](#), [GiNaC::ex::subs\(\)](#), and [x](#).

6.183.3.6 uses_Laurent_series()

```
bool GiNaC::user_defined_kernel::uses_Laurent_series ( ) const [override], [protected], [virtual]
```

Returns true, if the coefficients are computed from the Laurent series (in which case the method `Laurent_series` needs to be implemented).

Returns false if this is not the case (and the class has an implementation of `series_coeff_impl`).

Reimplemented from [GiNaC::integration_kernel](#).

6.183.3.7 do_print()

```
void GiNaC::user_defined_kernel::do_print (
    const print\_context & c,
    unsigned level ) const [protected]
```

References [c](#), [f](#), [GiNaC::ex::print\(\)](#), and [x](#).

6.183.4 Member Data Documentation

6.183.4.1 f

```
ex GiNaC::user_defined_kernel::f [protected]
```

Referenced by [do_print\(\)](#), [is_numeric\(\)](#), [Laurent_series\(\)](#), [let_op\(\)](#), and [op\(\)](#).

6.183.4.2 x

```
ex GiNaC::user_defined_kernel::x [protected]
```

Referenced by [do_print\(\)](#), [is_numeric\(\)](#), [Laurent_series\(\)](#), [let_op\(\)](#), and [op\(\)](#).

The documentation for this class was generated from the following files:

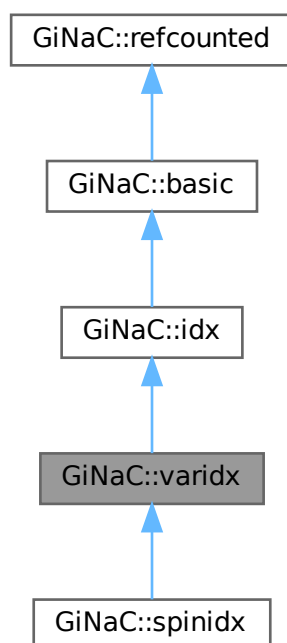
- [integration_kernel.h](#)
- [integration_kernel.cpp](#)

6.184 GiNaC::varidx Class Reference

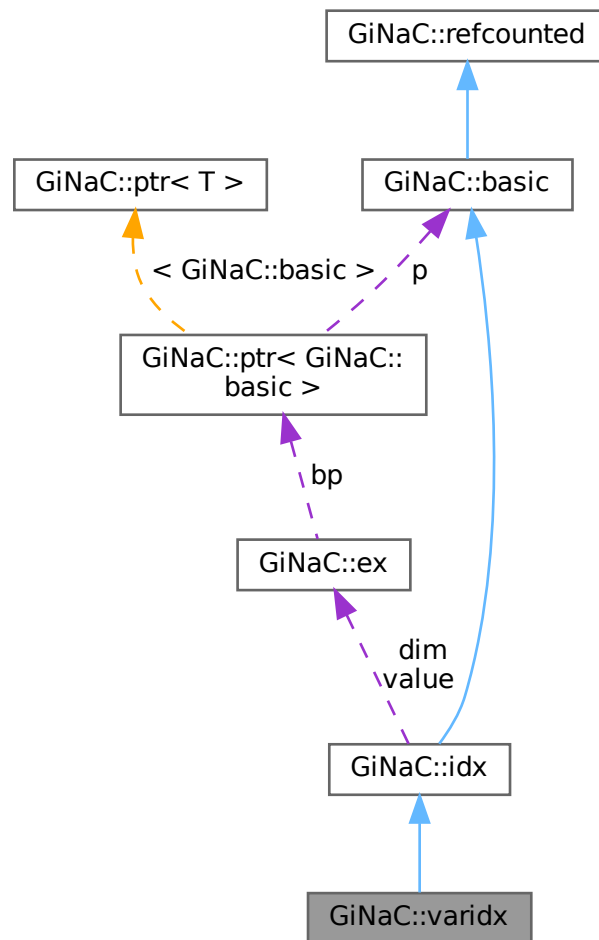
This class holds an index with a variance (co- or contravariant).

```
#include <idx.h>
```

Inheritance diagram for GiNaC::varidx:



Collaboration diagram for GiNaC::varidx:



Public Member Functions

- `varidx` (const `ex` &`v`, const `ex` &`dim`, bool `covariant`=false)
Construct index with given value, dimension and variance.
- bool `is_dummy_pair_same_type` (const `basic` &`other`) const override
Check whether the index forms a dummy index pair with another index of the same type.
- void `archive` (`archive_node` &`n`) const override
Save (serialize) the object into archive node.
- void `read_archive` (const `archive_node` &`n`, `lst` &`syms`) override
Load (deserialize) the object from an archive node.
- bool `is_covariant` () const
Check whether the index is covariant.
- bool `is_contravariant` () const
Check whether the index is contravariant (not covariant).
- `ex toggle_variance` () const
Make a new index with the same value but the opposite variance.

Public Member Functions inherited from [GiNaC::idx](#)

- [idx](#) (const [ex](#) &v, const [ex](#) &dim)
Construct index with given value and dimension.
- bool [info](#) (unsigned inf) const override
Information about the object.
- size_t [nops](#) () const override
Number of operands/members.
- [ex op](#) (size_t i) const override
Return operand/member at position i.
- [ex map](#) (map_function &f) const override
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- [ex evalf](#) () const override
By default, [basic::evalf](#) would evaluate the index value but we don't want a.1 to become a.
- [ex subs](#) (const [exmap](#) &m, unsigned [options](#)=0) const override
Substitute a set of objects by arbitrary expressions.
- void [archive](#) ([archive_node](#) &n) const override
Save (serialize) the object into archive node.
- void [read_archive](#) (const [archive_node](#) &n, lst &syms) override
Load (deserialize) the object from an archive node.
- virtual bool [is_dummy_pair_same_type](#) (const [basic](#) &other) const
Check whether the index forms a dummy index pair with another index of the same type.
- [ex get_value](#) () const
Get value of index.
- bool [is_numeric](#) () const
Check whether the index is numeric.
- bool [is_symbolic](#) () const
Check whether the index is symbolic.
- [ex get_dim](#) () const
Get dimension of index space.
- bool [is_dim_numeric](#) () const
Check whether the dimension is numeric.
- bool [is_dim_symbolic](#) () const
Check whether the dimension is symbolic.
- [ex replace_dim](#) (const [ex](#) &new_dim) const
Make a new index with the same value but a different dimension.
- [ex minimal_dim](#) (const [idx](#) &other) const
Return the minimum of the dimensions of this and another index.

Public Member Functions inherited from [GiNaC::basic](#)

- virtual [~basic](#) ()
basic destructor, virtual because class ex will delete objects of derived classes via a basic.*
- [basic](#) (const [basic](#) &other)
- const [basic](#) & [operator=](#) (const [basic](#) &other)
basic assignment operator: the other object might be of a derived class.
- virtual [basic](#) * [duplicate](#) () const
Create a clone of this object on the heap.
- virtual [ex eval](#) () const
Perform automatic non-interruptive term rewriting rules.

- virtual `ex evalf` () const
Evaluate object numerically.
- virtual `ex evalm` () const
Evaluate sums, products and integer powers of matrices.
- virtual `ex eval_integ` () const
Evaluate integrals, if result is known.
- virtual `ex eval_indexed` (const `basic` &i) const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.
- virtual void `print` (const `print_context` &c, unsigned level=0) const
Output to stream.
- virtual void `dbgprint` () const
Little wrapper around print to be called within a debugger.
- virtual void `dbgprinttree` () const
Little wrapper around printtree to be called within a debugger.
- virtual unsigned `precedence` () const
Return relative operator precedence (for parenthezing output).
- virtual bool `info` (unsigned inf) const
Information about the object.
- virtual size_t `nops` () const
Number of operands/members.
- virtual `ex op` (size_t i) const
Return operand/member at position i.
- virtual `ex operator[]` (const `ex` &index) const
- virtual `ex operator[]` (size_t i) const
- virtual `ex & let_op` (size_t i)
Return modifiable operand/member at position i.
- virtual `ex & operator[]` (const `ex` &index)
- virtual `ex & operator[]` (size_t i)
- virtual bool `has` (const `ex` &other, unsigned `options`=0) const
Test for occurrence of a pattern.
- virtual bool `match` (const `ex` &pattern, `exmap` &repls) const
Check whether the expression matches a given pattern.
- virtual `ex subs` (const `exmap` &m, unsigned `options`=0) const
Substitute a set of objects by arbitrary expressions.
- virtual `ex map` (`map_function` &f) const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void `accept` (GiNaC::visitor &v) const
- virtual bool `is_polynomial` (const `ex` &var) const
Check whether this is a polynomial in the given variables.
- virtual int `degree` (const `ex` &s) const
Return degree of highest power in object s.
- virtual int `ldegree` (const `ex` &s) const
Return degree of lowest power in object s.
- virtual `ex coeff` (const `ex` &s, int n=1) const
Return coefficient of degree n in object s.
- virtual `ex expand` (unsigned `options`=0) const
Expand expression, i.e.
- virtual `ex collect` (const `ex` &s, bool distributed=false) const
Sort expanded expression in terms of powers of some object(s).
- virtual `ex series` (const `relational` &r, int `order`, unsigned `options`=0) const
Default implementation of `ex::series()`.

- virtual `ex normal` (`exmap` &repl, `exmap` &rev_lookup, `lst` &modifier) const
Default implementation of `ex::normal()`.
- virtual `ex to_rational` (`exmap` &repl) const
Default implementation of `ex::to_rational()`.
- virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const
Apply symmetric modular homomorphism to an expanded multivariate polynomial.
- virtual `numeric max_coefficient` () const
Implementation `ex::max_coefficient()`.
- virtual `exvector get_free_indices` () const
Return a vector containing the free indices of an expression.
- virtual `ex add_indexed` (const `ex` &self, const `ex` &other) const
Add two indexed expressions.
- virtual `ex scalar_mul_indexed` (const `ex` &self, const `numeric` &other) const
Multiply an indexed expression with a scalar.
- virtual bool `contract_with` (`exvector::iterator` self, `exvector::iterator` other, `exvector` &v) const
Try to contract two indexed expressions that appear in the same product.
- virtual unsigned `return_type` () const
- virtual `return_type_t return_type_tinfo` () const
- virtual `ex conjugate` () const
- virtual `ex real_part` () const
- virtual `ex imag_part` () const
- template<class T >
void `print_dispatch` (const `print_context` &c, unsigned level) const
Like `print()`, but dispatch to the specified class.
- void `print_dispatch` (const `registered_class_info` &ri, const `print_context` &c, unsigned level) const
Like `print()`, but dispatch to the specified class.
- virtual void `archive` (`archive_node` &n) const
Save (serialize) the object into archive node.
- virtual void `read_archive` (const `archive_node` &n, `lst` &syms)
Load (deserialize) the object from an archive node.
- `ex subs_one_level` (const `exmap` &m, unsigned `options`) const
Helper function for `subs()`.
- `ex diff` (const `symbol` &s, unsigned nth=1) const
Default interface of nth derivative `ex::diff(s, n)`.
- int `compare` (const `basic` &other) const
Compare objects syntactically to establish canonical ordering.
- bool `is_equal` (const `basic` &other) const
Test for syntactic equality.
- const `basic` & `hold` () const
Stop further evaluation.
- unsigned `gethash` () const
- const `basic` & `setflag` (unsigned f) const
Set some `status_flags`.
- const `basic` & `clearflag` (unsigned f) const
Clear some `status_flags`.

Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add_reference](#) () noexcept
- unsigned int [remove_reference](#) () noexcept
- unsigned int [get_refcount](#) () const noexcept
- void [set_refcount](#) (unsigned int r) noexcept

Protected Member Functions

- bool [match_same_type](#) (const [basic](#) &other) const override
Returns true if the attributes of two objects are similar enough for a match.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const

Protected Member Functions inherited from [GiNaC::idx](#)

- [ex_derivative](#) (const [symbol](#) &s) const override
Implementation of [ex::diff\(\)](#) for an index always returns 0.
- bool [match_same_type](#) (const [basic](#) &other) const override
Returns true if the attributes of two objects are similar enough for a match.
- unsigned [calchash](#) () const override
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- void [print_index](#) (const [print_context](#) &c, unsigned level) const
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
- void [do_print_csrc](#) (const [print_csrc](#) &c, unsigned level) const
- void [do_print_latex](#) (const [print_latex](#) &c, unsigned level) const
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const

Protected Member Functions inherited from [GiNaC::basic](#)

- [basic](#) ()
- virtual [ex eval_ncmul](#) (const [exvector](#) &v) const
- virtual bool [match_same_type](#) (const [basic](#) &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual [ex_derivative](#) (const [symbol](#) &s) const
Default implementation of [ex::diff\(\)](#).
- virtual int [compare_same_type](#) (const [basic](#) &other) const
Returns order relation between two objects of same type.
- virtual bool [is_equal_same_type](#) (const [basic](#) &other) const
Returns true if two objects of same type are equal.
- virtual unsigned [calchash](#) () const
Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.
- void [ensure_if_modifiable](#) () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void [do_print](#) (const [print_context](#) &c, unsigned level) const
Default output to stream.
- void [do_print_tree](#) (const [print_tree](#) &c, unsigned level) const
Tree output to stream.
- void [do_print_python_repr](#) (const [print_python_repr](#) &c, unsigned level) const
Python parsable output to stream.

Protected Attributes

- bool `covariant`

`x.mu`, default is contravariant: $x \sim \mu$

Protected Attributes inherited from `GiNaC::idx`

- `ex value`

Expression that constitutes the index (numeric or symbolic name)

- `ex dim`

Dimension of space (can be symbolic or numeric)

Protected Attributes inherited from `GiNaC::basic`

- unsigned `flags`

of type `status_flags`

- unsigned `hashvalue`

hash value

6.184.1 Detailed Description

This class holds an index with a variance (co- or contravariant).

There is an associated metric tensor that can be used to raise/lower indices.

6.184.2 Constructor & Destructor Documentation

6.184.2.1 `varidx()`

```
GiNaC::varidx::varidx (
    const ex & v,
    const ex & dim,
    bool covariant = false )
```

Construct index with given value, dimension and variance.

Parameters

<code>v</code>	Value of index (numeric or symbolic)
<code>dim</code>	Dimension of index space (numeric or symbolic)
<code>covariant</code>	Make covariant index (default is contravariant)

6.184.3 Member Function Documentation

6.184.3.1 is_dummy_pair_same_type()

```
bool GiNaC::varidx::is_dummy_pair_same_type (
    const basic & other ) const [override], [virtual]
```

Check whether the index forms a dummy index pair with another index of the same type.

Reimplemented from [GiNaC::idx](#).

Reimplemented in [GiNaC::spinidx](#).

References [covariant](#).

6.184.3.2 archive()

```
void GiNaC::varidx::archive (
    archive\_node & n ) const [override], [virtual]
```

Save (serialize) the object into archive node.

Archive the object.

Losely speaking, this method turns an expression into a byte stream (which can be saved and restored later on, or sent via network, etc.)

Reimplemented from [GiNaC::idx](#).

Reimplemented in [GiNaC::spinidx](#).

References [covariant](#), and [n](#).

6.184.3.3 read_archive()

```
void GiNaC::varidx::read_archive (
    const archive\_node & n,
    lst & syms ) [override], [virtual]
```

Load (deserialize) the object from an archive node.

Construct object from [archive_node](#).

Note

This method is essentially a constructor. However, constructors can't be virtual. So, if unarchiving routines are implemented as constructors one would need to define such a constructor in every class, even if all it does is simply calling constructor of a superclass.

Reimplemented from [GiNaC::idx](#).

Reimplemented in [GiNaC::spinidx](#).

References [covariant](#), and [n](#).

6.184.3.4 `match_same_type()`

```
bool GiNaC::varidx::match_same_type (
    const basic & other ) const [override], [protected], [virtual]
```

Returns true if the attributes of two objects are similar enough for a match.

This function must not match subexpressions (this is already done by [basic::match\(\)](#)). Only attributes not accessible by [op\(\)](#) should be compared. This is also the reason why this function doesn't take the wildcard replacement list from [match\(\)](#) as an argument: only subexpressions are subject to wildcard matches. Also, this function only needs to be implemented for container classes because [is_equal_same_type\(\)](#) is automatically used instead of [match_same_type\(\)](#) if [nops\(\)](#) == 0.

See also

[basic::match](#)

Reimplemented from [GiNaC::idx](#).

Reimplemented in [GiNaC::spinidx](#).

References [covariant](#), and [GINAC_ASSERT](#).

6.184.3.5 `is_covariant()`

```
bool GiNaC::varidx::is_covariant ( ) const [inline]
```

Check whether the index is covariant.

References [covariant](#).

Referenced by [GiNaC::tensmetric::eval_indexed\(\)](#).

6.184.3.6 `is_contravariant()`

```
bool GiNaC::varidx::is_contravariant ( ) const [inline]
```

Check whether the index is contravariant (not covariant).

References [covariant](#).

6.184.3.7 `toggle_variance()`

```
ex GiNaC::varidx::toggle_variance ( ) const
```

Make a new index with the same value but the opposite variance.

References [GiNaC::basic::clearflag\(\)](#), [covariant](#), [GiNaC::basic::duplicate\(\)](#), and [GiNaC::status_flags::hash_calculated](#).

6.184.3.8 do_print()

```
void GiNaC::varidx::do_print (
    const print\_context & c,
    unsigned level ) const [protected]
```

References [c](#), [covariant](#), and [GiNaC::idx::print_index\(\)](#).

6.184.3.9 do_print_tree()

```
void GiNaC::varidx::do_print_tree (
    const print\_tree & c,
    unsigned level ) const [protected]
```

References [c](#), [covariant](#), [GiNaC::idx::dim](#), [GiNaC::basic::flags](#), [GiNaC::basic::hashvalue](#), [GiNaC::ex::print\(\)](#), and [GiNaC::idx::value](#).

6.184.4 Member Data Documentation

6.184.4.1 covariant

```
bool GiNaC::varidx::covariant [protected]
```

x.mu, default is contravariant: $x \sim \mu$

Referenced by [archive\(\)](#), [do_print\(\)](#), [GiNaC::spinidx::do_print\(\)](#), [do_print_tree\(\)](#), [GiNaC::spinidx::do_print_tree\(\)](#), [is_contravariant\(\)](#), [is_covariant\(\)](#), [is_dummy_pair_same_type\(\)](#), [match_same_type\(\)](#), [read_archive\(\)](#), [toggle_variance\(\)](#), and [GiNaC::spinidx::toggle_variance_dot\(\)](#).

The documentation for this class was generated from the following files:

- [idx.h](#)
- [idx.cpp](#)

6.185 GiNaC::visitor Class Reference

Degenerate base class for visitors.

```
#include <basic.h>
```

Protected Member Functions

- virtual [~visitor](#) ()

6.185.1 Detailed Description

Degenerate base class for visitors.

basic and derivative classes support Robert C. Martin's Acyclic Visitor pattern (cf. <http://condor.depaul.edu/dmumaugh/OOT/Design-Principles/acv.pdf> or chapter 10 of Andrei Alexandrescu's "Modern C++ Design").

6.185.2 Constructor & Destructor Documentation

6.185.2.1 ~visitor()

```
virtual GiNaC::visitor::~~visitor ( ) [inline], [protected], [virtual]
```

The documentation for this class was generated from the following file:

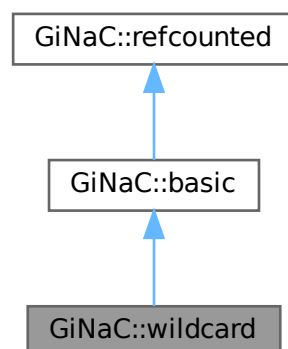
- [basic.h](#)

6.186 GiNaC::wildcard Class Reference

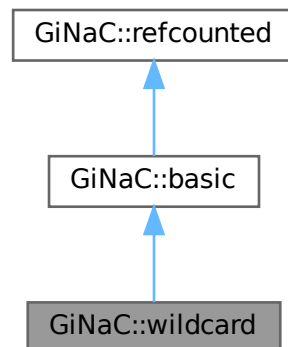
This class acts as a wildcard for [subs\(\)](#), [match\(\)](#), [has\(\)](#) and [find\(\)](#).

```
#include <wildcard.h>
```

Inheritance diagram for GiNaC::wildcard:



Collaboration diagram for GiNaC::wildcard:



Public Member Functions

- `wildcard` (unsigned `label`)
Construct wildcard with specified label.
- `bool match` (const `ex` &pattern, `exmap` &repl_lst) const override
Check whether the expression matches a given pattern.
- `void archive` (`archive_node` &n) const override
Save (a.k.a.
- `void read_archive` (const `archive_node` &n, `lst` &symbols) override
Read (a.k.a.
- unsigned `get_label` () const

Public Member Functions inherited from `GiNaC::basic`

- virtual `~basic` ()
basic destructor, virtual because class `ex` will delete objects of derived classes via a `basic`.*
- `basic` (const `basic` &other)
- const `basic` & `operator=` (const `basic` &other)
basic assignment operator: the other object might be of a derived class.
- virtual `basic * duplicate` () const
Create a clone of this object on the heap.
- virtual `ex eval` () const
Perform automatic non-interruptive term rewriting rules.
- virtual `ex evalf` () const
Evaluate object numerically.
- virtual `ex evalm` () const
Evaluate sums, products and integer powers of matrices.
- virtual `ex eval_integ` () const
Evaluate integrals, if result is known.
- virtual `ex eval_indexed` (const `basic` &i) const
Perform automatic symbolic evaluations on indexed expression that contains this object as the base expression.

- virtual void `print` (const `print_context` &c, unsigned level=0) const
Output to stream.
- virtual void `dbgprint` () const
Little wrapper around print to be called within a debugger.
- virtual void `dbgprintree` () const
Little wrapper around printree to be called within a debugger.
- virtual unsigned `precedence` () const
Return relative operator precedence (for parenthezing output).
- virtual bool `info` (unsigned inf) const
Information about the object.
- virtual size_t `nops` () const
Number of operands/members.
- virtual `ex op` (size_t i) const
Return operand/member at position i.
- virtual `ex operator[]` (const `ex` &index) const
- virtual `ex operator[]` (size_t i) const
- virtual `ex & let_op` (size_t i)
Return modifiable operand/member at position i.
- virtual `ex & operator[]` (const `ex` &index)
- virtual `ex & operator[]` (size_t i)
- virtual bool `has` (const `ex` &other, unsigned `options`=0) const
Test for occurrence of a pattern.
- virtual bool `match` (const `ex` &pattern, `exmap` &repls) const
Check whether the expression matches a given pattern.
- virtual `ex subs` (const `exmap` &m, unsigned `options`=0) const
Substitute a set of objects by arbitrary expressions.
- virtual `ex map` (`map_function` &f) const
Construct new expression by applying the specified function to all sub-expressions (one level only, not recursively).
- virtual void `accept` (`GiNaC::visitor` &v) const
- virtual bool `is_polynomial` (const `ex` &var) const
Check whether this is a polynomial in the given variables.
- virtual int `degree` (const `ex` &s) const
Return degree of highest power in object s.
- virtual int `ldegree` (const `ex` &s) const
Return degree of lowest power in object s.
- virtual `ex coeff` (const `ex` &s, int n=1) const
Return coefficient of degree n in object s.
- virtual `ex expand` (unsigned `options`=0) const
Expand expression, i.e.
- virtual `ex collect` (const `ex` &s, bool distributed=false) const
Sort expanded expression in terms of powers of some object(s).
- virtual `ex series` (const `relational` &r, int `order`, unsigned `options`=0) const
Default implementation of `ex::series()`.
- virtual `ex normal` (`exmap` &repl, `exmap` &rev_lookup, `lst` &modifier) const
Default implementation of `ex::normal()`.
- virtual `ex to_rational` (`exmap` &repl) const
Default implementation of `ex::to_rational()`.
- virtual `ex to_polynomial` (`exmap` &repl) const
- virtual `numeric integer_content` () const
- virtual `ex smod` (const `numeric` &xi) const
Apply symmetric modular homomorphism to an expanded multivariate polynomial.

- virtual [numeric max_coefficient](#) () const
Implementation [ex::max_coefficient\(\)](#).
- virtual [exvector get_free_indices](#) () const
Return a vector containing the free indices of an expression.
- virtual [ex add_indexed](#) (const [ex](#) &self, const [ex](#) &other) const
Add two indexed expressions.
- virtual [ex scalar_mul_indexed](#) (const [ex](#) &self, const [numeric](#) &other) const
Multiply an indexed expression with a scalar.
- virtual bool [contract_with](#) (exvector::iterator self, exvector::iterator other, [exvector](#) &v) const
Try to contract two indexed expressions that appear in the same product.
- virtual unsigned [return_type](#) () const
- virtual [return_type_t](#) [return_type_tinfo](#) () const
- virtual [ex conjugate](#) () const
- virtual [ex real_part](#) () const
- virtual [ex imag_part](#) () const
- template<class T >
void [print_dispatch](#) (const [print_context](#) &c, unsigned level) const
Like [print\(\)](#), but dispatch to the specified class.
- void [print_dispatch](#) (const [registered_class_info](#) &ri, const [print_context](#) &c, unsigned level) const
Like [print\(\)](#), but dispatch to the specified class.
- virtual void [archive](#) ([archive_node](#) &n) const
Save (serialize) the object into archive node.
- virtual void [read_archive](#) (const [archive_node](#) &n, [lst](#) &syms)
Load (deserialize) the object from an archive node.
- [ex subs_one_level](#) (const [exmap](#) &m, unsigned [options](#)) const
Helper function for [subs\(\)](#).
- [ex diff](#) (const [symbol](#) &s, unsigned nth=1) const
Default interface of nth derivative [ex::diff\(s, n\)](#).
- int [compare](#) (const [basic](#) &other) const
Compare objects syntactically to establish canonical ordering.
- bool [is_equal](#) (const [basic](#) &other) const
Test for syntactic equality.
- const [basic](#) & [hold](#) () const
Stop further evaluation.
- unsigned [gethash](#) () const
- const [basic](#) & [setflag](#) (unsigned f) const
Set some [status_flags](#).
- const [basic](#) & [clearflag](#) (unsigned f) const
Clear some [status_flags](#).

Public Member Functions inherited from [GiNaC::refcounted](#)

- [refcounted](#) () noexcept
- unsigned int [add_reference](#) () noexcept
- unsigned int [remove_reference](#) () noexcept
- unsigned int [get_refcount](#) () const noexcept
- void [set_refcount](#) (unsigned int r) noexcept

Protected Member Functions

- unsigned `calchash` () const override
Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.
- void `do_print` (const `print_context` &c, unsigned level) const
- void `do_print_tree` (const `print_tree` &c, unsigned level) const
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const

Protected Member Functions inherited from `GiNaC::basic`

- `basic` ()
- virtual `ex eval_ncmul` (const `exvector` &v) const
- virtual bool `match_same_type` (const `basic` &other) const
Returns true if the attributes of two objects are similar enough for a match.
- virtual `ex derivative` (const `symbol` &s) const
Default implementation of `ex::diff()`.
- virtual int `compare_same_type` (const `basic` &other) const
Returns order relation between two objects of same type.
- virtual bool `is_equal_same_type` (const `basic` &other) const
Returns true if two objects of same type are equal.
- virtual unsigned `calchash` () const
Compute the hash value of an object and if it makes sense to store it in the objects `status_flags`, do so.
- void `ensure_if_modifiable` () const
Ensure the object may be modified without hurting others, throws if this is not the case.
- void `do_print` (const `print_context` &c, unsigned level) const
Default output to stream.
- void `do_print_tree` (const `print_tree` &c, unsigned level) const
Tree output to stream.
- void `do_print_python_repr` (const `print_python_repr` &c, unsigned level) const
Python parsable output to stream.

Private Attributes

- unsigned `label`
Label used to distinguish different wildcards.

Additional Inherited Members

Protected Attributes inherited from `GiNaC::basic`

- unsigned `flags`
of type `status_flags`
- unsigned `hashvalue`
hash value

6.186.1 Detailed Description

This class acts as a wildcard for `subs()`, `match()`, `has()` and `find()`.

An integer label is used to identify different wildcards.

6.186.2 Constructor & Destructor Documentation

6.186.2.1 wildcard()

```
GiNaC::wildcard::wildcard (
    unsigned label )
```

Construct wildcard with specified label.

References [GiNaC::status_flags::evaluated](#), [GiNaC::status_flags::expanded](#), and [GiNaC::basic::setflag\(\)](#).

6.186.3 Member Function Documentation

6.186.3.1 match()

```
bool GiNaC::wildcard::match (
    const ex & pattern,
    exmap & repl_lst ) const [override], [virtual]
```

Check whether the expression matches a given pattern.

For every wildcard object in the pattern, a pair with the wildcard as a key and matching expression as a value is added to *repl_lst*.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::basic::is_equal\(\)](#).

6.186.3.2 archive()

```
void GiNaC::wildcard::archive (
    archive_node & n ) const [override], [virtual]
```

Save (a.k.a.

serialize) object into archive.

Reimplemented from [GiNaC::basic](#).

References [label](#), and [n](#).

6.186.3.3 read_archive()

```
void GiNaC::wildcard::read_archive (
    const archive_node & n,
    lst & syms ) [override], [virtual]
```

Read (a.k.a.

deserialize) object from archive.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::status_flags::evaluated](#), [GiNaC::status_flags::expanded](#), [label](#), [n](#), and [GiNaC::basic::setflag\(\)](#).

6.186.3.4 calchash()

```
unsigned GiNaC::wildcard::calchash ( ) const [override], [protected], [virtual]
```

Compute the hash value of an object and if it makes sense to store it in the objects [status_flags](#), do so.

The method inherited from class basic computes a hash value based on the type and hash values of possible members. For this reason it is well suited for container classes but atomic classes should override this implementation because otherwise they would all end up with the same hashvalue.

Reimplemented from [GiNaC::basic](#).

References [GiNaC::golden_ratio_hash\(\)](#), [GiNaC::status_flags::hash_calculated](#), [GiNaC::basic::hashvalue](#), [label](#), [GiNaC::make_hash_seed\(\)](#), and [GiNaC::basic::setflag\(\)](#).

6.186.3.5 get_label()

```
unsigned GiNaC::wildcard::get_label ( ) const [inline]
```

References [label](#).

6.186.3.6 do_print()

```
void GiNaC::wildcard::do_print (
    const print_context & c,
    unsigned level ) const [protected]
```

References [c](#), and [label](#).

6.186.3.7 do_print_tree()

```
void GiNaC::wildcard::do_print_tree (
    const print\_tree & c,
    unsigned level ) const [protected]
```

References [c](#), [GiNaC::basic::flags](#), [GiNaC::basic::hashvalue](#), and [label](#).

6.186.3.8 do_print_python_repr()

```
void GiNaC::wildcard::do_print_python_repr (
    const print\_python\_repr & c,
    unsigned level ) const [protected]
```

References [c](#), and [label](#).

6.186.4 Member Data Documentation

6.186.4.1 label

```
unsigned GiNaC::wildcard::label [private]
```

Label used to distinguish different wildcards.

Referenced by [archive\(\)](#), [calchash\(\)](#), [do_print\(\)](#), [do_print_python_repr\(\)](#), [do_print_tree\(\)](#), [get_label\(\)](#), and [read_archive\(\)](#).

The documentation for this class was generated from the following files:

- [wildcard.h](#)
- [wildcard.cpp](#)

6.187 GiNaC::zeta1_SERIAL Class Reference

Complex conjugate.

```
#include <inifcns.h>
```

Static Public Attributes

- static unsigned [serial](#)

6.187.1 Detailed Description

Complex conjugate.

Real part. Imaginary part. Absolute value. Step function. Complex sign. Eta function: $\log(a*b) == \log(a) + \log(b) + \eta(a, b)$. Sine. Cosine. Tangent. Exponential function. Natural logarithm. Inverse sine (arc sine). Inverse cosine (arc cosine). Inverse tangent (arc tangent). Inverse tangent with two arguments. Hyperbolic Sine. Hyperbolic Cosine. Hyperbolic Tangent. Inverse hyperbolic Sine (area hyperbolic sine). Inverse hyperbolic Cosine (area hyperbolic cosine). Inverse hyperbolic Tangent (area hyperbolic tangent). Dilogarithm. Trilogarithm. Derivatives of Riemann's Zeta-function. Multiple zeta value including Riemann's zeta-function.

6.187.2 Member Data Documentation

6.187.2.1 serial

```
unsigned GiNaC::zeta1_SERIAL::serial [static]
```

Initial value:

```
= function::register_new(function_options("zeta", 1).
    evalf_func(zeta1_evalf).
    eval_func(zeta1_eval).
    derivative_func(zeta1_deriv).
    print_func<print_latex>(zeta1_print_latex).
    do_not_evalf_params().
    overloaded(2))
```

Referenced by [GiNaC::zeta\(\)](#).

The documentation for this class was generated from the following files:

- [inifcns.h](#)
- [inifcns_nstdsums.cpp](#)

6.188 GiNaC::zeta2_SERIAL Class Reference

Alternating Euler sum or colored MZV.

```
#include <inifcns.h>
```

Static Public Attributes

- static unsigned [serial](#)

6.188.1 Detailed Description

Alternating Euler sum or colored MZV.

6.188.2 Member Data Documentation

6.188.2.1 serial

unsigned GiNaC::zeta2_SERIAL::serial [static]

Initial value:

```
= function::register_new(function_options("zeta", 2).
    evalf_func(zeta2_evalf).
    eval_func(zeta2_eval).
    derivative_func(zeta2_deriv).
    print_func<print_latex>(zeta2_print_latex).
    do_not_evalf_params().
    overloaded(2))
```

Referenced by [GiNaC::zeta\(\)](#).

The documentation for this class was generated from the following files:

- [inifcns.h](#)
- [inifcns_nstdsums.cpp](#)

Chapter 7

File Documentation

7.1 add.cpp File Reference

Implementation of [GiNaC](#)'s sums of expressions.

```
#include "add.h"
#include "mul.h"
#include "archive.h"
#include "operators.h"
#include "matrix.h"
#include "utils.h"
#include "clifford.h"
#include "ncmul.h"
#include "compiler.h"
#include <iostream>
#include <limits>
#include <stdexcept>
#include <string>
```

Namespaces

- namespace [GiNaC](#)

Functions

- [GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) (add, expairseq, print_func< print_context >(&add::do_print). print_func< print_latex >(&add::do_print_latex). print_func< print_csrc >(&add::do_print_csrc). print_func< print_tree >(&add::do_print_tree). print_func< print_python_repr >(&add::do_print_python_repr)) add
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (add)

7.1.1 Detailed Description

Implementation of [GiNaC](#)'s sums of expressions.

7.2 add.h File Reference

Interface to [GiNaC](#)'s sums of expressions.

```
#include "expairseq.h"
```

Classes

- class [GiNaC::add](#)
Sum of expressions.

Namespaces

- namespace [GiNaC](#)

Functions

- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (add)

7.2.1 Detailed Description

Interface to [GiNaC](#)'s sums of expressions.

7.3 archive.cpp File Reference

Archiving of [GiNaC](#) expressions.

```
#include "archive.h"  
#include "registrar.h"  
#include "ex.h"  
#include "lst.h"  
#include "version.h"  
#include <iostream>  
#include <stdexcept>
```

Namespaces

- namespace [GiNaC](#)

Functions

- static void [GiNaC::write_unsigned](#) (std::ostream &os, unsigned val)
Write unsigned integer quantity to stream.
- static unsigned [GiNaC::read_unsigned](#) (std::istream &is)
Read unsigned integer quantity from stream.
- std::ostream & [GiNaC::operator<<](#) (std::ostream &os, const archive_node &n)
Write [archive_node](#) to binary data stream.
- std::ostream & [GiNaC::operator<<](#) (std::ostream &os, const archive &ar)
Write archive to binary data stream.
- std::istream & [GiNaC::operator>>](#) (std::istream &is, archive_node &n)
Read [archive_node](#) from binary data stream.
- std::istream & [GiNaC::operator>>](#) (std::istream &is, archive &ar)
Read archive from binary data stream.
- static synthesizer_func [GiNaC::find_factory_fcn](#) (const std::string &name)

7.3.1 Detailed Description

Archiving of [GiNaC](#) expressions.

7.4 archive.h File Reference

Archiving of [GiNaC](#) expressions.

```
#include "ex.h"
#include <iosfwd>
#include <map>
#include <string>
#include <vector>
```

Classes

- class [GiNaC::archive_node](#)
This class stores all properties needed to record/retrieve the state of one object of class basic (or a derived class).
- struct [GiNaC::archive_node::property_info](#)
Information about a stored property.
- struct [GiNaC::archive_node::property](#)
Archived property (data type, name and associated data)
- struct [GiNaC::archive_node::archive_node_cit_range](#)
- class [GiNaC::unarchive_table_t](#)
- class [GiNaC::archive](#)
This class holds archived versions of [GiNaC](#) expressions (class ex).
- struct [GiNaC::archive::archived_ex](#)
Archived expression descriptor.

Namespaces

- namespace [GiNaC](#)

Macros

- #define [GINAC_DECLARE_UNARCHIVER](#)(classname)
Helper macros to register a class with (un)archiving (a.k.a.
- #define [GINAC_BIND_UNARCHIVER](#)(classname)

Typedefs

- typedef unsigned [GiNaC::archive_node_id](#)
Numerical ID value to refer to an [archive_node](#).
- typedef unsigned [GiNaC::archive_atom](#)
Numerical ID value to refer to a string.
- typedef basic <(* [GiNaC::synthesize_func](#)) ()
- typedef std::map< std::string, synthesize_func > [GiNaC::unarchive_map_t](#)

Functions

- std::ostream & [GiNaC::operator<<](#) (std::ostream &os, const archive &ar)
Write archive to binary data stream.
- std::istream & [GiNaC::operator>>](#) (std::istream &is, archive &ar)
Read archive from binary data stream.

Variables

- static unarchive_table_t [GiNaC::unarch_table_instance](#)

7.4.1 Detailed Description

Archiving of [GiNaC](#) expressions.

7.4.2 Macro Definition Documentation

7.4.2.1 GINAC_DECLARE_UNARCHIVER

```
#define GINAC_DECLARE_UNARCHIVER(  
    classname )
```

Value:

```
class classname ## _unarchiver  
{  
    static int usecount;  
public:  
    static GiNaC::basic* create();  
    classname ## _unarchiver();  
    ~ classname ## _unarchiver();  
};  
static classname ## _unarchiver classname ## _unarchiver_instance
```

Helper macros to register a class with (un)archiving (a.k.a.

(de)serialization).

Usage: put

`GINAC_DECLARE_UNARCHIVER(myclass);`

into the header file (in the global or namespace scope), and

`GINAC_BIND_UNARCHIVER(myclass);`

into the source file.

Effect: the 'myclass' (being a class derived directly or indirectly from `GiNaC::basic`) can be archived and unarchived.

Note: you need to use `GINAC_{DECLARE,BIND}_UNARCHIVER` incantations in order to make your class (un)archivable *even if your class does not overload 'read_archive' method*. Sorry for inconvenience.

How it works:

The 'basic' class has a 'read_archive' virtual method which reads an expression from archive. Derived classes can overload that method. There's a small problem, though. On unarchiving all we have is a set of named byte streams. In C++ the class name (as written in the source code) has nothing to do with its actual type. Thus, we need establish a correspondence ourselves. To do so we maintain a 'class_name' => 'function_pointer' table (see the `unarchive_table_t` class above). Every function in this table is supposed to create a new object of the 'class_name' type. The 'archive_node' class uses that table to construct an object of correct type. Next it invokes `read_archive` virtual method of newly created object, which does the actual job.

Note: this approach is very simple-minded (it does not handle classes with same names from different namespaces, multiple inheritance, etc), but it happens to work surprisingly well.

7.4.2.2 GINAC_BIND_UNARCHIVER

```
#define GINAC_BIND_UNARCHIVER(  
    classname )
```

Value:

```
classname ## _unarchiver::classname ## _unarchiver()  
{  
    static GiNaC::unarchive_table_t table;  
    if (usecount++ == 0) {  
        table.insert(std::string(#classname),  
            &(classname ## _unarchiver::create));  
    }  
}  
GiNaC::basic* classname ## _unarchiver::create()  
{  
    return new classname();  
}  
classname ## _unarchiver::~~ classname ## _unarchiver() { }  
int classname ## _unarchiver::usecount = 0
```

7.5 `assertion.h` File Reference

Assertion macro definition.

Macros

- `#define GINAC_ASSERT(X) ((void)0)`
Assertion macro for checking invariances.

7.5.1 Detailed Description

Assertion macro definition.

7.5.2 Macro Definition Documentation

7.5.2.1 `GINAC_ASSERT`

```
#define GINAC_ASSERT(  
    X ) ((void)0)
```

Assertion macro for checking invariances.

7.6 `basic.cpp` File Reference

Implementation of [GiNaC's](#) ABC.

```
#include "basic.h"  
#include "ex.h"  
#include "numeric.h"  
#include "power.h"  
#include "add.h"  
#include "symbol.h"  
#include "lst.h"  
#include "ncmul.h"  
#include "relational.h"  
#include "operators.h"  
#include "wildcard.h"  
#include "archive.h"  
#include "utils.h"  
#include "hash_seed.h"  
#include "inifcns.h"  
#include <iostream>  
#include <stdexcept>  
#include <typeinfo>
```

Classes

- struct [GiNaC::evalf_map_function](#)
Function object to be applied by [basic::evalf\(\)](#).
- struct [GiNaC::evalm_map_function](#)
Function object to be applied by [basic::evalm\(\)](#).
- struct [GiNaC::eval_integ_map_function](#)
Function object to be applied by [basic::eval_integ\(\)](#).
- struct [GiNaC::derivative_map_function](#)
Function object to be applied by [basic::derivative\(\)](#).
- struct [GiNaC::expand_map_function](#)
Function object to be applied by [basic::expand\(\)](#).

Namespaces

- namespace [GiNaC](#)

Functions

- [GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) (basic, void, print_func< print_context >(&basic::do_print). print_func< print_tree >(&basic::do_print_tree). print_func< print_python_repr >(&basic::do_print_python_repr)) basic
basic copy constructor: implicitly assumes that the other class is of the exact same type (as it's used by duplicate()), so it can copy the tinfo_key and the hash value.

Variables

- [GiNaC::evalm_map_function](#) [GiNaC::map_evalm](#)
- [GiNaC::eval_integ_map_function](#) [GiNaC::map_eval_integ](#)

7.6.1 Detailed Description

Implementation of [GiNaC](#)'s ABC.

7.7 basic.h File Reference

Interface to [GiNaC](#)'s ABC.

```
#include "flags.h"
#include "ptr.h"
#include "assertion.h"
#include "registrar.h"
#include <stddef>
#include <map>
#include <set>
#include <typeinfo>
#include <vector>
#include <utility>
```

Classes

- struct [GiNaC::map_function](#)
Function object for map().
- class [GiNaC::visitor](#)
Degenerate base class for visitors.
- class [GiNaC::basic](#)
This class is the ABC (abstract base class) of [GiNaC](#)'s class hierarchy.

Namespaces

- namespace [GiNaC](#)

Typedefs

- typedef std::vector< ex > [GiNaC::exvector](#)
- typedef std::set< ex, ex_is_less > [GiNaC::exset](#)
- typedef std::map< ex, ex, ex_is_less > [GiNaC::exmap](#)

Functions

- template<class T >
bool [GiNaC::is_a](#) (const basic &obj)
Check if obj is a T, including base classes.
- template<class T >
bool [GiNaC::is_exactly_a](#) (const basic &obj)
Check if obj is a T, not including base classes.
- template<class B , typename... Args>
B & [GiNaC::dynallocate](#) (Args &&... args)
Constructs a new (class basic or derived) B object on the heap.
- template<class B >
B & [GiNaC::dynallocate](#) (std::initializer_list< ex > il)
Constructs a new (class basic or derived) B object on the heap.

7.7.1 Detailed Description

Interface to [GiNaC](#)'s ABC.

7.8 class_info.h File Reference

Helper templates to provide per-class information for class hierarchies.

```
#include <cstddef>
#include <cstring>
#include <iomanip>
#include <iostream>
#include <map>
#include <stdexcept>
#include <string>
#include <vector>
```

Classes

- class [GiNaC::class_info< OPT >](#)
- struct [GiNaC::class_info< OPT >::tree_node](#)

Namespaces

- namespace [GiNaC](#)

7.8.1 Detailed Description

Helper templates to provide per-class information for class hierarchies.

7.9 clifford.cpp File Reference

Implementation of [GiNaC](#)'s clifford algebra (Dirac gamma) objects.

```
#include "clifford.h"
#include "ex.h"
#include "idx.h"
#include "ncmul.h"
#include "symbol.h"
#include "numeric.h"
#include "symmetry.h"
#include "lst.h"
#include "relational.h"
#include "operators.h"
#include "add.h"
#include "mul.h"
#include "power.h"
#include "matrix.h"
#include "archive.h"
#include "utils.h"
#include <stdexcept>
```

Classes

- struct [GiNaC::is_not_a_clifford](#)
Predicate for finding non-clifford objects.

Namespaces

- namespace [GiNaC](#)

Functions

- [GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) (clifford, indexed, print_func< print_dflt >(&clifford::do_print_dflt). print_func< print_latex >(&clifford::do_print_latex). print_func< print_tree >(&clifford::do_print_tree)) GINAC_IMPLEMENT_REGISTERED_CLASS_OPT(diracone
- [GiNaC::print_func< print_dflt >](#) (&diracone::do_print). print_func< print_latex >(&diracone
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (clifford)
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (cliffordunit)
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (diracone)
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (diracgamma)
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (diracgamma5)
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (diracgammaL)
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (diracgammaR)
- static bool [GiNaC::is_dirac_slash](#) (const ex &seq0)
- static void [GiNaC::base_and_index](#) (const ex &c, ex &b, ex &i)
This function decomposes $\gamma_{\sim\mu} \rightarrow (1, \mu)$ and $a_l \rightarrow (a.ix, ix)$
- ex [GiNaC::dirac_ONE](#) (unsigned char rl=0)
Create a Clifford unity object.
- static unsigned [GiNaC::get_dim_uint](#) (const ex &e)
- ex [GiNaC::clifford_unit](#) (const ex &mu, const ex &metr, unsigned char rl=0)
Create a Clifford unit object.
- ex [GiNaC::dirac_gamma](#) (const ex &mu, unsigned char rl=0)
Create a Dirac gamma object.
- ex [GiNaC::dirac_gamma5](#) (unsigned char rl=0)
Create a Dirac gamma5 object.
- ex [GiNaC::dirac_gammaL](#) (unsigned char rl=0)
Create a Dirac gammaL object.
- ex [GiNaC::dirac_gammaR](#) (unsigned char rl=0)
Create a Dirac gammaR object.
- ex [GiNaC::dirac_slash](#) (const ex &e, const ex &dim, unsigned char rl=0)
*Create a term of the form $e_{\mu} * \gamma_{\sim\mu}$ with a unique index μ .*
- static unsigned char [GiNaC::get_representation_label](#) (const return_type_t &ti)
Extract representation label from tinfo key (as returned by return_type_tinfo()).
- static ex [GiNaC::trace_string](#) (exvector::const_iterator ix, size_t num)
Take trace of a string of an even number of Dirac gammas given a vector of indices.
- ex [GiNaC::dirac_trace](#) (const ex &e, const std::set< unsigned char > &rls, const ex &trONE=4)
Calculate dirac traces over the specified set of representation labels.
- ex [GiNaC::dirac_trace](#) (const ex &e, const lst &rls, const ex &trONE=4)
Calculate dirac traces over the specified list of representation labels.
- ex [GiNaC::dirac_trace](#) (const ex &e, unsigned char rl=0, const ex &trONE=4)
Calculate the trace of an expression containing gamma objects with a specified representation label.
- ex [GiNaC::canonicalize_clifford](#) (const ex &e)
Bring all products of clifford objects in an expression into a canonical order.
- ex [GiNaC::clifford_star_bar](#) (const ex &e, bool do_bar, unsigned options)
An auxillary function performing [clifford_star\(\)](#) and [clifford_bar\(\)](#).
- ex [GiNaC::clifford_prime](#) (const ex &e)
Automorphism of the Clifford algebra, simply changes signs of all clifford units.
- ex [GiNaC::remove_dirac_ONE](#) (const ex &e, unsigned char rl=0, unsigned options=0)
Replaces [dirac_ONE](#)'s (with a representation_label no less than rl) in e with 1.
- int [GiNaC::clifford_max_label](#) (const ex &e, bool ignore_ONE=false)
Returns the maximal representation label of a clifford object if e contains at least one, otherwise returns -1.
- ex [GiNaC::clifford_norm](#) (const ex &e)

- Calculation of the norm in the Clifford algebra.*

 - ex [GiNaC::clifford_inverse](#) (const ex &e)
- Calculation of the inverse in the Clifford algebra.*

 - ex [GiNaC::lst_to_clifford](#) (const ex &v, const ex &mu, const ex &metr, unsigned char rl=0)
- List or vector conversion into the Clifford vector.*

 - ex [GiNaC::lst_to_clifford](#) (const ex &v, const ex &e)
- List or vector conversion into the Clifford vector.*

 - static ex [GiNaC::get_clifford_comp](#) (const ex &e, const ex &c, bool root=true)
- Auxiliary structure to define a function for stripping one Clifford unit from vectors.*

 - lst [GiNaC::clifford_to_lst](#) (const ex &e, const ex &c, bool algebraic=true)
- An inverse function to [lst_to_clifford\(\)](#).*

 - ex [GiNaC::clifford_moebius_map](#) (const ex &a, const ex &b, const ex &c, const ex &d, const ex &v, const ex &G, unsigned char rl=0)
- Calculations of Moebius transformations (conformal map) defined by a 2x2 Clifford matrix (a b|c d) in linear spaces with arbitrary signature.*

 - ex [GiNaC::clifford_moebius_map](#) (const ex &M, const ex &v, const ex &G, unsigned char rl=0)
- The second form of Moebius transformations defined by a 2x2 Clifford matrix M This function takes the transformation matrix M as a single entity.*

Variables

- [GiNaC::tensor](#)

7.9.1 Detailed Description

Implementation of [GiNaC](#)'s clifford algebra (Dirac gamma) objects.

7.10 clifford.h File Reference

Interface to [GiNaC](#)'s clifford algebra (Dirac gamma) objects.

```
#include "indexed.h"
#include "tensor.h"
#include "symbol.h"
#include "idx.h"
#include <set>
```

Classes

- class [GiNaC::clifford](#)

This class holds an object representing an element of the Clifford algebra (the Dirac gamma matrices).
- class [GiNaC::diracone](#)

This class represents the Clifford algebra unity element.
- class [GiNaC::cliffordunit](#)

This class represents the Clifford algebra generators (units).
- class [GiNaC::diracgamma](#)

This class represents the Dirac gamma Lorentz vector.
- class [GiNaC::diracgamma5](#)

This class represents the Dirac gamma5 object which anticommutes with all other gammas.
- class [GiNaC::diracgammaL](#)

This class represents the Dirac gammaL object which behaves like 1/2 (1-gamma5).
- class [GiNaC::diracgammaR](#)

This class represents the Dirac gammaL object which behaves like 1/2 (1+gamma5).

Namespaces

- namespace [GiNaC](#)

Functions

- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (clifford)
- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (diracone)
- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (cliffordunit)
- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (diracgamma)
- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (diracgamma5)
- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (diracgammaL)
- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (diracgammaR)
- bool [GiNaC::is_clifford_tinfo](#) (const return_type_t &ti)
Check whether a given [return_type_t](#) object (as returned by [return_type_tinfo\(\)](#)) is that of a clifford object (with an arbitrary representation label).
- ex [GiNaC::dirac_ONE](#) (unsigned char rl=0)
Create a Clifford unity object.
- ex [GiNaC::clifford_unit](#) (const ex &mu, const ex &metr, unsigned char rl=0)
Create a Clifford unit object.
- ex [GiNaC::dirac_gamma](#) (const ex &mu, unsigned char rl=0)
Create a Dirac gamma object.
- ex [GiNaC::dirac_gamma5](#) (unsigned char rl=0)
Create a Dirac gamma5 object.
- ex [GiNaC::dirac_gammaL](#) (unsigned char rl=0)
Create a Dirac gammaL object.
- ex [GiNaC::dirac_gammaR](#) (unsigned char rl=0)
Create a Dirac gammaR object.
- ex [GiNaC::dirac_slash](#) (const ex &e, const ex &dim, unsigned char rl=0)
*Create a term of the form $e_{\mu} * \gamma^{\sim\mu}$ with a unique index μ .*
- ex [GiNaC::dirac_trace](#) (const ex &e, const std::set< unsigned char > &rls, const ex &trONE=4)
Calculate dirac traces over the specified set of representation labels.
- ex [GiNaC::dirac_trace](#) (const ex &e, const lst &rl, const ex &trONE=4)
Calculate dirac traces over the specified list of representation labels.
- ex [GiNaC::dirac_trace](#) (const ex &e, unsigned char rl=0, const ex &trONE=4)
Calculate the trace of an expression containing gamma objects with a specified representation label.
- ex [GiNaC::canonicalize_clifford](#) (const ex &e)
Bring all products of clifford objects in an expression into a canonical order.
- ex [GiNaC::clifford_prime](#) (const ex &e)
Automorphism of the Clifford algebra, simply changes signs of all clifford units.
- ex [GiNaC::clifford_star_bar](#) (const ex &e, bool do_bar, unsigned options)
An auxillary function performing [clifford_star\(\)](#) and [clifford_bar\(\)](#).
- ex [GiNaC::clifford_bar](#) (const ex &e)
Main anti-automorphism of the Clifford algebra: makes reversion and changes signs of all clifford units.
- ex [GiNaC::clifford_star](#) (const ex &e)
Reversion of the Clifford algebra, reverse the order of all clifford units in ncmul.
- ex [GiNaC::remove_dirac_ONE](#) (const ex &e, unsigned char rl=0, unsigned options=0)
Replaces [dirac_ONE](#)'s (with a [representation_label](#) no less than rl) in e with 1.
- int [GiNaC::clifford_max_label](#) (const ex &e, bool ignore_ONE=false)
Returns the maximal representation label of a clifford object if e contains at least one, otherwise returns -1.
- ex [GiNaC::clifford_norm](#) (const ex &e)

- Calculation of the norm in the Clifford algebra.*

 - ex `GiNaC::clifford_inverse` (const ex &e)
- Calculation of the inverse in the Clifford algebra.*

 - ex `GiNaC::lst_to_clifford` (const ex &v, const ex &mu, const ex &metr, unsigned char rl=0)
- List or vector conversion into the Clifford vector.*

 - ex `GiNaC::lst_to_clifford` (const ex &v, const ex &e)
- List or vector conversion into the Clifford vector.*

 - lst `GiNaC::clifford_to_lst` (const ex &e, const ex &c, bool algebraic=true)
- An inverse function to `lst_to_clifford()`.*

 - ex `GiNaC::clifford_moebius_map` (const ex &a, const ex &b, const ex &c, const ex &d, const ex &v, const ex &G, unsigned char rl=0)
- Calculations of Moebius transformations (conformal map) defined by a 2x2 Clifford matrix (a b\c d) in linear spaces with arbitrary signature.*

 - ex `GiNaC::clifford_moebius_map` (const ex &M, const ex &v, const ex &G, unsigned char rl=0)
- The second form of Moebius transformations defined by a 2x2 Clifford matrix M This function takes the transformation matrix M as a single entity.*

7.10.1 Detailed Description

Interface to `GiNaC`'s clifford algebra (Dirac gamma) objects.

7.11 color.cpp File Reference

Implementation of `GiNaC`'s color (SU(3) Lie algebra) objects.

```
#include "color.h"
#include "idx.h"
#include "ncmul.h"
#include "symmetry.h"
#include "operators.h"
#include "numeric.h"
#include "mul.h"
#include "power.h"
#include "symbol.h"
#include "archive.h"
#include "utils.h"
#include <iostream>
#include <stdexcept>
```

Namespaces

- namespace `GiNaC`

Macros

- #define `TEST_PERMUTATION`(A, B, C, P)
- #define `CMPINDICES`(A, B, C) ((v[0] == (A)) && (v[1] == (B)) && (v[2] == (C)))

Functions

- [GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) (su3one, tensor, print_func< print_dflt >(&su3one::do_print). print_func< print_latex >(&su3one::do_print_latex)) GINAC_IMPLEMENT_↵ REGISTERED_CLASS_OPT(su3t
- [GiNaC::print_func< print_dflt >](#) (&su3t::do_print). print_func< print_latex >(&su3t
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (color)
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (su3one)
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (su3t)
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (su3f)
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (su3d)
- static ex [GiNaC::permute_free_index_to_front](#) (const exvector &iv3, const exvector &iv2, int &sig)

Given a vector iv3 of three indices and a vector iv2 of two indices that is a subset of iv3, return the (free) index that is in iv3 but not in iv2 and the sign introduced by permuting that index to the front.
- ex [GiNaC::color_ONE](#) (unsigned char rl=0)

Create the su(3) unity element.
- ex [GiNaC::color_T](#) (const ex &a, unsigned char rl=0)

Create an su(3) generator.
- ex [GiNaC::color_f](#) (const ex &a, const ex &b, const ex &c)

Create an su(3) antisymmetric structure constant.
- ex [GiNaC::color_d](#) (const ex &a, const ex &b, const ex &c)

Create an su(3) symmetric structure constant.
- ex [GiNaC::color_h](#) (const ex &a, const ex &b, const ex &c)

*This returns the linear combination d.a.b.c+l*f.a.b.c.*
- static bool [GiNaC::is_color_tinfo](#) (const return_type_t &ti)

Check whether a given tinfo key (as returned by return_type_tinfo()) is that of a color object (with an arbitrary representation label).
- static unsigned char [GiNaC::get_representation_label](#) (const return_type_t &ti)

Extract representation label from tinfo key (as returned by return_type_tinfo()).
- ex [GiNaC::color_trace](#) (const ex &e, const std::set< unsigned char > &rls)

Calculate color traces over the specified set of representation labels.
- ex [GiNaC::color_trace](#) (const ex &e, const lst &rls)

Calculate color traces over the specified list of representation labels.
- ex [GiNaC::color_trace](#) (const ex &e, unsigned char rl=0)

Calculate the trace of an expression containing color objects with a specified representation label.

7.11.1 Detailed Description

Implementation of [GiNaC](#)'s color (SU(3) Lie algebra) objects.

7.11.2 Macro Definition Documentation

7.11.2.1 TEST_PERMUTATION

```
#define TEST_PERMUTATION(
    A,
    B,
    C,
    P )
```

Value:

```
if (iv3[B].is_equal(iv2[0]) && iv3[C].is_equal(iv2[1])) { \
    sig = P; \
    return iv3[A]; \
}
```

7.11.2.2 CMPINDICES

```
#define CMPINDICES(
    A,
    B,
    C ) ((v[0] == (A)) && (v[1] == (B)) && (v[2] == (C)))
```

7.12 color.h File Reference

Interface to [GiNaC](#)'s color (SU(3) Lie algebra) objects.

```
#include "indexed.h"
#include "tensor.h"
#include <set>
```

Classes

- class [GiNaC::color](#)
This class holds a generator T_a or the unity element of the Lie algebra of SU(3), as used for calculations in quantum chromodynamics.
- class [GiNaC::su3one](#)
This class represents the su(3) unity element.
- class [GiNaC::su3t](#)
This class represents an su(3) generator.
- class [GiNaC::su3f](#)
This class represents the tensor of antisymmetric su(3) structure constants.
- class [GiNaC::su3d](#)
This class represents the tensor of symmetric su(3) structure constants.

Namespaces

- namespace [GiNaC](#)

Functions

- `GiNaC::GINAC_DECLARE_UNARCHIVER` (color)
- `GiNaC::GINAC_DECLARE_UNARCHIVER` (su3one)
- `GiNaC::GINAC_DECLARE_UNARCHIVER` (su3t)
- `GiNaC::GINAC_DECLARE_UNARCHIVER` (su3f)
- `GiNaC::GINAC_DECLARE_UNARCHIVER` (su3d)
- ex `GiNaC::color_ONE` (unsigned char rl=0)
Create the su(3) unity element.
- ex `GiNaC::color_T` (const ex &a, unsigned char rl=0)
Create an su(3) generator.
- ex `GiNaC::color_f` (const ex &a, const ex &b, const ex &c)
Create an su(3) antisymmetric structure constant.
- ex `GiNaC::color_d` (const ex &a, const ex &b, const ex &c)
Create an su(3) symmetric structure constant.
- ex `GiNaC::color_h` (const ex &a, const ex &b, const ex &c)
*This returns the linear combination d.a.b.c+l*f.a.b.c.*
- ex `GiNaC::color_trace` (const ex &e, const std::set< unsigned char > &rls)
Calculate color traces over the specified set of representation labels.
- ex `GiNaC::color_trace` (const ex &e, const lst &rls)
Calculate color traces over the specified list of representation labels.
- ex `GiNaC::color_trace` (const ex &e, unsigned char rl=0)
Calculate the trace of an expression containing color objects with a specified representation label.

7.12.1 Detailed Description

Interface to `GiNaC`'s color (SU(3) Lie algebra) objects.

7.13 compiler.h File Reference

Definition of optimizing macros.

Macros

- `#define unlikely`(cond) (cond)
- `#define likely`(cond) (cond)
- `#define attribute_deprecated`

7.13.1 Detailed Description

Definition of optimizing macros.

7.13.2 Macro Definition Documentation

7.13.2.1 unlikely

```
#define unlikely(  
    cond ) (cond)
```

7.13.2.2 likely

```
#define likely(  
    cond ) (cond)
```

7.13.2.3 attribute_deprecated

```
#define attribute_deprecated
```

7.14 constant.cpp File Reference

Implementation of [GiNaC](#)'s constant types and some special constants.

```
#include "constant.h"  
#include "numeric.h"  
#include "ex.h"  
#include "archive.h"  
#include "utils.h"  
#include "inifcns.h"  
#include <iostream>  
#include <stdexcept>  
#include <string>
```

Namespaces

- namespace [GiNaC](#)

Functions

- [GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) (constant, basic, print_func< print_context >(&constant::do_print). print_func< print_latex >(&constant::do_print_latex). print_func< print_tree >(&constant::do_print_tree). print_func< print_python_repr >(&constant::do_print_python_repr)) constant
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (constant)

Variables

- const constant `GiNaC::Pi` ("Pi", PiEvalf, "\\pi", domain::positive)
Pi.
- const constant `GiNaC::Euler` ("Euler", EulerEvalf, "\\gamma_E", domain::positive)
Euler's constant.
- const constant `GiNaC::Catalan` ("Catalan", CatalanEvalf, "G", domain::positive)
Catalan's constant.

7.14.1 Detailed Description

Implementation of `GiNaC`'s constant types and some special constants.

7.15 constant.h File Reference

Interface to `GiNaC`'s constant types and some special constants.

```
#include "basic.h"
#include "ex.h"
#include "archive.h"
#include <string>
```

Classes

- class `GiNaC::constant`
This class holds constants, symbols with specific numerical value.

Namespaces

- namespace `GiNaC`

Typedefs

- typedef `ex(* GiNaC::evalffunctype) ()`

Functions

- `GiNaC::GINAC_DECLARE_UNARCHIVER` (constant)

7.15.1 Detailed Description

Interface to `GiNaC`'s constant types and some special constants.

7.16 container.h File Reference

Wrapper template for making [GiNaC](#) classes out of STL containers.

```
#include "ex.h"
#include "print.h"
#include "archive.h"
#include "assertion.h"
#include "compiler.h"
#include <algorithm>
#include <iterator>
#include <list>
#include <memory>
#include <stdexcept>
#include <vector>
```

Classes

- class [GiNaC::container_storage< C >](#)
Helper template for encapsulating the [reserve\(\)](#) mechanics of STL containers.
- class [GiNaC::container< C >](#)
Wrapper template for making [GiNaC](#) classes out of STL containers.

Namespaces

- namespace [GiNaC](#)

7.16.1 Detailed Description

Wrapper template for making [GiNaC](#) classes out of STL containers.

7.17 crc32.h File Reference

CRC32 hash function.

Namespaces

- namespace [GiNaC](#)

Functions

- static unsigned [GiNaC::crc32](#) (const char *c, const unsigned len, const unsigned crcinit)

Variables

- static unsigned const [GiNaC::crctab](#) [256]

7.17.1 Detailed Description

CRC32 hash function.

Shamelessly stolen from GNU coreutils (cksum.c).

7.18 ex.cpp File Reference

Implementation of [GiNaC](#)'s light-weight expression handles.

```
#include "ex.h"
#include "add.h"
#include "mul.h"
#include "ncmul.h"
#include "numeric.h"
#include "matrix.h"
#include "power.h"
#include "lst.h"
#include "relational.h"
#include "utils.h"
#include <iostream>
#include <stdexcept>
```

Namespaces

- namespace [GiNaC](#)

7.18.1 Detailed Description

Implementation of [GiNaC](#)'s light-weight expression handles.

7.19 ex.h File Reference

Interface to [GiNaC](#)'s light-weight expression handles.

```
#include "basic.h"
#include "ptr.h"
#include <functional>
#include <iosfwd>
#include <iterator>
#include <memory>
#include <stack>
```


Classes

- class [GiNaC::library_init](#)
Helper class to initialize the library.
- class [GiNaC::ex](#)
Lightweight wrapper for [GiNaC](#)'s symbolic objects.
- class [GiNaC::const_iterator](#)
- struct [GiNaC::internal::_iter_rep](#)
- class [GiNaC::const_preorder_iterator](#)
- class [GiNaC::const_postorder_iterator](#)
- struct [GiNaC::ex_is_less](#)
- struct [GiNaC::ex_is_equal](#)
- struct [GiNaC::op0_is_equal](#)
- struct [GiNaC::ex_swap](#)
- class [GiNaC::pointer_to_map_function](#)
- class [GiNaC::pointer_to_map_function_1arg< T1 >](#)
- class [GiNaC::pointer_to_map_function_2args< T1, T2 >](#)
- class [GiNaC::pointer_to_map_function_3args< T1, T2, T3 >](#)
- class [GiNaC::pointer_to_member_to_map_function< C >](#)
- class [GiNaC::pointer_to_member_to_map_function_1arg< C, T1 >](#)
- class [GiNaC::pointer_to_member_to_map_function_2args< C, T1, T2 >](#)
- class [GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2, T3 >](#)
- struct [std::hash< GiNaC::ex >](#)
Specialization of `std::hash()` for `ex` objects.
- struct [std::equal_to< GiNaC::ex >](#)
Specialization of `std::equal_to()` for `ex` objects.

Namespaces

- namespace [GiNaC](#)
- namespace [GiNaC::internal](#)
- namespace [std](#)

Functions

- bool [GiNaC::are_ex_trivially_equal](#) (const ex &e1, const ex &e2)
Compare two objects of class quickly without doing a deep tree traversal.
- std::ostream & [GiNaC::operator<<](#) (std::ostream &os, const exvector &e)
- std::ostream & [GiNaC::operator<<](#) (std::ostream &os, const exset &e)
- std::ostream & [GiNaC::operator<<](#) (std::ostream &os, const exmap &e)
- size_t [GiNaC::nops](#) (const ex &thisex)
- ex [GiNaC::expand](#) (const ex &thisex, unsigned [options](#)=0)
- ex [GiNaC::conjugate](#) (const ex &thisex)
- ex [GiNaC::real_part](#) (const ex &thisex)
- ex [GiNaC::imag_part](#) (const ex &thisex)
- bool [GiNaC::has](#) (const ex &thisex, const ex &pattern, unsigned [options](#)=0)
- bool [GiNaC::find](#) (const ex &thisex, const ex &pattern, exset &found)
- bool [GiNaC::is_polynomial](#) (const ex &thisex, const ex &vars)
- int [GiNaC::degree](#) (const ex &thisex, const ex &s)
- int [GiNaC::ldegree](#) (const ex &thisex, const ex &s)
- ex [GiNaC::coeff](#) (const ex &thisex, const ex &s, int [n](#)=1)
- ex [GiNaC::numer](#) (const ex &thisex)

- ex [GiNaC::denom](#) (const ex &thisex)
- ex [GiNaC::numer_denom](#) (const ex &thisex)
- ex [GiNaC::normal](#) (const ex &thisex)
- ex [GiNaC::to_rational](#) (const ex &thisex, exmap &repl)
- ex [GiNaC::to_polynomial](#) (const ex &thisex, exmap &repl)
- ex [GiNaC::collect](#) (const ex &thisex, const ex &s, bool distributed=false)
- ex [GiNaC::eval](#) (const ex &thisex)
- ex [GiNaC::evalf](#) (const ex &thisex)
- ex [GiNaC::evalm](#) (const ex &thisex)
- ex [GiNaC::eval_integ](#) (const ex &thisex)
- ex [GiNaC::diff](#) (const ex &thisex, const symbol &s, unsigned nth=1)
- ex [GiNaC::series](#) (const ex &thisex, const ex &r, int [order](#), unsigned [options](#)=0)
- bool [GiNaC::match](#) (const ex &thisex, const ex &pattern, exmap &repl_lst)
- ex [GiNaC::simplify_indexed](#) (const ex &thisex, unsigned [options](#)=0)
- ex [GiNaC::simplify_indexed](#) (const ex &thisex, const scalar_products &sp, unsigned [options](#)=0)
- ex [GiNaC::symmetrize](#) (const ex &thisex)
- ex [GiNaC::symmetrize](#) (const ex &thisex, const lst &l)
- ex [GiNaC::antisymmetrize](#) (const ex &thisex)
- ex [GiNaC::antisymmetrize](#) (const ex &thisex, const lst &l)
- ex [GiNaC::symmetrize_cyclic](#) (const ex &thisex)
- ex [GiNaC::symmetrize_cyclic](#) (const ex &thisex, const lst &l)
- ex [GiNaC::op](#) (const ex &thisex, size_t i)
- ex [GiNaC::lhs](#) (const ex &thisex)
- ex [GiNaC::rhs](#) (const ex &thisex)
- bool [GiNaC::is_zero](#) (const ex &thisex)
- void [GiNaC::swap](#) (ex &e1, ex &e2)
- ex [GiNaC::subs](#) (const ex &thisex, const exmap &m, unsigned [options](#)=0)
- ex [GiNaC::subs](#) (const ex &thisex, const lst &ls, const lst &lr, unsigned [options](#)=0)
- ex [GiNaC::subs](#) (const ex &thisex, const ex &e, unsigned [options](#)=0)
- template<class T >
 bool [GiNaC::is_a](#) (const ex &obj)
Check if ex is a handle to a T, including base classes.
- template<class T >
 bool [GiNaC::is_exactly_a](#) (const ex &obj)
Check if ex is a handle to a T, not including base classes.
- template<class T >
 const T & [GiNaC::ex_to](#) (const ex &e)
Return a reference to the basic-derived class T object embedded in an expression.
- template<> void [std::swap](#) ([GiNaC::ex](#) &a, [GiNaC::ex](#) &b)
Specialization of [std::swap\(\)](#) for ex objects.

Variables

- static library_init [GiNaC::library_initializer](#)
For construction of flyweights, etc.
- const basic * [GiNaC::_num0_bp](#)

7.19.1 Detailed Description

Interface to [GiNaC](#)'s light-weight expression handles.

7.20 excompiler.cpp File Reference

Functions to facilitate the conversion of a `ex` to a function pointer suited for fast numerical integration.

```
#include "excompiler.h"
#include "ex.h"
#include "lst.h"
#include "operators.h"
#include "relational.h"
#include "symbol.h"
#include <cstdlib>
#include <fstream>
#include <ios>
#include <sstream>
#include <stdexcept>
#include <string>
#include <vector>
```

Namespaces

- namespace [GiNaC](#)

Functions

- void [GiNaC::compile_ex](#) (const `ex` &expr, const symbol &sym, FUNCP_1P &fp, const std::string filename="")
Takes an expression and produces a function pointer to the compiled and linked C code equivalent in double precision.
- void [GiNaC::compile_ex](#) (const `ex` &expr, const symbol &sym1, const symbol &sym2, FUNCP_2P &fp, const std::string filename="")
Takes an expression and produces a function pointer to the compiled and linked C code equivalent in double precision.
- void [GiNaC::compile_ex](#) (const lst &exprs, const lst &syms, FUNCP_CUBA &fp, const std::string filename="")
Takes an expression and produces a function pointer to the compiled and linked C code equivalent in double precision.
- void [GiNaC::link_ex](#) (const std::string filename, FUNCP_1P &fp)
Opens an existing so-file and returns a function pointer of type FUNCP_1P to the contained function.
- void [GiNaC::link_ex](#) (const std::string filename, FUNCP_2P &fp)
Opens an existing so-file and returns a function pointer of type FUNCP_2P to the contained function.
- void [GiNaC::link_ex](#) (const std::string filename, FUNCP_CUBA &fp)
Opens an existing so-file and returns a function pointer of type FUNCP_CUBA to the contained function.
- void [GiNaC::unlink_ex](#) (const std::string filename)
Closes all linked .so files that have the supplied filename.

7.20.1 Detailed Description

Functions to facilitate the conversion of a `ex` to a function pointer suited for fast numerical integration.

7.21 excompiler.h File Reference

Functions to facilitate the conversion of a `ex` to a function pointer suited for fast numerical integration.

```
#include "lst.h"
#include <string>
```

Namespaces

- namespace [GiNaC](#)

Typedefs

- typedef double(* [GiNaC::FUNCP_1P](#)) (double)
Function pointer with one function parameter.
- typedef double(* [GiNaC::FUNCP_2P](#)) (double, double)
Function pointer with two function parameters.
- typedef void(* [GiNaC::FUNCP_CUBA](#)) (const int *, const double[], const int *, double[])
Function pointer for use with the CUBA library (<http://www.feynarts.de/cuba>).

Functions

- void [GiNaC::compile_ex](#) (const ex &expr, const symbol &sym, FUNCP_1P &fp, const std::string filename="")
Takes an expression and produces a function pointer to the compiled and linked C code equivalent in double precision.
- void [GiNaC::compile_ex](#) (const ex &expr, const symbol &sym1, const symbol &sym2, FUNCP_2P &fp, const std::string filename="")
Takes an expression and produces a function pointer to the compiled and linked C code equivalent in double precision.
- void [GiNaC::compile_ex](#) (const lst &exprs, const lst &syms, FUNCP_CUBA &fp, const std::string filename="")
Takes an expression and produces a function pointer to the compiled and linked C code equivalent in double precision.
- void [GiNaC::link_ex](#) (const std::string filename, FUNCP_1P &fp)
Opens an existing so-file and returns a function pointer of type FUNCP_1P to the contained function.
- void [GiNaC::link_ex](#) (const std::string filename, FUNCP_2P &fp)
Opens an existing so-file and returns a function pointer of type FUNCP_2P to the contained function.
- void [GiNaC::link_ex](#) (const std::string filename, FUNCP_CUBA &fp)
Opens an existing so-file and returns a function pointer of type FUNCP_CUBA to the contained function.
- void [GiNaC::unlink_ex](#) (const std::string filename)
Closes all linked .so files that have the supplied filename.

7.21.1 Detailed Description

Functions to facilitate the conversion of a ex to a function pointer suited for fast numerical integration.

7.22 expair.cpp File Reference

Implementation of expression pairs (building blocks of expairseq).

```
#include "expair.h"
#include "operators.h"
#include <iostream>
```

Namespaces

- namespace [GiNaC](#)

7.22.1 Detailed Description

Implementation of expression pairs (building blocks of `expairseq`).

7.23 `expair.h` File Reference

Definition of expression pairs (building blocks of `expairseq`).

```
#include "ex.h"
#include "numeric.h"
#include "print.h"
```

Classes

- class [GiNaC::expair](#)
A pair of expressions.
- struct [GiNaC::expair_is_less](#)
Function object for insertion into third argument of STL's `sort()` etc.
- struct [GiNaC::expair_rest_is_less](#)
Function object not caring about the numerical coefficients for insertion into third argument of STL's `sort()`.
- struct [GiNaC::expair_swap](#)

Namespaces

- namespace [GiNaC](#)

Functions

- void [GiNaC::swap](#) (`expair &e1`, `expair &e2`)

7.23.1 Detailed Description

Definition of expression pairs (building blocks of `expairseq`).

7.24 expairseq.cpp File Reference

Implementation of sequences of expression pairs.

```
#include "expairseq.h"
#include "lst.h"
#include "add.h"
#include "mul.h"
#include "power.h"
#include "relational.h"
#include "wildcard.h"
#include "archive.h"
#include "operators.h"
#include "utils.h"
#include "hash_seed.h"
#include "indexed.h"
#include "compiler.h"
#include <algorithm>
#include <iostream>
#include <iterator>
#include <memory>
#include <stdexcept>
#include <string>
```

Namespaces

- namespace [GiNaC](#)

Functions

- [GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) (expairseq, basic, print_func< print_context >(&expairseq::do_print). print_func< print_tree >(&expairseq::do_print_tree)) class epp_is_less
- `epvector *` [GiNaC::conjugateepvector](#) (const epvector &)

Complex conjugate every element of an epvector.

7.24.1 Detailed Description

Implementation of sequences of expression pairs.

7.25 expairseq.h File Reference

Interface to sequences of expression pairs.

```
#include "expair.h"
#include "indexed.h"
#include <vector>
```

Classes

- class [GiNaC::expairseq](#)
A sequence of class expair.
- class [GiNaC::make_flat_inserter](#)
Class to handle the renaming of dummy indices.

Namespaces

- namespace [GiNaC](#)

Typedefs

- typedef `std::vector< expair >` [GiNaC::epvector](#)
expair-vector
- typedef `epvector::iterator` [GiNaC::epp](#)
expair-vector pointer

Functions

- `epvector *` [GiNaC::conjugateepvector](#) (const epvector &)
Complex conjugate every element of an epvector.

7.25.1 Detailed Description

Interface to sequences of expression pairs.

7.26 exprseq.cpp File Reference

Implementation of [GiNaC](#)'s exprseq.

```
#include "exprseq.h"
```

Namespaces

- namespace [GiNaC](#)

7.26.1 Detailed Description

Implementation of [GiNaC](#)'s exprseq.

7.27 exprseq.h File Reference

Definition of [GiNaC's](#) `exprseq`.

```
#include "container.h"  
#include <vector>
```

Namespaces

- namespace [GiNaC](#)

Typedefs

- typedef container< std::vector > [GiNaC::exprseq](#)

7.27.1 Detailed Description

Definition of [GiNaC's](#) `exprseq`.

7.28 factor.cpp File Reference

Polynomial factorization (implementation).

```
#include "factor.h"  
#include "ex.h"  
#include "numeric.h"  
#include "operators.h"  
#include "inifcns.h"  
#include "symbol.h"  
#include "relational.h"  
#include "power.h"  
#include "mul.h"  
#include "normal.h"  
#include "add.h"  
#include <type_traits>  
#include <algorithm>  
#include <limits>  
#include <list>  
#include <vector>  
#include <stack>  
#include <cln/cln.h>
```

Namespaces

- namespace [GiNaC](#)

Macros

- `#define DCOUT(str)`
- `#define DCOUTVAR(var)`
- `#define DCOUT2(str, var)`
- `#define USE_SAME_DEGREE_FACTOR`

Functions

- `ex GiNaC::factor` (const ex &poly, unsigned options)

Interface function to the outside world.

7.28.1 Detailed Description

Polynomial factorization (implementation).

The interface function `factor()` at the end of this file is defined in the `GiNaC` namespace. All other utility functions and classes are defined in an additional anonymous namespace.

Factorization starts by doing a square free factorization and making the coefficients integer. Then, depending on the number of free variables it proceeds either in dedicated univariate or multivariate factorization code.

Univariate factorization does a modular factorization via Berlekamp's algorithm and distinct degree factorization. Hensel lifting is used at the end.

Multivariate factorization uses the univariate factorization (applying a evaluation homomorphism first) and Hensel lifting raises the answer to the multivariate domain. The Hensel lifting code is completely distinct from the code used by the univariate factorization.

Algorithms used can be found in [Wan] An Improved Multivariate Polynomial Factoring Algorithm, P.S.Wang, Mathematics of Computation, Vol. 32, No. 144 (1978) 1215–1231. [GCL] Algorithms for Computer Algebra, K.O.Geddes, S.R.Czapor, G.Labahn, Springer Verlag, 1992. [Mig] Some Useful Bounds, M.Mignotte, In "Computer Algebra, Symbolic and Algebraic Computation" (B.Buchberger et al., eds.), pp. 259-263, Springer-Verlag, New York, 1982.

7.28.2 Macro Definition Documentation

7.28.2.1 DCOUT

```
#define DCOUT(  
    str )
```

7.28.2.2 DCOUTVAR

```
#define DCOUTVAR(  
    var )
```

7.28.2.3 DCOUT2

```
#define DCOUT2(
    str,
    var )
```

7.28.2.4 USE_SAME_DEGREE_FACTOR

```
#define USE_SAME_DEGREE_FACTOR
```

7.28.3 Variable Documentation

7.28.3.1 value

```
const bool value = false [static]
```

Referenced by [GiNaC::archive_node::add_bool\(\)](#), [GiNaC::archive_node::add_ex\(\)](#), [GiNaC::archive_node::add_string\(\)](#), [GiNaC::archive_node::add_unsigned\(\)](#), [GiNaC::Li2_\(\)](#), [GiNaC::matrix::set\(\)](#), and [GiNaC::subsvalue\(\)](#).

7.28.3.2 r

```
size_t r [private]
```

Referenced by [GiNaC::matrix::charpoly\(\)](#), [GiNaC::collect_common_factors\(\)](#), [GiNaC::ex::content\(\)](#), [GiNaC::numeric::csgn\(\)](#), [GiNaC::numeric::denom\(\)](#), [GiNaC::matrix::determinant\(\)](#), [GiNaC::matrix::determinant_minor\(\)](#), [GiNaC::divide\(\)](#), [GiNaC::divide_in_z\(\)](#), [GiNaC::matrix::division_free_elimination\(\)](#), [GiNaC::matrix::echelon_form\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::power::expand\(\)](#), [GiNaC::power::expand_add\(\)](#), [GiNaC::power::expand_add_2\(\)](#), [GiNaC::matrix::fraction_free_elimination\(\)](#), [GiNaC::matrix::gauss_elimination\(\)](#), [GiNaC::idx_symmetrization\(\)](#), [GiNaC::matrix::inverse\(\)](#), [GiNaC::iquo\(\)](#), [GiNaC::lsolve\(\)](#), [GiNaC::matrix::markowitz_elimination\(\)](#), [GiNaC::matrix::matrix\(\)](#), [GiNaC::matrix::mul\(\)](#), [GiNaC::matrix::mul_scalar\(\)](#), [GiNaC::numeric::numer\(\)](#), [GiNaC::Order_series\(\)](#), [GiNaC::matrix::pow\(\)](#), [GiNaC::prem\(\)](#), [GiNaC::numeric::print_numeric\(\)](#), [GiNaC::quo\(\)](#), [GiNaC::matrix::rank\(\)](#), [GiNaC::reduced_matrix\(\)](#), [GiNaC::rem\(\)](#), [GiNaC::structure< T, ComparisonPolicy >::return_type\(\)](#), [GiNaC::ex::series\(\)](#), [GiNaC::series\(\)](#), [GiNaC::basic::series\(\)](#), [GiNaC::add::series\(\)](#), [GiNaC::fderivative::series\(\)](#), [GiNaC::function::series\(\)](#), [GiNaC::integral::series\(\)](#), [GiNaC::integration_kernel::series\(\)](#), [GiNaC::Eisenstein_kernel::series\(\)](#), [GiNaC::modular_form_kernel::series\(\)](#), [GiNaC::pseries::series\(\)](#), [GiNaC::structure< T, ComparisonPolicy >::series\(\)](#), [GiNaC::mul::series\(\)](#), [GiNaC::power::series\(\)](#), [GiNaC::symbol::series\(\)](#), [GiNaC::refcounted::set_refcount\(\)](#), [GiNaC::matrix::solve\(\)](#), [GiNaC::sprem\(\)](#), [GiNaC::sqrfree_pfrac\(\)](#), [GiNaC::sr_gcd\(\)](#), [GiNaC::numeric::step\(\)](#), [GiNaC::sub_matrix\(\)](#), [GiNaC::ex::subs\(\)](#), [GiNaC::matrix::subs\(\)](#), [GiNaC::symbolic_matrix\(\)](#), [GiNaC::matrix::trace\(\)](#), [GiNaC::matrix::transpose\(\)](#), [GiNaC::unit_matrix\(\)](#), and [GiNaC::zeta1_evalf\(\)](#).

7.28.3.3 c

size_t c [private]

Referenced by [GiNaC::abs_print_csrc_float\(\)](#), [GiNaC::abs_print_latex\(\)](#), [GiNaC::symmetry::add\(\)](#), [GiNaC::bernoulli\(\)](#), [GiNaC::matrix::charpoly\(\)](#), [GiNaC::mul::coeff\(\)](#), [GiNaC::ncmul::coeff\(\)](#), [GiNaC::color_d\(\)](#), [GiNaC::color_f\(\)](#), [GiNaC::color_h\(\)](#), [GiNaC::expairseq::combine_ex_with_coeff_to_pair\(\)](#), [GiNaC::add::combine_ex_with_coeff_to_pair\(\)](#), [GiNaC::mul::combine_ex_with_coeff_to_pair\(\)](#), [GiNaC::expairseq::combine_overall_coeff\(\)](#), [GiNaC::mul::combine_overall_coeff\(\)](#), [GiNaC::expairseq::combine_pair_with_coeff_to_pair\(\)](#), [GiNaC::add::combine_pair_with_coeff_to_pair\(\)](#), [GiNaC::mul::combine_pair_v](#), [GiNaC::mul::conjugate\(\)](#), [GiNaC::conjugate_print_latex\(\)](#), [GiNaC::ex::content\(\)](#), [GiNaC::crc32\(\)](#), [GiNaC::pseries::derivative\(\)](#), [GiNaC::matrix::determinant\(\)](#), [GiNaC::matrix::determinant_minor\(\)](#), [GiNaC::divide_in_z\(\)](#), [GiNaC::matrix::division_free_elimination\(\)](#), [GiNaC::add::do_print\(\)](#), [GiNaC::basic::do_print\(\)](#), [GiNaC::constant::do_print\(\)](#), [GiNaC::container< C >::do_print\(\)](#), [GiNaC::expairseq::do_print\(\)](#), [GiNaC::fderivative::do_print\(\)](#), [GiNaC::idx::do_print\(\)](#), [GiNaC::varidx::do_print\(\)](#), [GiNaC::spinidx::do_print\(\)](#), [GiNaC::indexed::do_print\(\)](#), [GiNaC::integral::do_print\(\)](#), [GiNaC::integration_kernel::do_print\(\)](#), [GiNaC::basic_log_kernel::do_print\(\)](#), [GiNaC::multiple_polylog_kernel::do_print\(\)](#), [GiNaC::ELi_kernel::do_print\(\)](#), [GiNaC::Ebar_kernel::do_print\(\)](#), [GiNaC::Kronecker_dtau_kernel::do_print\(\)](#), [GiNaC::Kronecker_dz_kernel::do_print\(\)](#), [GiNaC::Eisenstein_kernel::do_print\(\)](#), [GiNaC::Eisenstein_h_kernel::do_print\(\)](#), [GiNaC::modular_form_kernel::do_print\(\)](#), [GiNaC::user_defined_kernel::do_print\(\)](#), [GiNaC::matrix::do_print\(\)](#), [GiNaC::mul::do_print\(\)](#), [GiNaC::ncmul::do_print\(\)](#), [GiNaC::numeric::do_print\(\)](#), [GiNaC::pseries::do_print\(\)](#), [GiNaC::relational::do_print\(\)](#), [GiNaC::symbol::do_print\(\)](#), [GiNaC::symmetry::do_print\(\)](#), [GiNaC::wildcard::do_print\(\)](#), [GiNaC::ncmul::do_print_csrc\(\)](#), [GiNaC::add::do_print_csrc\(\)](#), [GiNaC::fderivative::do_print_csrc\(\)](#), [GiNaC::idx::do_print_csrc\(\)](#), [GiNaC::mul::do_print_csrc\(\)](#), [GiNaC::numeric::do_print_csrc\(\)](#), [GiNaC::power::do_print_csrc\(\)](#), [GiNaC::numeric::do_print_csrc_cl_N\(\)](#), [GiNaC::power::do_print_csrc_cl_N\(\)](#), [GiNaC::clifford::do_print_dfft\(\)](#), [GiNaC::power::do_print_dfft\(\)](#), [GiNaC::fderivative::do_print_latex\(\)](#), [GiNaC::add::do_print_latex\(\)](#), [GiNaC::clifford::do_print_latex\(\)](#), [GiNaC::constant::do_print_latex\(\)](#), [GiNaC::idx::do_print_latex\(\)](#), [GiNaC::spinidx::do_print_latex\(\)](#), [GiNaC::indexed::do_print_latex\(\)](#), [GiNaC::integral::do_print_latex\(\)](#), [GiNaC::matrix::do_print_latex\(\)](#), [GiNaC::mul::do_print_latex\(\)](#), [GiNaC::numeric::do_print_latex\(\)](#), [GiNaC::power::do_print_latex\(\)](#), [GiNaC::pseries::do_print_latex\(\)](#), [GiNaC::symbol::do_print_latex\(\)](#), [GiNaC::container< C >::do_print_python\(\)](#), [GiNaC::power::do_print_python\(\)](#), [GiNaC::pseries::do_print_python\(\)](#), [GiNaC::add::do_print_python_repr\(\)](#), [GiNaC::basic::do_print_python_repr\(\)](#), [GiNaC::constant::do_print_python_repr\(\)](#), [GiNaC::container< C >::do_print_python_repr\(\)](#), [GiNaC::matrix::do_print_python_repr\(\)](#), [GiNaC::mul::do_print_python_repr\(\)](#), [GiNaC::numeric::do_print_python_repr\(\)](#), [GiNaC::power::do_print_python_repr\(\)](#), [GiNaC::pseries::do_print_python_repr\(\)](#), [GiNaC::relational::do_print_python_repr\(\)](#), [GiNaC::symbol::do_print_python_repr\(\)](#), [GiNaC::wildcard::do_print_python_repr\(\)](#), [GiNaC::basic::do_print_tree\(\)](#), [GiNaC::clifford::do_print_tree\(\)](#), [GiNaC::constant::do_print_tree\(\)](#), [GiNaC::container< C >::do_print_tr](#), [GiNaC::expairseq::do_print_tree\(\)](#), [GiNaC::fderivative::do_print_tree\(\)](#), [GiNaC::idx::do_print_tree\(\)](#), [GiNaC::varidx::do_print_tree\(\)](#), [GiNaC::spinidx::do_print_tree\(\)](#), [GiNaC::indexed::do_print_tree\(\)](#), [GiNaC::numeric::do_print_tree\(\)](#), [GiNaC::pseries::do_print_tree\(\)](#), [GiNaC::symbol::do_print_tree\(\)](#), [GiNaC::symmetry::do_print_tree\(\)](#), [GiNaC::wildcard::do_print_tree\(\)](#), [GiNaC::matrix::echelon_form\(\)](#), [GiNaC::EllipticE_print_latex\(\)](#), [GiNaC::EllipticK_print_latex\(\)](#), [GiNaC::mul::eval\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::power::expand_add\(\)](#), [GiNaC::power::expand_add_2\(\)](#), [GiNaC::factorial_print_dfft_latex\(\)](#), [GiNaC::matrix::fraction_free_elimination\(\)](#), [GiNaC::matrix::gauss_elimination\(\)](#), [GiNaC::H_print_latex\(\)](#), [GiNaC::power::imag_part\(\)](#), [GiNaC::imag_part_print_latex\(\)](#), [GiNaC::add::integer_content\(\)](#), [GiNaC::matrix::inverse\(\)](#), [GiNaC::lcmcoeff\(\)](#), [GiNaC::Li_print_latex\(\)](#), [GiNaC::lsolve\(\)](#), [GiNaC::matrix::markowitz_elimination\(\)](#), [GiNaC::matrix::matrix\(\)](#), [GiNaC::matrix::mul\(\)](#), [GiNaC::matrix::mul_scalar\(\)](#), [GiNaC::print_functor::operator\(\)](#), [GiNaC::print_ptrfun_handler< T, C >::operator\(\)](#), [GiNaC::print_memfun_handler< T, C >::opera](#), [GiNaC::error_and_integral_is_less::operator\(\)](#), [GiNaC::matrix::pivot\(\)](#), [GiNaC::pseries::power_const\(\)](#), [GiNaC::ex::primpart\(\)](#), [GiNaC::basic::print\(\)](#), [GiNaC::ex::print\(\)](#), [GiNaC::fderivative::print\(\)](#), [GiNaC::function::print\(\)](#), [GiNaC::structure< T, ComparisonPolicy](#), [GiNaC::expair::print\(\)](#), [GiNaC::add::print_add\(\)](#), [GiNaC::basic::print_dispatch\(\)](#), [GiNaC::matrix::print_elements\(\)](#), [GiNaC::idx::print_index\(\)](#), [GiNaC::indexed::print_indexed\(\)](#), [GiNaC::print_integer_csrc\(\)](#), [GiNaC::numeric::print_numeric\(\)](#), [GiNaC::print_operator\(\)](#), [GiNaC::mul::print_overall_coeff\(\)](#), [GiNaC::power::print_power\(\)](#), [GiNaC::print_real_cl_N\(\)](#), [GiNaC::print_real_csrc\(\)](#), [GiNaC::print_real_number\(\)](#), [GiNaC::pseries::print_series\(\)](#), [GiNaC::print_sym_pow\(\)](#), [GiNaC::indexed::printindices\(\)](#), [GiNaC::expairseq::printpair\(\)](#), [GiNaC::expairseq::printseq\(\)](#), [GiNaC::container< C >::printseq\(\)](#), [GiNaC::numeric::read_archive\(\)](#), [GiNaC::power::real_part\(\)](#), [GiNaC::real_part_print_latex\(\)](#), [GiNaC::reduced_matrix\(\)](#), [GiNaC::S_print_latex\(\)](#), [GiNaC::set_print_context\(\)](#), [GiNaC::matrix::solve\(\)](#), [GiNaC::sr_gcd\(\)](#), [GiNaC::sub_matrix\(\)](#), [GiNaC::clifford::subs\(\)](#), [GiNaC::matrix::subs\(\)](#), [GiNaC::symbolic_matrix\(\)](#), [GiNaC::matrix::transpose\(\)](#), [GiNaC::ex::unit\(\)](#), [GiNaC::unit_matrix\(\)](#), [GiNaC::ex::unitcontprim\(\)](#), [GiNaC::zeta1_print_latex\(\)](#), and [GiNaC::zeta2_print_latex\(\)](#).

7.28.3.4 m

mvec m [private]

Referenced by [GiNaC::mul::algebraic_subs_mul\(\)](#), [GiNaC::charpoly\(\)](#), [GiNaC::Eisenstein_h_kernel::coefficient_an\(\)](#), [GiNaC::cols\(\)](#), [GiNaC::convert_H_to_Li\(\)](#), [GiNaC::determinant\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::tensdelta::eval_indexed\(\)](#), [GiNaC::tensmetric::eval_indexed\(\)](#), [GiNaC::evalf\(\)](#), [GiNaC::add::evalm\(\)](#), [GiNaC::mul::evalm\(\)](#), [GiNaC::expand\(\)](#), [GiNaC::power::expand\(\)](#), [GiNaC::power::expand_mul\(\)](#), [GiNaC::fibonacci\(\)](#), [GiNaC::H_deriv\(\)](#), [GiNaC::H_eval\(\)](#), [GiNaC::H_evalf\(\)](#), [GiNaC::H_print_latex\(\)](#), [GiNaC::H_series\(\)](#), [GiNaC::inverse\(\)](#), [GiNaC::lgamma_series\(\)](#), [GiNaC::Li_deriv\(\)](#), [GiNaC::Li_eval\(\)](#), [GiNaC::Li_evalf\(\)](#), [GiNaC::Li_print_latex\(\)](#), [GiNaC::Li_series\(\)](#), [GiNaC::nops\(\)](#), [GiNaC::Order_eval\(\)](#), [GiNaC::psi1_series\(\)](#), [GiNaC::psi2_eval\(\)](#), [GiNaC::psi2_series\(\)](#), [GiNaC::rank\(\)](#), [GiNaC::reduced_matrix\(\)](#), [GiNaC::resultant\(\)](#), [GiNaC::rows\(\)](#), [GiNaC::S_eval\(\)](#), [GiNaC::smod\(\)](#), [GiNaC::sub_matrix\(\)](#), [GiNaC::subs\(\)](#), [GiNaC::basic::subs\(\)](#), [GiNaC::clifford::subs\(\)](#), [GiNaC::container< C >::subs\(\)](#), [GiNaC::expairseq::subs\(\)](#), [GiNaC::idx::subs\(\)](#), [GiNaC::numeric::subs\(\)](#), [GiNaC::power::subs\(\)](#), [GiNaC::pseries::subs\(\)](#), [GiNaC::relational::subs\(\)](#), [GiNaC::structure< T, ComparisonPolicy >::subs\(\)](#), [GiNaC::symbol::subs\(\)](#), [GiNaC::ex::subs\(\)](#), [GiNaC::basic::subs_one_level\(\)](#), [GiNaC::container< C >::subschildren\(\)](#), [GiNaC::expairseq::subschildren\(\)](#), [GiNaC::tgamma_series\(\)](#), [GiNaC::trace\(\)](#), [GiNaC::transpose\(\)](#), [GiNaC::zeta1_deriv\(\)](#), [GiNaC::zeta1_eval\(\)](#), [GiNaC::zeta1_print_latex\(\)](#), [GiNaC::zeta2_deriv\(\)](#), [GiNaC::zeta2_eval\(\)](#), and [GiNaC::zeta2_print_latex\(\)](#).

7.28.3.5 lr

```
umodpoly lr[2] [private]
```

Referenced by [GiNaC::subs\(\)](#), and [GiNaC::ex::subs\(\)](#).

7.28.3.6 cache

```
vector<vector<umodpoly> > cache [private]
```

7.28.3.7 factors

```
upvec factors [private]
```

Referenced by [GiNaC::ncmul::count_factors\(\)](#), [GiNaC::ncmul::eval\(\)](#), [GiNaC::mul::expand\(\)](#), [GiNaC::mul::mul\(\)](#), [GiNaC::sqrfree\(\)](#), and [GiNaC::sqrfree_yun\(\)](#).

7.28.3.8 one

```
umodpoly one [private]
```

Referenced by [GiNaC::integration_kernel::get_numerical_value_impl\(\)](#), and [GiNaC::iterated_integral_evalf_impl\(\)](#).

7.28.3.9 n

size_t n [private]

Referenced by [GiNaC::class_info< OPT >::tree_node::add_child\(\)](#), [GiNaC::archive::add_node\(\)](#), [GiNaC::basic::archive\(\)](#), [GiNaC::clifford::archive\(\)](#), [GiNaC::color::archive\(\)](#), [GiNaC::constant::archive\(\)](#), [GiNaC::container< C >::archive\(\)](#), [GiNaC::expairseq::archive\(\)](#), [GiNaC::fderivative::archive\(\)](#), [GiNaC::function::archive\(\)](#), [GiNaC::idx::archive\(\)](#), [GiNaC::varidx::archive\(\)](#), [GiNaC::spinidx::archive\(\)](#), [GiNaC::indexed::archive\(\)](#), [GiNaC::integral::archive\(\)](#), [GiNaC::matrix::archive\(\)](#), [GiNaC::numeric::archive\(\)](#), [GiNaC::power::archive\(\)](#), [GiNaC::pseries::archive\(\)](#), [GiNaC::relational::archive\(\)](#), [GiNaC::symbol::archive\(\)](#), [GiNaC::symmetry::archive\(\)](#), [GiNaC::minkmetric::archive\(\)](#), [GiNaC::tensepsilon::archive\(\)](#), [GiNaC::wildcard::archive\(\)](#), [GiNaC::archive::archive\(\)](#), [GiNaC::bernoulli\(\)](#), [GiNaC::binomial\(\)](#), [GiNaC::basic::coeff\(\)](#), [GiNaC::ex::coeff\(\)](#), [GiNaC::add::coeff\(\)](#), [GiNaC::mul::coeff\(\)](#), [GiNaC::ncmul::coeff\(\)](#), [GiNaC::numeric::coeff\(\)](#), [GiNaC::power::coeff\(\)](#), [GiNaC::pseries::coeff\(\)](#), [GiNaC::structure< T, ComparisonPolicy >::coeff\(\)](#), [GiNaC::coeff\(\)](#), [GiNaC::Eisenstein_h_kernel::coefficient_an\(\)](#), [GiNaC::basic::collect\(\)](#), [GiNaC::const_postorder_iterator::const_postorder_iterator\(\)](#), [GiNaC::const_preorder_iterator::const_preorder_iterator\(\)](#), [GiNaC::composition_generator::coolmulti::coolmulti\(\)](#), [GiNaC::matrix::determinant_minor\(\)](#), [GiNaC::dirichlet_character\(\)](#), [GiNaC::matrix::division_free_elimination\(\)](#), [GiNaC::doublefactorial\(\)](#), [GiNaC::class_info< OPT >::dump_tree\(\)](#), [GiNaC::matrix::echelon_form\(\)](#), [GiNaC::power::eval\(\)](#), [GiNaC::mul::expand\(\)](#), [GiNaC::power::expand_add\(\)](#), [GiNaC::power::expand_mul\(\)](#), [GiNaC::factorial\(\)](#), [GiNaC::fibonacci\(\)](#), [GiNaC::frac_cancel\(\)](#), [GiNaC::matrix::fraction_free_elimination\(\)](#), [GiNaC::function_options::function_options\(\)](#), [GiNaC::matrix::gauss_elimination\(\)](#), [GiNaC::gcd\(\)](#), [GiNaC::golden_ratio_hash\(\)](#), [GiNaC::H_eval\(\)](#), [GiNaC::ifactor\(\)](#), [GiNaC::power::imag_part\(\)](#), [GiNaC::is_discriminant_of_quadratic_number_field\(\)](#), [GiNaC::kronecker_symbol\(\)](#), [GiNaC::integration_kernel::Laurent_series\(\)](#), [GiNaC::log2\(\)](#), [GiNaC::log_series\(\)](#), [GiNaC::basic::map\(\)](#), [GiNaC::matrix::markowitz_elimination\(\)](#), [GiNaC::multinomial_coefficient\(\)](#), [GiNaC::add::normal\(\)](#), [GiNaC::mul::normal\(\)](#), [GiNaC::pseries::normal\(\)](#), [GiNaC::const_iterator::operator+\(\)](#), [GiNaC::const_iterator::operator+=\(\)](#), [GiNaC::const_iterator::operator-\(\)](#), [GiNaC::const_iterator::operator-=\(\)](#), [GiNaC::const_iterator::operator\[\]\(\)](#), [GiNaC::primitive_dirichlet_character\(\)](#), [GiNaC::psi2_deriv\(\)](#), [GiNaC::psi2_eval\(\)](#), [GiNaC::psi2_evalf\(\)](#), [GiNaC::psi2_series\(\)](#), [GiNaC::clifford::read_archive\(\)](#), [GiNaC::color::read_archive\(\)](#), [GiNaC::container< C >::read_archive\(\)](#), [GiNaC::constant::read_archive\(\)](#), [GiNaC::expairseq::read_archive\(\)](#), [GiNaC::fderivative::read_archive\(\)](#), [GiNaC::function::read_archive\(\)](#), [GiNaC::idx::read_archive\(\)](#), [GiNaC::varidx::read_archive\(\)](#), [GiNaC::spinidx::read_archive\(\)](#), [GiNaC::indexed::read_archive\(\)](#), [GiNaC::integral::read_archive\(\)](#), [GiNaC::matrix::read_archive\(\)](#), [GiNaC::numeric::read_archive\(\)](#), [GiNaC::power::read_archive\(\)](#), [GiNaC::pseries::read_archive\(\)](#), [GiNaC::relational::read_archive\(\)](#), [GiNaC::symbol::read_archive\(\)](#), [GiNaC::symmetry::read_archive\(\)](#), [GiNaC::minkmetric::read_archive\(\)](#), [GiNaC::tensepsilon::read_archive\(\)](#), [GiNaC::wildcard::read_archive\(\)](#), [GiNaC::power::real_part\(\)](#), [GiNaC::container_storage< C >::reserve\(\)](#), [GiNaC::rotate_left\(\)](#), [GiNaC::S_deriv\(\)](#), [GiNaC::S_eval\(\)](#), [GiNaC::S_evalf\(\)](#), [GiNaC::S_print_latex\(\)](#), [GiNaC::S_series\(\)](#), [GiNaC::basic::series\(\)](#), [GiNaC::symbol::set_name\(\)](#), [GiNaC::function_options::set_name\(\)](#), [GiNaC::symbol::set_TeX_name\(\)](#), [GiNaC::matrix::solve\(\)](#), [GiNaC::sqrfree_parrfrac\(\)](#), [GiNaC::function_options::test_and_set_nparams\(\)](#), [GiNaC::tgamma_eval\(\)](#), [GiNaC::ex::traverse_postorder\(\)](#), [GiNaC::ex::traverse_preorder\(\)](#), [GiNaC::symmetry::validate\(\)](#), [GiNaC::write_real_float\(\)](#), [GiNaC::zetaderiv_deriv\(\)](#), and [GiNaC::zetaderiv_eval\(\)](#).

7.28.3.10 len

size_t len [private]

Referenced by [GiNaC::crc32\(\)](#).

7.28.3.11 last

size_t last [private]

Referenced by [GiNaC::antisymmetrize\(\)](#), [GiNaC::expairseq::combine_same_terms_sorted_seq\(\)](#), [GiNaC::expairseq::construct_from_permutation\(\)](#), [GiNaC::cyclic_permutation\(\)](#), [GiNaC::mul::eval\(\)](#), [GiNaC::expairseq::evalchildren\(\)](#), [GiNaC::power::expand_add_2\(\)](#), [GiNaC::expairseq::expandchildren\(\)](#), [GiNaC::mul::expandchildren\(\)](#), [GiNaC::find_free_and_dummy\(\)](#), [GiNaC::permutation_sign\(\)](#), [GiNaC::shaker_sort\(\)](#), [GiNaC::expairseq::subchildren\(\)](#), [GiNaC::symm\(\)](#), [GiNaC::symmetrize\(\)](#), and [GiNaC::symmetrize_cyclic\(\)](#).

7.28.3.12 k

```
vector<int> k [private]
```

Referenced by [GiNaC::bernoulli\(\)](#), [GiNaC::Bernoulli_polynomial\(\)](#), [GiNaC::binomial\(\)](#), [GiNaC::scalar_products::debugprint\(\)](#), [GiNaC::divide_in_z\(\)](#), [GiNaC::EllipticE_deriv\(\)](#), [GiNaC::EllipticE_eval\(\)](#), [GiNaC::EllipticE_evalf\(\)](#), [GiNaC::EllipticE_print_latex\(\)](#), [GiNaC::EllipticE_series\(\)](#), [GiNaC::EllipticK_deriv\(\)](#), [GiNaC::EllipticK_eval\(\)](#), [GiNaC::EllipticK_evalf\(\)](#), [GiNaC::EllipticK_print_latex\(\)](#), [GiNaC::EllipticK_series\(\)](#), [GiNaC::ncmul::expand\(\)](#), [GiNaC::power::expand_add\(\)](#), [GiNaC::find_common_factor\(\)](#), [GiNaC::generalised_Bernoulli_number\(\)](#), [GiNaC::multi_iterator_permutation< T >::get_sign\(\)](#), [GiNaC::log2\(\)](#), [GiNaC::matrix::markowitz_elimination\(\)](#), [GiNaC::basic_partition_generator::mpartition2::mpartition2\(\)](#), [GiNaC::basic_partition_generator::composition_generator::coolmulti::next_permutation\(\)](#), [GiNaC::multi_iterator_ordered< T >::operator++\(\)](#), [GiNaC::multi_iterator_ordered_eq< T >::operator++\(\)](#), [GiNaC::multi_iterator_ordered_eq_indv< T >::operator++\(\)](#), [GiNaC::multi_iterator_counter< T >::operator++\(\)](#), [GiNaC::multi_iterator_counter_indv< T >::operator++\(\)](#), [GiNaC::multi_iterator_permutation< T >::operator++\(\)](#), [GiNaC::multi_iterator_shuffle< T >::operator++\(\)](#), [GiNaC::matrix::pivot\(\)](#), [GiNaC::resultant\(\)](#), [GiNaC::ELi_kernel::series_coeff_impl\(\)](#), [GiNaC::Ebar_kernel::series_coeff_impl\(\)](#), and [GiNaC::sqrfree_parfrac\(\)](#).

7.28.3.13 poly

```
const ex poly
```

Referenced by [GiNaC::matrix::charpoly\(\)](#), and [GiNaC::factor\(\)](#).

7.28.3.14 x

```
const ex x
```

Referenced by [GiNaC::abs\(\)](#), [GiNaC::acos\(\)](#), [GiNaC::acos_conjugate\(\)](#), [GiNaC::acos_deriv\(\)](#), [GiNaC::acos_eval\(\)](#), [GiNaC::acos_evalf\(\)](#), [GiNaC::acosh\(\)](#), [GiNaC::acosh_conjugate\(\)](#), [GiNaC::acosh_deriv\(\)](#), [GiNaC::acosh_eval\(\)](#), [GiNaC::acosh_evalf\(\)](#), [GiNaC::adaptivesimpson\(\)](#), [GiNaC::asin\(\)](#), [GiNaC::asin_conjugate\(\)](#), [GiNaC::asin_deriv\(\)](#), [GiNaC::asin_eval\(\)](#), [GiNaC::asin_evalf\(\)](#), [GiNaC::asin_info\(\)](#), [GiNaC::asinh\(\)](#), [GiNaC::asinh_conjugate\(\)](#), [GiNaC::asinh_deriv\(\)](#), [GiNaC::asinh_eval\(\)](#), [GiNaC::asinh_evalf\(\)](#), [GiNaC::atan\(\)](#), [GiNaC::atan2_deriv\(\)](#), [GiNaC::atan2_eval\(\)](#), [GiNaC::atan2_evalf\(\)](#), [GiNaC::atan2_info\(\)](#), [GiNaC::atan_conjugate\(\)](#), [GiNaC::atan_deriv\(\)](#), [GiNaC::atan_eval\(\)](#), [GiNaC::atan_evalf\(\)](#), [GiNaC::atan_info\(\)](#), [GiNaC::atanh\(\)](#), [GiNaC::atanh_conjugate\(\)](#), [GiNaC::atanh_deriv\(\)](#), [GiNaC::atanh_eval\(\)](#), [GiNaC::atanh_evalf\(\)](#), [GiNaC::Bernoulli_polynomial\(\)](#), [GiNaC::beta_deriv\(\)](#), [GiNaC::beta_eval\(\)](#), [GiNaC::beta_evalf\(\)](#), [GiNaC::binomial_conjugate\(\)](#), [GiNaC::binomial_eval\(\)](#), [GiNaC::binomial_evalf\(\)](#), [GiNaC::binomial_real_part\(\)](#), [GiNaC::binomial_sym\(\)](#), [GiNaC::lanczos_coeffs::calc_lanczos_A\(\)](#), [GiNaC::basic::collect\(\)](#), [GiNaC::container< C >::conjugate\(\)](#), [GiNaC::expairseq::conjugate\(\)](#), [GiNaC::matrix::conjugate\(\)](#), [GiNaC::mul::conjugate\(\)](#), [GiNaC::conjugateepvector\(\)](#), [GiNaC::ex::content\(\)](#), [GiNaC::convert_H_to_Li\(\)](#), [GiNaC::cos\(\)](#), [GiNaC::cos_conjugate\(\)](#), [GiNaC::cos_deriv\(\)](#), [GiNaC::cos_eval\(\)](#), [GiNaC::cos_evalf\(\)](#), [GiNaC::cos_imag_part\(\)](#), [GiNaC::cos_real_part\(\)](#), [GiNaC::cosh\(\)](#), [GiNaC::cosh_conjugate\(\)](#), [GiNaC::cosh_deriv\(\)](#), [GiNaC::cosh_eval\(\)](#), [GiNaC::cosh_evalf\(\)](#), [GiNaC::cosh_imag_part\(\)](#), [GiNaC::cosh_real_part\(\)](#), [GiNaC::csgn\(\)](#), [GiNaC::decomp_rational\(\)](#), [GiNaC::denom\(\)](#), [GiNaC::divide\(\)](#), [GiNaC::divide_in_z\(\)](#), [GiNaC::eta_conjugate\(\)](#), [GiNaC::eta_eval\(\)](#), [GiNaC::eta_evalf\(\)](#), [GiNaC::eta_imag_part\(\)](#), [GiNaC::eta_series\(\)](#), [GiNaC::tensepsilon::eval_indexed\(\)](#), [GiNaC::exp\(\)](#), [GiNaC::exp_conjugate\(\)](#), [GiNaC::exp_deriv\(\)](#), [GiNaC::exp_eval\(\)](#), [GiNaC::exp_evalf\(\)](#), [GiNaC::exp_imag_part\(\)](#), [GiNaC::exp_info\(\)](#), [GiNaC::exp_power\(\)](#), [GiNaC::exp_real_part\(\)](#), [GiNaC::factorial_conjugate\(\)](#), [GiNaC::factorial_eval\(\)](#), [GiNaC::factorial_evalf\(\)](#), [GiNaC::factorial_print_dflt_latex\(\)](#), [GiNaC::factorial_real_part\(\)](#), [GiNaC::find_common_factor\(\)](#), [GiNaC::frac_cancel\(\)](#), [GiNaC::fsolve\(\)](#), [GiNaC::G\(\)](#), [GiNaC::G2_eval\(\)](#), [GiNaC::G2_evalf\(\)](#), [GiNaC::G3_eval\(\)](#), [GiNaC::G3_evalf\(\)](#), [GiNaC::gcd\(\)](#), [GiNaC::generalised_Bernoulli_number\(\)](#), [GiNaC::get_first_symbol\(\)](#), [GiNaC::guess_precision\(\)](#), [GiNaC::H_deriv\(\)](#), [GiNaC::H_eval\(\)](#), [GiNaC::H_evalf\(\)](#), [GiNaC::H_print_latex\(\)](#), [GiNaC::H_series\(\)](#), [GiNaC::make_flat_inserter::handle_factor\(\)](#), [GiNaC::hasindex\(\)](#),

[GiNaC::haswild\(\)](#), [GiNaC::heur_gcd_z\(\)](#), [GiNaC::imag\(\)](#), [GiNaC::interpolate\(\)](#), [GiNaC::inverse\(\)](#), [GiNaC::is_cinteger\(\)](#),
[GiNaC::is_crational\(\)](#), [GiNaC::is_even\(\)](#), [GiNaC::is_integer\(\)](#), [GiNaC::is_negative\(\)](#), [GiNaC::is_nonneg_integer\(\)](#),
[GiNaC::is_odd\(\)](#), [GiNaC::is_pos_integer\(\)](#), [GiNaC::is_positive\(\)](#), [GiNaC::is_prime\(\)](#), [GiNaC::is_rational\(\)](#),
[GiNaC::is_real\(\)](#), [GiNaC::is_the_function\(\)](#), [GiNaC::is_the_function< G_SERIAL >\(\)](#), [GiNaC::is_the_function< iterated_integral_SERIAL >\(\)](#),
[GiNaC::is_the_function< psi_SERIAL >\(\)](#), [GiNaC::is_the_function< zeta_SERIAL >\(\)](#), [GiNaC::is_zero\(\)](#),
[GiNaC::isqrt\(\)](#), [GiNaC::Eisenstein_kernel::Laurent_series\(\)](#), [GiNaC::Eisenstein_h_kernel::Laurent_series\(\)](#),
[GiNaC::lgamma\(\)](#), [GiNaC::lgamma_conjugate\(\)](#), [GiNaC::lgamma_deriv\(\)](#), [GiNaC::lgamma_eval\(\)](#), [GiNaC::lgamma_evalf\(\)](#),
[GiNaC::Li2\(\)](#), [GiNaC::Li2_conjugate\(\)](#), [GiNaC::Li2_deriv\(\)](#), [GiNaC::Li2_eval\(\)](#), [GiNaC::Li2_evalf\(\)](#), [GiNaC::Li2_projection\(\)](#),
[GiNaC::Li2_series\(\)](#), [GiNaC::Li3_eval\(\)](#), [GiNaC::Li_deriv\(\)](#), [GiNaC::Li_eval\(\)](#), [GiNaC::Li_evalf\(\)](#), [GiNaC::Li_print_latex\(\)](#),
[GiNaC::Li_series\(\)](#), [GiNaC::log\(\)](#), [GiNaC::log_conjugate\(\)](#), [GiNaC::log_deriv\(\)](#), [GiNaC::log_eval\(\)](#), [GiNaC::log_evalf\(\)](#),
[GiNaC::log_imag_part\(\)](#), [GiNaC::log_info\(\)](#), [GiNaC::log_real_part\(\)](#), [GiNaC::make_real_float\(\)](#), [GiNaC::matrix::matrix\(\)](#),
[GiNaC::numer\(\)](#), [GiNaC::sym_desc::operator<\(\)](#), [GiNaC::Order_conjugate\(\)](#), [GiNaC::Order_eval\(\)](#), [GiNaC::Order_imag_part\(\)](#),
[GiNaC::Order_power\(\)](#), [GiNaC::Order_real_part\(\)](#), [GiNaC::Order_series\(\)](#), [GiNaC::pow\(\)](#), [GiNaC::prem\(\)](#),
[GiNaC::ex::primpart\(\)](#), [GiNaC::print_integer_csrc\(\)](#), [GiNaC::print_real_cl_N\(\)](#), [GiNaC::print_real_csrc\(\)](#), [GiNaC::print_real_number\(\)](#),
[GiNaC::print_sym_pow\(\)](#), [GiNaC::psi1_deriv\(\)](#), [GiNaC::psi1_eval\(\)](#), [GiNaC::psi1_evalf\(\)](#), [GiNaC::psi2_deriv\(\)](#),
[GiNaC::psi2_eval\(\)](#), [GiNaC::psi2_evalf\(\)](#), [GiNaC::quo\(\)](#), [GiNaC::read_real_float\(\)](#), [GiNaC::real\(\)](#), [GiNaC::rem\(\)](#),
[GiNaC::S_deriv\(\)](#), [GiNaC::S_eval\(\)](#), [GiNaC::S_evalf\(\)](#), [GiNaC::S_print_latex\(\)](#), [GiNaC::S_series\(\)](#), [GiNaC::sin\(\)](#),
[GiNaC::sin_conjugate\(\)](#), [GiNaC::sin_deriv\(\)](#), [GiNaC::sin_eval\(\)](#), [GiNaC::sin_evalf\(\)](#), [GiNaC::sin_imag_part\(\)](#),
[GiNaC::sin_real_part\(\)](#), [GiNaC::sinh\(\)](#), [GiNaC::sinh_conjugate\(\)](#), [GiNaC::sinh_deriv\(\)](#), [GiNaC::sinh_eval\(\)](#),
[GiNaC::sinh_evalf\(\)](#), [GiNaC::sinh_imag_part\(\)](#), [GiNaC::sinh_real_part\(\)](#), [GiNaC::sprem\(\)](#), [GiNaC::sqrfree\(\)](#),
[GiNaC::sqrfree_parfrac\(\)](#), [GiNaC::sqrfree_yun\(\)](#), [GiNaC::sqrt\(\)](#), [GiNaC::sr_gcd\(\)](#), [GiNaC::step\(\)](#), [GiNaC::tan\(\)](#),
[GiNaC::tan_conjugate\(\)](#), [GiNaC::tan_deriv\(\)](#), [GiNaC::tan_eval\(\)](#), [GiNaC::tan_evalf\(\)](#), [GiNaC::tan_imag_part\(\)](#),
[GiNaC::tan_real_part\(\)](#), [GiNaC::tan_series\(\)](#), [GiNaC::tanh\(\)](#), [GiNaC::tanh_conjugate\(\)](#), [GiNaC::tanh_deriv\(\)](#),
[GiNaC::tanh_eval\(\)](#), [GiNaC::tanh_evalf\(\)](#), [GiNaC::tanh_imag_part\(\)](#), [GiNaC::tanh_real_part\(\)](#), [GiNaC::tanh_series\(\)](#),
[GiNaC::tgamma\(\)](#), [GiNaC::tgamma_conjugate\(\)](#), [GiNaC::tgamma_deriv\(\)](#), [GiNaC::tgamma_eval\(\)](#), [GiNaC::tgamma_evalf\(\)](#),
[GiNaC::to_double\(\)](#), [GiNaC::to_int\(\)](#), [GiNaC::to_long\(\)](#), [GiNaC::trig_info\(\)](#), [GiNaC::ex::unit\(\)](#), [GiNaC::unit_matrix\(\)](#),
[GiNaC::ex::unitcontprim\(\)](#), [GiNaC::zeta\(\)](#), [GiNaC::zeta1_evalf\(\)](#), [GiNaC::zeta2_evalf\(\)](#), [GiNaC::zetaderiv_deriv\(\)](#),
and [GiNaC::zetaderiv_eval\(\)](#).

7.28.3.15 evalpoint

```
int evalpoint
```

7.28.3.16 R

```
cl_modint_ring R
```

7.28.3.17 syms_wox

```
const exset syms_wox
```

7.28.3.18 unit

`ex unit`

Referenced by [GiNaC::kronecker_symbol\(\)](#), [GiNaC::ex::primpart\(\)](#), and [GiNaC::ex::unitcontprim\(\)](#).

7.28.3.19 cont

`ex cont`

Referenced by [GiNaC::ex::content\(\)](#), [GiNaC::container< C >::imag_part\(\)](#), and [GiNaC::container< C >::real_part\(\)](#).

7.28.3.20 pp

`ex pp`

7.28.3.21 vn

`ex vn`

7.28.3.22 vnlst

`exvector vnlst`

7.28.3.23 modulus

`numeric modulus`

7.28.3.24 syms

`exset syms`

Referenced by [GiNaC::lsolve\(\)](#).

7.28.3.25 options

unsigned options

Referenced by [GiNaC::abs_expand\(\)](#), [GiNaC::mul::algebraic_subs_mul\(\)](#), [GiNaC::atan_series\(\)](#), [GiNaC::atanh_series\(\)](#), [GiNaC::beta_series\(\)](#), [GiNaC::csgn_series\(\)](#), [GiNaC::determinant\(\)](#), [GiNaC::exp_expand\(\)](#), [GiNaC::expand\(\)](#), [GiNaC::basic::expand\(\)](#), [GiNaC::ex::expand\(\)](#), [GiNaC::add::expand\(\)](#), [GiNaC::expairseq::expand\(\)](#), [GiNaC::function::expand\(\)](#), [GiNaC::indexed::expand\(\)](#), [GiNaC::integral::expand\(\)](#), [GiNaC::mul::expand\(\)](#), [GiNaC::ncmul::expand\(\)](#), [GiNaC::power::expand\(\)](#), [GiNaC::pseries::expand\(\)](#), [GiNaC::structure< T, ComparisonPolicy >::expand\(\)](#), [GiNaC::power::expand_add\(\)](#), [GiNaC::power::expand_add_2\(\)](#), [GiNaC::power::expand_mul\(\)](#), [GiNaC::expairseq::expandchildren\(\)](#), [GiNaC::mul::expandchildren\(\)](#), [GiNaC::ncmul::expandchildren\(\)](#), [GiNaC::factor\(\)](#), [GiNaC::gcd\(\)](#), [GiNaC::basic::has\(\)](#), [GiNaC::mul::has\(\)](#), [GiNaC::power::has\(\)](#), [GiNaC::structure< T, ComparisonPolicy >::has\(\)](#), [GiNaC::ex::has\(\)](#), [GiNaC::has\(\)](#), [GiNaC::lgamma_series\(\)](#), [GiNaC::Li2_series\(\)](#), [GiNaC::log_expand\(\)](#), [GiNaC::log_series\(\)](#), [GiNaC::lsolve\(\)](#), [GiNaC::expand_map_function::operator\(\)](#), [GiNaC::function_options::print_func\(\)](#), [GiNaC::registered_class_options::print_func\(\)](#), [GiNaC::psi1_series\(\)](#), [GiNaC::psi2_series\(\)](#), [GiNaC::S_series\(\)](#), [GiNaC::ex::series\(\)](#), [GiNaC::series\(\)](#), [GiNaC::add::series\(\)](#), [GiNaC::fderivative::series\(\)](#), [GiNaC::function::series\(\)](#), [GiNaC::integral::series\(\)](#), [GiNaC::pseries::series\(\)](#), [GiNaC::structure< T, ComparisonPolicy >::series\(\)](#), [GiNaC::mul::series\(\)](#), [GiNaC::power::series\(\)](#), [GiNaC::set_print_context\(\)](#), [GiNaC::set_print_func\(\)](#), [GiNaC::set_print_options\(\)](#), [GiNaC::simplify_indexed\(\)](#), [GiNaC::step_series\(\)](#), [GiNaC::subs\(\)](#), [GiNaC::basic::subs\(\)](#), [GiNaC::clifford::subs\(\)](#), [GiNaC::container< C >::subs\(\)](#), [GiNaC::expairseq::subs\(\)](#), [GiNaC::idx::subs\(\)](#), [GiNaC::matrix::subs\(\)](#), [GiNaC::numeric::subs\(\)](#), [GiNaC::power::subs\(\)](#), [GiNaC::pseries::subs\(\)](#), [GiNaC::relational::subs\(\)](#), [GiNaC::structure< T, ComparisonPolicy >::subs\(\)](#), [GiNaC::symbol::subs\(\)](#), [GiNaC::ex::subs\(\)](#), [GiNaC::basic::subs_one_level\(\)](#), [GiNaC::container< C >::subschildren\(\)](#), [GiNaC::expairseq::subschildren\(\)](#), [GiNaC::tan_series\(\)](#), [GiNaC::tanh_series\(\)](#), and [GiNaC::tgamma_series\(\)](#).

7.29 factor.h File Reference

Polynomial factorization.

Namespaces

- namespace [GiNaC](#)

Functions

- [ex](#) [GiNaC::factor](#) (const [ex](#) &[poly](#), unsigned [options](#))

Interface function to the outside world.

7.29.1 Detailed Description

Polynomial factorization.

7.30 fail.cpp File Reference

Implementation of class signaling failure of operation.

```
#include "fail.h"
#include "archive.h"
#include "utils.h"
#include <iostream>
```

Namespaces

- namespace [GiNaC](#)

Functions

- [GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) (fail, basic, print_func< print_context >(&fail←→::do_print). print_func< print_tree >(&fail::do_print_tree)) [GINAC_BIND_UNARCHIVER](#)(fail)

7.30.1 Detailed Description

Implementation of class signaling failure of operation.

Considered somewhat obsolete (most of this can be replaced by exceptions).

7.31 fail.h File Reference

Interface to class signaling failure of operation.

```
#include "basic.h"
#include "archive.h"
```

Classes

- class [GiNaC::fail](#)

Namespaces

- namespace [GiNaC](#)

Functions

- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (fail)

7.31.1 Detailed Description

Interface to class signaling failure of operation.

Considered obsolete somewhat obsolete (most of this can be replaced by exceptions).

7.32 fderivative.cpp File Reference

Implementation of abstract derivatives of functions.

```
#include "fderivative.h"
#include "operators.h"
#include "archive.h"
#include "utils.h"
#include <iostream>
```

Namespaces

- namespace [GiNaC](#)

Functions

- [GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) (fderivative, function, print_func< print_context >(&fderivative::do_print). print_func< print_latex >(&fderivative::do_print_latex). print_func< print_csrc >(&fderivative::do_print_csrc). print_func< print_tree >(&fderivative::do_print_tree)) fderivative
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (fderivative)

7.32.1 Detailed Description

Implementation of abstract derivatives of functions.

7.33 fderivative.h File Reference

Interface to abstract derivatives of functions.

```
#include "function.h"
#include <set>
```

Classes

- class [GiNaC::fderivative](#)
This class represents the (abstract) derivative of a symbolic function.

Namespaces

- namespace [GiNaC](#)

Typedefs

- typedef std::multiset< unsigned > [GiNaC::paramset](#)

Functions

- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (fderivative)

7.33.1 Detailed Description

Interface to abstract derivatives of functions.

7.34 flags.h File Reference

Collection of all flags used through the [GiNaC](#) framework.

Classes

- class [GiNaC::expand_options](#)
Flags to control the behavior of [expand\(\)](#).
- class [GiNaC::has_options](#)
Flags to control the behavior of [has\(\)](#).
- class [GiNaC::subs_options](#)
Flags to control the behavior of [subs\(\)](#).
- class [GiNaC::domain](#)
Domain of an object.
- class [GiNaC::series_options](#)
Flags to control series expansion.
- class [GiNaC::determinant_algo](#)
Switch to control algorithm for determinant computation.
- class [GiNaC::solve_algo](#)
Switch to control algorithm for linear system solving.
- class [GiNaC::status_flags](#)
Flags to store information about the state of an object.
- class [GiNaC::info_flags](#)
Possible attributes an object can have.
- class [GiNaC::return_types](#)
- class [GiNaC::remember_strategies](#)
Strategies how to clean up the function remember cache.
- class [GiNaC::factor_options](#)
Flags to control the polynomial factorization.

Namespaces

- namespace [GiNaC](#)

7.34.1 Detailed Description

Collection of all flags used through the [GiNaC](#) framework.

7.35 function.cpp File Reference

Implementation of class of symbolic functions.

```
#include "function.h"
#include "operators.h"
#include "fderivative.h"
#include "ex.h"
#include "lst.h"
#include "symmetry.h"
#include "print.h"
#include "power.h"
#include "archive.h"
#include "inifcns.h"
#include "utils.h"
#include "hash_seed.h"
#include "remember.h"
#include <iostream>
#include <limits>
#include <list>
#include <stdexcept>
#include <string>
```

Namespaces

- namespace [GiNaC](#)

Functions

- [GiNaC::GINAC_BIND_UNARCHIVER](#) (function)

7.35.1 Detailed Description

Implementation of class of symbolic functions.

7.36 function.h File Reference

Interface to class of symbolic functions.

```
#include "exprseq.h"
#include <string>
#include <vector>
```

Classes

- class [GiNaC::function_options](#)
- class [GiNaC::do_taylor](#)

Exception class thrown by classes which provide their own series expansion to signal that ordinary Taylor expansion is safe.

- class [GiNaC::function](#)

The class function is used to implement builtin functions like sin, cos... and user defined functions.

Namespaces

- namespace [GiNaC](#)

Macros

- #define [DECLARE_FUNCTION_1P](#)(NAME)
- #define [DECLARE_FUNCTION_2P](#)(NAME)
- #define [DECLARE_FUNCTION_3P](#)(NAME)
- #define [DECLARE_FUNCTION_4P](#)(NAME)
- #define [DECLARE_FUNCTION_5P](#)(NAME)
- #define [DECLARE_FUNCTION_6P](#)(NAME)
- #define [DECLARE_FUNCTION_7P](#)(NAME)
- #define [DECLARE_FUNCTION_8P](#)(NAME)
- #define [DECLARE_FUNCTION_9P](#)(NAME)
- #define [DECLARE_FUNCTION_10P](#)(NAME)
- #define [DECLARE_FUNCTION_11P](#)(NAME)
- #define [DECLARE_FUNCTION_12P](#)(NAME)
- #define [DECLARE_FUNCTION_13P](#)(NAME)
- #define [DECLARE_FUNCTION_14P](#)(NAME)
- #define [REGISTER_FUNCTION](#)(NAME, OPT)
- #define [is_ex_the_function](#)(OBJ, FUNCNAME) ([GiNaC::is_the_function](#)<FUNCNAME##_SERIAL>(OBJ))

Typedefs

- typedef ex(* [GiNaC::eval_funcp](#)) ()
- typedef ex(* [GiNaC::evalf_funcp](#)) ()
- typedef ex(* [GiNaC::conjugate_funcp](#)) ()
- typedef ex(* [GiNaC::real_part_funcp](#)) ()
- typedef ex(* [GiNaC::imag_part_funcp](#)) ()
- typedef ex(* [GiNaC::expand_funcp](#)) ()
- typedef ex(* [GiNaC::derivative_funcp](#)) ()
- typedef ex(* [GiNaC::expl_derivative_funcp](#)) ()
- typedef ex(* [GiNaC::power_funcp](#)) ()
- typedef ex(* [GiNaC::series_funcp](#)) ()
- typedef void(* [GiNaC::print_funcp](#)) ()
- typedef bool(* [GiNaC::info_funcp](#)) ()
- typedef ex(* [GiNaC::eval_funcp_1](#)) (const ex &)
- typedef ex(* [GiNaC::evalf_funcp_1](#)) (const ex &)
- typedef ex(* [GiNaC::conjugate_funcp_1](#)) (const ex &)
- typedef ex(* [GiNaC::real_part_funcp_1](#)) (const ex &)
- typedef ex(* [GiNaC::imag_part_funcp_1](#)) (const ex &)
- typedef ex(* [GiNaC::expand_funcp_1](#)) (const ex &, unsigned)

- [illegible]

[illegible]

- [illegible]

- typedef ex(* [GiNaC::evalf_funcp_exvector](#)) (const exvector &)
- typedef ex(* [GiNaC::conjugate_funcp_exvector](#)) (const exvector &)
- typedef ex(* [GiNaC::real_part_funcp_exvector](#)) (const exvector &)
- typedef ex(* [GiNaC::imag_part_funcp_exvector](#)) (const exvector &)
- typedef ex(* [GiNaC::expand_funcp_exvector](#)) (const exvector &, unsigned)
- typedef ex(* [GiNaC::derivative_funcp_exvector](#)) (const exvector &, unsigned)
- typedef ex(* [GiNaC::expl_derivative_funcp_exvector](#)) (const exvector &, const symbol &)
- typedef ex(* [GiNaC::power_funcp_exvector](#)) (const exvector &, const ex &)
- typedef ex(* [GiNaC::series_funcp_exvector](#)) (const exvector &, const relational &, int, unsigned)
- typedef void(* [GiNaC::print_funcp_exvector](#)) (const exvector &, const print_context &)
- typedef bool(* [GiNaC::info_funcp_exvector](#)) (const exvector &, unsigned)

Functions

- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (function)
- template<typename T >
bool [GiNaC::is_the_function](#) (const ex &x)

7.36.1 Detailed Description

Interface to class of symbolic functions.

7.36.2 Macro Definition Documentation

7.36.2.1 DECLARE_FUNCTION_1P

```
#define DECLARE_FUNCTION_1P (
    NAME )
```

Value:

```
class NAME##_SERIAL { public: static unsigned serial; }; \
const unsigned NAME##_NPARAMS = 1; \
template< typename T1 > const GiNaC::function NAME( const T1 & p1 ) { \
    return GiNaC::function(NAME##_SERIAL::serial, GiNaC::ex(p1) ); \
}
```

7.36.2.2 DECLARE_FUNCTION_2P

```
#define DECLARE_FUNCTION_2P (
    NAME )
```

Value:

```
class NAME##_SERIAL { public: static unsigned serial; }; \
const unsigned NAME##_NPARAMS = 2; \
template< typename T1, typename T2 > const GiNaC::function NAME( const T1 & p1, const T2 & p2 ) { \
    return GiNaC::function(NAME##_SERIAL::serial, GiNaC::ex(p1), GiNaC::ex(p2) ); \
}
```

7.36.2.3 DECLARE_FUNCTION_3P

```
#define DECLARE_FUNCTION_3P (
    NAME )
```

Value:

```
class NAME##_SERIAL { public: static unsigned serial; }; \
const unsigned NAME##_NPARAMS = 3; \
template< typename T1, typename T2, typename T3 > const GiNaC::function NAME( const T1 & p1, const T2 & p2,
    const T3 & p3 ) { \
    return GiNaC::function(NAME##_SERIAL::serial, GiNaC::ex(p1), GiNaC::ex(p2), GiNaC::ex(p3) ); \
}
```

7.36.2.4 DECLARE_FUNCTION_4P

```
#define DECLARE_FUNCTION_4P (
    NAME )
```

Value:

```
class NAME##_SERIAL { public: static unsigned serial; }; \
const unsigned NAME##_NPARAMS = 4; \
template< typename T1, typename T2, typename T3, typename T4 > const GiNaC::function NAME( const T1 & p1,
    const T2 & p2, const T3 & p3, const T4 & p4 ) { \
    return GiNaC::function(NAME##_SERIAL::serial, GiNaC::ex(p1), GiNaC::ex(p2), GiNaC::ex(p3), GiNaC::ex(p4)
    ); \
}
```

7.36.2.5 DECLARE_FUNCTION_5P

```
#define DECLARE_FUNCTION_5P (
    NAME )
```

Value:

```
class NAME##_SERIAL { public: static unsigned serial; }; \
const unsigned NAME##_NPARAMS = 5; \
template< typename T1, typename T2, typename T3, typename T4, typename T5 > const GiNaC::function NAME(
    const T1 & p1, const T2 & p2, const T3 & p3, const T4 & p4, const T5 & p5 ) { \
    return GiNaC::function(NAME##_SERIAL::serial, GiNaC::ex(p1), GiNaC::ex(p2), GiNaC::ex(p3),
    GiNaC::ex(p4), GiNaC::ex(p5) ); \
}
```

7.36.2.6 DECLARE_FUNCTION_6P

```
#define DECLARE_FUNCTION_6P (
    NAME )
```

Value:

```
class NAME##_SERIAL { public: static unsigned serial; }; \
const unsigned NAME##_NPARAMS = 6; \
template< typename T1, typename T2, typename T3, typename T4, typename T5, typename T6 > const
    GiNaC::function NAME( const T1 & p1, const T2 & p2, const T3 & p3, const T4 & p4, const T5 & p5, const
    T6 & p6 ) { \
    return GiNaC::function(NAME##_SERIAL::serial, GiNaC::ex(p1), GiNaC::ex(p2), GiNaC::ex(p3),
    GiNaC::ex(p4), GiNaC::ex(p5), GiNaC::ex(p6) ); \
}
```

7.36.2.7 DECLARE_FUNCTION_7P

```
#define DECLARE_FUNCTION_7P (
    NAME )
```

Value:

```
class NAME##_SERIAL { public: static unsigned serial; }; \
const unsigned NAME##_NPARAMS = 7; \
template< typename T1, typename T2, typename T3, typename T4, typename T5, typename T6, typename T7 > const
    GiNaC::function NAME( const T1 & p1, const T2 & p2, const T3 & p3, const T4 & p4, const T5 & p5, const
        T6 & p6, const T7 & p7 ) { \
    return GiNaC::function(NAME##_SERIAL::serial, GiNaC::ex(p1), GiNaC::ex(p2), GiNaC::ex(p3),
        GiNaC::ex(p4), GiNaC::ex(p5), GiNaC::ex(p6), GiNaC::ex(p7) ); \
}
```

7.36.2.8 DECLARE_FUNCTION_8P

```
#define DECLARE_FUNCTION_8P (
    NAME )
```

Value:

```
class NAME##_SERIAL { public: static unsigned serial; }; \
const unsigned NAME##_NPARAMS = 8; \
template< typename T1, typename T2, typename T3, typename T4, typename T5, typename T6, typename T7,
    typename T8 > const GiNaC::function NAME( const T1 & p1, const T2 & p2, const T3 & p3, const T4 & p4,
    const T5 & p5, const T6 & p6, const T7 & p7, const T8 & p8 ) { \
    return GiNaC::function(NAME##_SERIAL::serial, GiNaC::ex(p1), GiNaC::ex(p2), GiNaC::ex(p3),
        GiNaC::ex(p4), GiNaC::ex(p5), GiNaC::ex(p6), GiNaC::ex(p7), GiNaC::ex(p8) ); \
}
```

7.36.2.9 DECLARE_FUNCTION_9P

```
#define DECLARE_FUNCTION_9P (
    NAME )
```

Value:

```
class NAME##_SERIAL { public: static unsigned serial; }; \
const unsigned NAME##_NPARAMS = 9; \
template< typename T1, typename T2, typename T3, typename T4, typename T5, typename T6, typename T7,
    typename T8, typename T9 > const GiNaC::function NAME( const T1 & p1, const T2 & p2, const T3 & p3,
    const T4 & p4, const T5 & p5, const T6 & p6, const T7 & p7, const T8 & p8, const T9 & p9 ) { \
    return GiNaC::function(NAME##_SERIAL::serial, GiNaC::ex(p1), GiNaC::ex(p2), GiNaC::ex(p3),
        GiNaC::ex(p4), GiNaC::ex(p5), GiNaC::ex(p6), GiNaC::ex(p7), GiNaC::ex(p8), GiNaC::ex(p9) ); \
}
```

7.36.2.10 DECLARE_FUNCTION_10P

```
#define DECLARE_FUNCTION_10P (
    NAME )
```

Value:

```
class NAME##_SERIAL { public: static unsigned serial; }; \
const unsigned NAME##_NPARAMS = 10; \
template< typename T1, typename T2, typename T3, typename T4, typename T5, typename T6, typename T7,
    typename T8, typename T9, typename T10 > const GiNaC::function NAME( const T1 & p1, const T2 & p2,
    const T3 & p3, const T4 & p4, const T5 & p5, const T6 & p6, const T7 & p7, const T8 & p8, const T9 &
    p9, const T10 & p10 ) { \
    return GiNaC::function(NAME##_SERIAL::serial, GiNaC::ex(p1), GiNaC::ex(p2), GiNaC::ex(p3),
        GiNaC::ex(p4), GiNaC::ex(p5), GiNaC::ex(p6), GiNaC::ex(p7), GiNaC::ex(p8), GiNaC::ex(p9),
        GiNaC::ex(p10) ); \
}
```

7.36.2.11 DECLARE_FUNCTION_11P

```
#define DECLARE_FUNCTION_11P(  
    NAME )
```

Value:

```
class NAME##_SERIAL { public: static unsigned serial; }; \
const unsigned NAME##_NPARAMS = 11; \
template< typename T1, typename T2, typename T3, typename T4, typename T5, typename T6, typename T7,  
    typename T8, typename T9, typename T10, typename T11 > const GiNaC::function NAME( const T1 & p1,  
    const T2 & p2, const T3 & p3, const T4 & p4, const T5 & p5, const T6 & p6, const T7 & p7, const T8 &  
    p8, const T9 & p9, const T10 & p10, const T11 & p11 ) { \
    return GiNaC::function(NAME##_SERIAL::serial, GiNaC::ex(p1), GiNaC::ex(p2), GiNaC::ex(p3),  
        GiNaC::ex(p4), GiNaC::ex(p5), GiNaC::ex(p6), GiNaC::ex(p7), GiNaC::ex(p8), GiNaC::ex(p9),  
        GiNaC::ex(p10), GiNaC::ex(p11) ); \
}
```

7.36.2.12 DECLARE_FUNCTION_12P

```
#define DECLARE_FUNCTION_12P(  
    NAME )
```

Value:

```
class NAME##_SERIAL { public: static unsigned serial; }; \
const unsigned NAME##_NPARAMS = 12; \
template< typename T1, typename T2, typename T3, typename T4, typename T5, typename T6, typename T7,  
    typename T8, typename T9, typename T10, typename T11, typename T12 > const GiNaC::function NAME( const  
    T1 & p1, const T2 & p2, const T3 & p3, const T4 & p4, const T5 & p5, const T6 & p6, const T7 & p7,  
    const T8 & p8, const T9 & p9, const T10 & p10, const T11 & p11, const T12 & p12 ) { \
    return GiNaC::function(NAME##_SERIAL::serial, GiNaC::ex(p1), GiNaC::ex(p2), GiNaC::ex(p3),  
        GiNaC::ex(p4), GiNaC::ex(p5), GiNaC::ex(p6), GiNaC::ex(p7), GiNaC::ex(p8), GiNaC::ex(p9),  
        GiNaC::ex(p10), GiNaC::ex(p11), GiNaC::ex(p12) ); \
}
```

7.36.2.13 DECLARE_FUNCTION_13P

```
#define DECLARE_FUNCTION_13P(  
    NAME )
```

Value:

```
class NAME##_SERIAL { public: static unsigned serial; }; \
const unsigned NAME##_NPARAMS = 13; \
template< typename T1, typename T2, typename T3, typename T4, typename T5, typename T6, typename T7,  
    typename T8, typename T9, typename T10, typename T11, typename T12, typename T13 > const  
    GiNaC::function NAME( const T1 & p1, const T2 & p2, const T3 & p3, const T4 & p4, const T5 & p5, const  
    T6 & p6, const T7 & p7, const T8 & p8, const T9 & p9, const T10 & p10, const T11 & p11, const T12 &  
    p12, const T13 & p13 ) { \
    return GiNaC::function(NAME##_SERIAL::serial, GiNaC::ex(p1), GiNaC::ex(p2), GiNaC::ex(p3),  
        GiNaC::ex(p4), GiNaC::ex(p5), GiNaC::ex(p6), GiNaC::ex(p7), GiNaC::ex(p8), GiNaC::ex(p9),  
        GiNaC::ex(p10), GiNaC::ex(p11), GiNaC::ex(p12), GiNaC::ex(p13) ); \
}
```

7.36.2.14 DECLARE_FUNCTION_14P

```
#define DECLARE_FUNCTION_14P(
    NAME )
```

Value:

```
class NAME##_SERIAL { public: static unsigned serial; }; \
const unsigned NAME##_NPARAMS = 14; \
template< typename T1, typename T2, typename T3, typename T4, typename T5, typename T6, typename T7,
    typename T8, typename T9, typename T10, typename T11, typename T12, typename T13, typename T14 > const
GiNaC::function NAME( const T1 & p1, const T2 & p2, const T3 & p3, const T4 & p4, const T5 & p5, const
    T6 & p6, const T7 & p7, const T8 & p8, const T9 & p9, const T10 & p10, const T11 & p11, const T12 &
    p12, const T13 & p13, const T14 & p14 ) { \
    return GiNaC::function(NAME##_SERIAL::serial, GiNaC::ex(p1), GiNaC::ex(p2), GiNaC::ex(p3),
        GiNaC::ex(p4), GiNaC::ex(p5), GiNaC::ex(p6), GiNaC::ex(p7), GiNaC::ex(p8), GiNaC::ex(p9),
        GiNaC::ex(p10), GiNaC::ex(p11), GiNaC::ex(p12), GiNaC::ex(p13), GiNaC::ex(p14) ); \
}
```

7.36.2.15 REGISTER_FUNCTION

```
#define REGISTER_FUNCTION(
    NAME,
    OPT )
```

Value:

```
unsigned NAME##_SERIAL::serial = \
    GiNaC::function::register_new(GiNaC::function_options(#NAME, NAME##_NPARAMS).OPT);
```

7.36.2.16 is_ex_the_function

```
#define is_ex_the_function(
    OBJ,
    FUNCNAME ) (GiNaC::is_the_function<FUNCNAME##_SERIAL>(OBJ))
```

7.37 ginac.h File Reference

This include file includes all other public [GiNaC](#) headers.

```
#include "version.h"
#include "basic.h"
#include "ex.h"
#include "normal.h"
#include "archive.h"
#include "print.h"
#include "constant.h"
#include "fail.h"
#include "integral.h"
#include "lst.h"
#include "matrix.h"
#include "numeric.h"
#include "power.h"
#include "relational.h"
```



```

#include "structure.h"
#include "symbol.h"
#include "pseries.h"
#include "wildcard.h"
#include "symmetry.h"
#include "expair.h"
#include "expairseq.h"
#include "add.h"
#include "mul.h"
#include "exprseq.h"
#include "function.h"
#include "ncmul.h"
#include "inifcns.h"
#include "fderivative.h"
#include "operators.h"
#include "hash_map.h"
#include "idx.h"
#include "indexed.h"
#include "tensor.h"
#include "color.h"
#include "clifford.h"
#include "factor.h"
#include "integration_kernel.h"
#include "excompiler.h"
#include "parser.h"

```

7.37.1 Detailed Description

This include file includes all other public [GiNaC](#) headers.

7.38 hash_map.h File Reference

Replacement for map<> using hash tables.

```
#include <unordered_map>
```

Namespaces

- namespace [GiNaC](#)

Typedefs

- `template<typename T, class Hash = std::hash<ex>, class KeyEqual = std::equal_to<ex>, class Allocator = std::allocator<std::pair<const ex, T>>>`
`using GiNaC::exhashmap = std::unordered_map< ex, T, Hash, KeyEqual, Allocator >`

7.38.1 Detailed Description

Replacement for map<> using hash tables.

7.39 hash_seed.h File Reference

Type-specific hash seed.

```
#include <typeinfo>
#include <cstring>
#include "utils.h"
```

Namespaces

- namespace [GiNaC](#)

Functions

- static unsigned [GiNaC::make_hash_seed](#) (const std::type_info &tinfo)
We need a hash function which gives different values for objects of different types.

7.39.1 Detailed Description

Type-specific hash seed.

7.40 idx.cpp File Reference

Implementation of [GiNaC](#)'s indices.

```
#include "idx.h"
#include "symbol.h"
#include "lst.h"
#include "relational.h"
#include "operators.h"
#include "archive.h"
#include "utils.h"
#include "hash_seed.h"
#include <iostream>
#include <sstream>
#include <stdexcept>
```

Namespaces

- namespace [GiNaC](#)

Functions

- [GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) (idx, basic, print_func< print_context >(&idx::do_print). print_func< print_latex >(&idx::do_print_latex). print_func< print_csrc >(&idx::do_print_csrc). print_func< print_tree >(&idx::do_print_tree)) GINAC_IMPLEMENT_REGISTERED_CLASS_OPT(varidx
- [GiNaC::print_func< print_context >](#) (&varidx::do_print). print_func< print_latex >(&varidx
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (idx)
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (varidx)
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (spinidx)
- bool [GiNaC::is_dummy_pair](#) (const idx &i1, const idx &i2)
Check whether two indices form a dummy pair.
- bool [GiNaC::is_dummy_pair](#) (const ex &e1, const ex &e2)
Check whether two expressions form a dummy index pair.
- void [GiNaC::find_free_and_dummy](#) (exvector::const_iterator it, exvector::const_iterator itend, exvector &out_free, exvector &out_dummy)
Given a vector of indices, split them into two vectors, one containing the free indices, the other containing the dummy indices (numeric indices are neither free nor dummy ones).
- ex [GiNaC::minimal_dim](#) (const ex &dim1, const ex &dim2)
Return the minimum of two index dimensions.

Variables

- [GiNaC::idx](#)

7.40.1 Detailed Description

Implementation of [GiNaC](#)'s indices.

7.41 idx.h File Reference

Interface to [GiNaC](#)'s indices.

```
#include "ex.h"
#include "numeric.h"
```

Classes

- class [GiNaC::idx](#)
This class holds one index of an indexed object.
- class [GiNaC::varidx](#)
This class holds an index with a variance (co- or contravariant).
- class [GiNaC::spinidx](#)
This class holds a spinor index that can be dotted or undotted and that also has a variance.

Namespaces

- namespace [GiNaC](#)

Functions

- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (idx)
- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (varidx)
- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (spinidx)
- bool [GiNaC::is_dummy_pair](#) (const idx &i1, const idx &i2)
Check whether two indices form a dummy pair.
- bool [GiNaC::is_dummy_pair](#) (const ex &e1, const ex &e2)
Check whether two expressions form a dummy index pair.
- void [GiNaC::find_free_and_dummy](#) (exvector::const_iterator it, exvector::const_iterator itend, exvector &out_free, exvector &out_dummy)
Given a vector of indices, split them into two vectors, one containing the free indices, the other containing the dummy indices (numeric indices are neither free nor dummy ones).
- void [GiNaC::find_free_and_dummy](#) (const exvector &v, exvector &out_free, exvector &out_dummy)
Given a vector of indices, split them into two vectors, one containing the free indices, the other containing the dummy indices (numeric indices are neither free nor dummy ones).
- void [GiNaC::find_dummy_indices](#) (const exvector &v, exvector &out_dummy)
Given a vector of indices, find the dummy indices.
- size_t [GiNaC::count_dummy_indices](#) (const exvector &v)
Count the number of dummy index pairs in an index vector.
- size_t [GiNaC::count_free_indices](#) (const exvector &v)
Count the number of dummy index pairs in an index vector.
- ex [GiNaC::minimal_dim](#) (const ex &dim1, const ex &dim2)
Return the minimum of two index dimensions.

7.41.1 Detailed Description

Interface to [GiNaC](#)'s indices.

7.42 indexed.cpp File Reference

Implementation of [GiNaC](#)'s indexed expressions.

```
#include "indexed.h"
#include "idx.h"
#include "add.h"
#include "mul.h"
#include "ncmul.h"
#include "power.h"
#include "relational.h"
#include "symmetry.h"
#include "operators.h"
#include "lst.h"
#include "archive.h"
#include "symbol.h"
#include "utils.h"
#include "integral.h"
#include "matrix.h"
#include "inifcns.h"
#include <iostream>
#include <limits>
#include <sstream>
#include <stdexcept>
```

Classes

- struct [GiNaC::idx_is_equal_ignore_dim](#)
- struct [GiNaC::is_summation_idx](#)
- struct [GiNaC::ex_base_is_less](#)
- class [GiNaC::terminfo](#)

This structure stores the original and symmetrized versions of terms obtained during the simplification of sums.

- class [GiNaC::terminfo_is_less](#)
- class [GiNaC::symminfo](#)

This structure stores the individual symmetrized terms obtained during the simplification of sums.

- class [GiNaC::symminfo_is_less_by_symmterm](#)
- class [GiNaC::symminfo_is_less_by_orig](#)

Namespaces

- namespace [GiNaC](#)

Functions

- [GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) (indexed, exprseq, print_func< print_context >(&indexed::do_print). print_func< print_latex >(&indexed::do_print_latex). print_func< print_tree >(&indexed::do_print_tree)) indexed
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (indexed)
- static bool [GiNaC::indices_consistent](#) (const exvector &v1, const exvector &v2)
Check whether two sorted index vectors are consistent (i.e.
- template<class T >
size_t [GiNaC::number_of_type](#) (const exvector &v)
- template<class T >
static ex [GiNaC::rename_dummy_indices](#) (const ex &e, exvector &global_dummy_indices, exvector &local_↵_dummy_indices)
Rename dummy indices in an expression.
- static void [GiNaC::find_variant_indices](#) (const exvector &v, exvector &variant_indices)
Given a set of indices, extract those of class varidx.
- bool [GiNaC::reposition_dummy_indices](#) (ex &e, exvector &variant_dummy_indices, exvector &moved_↵_indices)
Raise/lower dummy indices in a single indexed objects to canonicalize their variance.
- static void [GiNaC::product_to_exvector](#) (const ex &e, exvector &v, bool &non_commutative)
- template<class T >
ex [GiNaC::idx_symmetrization](#) (const ex &r, const exvector &local_dummy_indices)
- ex [GiNaC::simplify_indexed](#) (const ex &e, exvector &free_indices, exvector &dummy_indices, const scalar_↵_products &sp)
Simplify indexed expression, return list of free indices.
- ex [GiNaC::simplify_indexed_product](#) (const ex &e, exvector &free_indices, exvector &dummy_indices, const scalar_products &sp)
Simplify product of indexed expressions (commutative, noncommutative and simple squares), return list of free indices.
- bool [GiNaC::hasindex](#) (const ex &x, const ex &sym)
- exvector [GiNaC::get_all_dummy_indices_safely](#) (const ex &e)
More reliable version of the form.
- exvector [GiNaC::get_all_dummy_indices](#) (const ex &e)
Returns all dummy indices from the exvector.
- lst [GiNaC::rename_dummy_indices_uniquely](#) (const exvector &va, const exvector &vb)

- Similar to above, where va and vb are the same and the return value is a list of two lists for substitution in b .*

 - ex [GiNaC::rename_dummy_indices_uniquely](#) (const exvector &va, const exvector &vb, const ex &b)

Same as above, where va and vb contain the indices of a and b and are sorted.

 - ex [GiNaC::rename_dummy_indices_uniquely](#) (const ex &a, const ex &b)

Returns b with all dummy indices, which are common with a , renamed.

 - ex [GiNaC::rename_dummy_indices_uniquely](#) (exvector &va, const ex &b, bool modify_va=false)

Returns b with all dummy indices, which are listed in va , renamed if `modify_va` is set to `TRUE` all dummy indices of b will be appended to va .

 - ex [GiNaC::expand_dummy_sum](#) (const ex &e, bool subs_idx=false)

This function returns the given expression with expanded sums for all dummy index summations, where the dimensionality of the dummy index is a nonnegative integer.

7.42.1 Detailed Description

Implementation of [GiNaC](#)'s indexed expressions.

7.43 indexed.h File Reference

Interface to [GiNaC](#)'s indexed expressions.

```
#include "exprseq.h"
#include "wildcard.h"
#include <map>
```

Classes

- class [GiNaC::indexed](#)

This class holds an indexed expression.
- class [GiNaC::spmapkey](#)
- class [GiNaC::scalar_products](#)

Helper class for storing information about known scalar products which are to be automatically replaced by [simplify_indexed\(\)](#).

Namespaces

- namespace [GiNaC](#)

Typedefs

- typedef std::map< spmapkey, ex > [GiNaC::spmap](#)

Functions

- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (indexed)
- [exvector GiNaC::get_all_dummy_indices](#) (const ex &e)
Returns all dummy indices from the exvector.
- [exvector GiNaC::get_all_dummy_indices_safely](#) (const ex &e)
More reliable version of the form.
- [ex GiNaC::rename_dummy_indices_uniquely](#) (exvector &va, const ex &b, bool modify_va=false)
Returns b with all dummy indices, which are listed in va, renamed if modify_va is set to TRUE all dummy indices of b will be appended to va.
- [ex GiNaC::rename_dummy_indices_uniquely](#) (const ex &a, const ex &b)
Returns b with all dummy indices, which are common with a, renamed.
- [ex GiNaC::rename_dummy_indices_uniquely](#) (const exvector &va, const exvector &vb, const ex &b)
Same as above, where va and vb contain the indices of a and b and are sorted.
- [lst GiNaC::rename_dummy_indices_uniquely](#) (const exvector &va, const exvector &vb)
Similar to above, where va and vb are the same and the return value is a list of two lists for substitution in b.
- [ex GiNaC::expand_dummy_sum](#) (const ex &e, bool subs_idx=false)
This function returns the given expression with expanded sums for all dummy index summations, where the dimensionality of the dummy index is a nonnegative integer.

7.43.1 Detailed Description

Interface to [GiNaC](#)'s indexed expressions.

7.44 inifcns.cpp File Reference

Implementation of [GiNaC](#)'s initially known functions.

```
#include "inifcns.h"
#include "ex.h"
#include "constant.h"
#include "lst.h"
#include "fderivative.h"
#include "matrix.h"
#include "mul.h"
#include "power.h"
#include "operators.h"
#include "relational.h"
#include "pseries.h"
#include "symbol.h"
#include "symmetry.h"
#include "utils.h"
#include <stdexcept>
#include <vector>
```

Classes

- class [GiNaC::symbolset](#)

Namespaces

- namespace [GiNaC](#)

Functions

- static ex [GiNaC::conjugate_evalf](#) (const ex &arg)
- static ex [GiNaC::conjugate_eval](#) (const ex &arg)
- static void [GiNaC::conjugate_print_latex](#) (const ex &arg, const print_context &c)
- static ex [GiNaC::conjugate_conjugate](#) (const ex &arg)
- static ex [GiNaC::conjugate_expl_derivative](#) (const ex &arg, const symbol &s)
- static ex [GiNaC::conjugate_real_part](#) (const ex &arg)
- static ex [GiNaC::conjugate_imag_part](#) (const ex &arg)
- static bool [GiNaC::func_arg_info](#) (const ex &arg, unsigned inf)
- static bool [GiNaC::conjugate_info](#) (const ex &arg, unsigned inf)
- [GiNaC::REGISTER_FUNCTION](#) (conjugate_function, eval_func(conjugate_eval). evalf_func(conjugate_evalf). expl_derivative_func(conjugate_expl_derivative). info_func(conjugate_info). print_func< print_latex >(conjugate_print_latex). conjugate_func(conjugate_conjugate). real_part_func(conjugate_real_part). imag_part_func(conjugate_imag_part). set_name("conjugate","conjugate"))
- static ex [GiNaC::real_part_evalf](#) (const ex &arg)
- static ex [GiNaC::real_part_eval](#) (const ex &arg)
- static void [GiNaC::real_part_print_latex](#) (const ex &arg, const print_context &c)
- static ex [GiNaC::real_part_conjugate](#) (const ex &arg)
- static ex [GiNaC::real_part_real_part](#) (const ex &arg)
- static ex [GiNaC::real_part_imag_part](#) (const ex &arg)
- static ex [GiNaC::real_part_expl_derivative](#) (const ex &arg, const symbol &s)
- [GiNaC::REGISTER_FUNCTION](#) (real_part_function, eval_func(real_part_eval). evalf_func(real_part_evalf). expl_derivative_func(real_part_expl_derivative). print_func< print_latex >(real_part_print_latex). conjugate_func(real_part_conjugate). real_part_func(real_part_real_part). imag_part_func(real_part_imag_part). set_name("real_part","real_part"))
- static ex [GiNaC::imag_part_evalf](#) (const ex &arg)
- static ex [GiNaC::imag_part_eval](#) (const ex &arg)
- static void [GiNaC::imag_part_print_latex](#) (const ex &arg, const print_context &c)
- static ex [GiNaC::imag_part_conjugate](#) (const ex &arg)
- static ex [GiNaC::imag_part_real_part](#) (const ex &arg)
- static ex [GiNaC::imag_part_imag_part](#) (const ex &arg)
- static ex [GiNaC::imag_part_expl_derivative](#) (const ex &arg, const symbol &s)
- [GiNaC::REGISTER_FUNCTION](#) (imag_part_function, eval_func(imag_part_eval). evalf_func(imag_part_evalf). expl_derivative_func(imag_part_expl_derivative). print_func< print_latex >(imag_part_print_latex). conjugate_func(imag_part_conjugate). real_part_func(imag_part_real_part). imag_part_func(imag_part_imag_part). set_name("imag_part","imag_part"))
- static ex [GiNaC::abs_evalf](#) (const ex &arg)
- static ex [GiNaC::abs_eval](#) (const ex &arg)
- static ex [GiNaC::abs_expand](#) (const ex &arg, unsigned options)
- static ex [GiNaC::abs_expl_derivative](#) (const ex &arg, const symbol &s)
- static void [GiNaC::abs_print_latex](#) (const ex &arg, const print_context &c)
- static void [GiNaC::abs_print_csrc_float](#) (const ex &arg, const print_context &c)
- static ex [GiNaC::abs_conjugate](#) (const ex &arg)
- static ex [GiNaC::abs_real_part](#) (const ex &arg)
- static ex [GiNaC::abs_imag_part](#) (const ex &arg)
- static ex [GiNaC::abs_power](#) (const ex &arg, const ex &exp)
- bool [GiNaC::abs_info](#) (const ex &arg, unsigned inf)

- `GiNaC::REGISTER_FUNCTION` (abs, eval_func(abs_eval). evalf_func(abs_evalf). expand_func(abs_↵ expand). expl_derivative_func(abs_expl_derivative). info_func(abs_info). print_func< print_latex >(abs_↵ _print_latex). print_func< print_csrc_float >(abs_print_csrc_float). print_func< print_csrc_double >(abs_↵ _print_csrc_float). conjugate_func(abs_conjugate). real_part_func(abs_real_part). imag_part_func(abs_↵ imag_part). power_func(abs_power))
- static ex `GiNaC::step_evalf` (const ex &arg)
- static ex `GiNaC::step_eval` (const ex &arg)
- static ex `GiNaC::step_series` (const ex &arg, const relational &rel, int `order`, unsigned `options`)
- static ex `GiNaC::step_conjugate` (const ex &arg)
- static ex `GiNaC::step_real_part` (const ex &arg)
- static ex `GiNaC::step_imag_part` (const ex &arg)
- `GiNaC::REGISTER_FUNCTION` (step, eval_func(step_eval). evalf_func(step_evalf). series_func(step_↵ series). conjugate_func(step_conjugate). real_part_func(step_real_part). imag_part_func(step_imag_part))
- static ex `GiNaC::csgn_evalf` (const ex &arg)
- static ex `GiNaC::csgn_eval` (const ex &arg)
- static ex `GiNaC::csgn_series` (const ex &arg, const relational &rel, int `order`, unsigned `options`)
- static ex `GiNaC::csgn_conjugate` (const ex &arg)
- static ex `GiNaC::csgn_real_part` (const ex &arg)
- static ex `GiNaC::csgn_imag_part` (const ex &arg)
- static ex `GiNaC::csgn_power` (const ex &arg, const ex &exp)
- `GiNaC::REGISTER_FUNCTION` (csgn, eval_func(csgn_eval). evalf_func(csgn_evalf). series_func(csgn_↵ series). conjugate_func(csgn_conjugate). real_part_func(csgn_real_part). imag_part_func(csgn_imag_↵ part). power_func(csgn_power))
- static ex `GiNaC::eta_evalf` (const ex &x, const ex &y)
- static ex `GiNaC::eta_eval` (const ex &x, const ex &y)
- static ex `GiNaC::eta_series` (const ex &x, const ex &y, const relational &rel, int `order`, unsigned `options`)
- static ex `GiNaC::eta_conjugate` (const ex &x, const ex &y)
- static ex `GiNaC::eta_real_part` (const ex &x, const ex &y)
- static ex `GiNaC::eta_imag_part` (const ex &x, const ex &y)
- `GiNaC::REGISTER_FUNCTION` (eta, eval_func(eta_eval). evalf_func(eta_evalf). series_func(eta_series). latex_name("\\eta"). set_symmetry(sy_symm(0, 1)). conjugate_func(eta_conjugate). real_part_func(eta_↵ real_part). imag_part_func(eta_imag_part))
- static ex `GiNaC::Li2_evalf` (const ex &x)
- static ex `GiNaC::Li2_eval` (const ex &x)
- static ex `GiNaC::Li2_deriv` (const ex &x, unsigned deriv_param)
- static ex `GiNaC::Li2_series` (const ex &x, const relational &rel, int `order`, unsigned `options`)
- static ex `GiNaC::Li2_conjugate` (const ex &x)
- `GiNaC::REGISTER_FUNCTION` (Li2, eval_func(Li2_eval). evalf_func(Li2_evalf). derivative_func(Li2_deriv). series_func(Li2_series). conjugate_func(Li2_conjugate). latex_name("\\mathrm{Li}_2"))
- static ex `GiNaC::Li3_eval` (const ex &x)
- `GiNaC::REGISTER_FUNCTION` (Li3, eval_func(Li3_eval). latex_name("\\mathrm{Li}_3"))
- static ex `GiNaC::zetaderiv_eval` (const ex &n, const ex &x)
- static ex `GiNaC::zetaderiv_deriv` (const ex &n, const ex &x, unsigned deriv_param)
- `GiNaC::REGISTER_FUNCTION` (zetaderiv, eval_func(zetaderiv_eval). derivative_func(zetaderiv_deriv). latex_name("\\zeta^{\\prime}"))
- static ex `GiNaC::factorial_evalf` (const ex &x)
- static ex `GiNaC::factorial_eval` (const ex &x)
- static void `GiNaC::factorial_print_dflt_latex` (const ex &x, const print_context &c)
- static ex `GiNaC::factorial_conjugate` (const ex &x)
- static ex `GiNaC::factorial_real_part` (const ex &x)
- static ex `GiNaC::factorial_imag_part` (const ex &x)
- `GiNaC::REGISTER_FUNCTION` (factorial, eval_func(factorial_eval). evalf_func(factorial_evalf). print_func< print_dflt >(factorial_print_dflt_latex). print_func< print_latex >(factorial_print_dflt_latex). conjugate_↵ func(factorial_conjugate). real_part_func(factorial_real_part). imag_part_func(factorial_imag_part))
- static ex `GiNaC::binomial_evalf` (const ex &x, const ex &y)

- static ex [GiNaC::binomial_sym](#) (const ex &x, const numeric &y)
 - static ex [GiNaC::binomial_eval](#) (const ex &x, const ex &y)
 - static ex [GiNaC::binomial_conjugate](#) (const ex &x, const ex &y)
 - static ex [GiNaC::binomial_real_part](#) (const ex &x, const ex &y)
 - static ex [GiNaC::binomial_imag_part](#) (const ex &x, const ex &y)
 - [GiNaC::REGISTER_FUNCTION](#) (binomial, eval_func(binomial_eval). evalf_func(binomial_evalf). conjugate↔_func(binomial_conjugate). real_part_func(binomial_real_part). imag_part_func(binomial_imag_part))
 - static ex [GiNaC::Order_eval](#) (const ex &x)
 - static ex [GiNaC::Order_series](#) (const ex &x, const relational &r, int [order](#), unsigned [options](#))
 - static ex [GiNaC::Order_conjugate](#) (const ex &x)
 - static ex [GiNaC::Order_real_part](#) (const ex &x)
 - static ex [GiNaC::Order_imag_part](#) (const ex &x)
 - static ex [GiNaC::Order_power](#) (const ex &x, const ex &e)
 - static ex [GiNaC::Order_expl_derivative](#) (const ex &arg, const symbol &s)
 - [GiNaC::REGISTER_FUNCTION](#) (Order, eval_func(Order_eval). series_func(Order_series). latex_↔name("\\mathcal{O}"). expl_derivative_func(Order_expl_derivative). conjugate_func(Order_conjugate). real_part_func(Order_real_part). imag_part_func(Order_imag_part). power_func(Order_power))
 - ex [GiNaC::lsolve](#) (const ex &eqns, const ex &symbols, unsigned [options](#)=solve_algo::automatic)
- Factorial function.*
- const numeric [GiNaC::fsolve](#) (const ex &f, const symbol &x, const numeric &x1, const numeric &x2)
- Find a real root of real-valued function f(x) numerically within a given interval.*

Variables

- unsigned [GiNaC::force_include_tgamma](#) = tgamma_SERIAL::serial
- unsigned [GiNaC::force_include_zeta1](#) = zeta1_SERIAL::serial

7.44.1 Detailed Description

Implementation of [GiNaC](#)'s initially known functions.

7.45 inifcns.h File Reference

Interface to [GiNaC](#)'s initially known functions.

```
#include "numeric.h"
#include "function.h"
#include "ex.h"
```

Classes

- class [GiNaC::zeta1_SERIAL](#)
Complex conjugate.
- class [GiNaC::zeta2_SERIAL](#)
Alternating Euler sum or colored MZV.
- class [GiNaC::G2_SERIAL](#)
Generalized multiple polylogarithm.
- class [GiNaC::G3_SERIAL](#)
Generalized multiple polylogarithm with explicit imaginary parts.
- class [GiNaC::psi1_SERIAL](#)
Polylogarithm and multiple polylogarithm.
- class [GiNaC::psi2_SERIAL](#)
Derivatives of Psi-function (aka polygamma-functions).
- class [GiNaC::iterated_integral2_SERIAL](#)
Complete elliptic integral of the first kind.
- class [GiNaC::iterated_integral3_SERIAL](#)
Iterated integral with explicit truncation.

Namespaces

- namespace [GiNaC](#)

Functions

- `template<typename T1 >`
function [GiNaC::zeta](#) (const T1 &p1)
- `template<typename T1 , typename T2 >`
function [GiNaC::zeta](#) (const T1 &p1, const T2 &p2)
- `template<> bool` [GiNaC::is_the_function< zeta_SERIAL >](#) (const ex &x)
- `template<typename T1 , typename T2 >`
function [GiNaC::G](#) (const T1 &x, const T2 &y)
- `template<typename T1 , typename T2 , typename T3 >`
function [GiNaC::G](#) (const T1 &x, const T2 &s, const T3 &y)
- `template<> bool` [GiNaC::is_the_function< G_SERIAL >](#) (const ex &x)
- `template<typename T1 >`
function [GiNaC::psi](#) (const T1 &p1)
- `template<typename T1 , typename T2 >`
function [GiNaC::psi](#) (const T1 &p1, const T2 &p2)
- `template<> bool` [GiNaC::is_the_function< psi_SERIAL >](#) (const ex &x)
- `template<typename T1 , typename T2 >`
function [GiNaC::iterated_integral](#) (const T1 &kernel_lst, const T2 &lambda)
- `template<typename T1 , typename T2 , typename T3 >`
function [GiNaC::iterated_integral](#) (const T1 &kernel_lst, const T2 &lambda, const T3 &N_trunc)
- `template<> bool` [GiNaC::is_the_function< iterated_integral_SERIAL >](#) (const ex &x)
- ex [GiNaC::lsolve](#) (const ex &eqns, const ex &symbols, unsigned [options](#)=solve_algo::automatic)
Factorial function.
- const numeric [GiNaC::fsolve](#) (const ex &f, const symbol &x, const numeric &x1, const numeric &x2)
Find a real root of real-valued function f(x) numerically within a given interval.
- bool [GiNaC::is_order_function](#) (const ex &e)
Check whether a function is the Order (O(n)) function.
- ex [GiNaC::convert_H_to_Li](#) (const ex ¶meterlst, const ex &arg)
Converts a given list containing parameters for H in Remiddi/Vermaseren notation into the corresponding [GiNaC](#) functions.

7.45.1 Detailed Description

Interface to [GiNaC](#)'s initially known functions.

7.46 inifcns_elliptic.cpp File Reference

Implementation of some special functions related to elliptic curves.

```
#include "inifcns.h"
#include "add.h"
#include "constant.h"
#include "lst.h"
#include "mul.h"
#include "numeric.h"
#include "operators.h"
#include "power.h"
#include "pseries.h"
#include "relational.h"
#include "symbol.h"
#include "utils.h"
#include "wildcard.h"
#include "integration_kernel.h"
#include "utils_multi_iterator.h"
#include <cln/cln.h>
#include <sstream>
#include <stdexcept>
#include <vector>
#include <cmath>
```

Namespaces

- namespace [GiNaC](#)

Functions

- static ex [GiNaC::EllipticK_evalf](#) (const ex &k)
- static ex [GiNaC::EllipticK_eval](#) (const ex &k)
- static ex [GiNaC::EllipticK_deriv](#) (const ex &k, unsigned deriv_param)
- static ex [GiNaC::EllipticK_series](#) (const ex &k, const relational &rel, int [order](#), unsigned [options](#))
- static void [GiNaC::EllipticK_print_latex](#) (const ex &k, const print_context &c)
- [GiNaC::REGISTER_FUNCTION](#) (EllipticK, evalf_func(EllipticK_evalf). eval_func(EllipticK_eval). derivative↵_func(EllipticK_deriv). series_func(EllipticK_series). print_func< print_latex >(EllipticK_print_latex). do_↵not_evalf_params())
- static ex [GiNaC::EllipticE_evalf](#) (const ex &k)
- static ex [GiNaC::EllipticE_eval](#) (const ex &k)
- static ex [GiNaC::EllipticE_deriv](#) (const ex &k, unsigned deriv_param)
- static ex [GiNaC::EllipticE_series](#) (const ex &k, const relational &rel, int [order](#), unsigned [options](#))
- static void [GiNaC::EllipticE_print_latex](#) (const ex &k, const print_context &c)
- [GiNaC::REGISTER_FUNCTION](#) (EllipticE, evalf_func(EllipticE_evalf). eval_func(EllipticE_eval). derivative↵_func(EllipticE_deriv). series_func(EllipticE_series). print_func< print_latex >(EllipticE_print_latex). do_↵not_evalf_params())
- static ex [GiNaC::iterated_integral_evalf_impl](#) (const ex &kernel_lst, const ex &lambda, const ex &N_trunc)
- static ex [GiNaC::iterated_integral2_evalf](#) (const ex &kernel_lst, const ex &lambda)
- static ex [GiNaC::iterated_integral3_evalf](#) (const ex &kernel_lst, const ex &lambda, const ex &N_trunc)
- static ex [GiNaC::iterated_integral2_eval](#) (const ex &kernel_lst, const ex &lambda)
- static ex [GiNaC::iterated_integral3_eval](#) (const ex &kernel_lst, const ex &lambda, const ex &N_trunc)

7.46.1 Detailed Description

Implementation of some special functions related to elliptic curves.

The functions are: complete elliptic integral of the first kind `EllipticK(k)` complete elliptic integral of the second kind `EllipticE(k)` iterated integral `iterated_integral(a,y)` or `iterated_integral(a,y,N_trunc)`

Some remarks:

- All formulae used can be looked up in the following publication: [WW] Numerical evaluation of iterated integrals related to elliptic Feynman integrals, M.Walden, S.Weinzierl, arXiv:2010.05271
- When these routines and methods are used for scientific work that leads to publication in a scientific journal, please refer to this program as : M.Walden, S.Weinzierl, "Numerical evaluation of iterated integrals related to elliptic Feynman integrals", arXiv:2010.05271
- As these routines build on the core part of [GiNaC](#), it is also polite to acknowledge C. Bauer, A. Frink, R. Kreckel, "Introduction to the GiNaC Framework for Symbolic Computation within the C++ Programming Language", J. Symbolic Computations 33, 1 (2002), cs.sc/0004015

7.47 inifcns_gamma.cpp File Reference

Implementation of Gamma-function, Beta-function, Polygamma-functions, and some related stuff.

```
#include "inifcns.h"
#include "constant.h"
#include "pseries.h"
#include "numeric.h"
#include "power.h"
#include "relational.h"
#include "operators.h"
#include "symbol.h"
#include "symmetry.h"
#include "utils.h"
#include <stdexcept>
#include <vector>
```

Namespaces

- namespace [GiNaC](#)

Functions

- static ex [GiNaC::lgamma_evalf](#) (const ex &x)
- static ex [GiNaC::lgamma_eval](#) (const ex &x)
Evaluation of $\lgamma(x)$, the natural logarithm of the Gamma function.
- static ex [GiNaC::lgamma_deriv](#) (const ex &x, unsigned deriv_param)
- static ex [GiNaC::lgamma_series](#) (const ex &arg, const relational &rel, int order, unsigned options)
- static ex [GiNaC::lgamma_conjugate](#) (const ex &x)

- `GiNaC::REGISTER_FUNCTION` (lgamma, eval_func(lgamma_eval). evalf_func(lgamma_evalf). derivative_func(lgamma_deriv). series_func(lgamma_series). conjugate_func(lgamma_conjugate). latex_name("\\log \\Gamma"))
- static ex `GiNaC::tgamma_evalf` (const ex &x)
- static ex `GiNaC::tgamma_eval` (const ex &x)
Evaluation of tgamma(x), the true Gamma function.
- static ex `GiNaC::tgamma_deriv` (const ex &x, unsigned deriv_param)
- static ex `GiNaC::tgamma_series` (const ex &arg, const relational &rel, int order, unsigned options)
- static ex `GiNaC::tgamma_conjugate` (const ex &x)
- `GiNaC::REGISTER_FUNCTION` (tgamma, eval_func(tgamma_eval). evalf_func(tgamma_evalf). derivative_func(tgamma_deriv). series_func(tgamma_series). conjugate_func(tgamma_conjugate). latex_name("\\Gamma"))
- static ex `GiNaC::beta_evalf` (const ex &x, const ex &y)
- static ex `GiNaC::beta_eval` (const ex &x, const ex &y)
- static ex `GiNaC::beta_deriv` (const ex &x, const ex &y, unsigned deriv_param)
- static ex `GiNaC::beta_series` (const ex &arg1, const ex &arg2, const relational &rel, int order, unsigned options)
- `GiNaC::REGISTER_FUNCTION` (beta, eval_func(beta_eval). evalf_func(beta_evalf). derivative_func(beta_deriv). series_func(beta_series). latex_name("\\mathrm{B}"). set_symmetry(sy_symm(0, 1)))
- static ex `GiNaC::psi1_evalf` (const ex &x)
- static ex `GiNaC::psi1_eval` (const ex &x)
Evaluation of digamma-function psi(x).
- static ex `GiNaC::psi1_deriv` (const ex &x, unsigned deriv_param)
- static ex `GiNaC::psi1_series` (const ex &arg, const relational &rel, int order, unsigned options)
- static ex `GiNaC::psi2_evalf` (const ex &n, const ex &x)
- static ex `GiNaC::psi2_eval` (const ex &n, const ex &x)
Evaluation of polygamma-function psi(n,x).
- static ex `GiNaC::psi2_deriv` (const ex &n, const ex &x, unsigned deriv_param)
- static ex `GiNaC::psi2_series` (const ex &n, const ex &arg, const relational &rel, int order, unsigned options)

7.47.1 Detailed Description

Implementation of Gamma-function, Beta-function, Polygamma-functions, and some related stuff.

7.48 inifcns_nstdsums.cpp File Reference

Implementation of some special functions that have a representation as nested sums.

```
#include "inifcns.h"
#include "add.h"
#include "constant.h"
#include "lst.h"
#include "mul.h"
#include "numeric.h"
#include "operators.h"
#include "power.h"
#include "pseries.h"
#include "relational.h"
#include "symbol.h"
#include "utils.h"
#include "wildcard.h"
#include <cln/cln.h>
```

```
#include <sstream>
#include <stdexcept>
#include <vector>
#include <cmath>
```

Namespaces

- namespace [GiNaC](#)

Functions

- static ex [GiNaC::G2_evalf](#) (const ex &x_, const ex &y)
- static ex [GiNaC::G2_eval](#) (const ex &x_, const ex &y)
- static ex [GiNaC::G3_evalf](#) (const ex &x_, const ex &s_, const ex &y)
- static ex [GiNaC::G3_eval](#) (const ex &x_, const ex &s_, const ex &y)
- static ex [GiNaC::Li_evalf](#) (const ex &m_, const ex &x_)
- static ex [GiNaC::Li_eval](#) (const ex &m_, const ex &x_)
- static ex [GiNaC::Li_series](#) (const ex &m, const ex &x, const relational &rel, int [order](#), unsigned [options](#))
- static ex [GiNaC::Li_deriv](#) (const ex &m_, const ex &x_, unsigned deriv_param)
- static void [GiNaC::Li_print_latex](#) (const ex &m_, const ex &x_, const print_context &c)
- [GiNaC::REGISTER_FUNCTION](#) (Li, evalf_func(Li_evalf). eval_func(Li_eval). series_func(Li_series). derivative_func(Li_deriv). print_func< print_latex >(Li_print_latex). do_not_evalf_params())
- static ex [GiNaC::S_evalf](#) (const ex &n, const ex &p, const ex &x)
- static ex [GiNaC::S_eval](#) (const ex &n, const ex &p, const ex &x)
- static ex [GiNaC::S_series](#) (const ex &n, const ex &p, const ex &x, const relational &rel, int [order](#), unsigned [options](#))
- static ex [GiNaC::S_deriv](#) (const ex &n, const ex &p, const ex &x, unsigned deriv_param)
- static void [GiNaC::S_print_latex](#) (const ex &n, const ex &p, const ex &x, const print_context &c)
- [GiNaC::REGISTER_FUNCTION](#) (S, evalf_func(S_evalf). eval_func(S_eval). series_func(S_series). derivative_func(S_deriv). print_func< print_latex >(S_print_latex). do_not_evalf_params())
- static ex [GiNaC::H_evalf](#) (const ex &x1, const ex &x2)
- static ex [GiNaC::H_eval](#) (const ex &m_, const ex &x)
- static ex [GiNaC::H_series](#) (const ex &m, const ex &x, const relational &rel, int [order](#), unsigned [options](#))
- static ex [GiNaC::H_deriv](#) (const ex &m_, const ex &x, unsigned deriv_param)
- static void [GiNaC::H_print_latex](#) (const ex &m_, const ex &x, const print_context &c)
- [GiNaC::REGISTER_FUNCTION](#) (H, evalf_func(H_evalf). eval_func(H_eval). series_func(H_series). derivative_func(H_deriv). print_func< print_latex >(H_print_latex). do_not_evalf_params())
- ex [GiNaC::convert_H_to_Li](#) (const ex ¶meterlst, const ex &arg)

Converts a given list containing parameters for H in Remiddi/Vermaseren notation into the corresponding [GiNaC](#) functions.
- static ex [GiNaC::zeta1_evalf](#) (const ex &x)
- static ex [GiNaC::zeta1_eval](#) (const ex &m)
- static ex [GiNaC::zeta1_deriv](#) (const ex &m, unsigned deriv_param)
- static void [GiNaC::zeta1_print_latex](#) (const ex &m_, const print_context &c)
- static ex [GiNaC::zeta2_evalf](#) (const ex &x, const ex &s)
- static ex [GiNaC::zeta2_eval](#) (const ex &m, const ex &s_)
- static ex [GiNaC::zeta2_deriv](#) (const ex &m, const ex &s, unsigned deriv_param)
- static void [GiNaC::zeta2_print_latex](#) (const ex &m_, const ex &s_, const print_context &c)

7.48.1 Detailed Description

Implementation of some special functions that have a representation as nested sums.

The functions are: classical polylogarithm $\text{Li}(n,x)$ multiple polylogarithm $\text{Li}(\text{lst}\{m_1,\dots,m_k\},\text{lst}\{x_1,\dots,x_k\})$ $G(\text{lst}\{a_1,\dots,a_k\},y)$ or $G(\text{lst}\{a_1,\dots,a_k\},\text{lst}\{s_1,\dots,s_k\},y)$ Nielsen's generalized polylogarithm $S(n,p,x)$ harmonic polylogarithm $H(m,x)$ or $H(\text{lst}\{m_1,\dots,m_k\},x)$ multiple zeta value $\text{zeta}(m)$ or $\text{zeta}(\text{lst}\{m_1,\dots,m_k\})$ alternating Euler sum $\text{zeta}(m,s)$ or $\text{zeta}(\text{lst}\{m_1,\dots,m_k\},\text{lst}\{s_1,\dots,s_k\})$

Some remarks:

- All formulae used can be looked up in the following publications: [Kol] Nielsen's Generalized Polylogarithms, K.S.Kolbig, SIAM J.Math.Anal. 17 (1986), pp. 1232-1258. [Cra] Fast Evaluation of Multiple Zeta Sums, R.E.Crandall, Math.Comp. 67 (1998), pp. 1163-1172. [ReV] Harmonic Polylogarithms, E.Remiddi, J.A.M. Vermaseren, Int.J.Mod.Phys. A15 (2000), pp. 725-754 [BBB] Special Values of Multiple Polylogarithms, J.Borwein, D.Bradley, D.Broadhurst, P.Lisonek, Trans.Amer.Math.Soc. 353/3 (2001), pp. 907-941 [VSW] Numerical evaluation of multiple polylogarithms, J.Vollinga, S.Weinzierl, hep-ph/0410259
- The order of parameters and arguments of Li and zeta is defined according to the nested sums representation. The parameters for H are understood as in [ReV]. They can be in expanded — only 0, 1 and -1 — or in compactified — a string with zeros in front of 1 or -1 is written as a single number — notation.
- All functions can be numerically evaluated with arguments in the whole complex plane. The parameters for Li, zeta and S must be positive integers. If you want to have an alternating Euler sum, you have to give the signs of the parameters as a second argument s to $\text{zeta}(m,s)$ containing 1 and -1.
- The calculation of classical polylogarithms is speeded up by using Bernoulli numbers and look-up tables. S uses look-up tables as well. The zeta function applies the algorithms in [Cra] and [BBB] for speed up. Multiple polylogarithms use Hoelder convolution [BBB].
- The functions have no means to do a series expansion into nested sums. To do this, you have to convert these functions into the appropriate objects from the nestedsums library, do the expansion and convert the result back.
- Numerical testing of this implementation has been performed by doing a comparison of results between this software and the commercial M..... 4.1. Multiple zeta values have been checked by means of evaluations into simple zeta values. Harmonic polylogarithms have been checked by comparison to $S(n,p,x)$ for corresponding parameter combinations and by continuity checks around $|x|=1$ along with comparisons to corresponding zeta functions. Multiple polylogarithms were checked against H and zeta and by means of shuffle and quasi-shuffle relations.

7.49 inifcns_trans.cpp File Reference

Implementation of transcendental (and trigonometric and hyperbolic) functions.

```
#include "inifcns.h"
#include "ex.h"
#include "constant.h"
#include "add.h"
#include "mul.h"
#include "numeric.h"
#include "power.h"
#include "operators.h"
#include "relational.h"
#include "symbol.h"
#include "pseries.h"
#include "utils.h"
#include <stdexcept>
#include <vector>
```


Namespaces

- namespace [GiNaC](#)

Functions

- static ex [GiNaC::exp_evalf](#) (const ex &x)
- static ex [GiNaC::exp_eval](#) (const ex &x)
- static ex [GiNaC::exp_expand](#) (const ex &arg, unsigned [options](#))
- static ex [GiNaC::exp_deriv](#) (const ex &x, unsigned deriv_param)
- static ex [GiNaC::exp_real_part](#) (const ex &x)
- static ex [GiNaC::exp_imag_part](#) (const ex &x)
- static ex [GiNaC::exp_conjugate](#) (const ex &x)
- static ex [GiNaC::exp_power](#) (const ex &x, const ex &a)
- static bool [GiNaC::exp_info](#) (const ex &x, unsigned inf)
- [GiNaC::REGISTER_FUNCTION](#) (exp, eval_func(exp_eval). evalf_func(exp_evalf). info_func(exp_info). expand_func(exp_expand). derivative_func(exp_deriv). real_part_func(exp_real_part). imag_part_↵
func(exp_imag_part). conjugate_func(exp_conjugate). power_func(exp_power). latex_name("\\exp"))
- static ex [GiNaC::log_evalf](#) (const ex &x)
- static ex [GiNaC::log_eval](#) (const ex &x)
- static ex [GiNaC::log_deriv](#) (const ex &x, unsigned deriv_param)
- static ex [GiNaC::log_series](#) (const ex &arg, const relational &rel, int [order](#), unsigned [options](#))
- static ex [GiNaC::log_real_part](#) (const ex &x)
- static ex [GiNaC::log_imag_part](#) (const ex &x)
- static ex [GiNaC::log_expand](#) (const ex &arg, unsigned [options](#))
- static ex [GiNaC::log_conjugate](#) (const ex &x)
- static bool [GiNaC::log_info](#) (const ex &x, unsigned inf)
- [GiNaC::REGISTER_FUNCTION](#) (log, eval_func(log_eval). evalf_func(log_evalf). info_func(log_info). expand_func(log_expand). derivative_func(log_deriv). series_func(log_series). real_part_func(log_↵
real_part). imag_part_func(log_imag_part). conjugate_func(log_conjugate). latex_name("\\ln"))
- static ex [GiNaC::sin_evalf](#) (const ex &x)
- static ex [GiNaC::sin_eval](#) (const ex &x)
- static ex [GiNaC::sin_deriv](#) (const ex &x, unsigned deriv_param)
- static ex [GiNaC::sin_real_part](#) (const ex &x)
- static ex [GiNaC::sin_imag_part](#) (const ex &x)
- static ex [GiNaC::sin_conjugate](#) (const ex &x)
- static bool [GiNaC::trig_info](#) (const ex &x, unsigned inf)
- [GiNaC::REGISTER_FUNCTION](#) (sin, eval_func(sin_eval). evalf_func(sin_evalf). info_func(trig_info). derivative_func(sin_deriv). real_part_func(sin_real_part). imag_part_func(sin_imag_part). conjugate_↵
func(sin_conjugate). latex_name("\\sin"))
- static ex [GiNaC::cos_evalf](#) (const ex &x)
- static ex [GiNaC::cos_eval](#) (const ex &x)
- static ex [GiNaC::cos_deriv](#) (const ex &x, unsigned deriv_param)
- static ex [GiNaC::cos_real_part](#) (const ex &x)
- static ex [GiNaC::cos_imag_part](#) (const ex &x)
- static ex [GiNaC::cos_conjugate](#) (const ex &x)
- [GiNaC::REGISTER_FUNCTION](#) (cos, eval_func(cos_eval). info_func(trig_info). evalf_func(cos_evalf). derivative_func(cos_deriv). real_part_func(cos_real_part). imag_part_func(cos_imag_part). conjugate_↵
func(cos_conjugate). latex_name("\\cos"))
- static ex [GiNaC::tan_evalf](#) (const ex &x)
- static ex [GiNaC::tan_eval](#) (const ex &x)
- static ex [GiNaC::tan_deriv](#) (const ex &x, unsigned deriv_param)
- static ex [GiNaC::tan_real_part](#) (const ex &x)
- static ex [GiNaC::tan_imag_part](#) (const ex &x)

- static ex `GiNaC::tan_series` (const ex &x, const relational &rel, int `order`, unsigned `options`)
- static ex `GiNaC::tan_conjugate` (const ex &x)
- `GiNaC::REGISTER_FUNCTION` (tan, eval_func(tan_eval). evalf_func(tan_evalf). info_func(trig_info). derivative_func(tan_deriv). series_func(tan_series). real_part_func(tan_real_part). imag_part_func(tan_↵imag_part). conjugate_func(tan_conjugate). latex_name("\\tan"))
- static ex `GiNaC::asin_evalf` (const ex &x)
- static ex `GiNaC::asin_eval` (const ex &x)
- static ex `GiNaC::asin_deriv` (const ex &x, unsigned deriv_param)
- static ex `GiNaC::asin_conjugate` (const ex &x)
- static bool `GiNaC::asin_info` (const ex &x, unsigned inf)
- `GiNaC::REGISTER_FUNCTION` (asin, eval_func(asin_eval). evalf_func(asin_evalf). info_func(asin_info). derivative_func(asin_deriv). conjugate_func(asin_conjugate). latex_name("\\arcsin"))
- static ex `GiNaC::acos_evalf` (const ex &x)
- static ex `GiNaC::acos_eval` (const ex &x)
- static ex `GiNaC::acos_deriv` (const ex &x, unsigned deriv_param)
- static ex `GiNaC::acos_conjugate` (const ex &x)
- `GiNaC::REGISTER_FUNCTION` (acos, eval_func(acos_eval). evalf_func(acos_evalf). info_func(asin_info). derivative_func(acos_deriv). conjugate_func(acos_conjugate). latex_name("\\arccos"))
- static ex `GiNaC::atan_evalf` (const ex &x)
- static ex `GiNaC::atan_eval` (const ex &x)
- static ex `GiNaC::atan_deriv` (const ex &x, unsigned deriv_param)
- static ex `GiNaC::atan_series` (const ex &arg, const relational &rel, int `order`, unsigned `options`)
- static ex `GiNaC::atan_conjugate` (const ex &x)
- static bool `GiNaC::atan_info` (const ex &x, unsigned inf)
- `GiNaC::REGISTER_FUNCTION` (atan, eval_func(atan_eval). evalf_func(atan_evalf). info_func(atan_↵info). derivative_func(atan_deriv). series_func(atan_series). conjugate_func(atan_conjugate). latex_↵name("\\arctan"))
- static ex `GiNaC::atan2_evalf` (const ex &y, const ex &x)
- static ex `GiNaC::atan2_eval` (const ex &y, const ex &x)
- static ex `GiNaC::atan2_deriv` (const ex &y, const ex &x, unsigned deriv_param)
- static bool `GiNaC::atan2_info` (const ex &y, const ex &x, unsigned inf)
- `GiNaC::REGISTER_FUNCTION` (atan2, eval_func(atan2_eval). evalf_func(atan2_evalf). info_func(atan2_↵info). evalf_func(atan2_evalf). derivative_func(atan2_deriv))
- static ex `GiNaC::sinh_evalf` (const ex &x)
- static ex `GiNaC::sinh_eval` (const ex &x)
- static ex `GiNaC::sinh_deriv` (const ex &x, unsigned deriv_param)
- static ex `GiNaC::sinh_real_part` (const ex &x)
- static ex `GiNaC::sinh_imag_part` (const ex &x)
- static ex `GiNaC::sinh_conjugate` (const ex &x)
- `GiNaC::REGISTER_FUNCTION` (sinh, eval_func(sinh_eval). evalf_func(sinh_evalf). info_func(atan_info). derivative_func(sinh_deriv). real_part_func(sinh_real_part). imag_part_func(sinh_imag_part). conjugate_↵func(sinh_conjugate). latex_name("\\sinh"))
- static ex `GiNaC::cosh_evalf` (const ex &x)
- static ex `GiNaC::cosh_eval` (const ex &x)
- static ex `GiNaC::cosh_deriv` (const ex &x, unsigned deriv_param)
- static ex `GiNaC::cosh_real_part` (const ex &x)
- static ex `GiNaC::cosh_imag_part` (const ex &x)
- static ex `GiNaC::cosh_conjugate` (const ex &x)
- `GiNaC::REGISTER_FUNCTION` (cosh, eval_func(cosh_eval). evalf_func(cosh_evalf). info_func(exp_↵_info). derivative_func(cosh_deriv). real_part_func(cosh_real_part). imag_part_func(cosh_imag_part). conjugate_func(cosh_conjugate). latex_name("\\cosh"))
- static ex `GiNaC::tanh_evalf` (const ex &x)
- static ex `GiNaC::tanh_eval` (const ex &x)
- static ex `GiNaC::tanh_deriv` (const ex &x, unsigned deriv_param)
- static ex `GiNaC::tanh_series` (const ex &x, const relational &rel, int `order`, unsigned `options`)

- static ex [GiNaC::tanh_real_part](#) (const ex &x)
- static ex [GiNaC::tanh_imag_part](#) (const ex &x)
- static ex [GiNaC::tanh_conjugate](#) (const ex &x)
- [GiNaC::REGISTER_FUNCTION](#) (tanh, eval_func(tanh_eval). evalf_func(tanh_evalf). info_func(atan_↵info). derivative_func(tanh_deriv). series_func(tanh_series). real_part_func(tanh_real_part). imag_part_↵_func(tanh_imag_part). conjugate_func(tanh_conjugate). latex_name("\\tanh"))
- static ex [GiNaC::asinh_evalf](#) (const ex &x)
- static ex [GiNaC::asinh_eval](#) (const ex &x)
- static ex [GiNaC::asinh_deriv](#) (const ex &x, unsigned deriv_param)
- static ex [GiNaC::asinh_conjugate](#) (const ex &x)
- [GiNaC::REGISTER_FUNCTION](#) (asinh, eval_func(asinh_eval). evalf_func(asinh_evalf). info_func(atan_↵info). derivative_func(asinh_deriv). conjugate_func(asinh_conjugate))
- static ex [GiNaC::acosh_evalf](#) (const ex &x)
- static ex [GiNaC::acosh_eval](#) (const ex &x)
- static ex [GiNaC::acosh_deriv](#) (const ex &x, unsigned deriv_param)
- static ex [GiNaC::acosh_conjugate](#) (const ex &x)
- [GiNaC::REGISTER_FUNCTION](#) (acosh, eval_func(acosh_eval). evalf_func(acosh_evalf). info_func(asin_↵info). derivative_func(acosh_deriv). conjugate_func(acosh_conjugate))
- static ex [GiNaC::atanh_evalf](#) (const ex &x)
- static ex [GiNaC::atanh_eval](#) (const ex &x)
- static ex [GiNaC::atanh_deriv](#) (const ex &x, unsigned deriv_param)
- static ex [GiNaC::atanh_series](#) (const ex &arg, const relational &rel, int [order](#), unsigned [options](#))
- static ex [GiNaC::atanh_conjugate](#) (const ex &x)
- [GiNaC::REGISTER_FUNCTION](#) (atanh, eval_func(atanh_eval). evalf_func(atanh_evalf). info_func(asin_↵info). derivative_func(atanh_deriv). series_func(atanh_series). conjugate_func(atanh_conjugate))

7.49.1 Detailed Description

Implementation of transcendental (and trigonometric and hyperbolic) functions.

7.50 integral.cpp File Reference

Implementation of [GiNaC](#)'s symbolic integral.

```
#include "integral.h"
#include "numeric.h"
#include "symbol.h"
#include "add.h"
#include "mul.h"
#include "power.h"
#include "inifcns.h"
#include "wildcard.h"
#include "archive.h"
#include "registrar.h"
#include "utils.h"
#include "operators.h"
#include "relational.h"
```

Classes

- struct [GiNaC::error_and_integral](#)
- struct [GiNaC::error_and_integral_is_less](#)

Namespaces

- namespace [GiNaC](#)

Typedefs

- typedef map< error_and_integral, ex, error_and_integral_is_less > [GiNaC::lookup_map](#)

Functions

- [GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) (integral, basic, print_func< print_dflt >(&integral::do_print). print_func< print_python >(&integral::do_print). print_func< print_latex >(&integral::do_print_latex)) integral
- ex [GiNaC::subvalue](#) (const ex &var, const ex &value, const ex &fun)
- ex [GiNaC::adaptivesimpson](#) (const ex &x, const ex &a_in, const ex &b_in, const ex &f, const ex &error)
Numeric integration routine based upon the "Adaptive Quadrature" one in "Numerical Analysis" by Burden and Faires.
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (integral)

7.50.1 Detailed Description

Implementation of [GiNaC](#)'s symbolic integral.

7.51 integral.h File Reference

Interface to [GiNaC](#)'s symbolic integral.

```
#include "basic.h"
#include "ex.h"
#include "archive.h"
```

Classes

- class [GiNaC::integral](#)
Symbolic integral.

Namespaces

- namespace [GiNaC](#)

Functions

- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (integral)
- ex [GiNaC::adaptivesimpson](#) (const ex &x, const ex &a_in, const ex &b_in, const ex &f, const ex &error)
Numeric integration routine based upon the "Adaptive Quadrature" one in "Numerical Analysis" by Burden and Faires.

7.51.1 Detailed Description

Interface to [GiNaC](#)'s symbolic integral.

7.52 integration_kernel.cpp File Reference

Implementation of [GiNaC](#)'s integration kernels for iterated integrals.

```
#include "integration_kernel.h"
#include "add.h"
#include "mul.h"
#include "operators.h"
#include "power.h"
#include "relational.h"
#include "symbol.h"
#include "constant.h"
#include "numeric.h"
#include "function.h"
#include "pseries.h"
#include "utils.h"
#include "inifcns.h"
#include <iostream>
#include <stdexcept>
#include <cln/cln.h>
```

Namespaces

- namespace [GiNaC](#)

Functions

- ex [GiNaC::ifactor](#) (const numeric &n)
Returns the decomposition of the positive integer n into prime numbers in the form $lst(p_1, \dots, p_r), lst(a_1, \dots, a_r)$ such that $n = p_1^{a_1} \dots p_r^{a_r}$.
- bool [GiNaC::is_discriminant_of_quadratic_number_field](#) (const numeric &n)
Returns true if the integer n is either one or the discriminant of a quadratic number field.
- numeric [GiNaC::kronecker_symbol](#) (const numeric &a, const numeric &n)
Returns the Kronecker symbol a: integer n: integer.
- numeric [GiNaC::primitive_dirichlet_character](#) (const numeric &n, const numeric &a)
Defines a primitive Dirichlet character through the Kronecker symbol.
- numeric [GiNaC::dirichlet_character](#) (const numeric &n, const numeric &a, const numeric &N)
Defines a Dirichlet character through the Kronecker symbol.
- numeric [GiNaC::generalised_Bernoulli_number](#) (const numeric &k, const numeric &b)
The generalised Bernoulli number.
- ex [GiNaC::Bernoulli_polynomial](#) (const numeric &k, const ex &x)
The Bernoulli polynomials.
- [GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) (integration_kernel, basic, print_func< print_↔ context >(&integration_kernel::do_print)) integration_kernel
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (integration_kernel)

- [GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) (basic_log_kernel, integration_kernel, print_func< print_context >(&basic_log_kernel::do_print)) basic_log_kernel
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (basic_log_kernel)
- [GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) (multiple_polylog_kernel, integration_kernel, print_func< print_context >(&multiple_polylog_kernel::do_print)) multiple_polylog_kernel
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (multiple_polylog_kernel)
- [GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) (ELi_kernel, integration_kernel, print_func< print_context >(&ELi_kernel::do_print)) ELi_kernel
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (ELi_kernel)
- [GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) (Ebar_kernel, integration_kernel, print_func< print_context >(&Ebar_kernel::do_print)) Ebar_kernel
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (Ebar_kernel)
- [GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) (Kronecker_dtau_kernel, integration_kernel, print_func< print_context >(&Kronecker_dtau_kernel::do_print)) Kronecker_dtau_kernel
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (Kronecker_dtau_kernel)
- [GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) (Kronecker_dz_kernel, integration_kernel, print_func< print_context >(&Kronecker_dz_kernel::do_print)) Kronecker_dz_kernel
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (Kronecker_dz_kernel)
- [GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) (Eisenstein_kernel, integration_kernel, print_func< print_context >(&Eisenstein_kernel::do_print)) Eisenstein_kernel
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (Eisenstein_kernel)
- [GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) (Eisenstein_h_kernel, integration_kernel, print_func< print_context >(&Eisenstein_h_kernel::do_print)) Eisenstein_h_kernel
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (Eisenstein_h_kernel)
- [GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) (modular_form_kernel, integration_kernel, print_func< print_context >(&modular_form_kernel::do_print)) modular_form_kernel
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (modular_form_kernel)
- [GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) (user_defined_kernel, integration_kernel, print_func< print_context >(&user_defined_kernel::do_print)) user_defined_kernel
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (user_defined_kernel)

7.52.1 Detailed Description

Implementation of [GiNaC](#)'s integration kernels for iterated integrals.

7.52.2 Variable Documentation

7.52.2.1 qbar

ex qbar

Referenced by [GiNaC::divide_in_z\(\)](#), [GiNaC::ELi_kernel::get_numerical_value\(\)](#), [GiNaC::Ebar_kernel::get_numerical_value\(\)](#), [GiNaC::Kronecker_dtau_kernel::get_numerical_value\(\)](#), [GiNaC::Eisenstein_kernel::get_numerical_value\(\)](#), [GiNaC::Eisenstein_h_kernel::get_numerical_value\(\)](#), [GiNaC::modular_form_kernel::get_numerical_value\(\)](#), [GiNaC::modular_form_kernel::is_numeric\(\)](#), [GiNaC::modular_form_kernel::Laurent_series\(\)](#), [GiNaC::Eisenstein_kernel::series\(\)](#), [GiNaC::Eisenstein_h_kernel::series\(\)](#), [GiNaC::modular_form_kernel::series\(\)](#), and [GiNaC::Kronecker_dz_kernel::series_coeff_impl\(\)](#).

7.52.2.2 order

```
int order
```

Referenced by [GiNaC::atan_series\(\)](#), [GiNaC::atanh_series\(\)](#), [GiNaC::beta_series\(\)](#), [GiNaC::fderivative::do_print_latex\(\)](#), [GiNaC::EllipticE_series\(\)](#), [GiNaC::EllipticK_series\(\)](#), [GiNaC::modular_form_kernel::Laurent_series\(\)](#), [GiNaC::integration_kernel::Laurent_series\(\)](#), [GiNaC::Eisenstein_kernel::Laurent_series\(\)](#), [GiNaC::Eisenstein_h_kernel::Laurent_series\(\)](#), [GiNaC::user_defined_kernel::Laurent_series\(\)](#), [GiNaC::lgamma_series\(\)](#), [GiNaC::Li2_series\(\)](#), [GiNaC::Li_series\(\)](#), [GiNaC::log_series\(\)](#), [GiNaC::Order_series\(\)](#), [GiNaC::psi1_series\(\)](#), [GiNaC::psi2_series\(\)](#), [GiNaC::Eisenstein_kernel::q_expansion_modular_form\(\)](#), [GiNaC::S_series\(\)](#), [GiNaC::ex::series\(\)](#), [GiNaC::series\(\)](#), [GiNaC::basic::series\(\)](#), [GiNaC::add::series\(\)](#), [GiNaC::fderivative::series\(\)](#), [GiNaC::function::series\(\)](#), [GiNaC::integral::series\(\)](#), [GiNaC::integration_kernel::series\(\)](#), [GiNaC::Eisenstein_kernel::series\(\)](#), [GiNaC::Eisenstein_h_kernel::series\(\)](#), [GiNaC::modular_form_kernel::series\(\)](#), [GiNaC::pseries::series\(\)](#), [GiNaC::structure< T, ComparsionOperator>::series\(\)](#), [GiNaC::mul::series\(\)](#), [GiNaC::power::series\(\)](#), [GiNaC::symbol::series\(\)](#), [GiNaC::tan_series\(\)](#), [GiNaC::tanh_series\(\)](#), and [GiNaC::tgamma_series\(\)](#).

7.52.2.3 cache_vec

```
std::vector<ex> cache_vec [static], [protected]
```

7.52.2.4 x

```
symbol x [static], [protected]
```

Referenced by [GiNaC::integration_kernel::Laurent_series\(\)](#), and [GiNaC::integration_kernel::series_coeff\(\)](#).

7.53 integration_kernel.h File Reference

Interface to [GiNaC](#)'s integration kernels for iterated integrals.

```
#include "basic.h"
#include "archive.h"
#include "numeric.h"
#include "lst.h"
#include <cln/complex.h>
#include <vector>
```

Classes

- class [GiNaC::integration_kernel](#)
The base class for integration kernels for iterated integrals.
- class [GiNaC::basic_log_kernel](#)
The basic integration kernel with a logarithmic singularity at the origin.
- class [GiNaC::multiple_polylog_kernel](#)
The integration kernel for multiple polylogarithms.
- class [GiNaC::ELi_kernel](#)
The ELi-kernel.
- class [GiNaC::Ebar_kernel](#)
The Ebar-kernel.
- class [GiNaC::Kronecker_dtau_kernel](#)
The kernel corresponding to integrating the Kronecker coefficient function $g^{(n)}(z_j, K\tau)$ in τ (or equivalently in \bar{q}).
- class [GiNaC::Kronecker_dz_kernel](#)
The kernel corresponding to integrating the Kronecker coefficient function $g^{(n-1)}(z - z_j, K\tau)$ in z .
- class [GiNaC::Eisenstein_kernel](#)
The kernel corresponding to the Eisenstein series $E_{k,N,a,b,K}(\tau)$.
- class [GiNaC::Eisenstein_h_kernel](#)
The kernel corresponding to the Eisenstein series $h_{k,N,r,s}(\tau)$.
- class [GiNaC::modular_form_kernel](#)
A kernel corresponding to a polynomial in Eisenstein series.
- class [GiNaC::user_defined_kernel](#)
A user-defined integration kernel.

Namespaces

- namespace [GiNaC](#)

Functions

- ex [GiNaC::ifactor](#) (const numeric &n)
Returns the decomposition of the positive integer n into prime numbers in the form $lst(lst(p1,...,pr), lst(a1,...,ar))$ such that $n = p1^{a1} \dots pr^{ar}$.
- bool [GiNaC::is_discriminant_of_quadratic_number_field](#) (const numeric &n)
Returns true if the integer n is either one or the discriminant of a quadratic number field.
- numeric [GiNaC::kronecker_symbol](#) (const numeric &a, const numeric &n)
Returns the Kronecker symbol a : integer n : integer.
- numeric [GiNaC::primitive_dirichlet_character](#) (const numeric &n, const numeric &a)
Defines a primitive Dirichlet character through the Kronecker symbol.
- numeric [GiNaC::dirichlet_character](#) (const numeric &n, const numeric &a, const numeric &N)
Defines a Dirichlet character through the Kronecker symbol.
- numeric [GiNaC::generalised_Bernoulli_number](#) (const numeric &k, const numeric &b)
The generalised Bernoulli number.
- ex [GiNaC::Bernoulli_polynomial](#) (const numeric &k, const ex &x)
The Bernoulli polynomials.
- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (integration_kernel)
- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (basic_log_kernel)
- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (multiple_polylog_kernel)
- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (ELi_kernel)

- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (Ebar_kernel)
- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (Kronecker_dtau_kernel)
- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (Kronecker_dz_kernel)
- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (Eisenstein_kernel)
- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (Eisenstein_h_kernel)
- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (modular_form_kernel)
- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (user_defined_kernel)

7.53.1 Detailed Description

Interface to [GiNaC](#)'s integration kernels for iterated integrals.

7.54 Ist.cpp File Reference

Implementation of [GiNaC](#)'s Ist.

```
#include "lst.h"
#include "archive.h"
```

Namespaces

- namespace [GiNaC](#)

Variables

- `template<> GINAC_IMPLEMENT_REGISTERED_CLASS_OPT_T(Ist, basic, print_func< print_context >(&Ist::do_print). print_func< print_tree >(&Ist::do_print_tree)) template<> bool Ist GiNaC::GINAC_BIND_UNARCHIVER (Ist)`

Specialization of [container::info\(\)](#) for Ist.

7.54.1 Detailed Description

Implementation of [GiNaC](#)'s Ist.

7.55 Ist.h File Reference

Definition of [GiNaC](#)'s Ist.

```
#include "container.h"
#include <list>
```

Namespaces

- namespace [GiNaC](#)

Typedefs

- typedef container< std::list > [GiNaC::lst](#)

Functions

- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (lst)

7.55.1 Detailed Description

Definition of [GiNaC](#)'s lst.

7.56 matrix.cpp File Reference

Implementation of symbolic matrices.

```
#include "matrix.h"
#include "numeric.h"
#include "lst.h"
#include "idx.h"
#include "indexed.h"
#include "add.h"
#include "power.h"
#include "symbol.h"
#include "operators.h"
#include "normal.h"
#include "archive.h"
#include "utils.h"
#include <algorithm>
#include <iostream>
#include <map>
#include <sstream>
#include <stdexcept>
#include <string>
```

Namespaces

- namespace [GiNaC](#)

Functions

- [GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) (matrix, basic, print_func< print_context >(&matrix::do_print). print_func< print_latex >(&matrix::do_print_latex). print_func< print_tree >(&matrix::do_print_tree). print_func< print_python_repr >(&matrix::do_print_python_repr)) matrix
Default ctor.
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (matrix)
- ex [GiNaC::lst_to_matrix](#) (const lst &l)
Convert list of lists to matrix.
- ex [GiNaC::diag_matrix](#) (const lst &l)
Convert list of diagonal elements to matrix.
- ex [GiNaC::diag_matrix](#) (std::initializer_list< ex > l)
- ex [GiNaC::unit_matrix](#) (unsigned r, unsigned c)
Create an r times c unit matrix.
- ex [GiNaC::symbolic_matrix](#) (unsigned r, unsigned c, const std::string &base_name, const std::string &tex_↵ base_name)
Create an r times c matrix of newly generated symbols consisting of the given base name plus the numeric row/column position of each element.
- ex [GiNaC::reduced_matrix](#) (const matrix &m, unsigned r, unsigned c)
Return the reduced matrix that is formed by deleting the rth row and cth column of matrix m.
- ex [GiNaC::sub_matrix](#) (const matrix &m, unsigned r, unsigned nr, unsigned c, unsigned nc)
Return the nr times nc submatrix starting at position r, c of matrix m.

7.56.1 Detailed Description

Implementation of symbolic matrices.

7.57 matrix.h File Reference

Interface to symbolic matrices.

```
#include "basic.h"
#include "ex.h"
#include "archive.h"
#include "compiler.h"
#include <string>
#include <vector>
```

Classes

- class [GiNaC::matrix](#)
Symbolic matrices.

Namespaces

- namespace [GiNaC](#)

Functions

- `GiNaC::GINAC_DECLARE_UNARCHIVER` (matrix)
- `size_t GiNaC::nops` (const matrix &m)
- ex `GiNaC::expand` (const matrix &m, unsigned options=0)
- ex `GiNaC::evalf` (const matrix &m)
- unsigned `GiNaC::rows` (const matrix &m)
- unsigned `GiNaC::cols` (const matrix &m)
- matrix `GiNaC::transpose` (const matrix &m)
- ex `GiNaC::determinant` (const matrix &m, unsigned options=determinant_algo::automatic)
- ex `GiNaC::trace` (const matrix &m)
- ex `GiNaC::charpoly` (const matrix &m, const ex &lambda)
- matrix `GiNaC::inverse` (const matrix &m)
- matrix `GiNaC::inverse` (const matrix &m, unsigned algo)
- unsigned `GiNaC::rank` (const matrix &m)
- unsigned `GiNaC::rank` (const matrix &m, unsigned solve_algo)
- ex `GiNaC::lst_to_matrix` (const lst &l)

Convert list of lists to matrix.
- ex `GiNaC::diag_matrix` (const lst &l)

Convert list of diagonal elements to matrix.
- ex `GiNaC::diag_matrix` (std::initializer_list< ex > l)
- ex `GiNaC::unit_matrix` (unsigned r, unsigned c)

Create an r times c unit matrix.
- ex `GiNaC::unit_matrix` (unsigned x)

Create a x times x unit matrix.
- ex `GiNaC::symbolic_matrix` (unsigned r, unsigned c, const std::string &base_name, const std::string &tex_↔
base_name)

Create an r times c matrix of newly generated symbols consisting of the given base name plus the numeric row/column position of each element.
- ex `GiNaC::reduced_matrix` (const matrix &m, unsigned r, unsigned c)

Return the reduced matrix that is formed by deleting the rth row and cth column of matrix m.
- ex `GiNaC::sub_matrix` (const matrix &m, unsigned r, unsigned nr, unsigned c, unsigned nc)

Return the nr times nc submatrix starting at position r, c of matrix m.
- ex `GiNaC::symbolic_matrix` (unsigned r, unsigned c, const std::string &base_name)

Create an r times c matrix of newly generated symbols consisting of the given base name plus the numeric row/column position of each element.

7.57.1 Detailed Description

Interface to symbolic matrices.

7.58 mul.cpp File Reference

Implementation of `GiNaC`'s products of expressions.

```
#include "mul.h"
#include "add.h"
#include "power.h"
#include "operators.h"
#include "matrix.h"
```

```
#include "indexed.h"
#include "lst.h"
#include "archive.h"
#include "utils.h"
#include "symbol.h"
#include "compiler.h"
#include <iostream>
#include <limits>
#include <stdexcept>
#include <vector>
```

Namespaces

- namespace [GiNaC](#)

Functions

- [GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) (mul, expairseq, print_func< print_context >(&mul::do_print). print_func< print_latex >(&mul::do_print_latex). print_func< print_csrc >(&mul::do_print_csrc). print_func< print_tree >(&mul::do_print_tree). print_func< print_python_repr >(&mul::do_print_python_repr)) mul
- bool [GiNaC::tryfactsubs](#) (const ex &origfactor, const ex &patternfactor, int &nummatches, exmap &repls)
- bool [GiNaC::algebraic_match_mul_with_mul](#) (const mul &e, const ex &pat, exmap &repls, int factor, int &nummatches, const std::vector< bool > &subsed, std::vector< bool > &matched)
Checks whether e matches to the pattern pat and the (possibly to be updated) list of replacements repls.
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (mul)

7.58.1 Detailed Description

Implementation of [GiNaC](#)'s products of expressions.

7.59 mul.h File Reference

Interface to [GiNaC](#)'s products of expressions.

```
#include "expairseq.h"
```

Classes

- class [GiNaC::mul](#)
Product of expressions.

Namespaces

- namespace [GiNaC](#)

Functions

- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (mul)

7.59.1 Detailed Description

Interface to [GiNaC](#)'s products of expressions.

7.60 ncmul.cpp File Reference

Implementation of [GiNaC](#)'s non-commutative products of expressions.

```
#include "ncmul.h"
#include "ex.h"
#include "add.h"
#include "mul.h"
#include "clifford.h"
#include "matrix.h"
#include "archive.h"
#include "indexed.h"
#include "utils.h"
#include <algorithm>
#include <iostream>
#include <stdexcept>
```

Namespaces

- namespace [GiNaC](#)

Typedefs

- typedef std::vector< std::size_t > [GiNaC::uintvector](#)
- typedef std::vector< unsigned > [GiNaC::unsignedvector](#)
- typedef std::vector< exvector > [GiNaC::exvectorvector](#)

Functions

- [GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) (ncmul, exprseq, print_func< print_context >(&ncmul::do_print). print_func< print_tree >(&ncmul::do_print_tree). print_func< print_csrc >(&ncmul::do_print_csrc). print_func< print_python_repr >(&ncmul::do_print_csrc)) ncmul
- ex [GiNaC::reeval_ncmul](#) (const exvector &v)
- ex [GiNaC::hold_ncmul](#) (const exvector &v)
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (ncmul)

7.60.1 Detailed Description

Implementation of [GiNaC](#)'s non-commutative products of expressions.

7.61 ncmul.h File Reference

Interface to [GiNaC](#)'s non-commutative products of expressions.

```
#include "exprseq.h"
#include "archive.h"
```

Classes

- class [GiNaC::ncmul](#)
Non-commutative product of expressions.

Namespaces

- namespace [GiNaC](#)

Functions

- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (ncmul)
- ex [GiNaC::reeval_ncmul](#) (const exvector &v)
- ex [GiNaC::hold_ncmul](#) (const exvector &v)

7.61.1 Detailed Description

Interface to [GiNaC](#)'s non-commutative products of expressions.

7.62 normal.cpp File Reference

This file implements several functions that work on univariate and multivariate polynomials and rational functions.

```
#include "normal.h"
#include "basic.h"
#include "ex.h"
#include "add.h"
#include "constant.h"
#include "expairseq.h"
#include "fail.h"
#include "inifcns.h"
#include "lst.h"
#include "mul.h"
#include "numeric.h"
#include "power.h"
#include "relational.h"
#include "operators.h"
#include "matrix.h"
#include "pseries.h"
#include "symbol.h"
#include "utils.h"
#include "polynomial/chinrem_gcd.h"
#include <algorithm>
#include <map>
```

Classes

- struct [GiNaC::sym_desc](#)
This structure holds information about the highest and lowest degrees in which a symbol appears in two multivariate polynomials "a" and "b".
- class [GiNaC::gcdheu_failed](#)
Exception thrown by [heur_gcd\(\)](#) to signal failure.
- struct [GiNaC::normal_map_function](#)
Function object to be applied by [basic::normal\(\)](#).

Namespaces

- namespace [GiNaC](#)

Macros

- `#define` [FAST_COMPARE](#) 1
- `#define` [USE_REMEMBER](#) 0
- `#define` [USE_TRIAL_DIVISION](#) 0
- `#define` [STATISTICS](#) 0

Typedefs

- typedef std::vector< sym_desc > [GiNaC::sym_desc_vec](#)

Functions

- static bool [GiNaC::get_first_symbol](#) (const ex &e, ex &x)
Return pointer to first symbol found in expression.
- static void [GiNaC::add_symbol](#) (const ex &s, sym_desc_vec &v)
- static void [GiNaC::collect_symbols](#) (const ex &e, sym_desc_vec &v)
- static void [GiNaC::get_symbol_stats](#) (const ex &a, const ex &b, sym_desc_vec &v)
Collect statistical information about symbols in polynomials.
- static numeric [GiNaC::lcmcoeff](#) (const ex &e, const numeric &l)
- static numeric [GiNaC::lcm_of_coefficients_denominators](#) (const ex &e)
Compute LCM of denominators of coefficients of a polynomial.
- static ex [GiNaC::multiply_lcm](#) (const ex &e, const numeric &lcm)
Bring polynomial from $Q[X]$ to $Z[X]$ by multiplying in the previously determined LCM of the coefficient's denominators.
- ex [GiNaC::quo](#) (const ex &a, const ex &b, const ex &x, bool check_args)
Quotient $q(x)$ of polynomials $a(x)$ and $b(x)$ in $Q[x]$.
- ex [GiNaC::rem](#) (const ex &a, const ex &b, const ex &x, bool check_args)
Remainder $r(x)$ of polynomials $a(x)$ and $b(x)$ in $Q[x]$.
- ex [GiNaC::decomp_rational](#) (const ex &a, const ex &x)
Decompose rational function $a(x)=N(x)/D(x)$ into $P(x)+n(x)/D(x)$ with $\text{degree}(n, x) < \text{degree}(D, x)$.
- ex [GiNaC::prem](#) (const ex &a, const ex &b, const ex &x, bool check_args)
Pseudo-remainder of polynomials $a(x)$ and $b(x)$ in $Q[x]$.
- ex [GiNaC::sprem](#) (const ex &a, const ex &b, const ex &x, bool check_args)
Sparse pseudo-remainder of polynomials $a(x)$ and $b(x)$ in $Q[x]$.
- bool [GiNaC::divide](#) (const ex &a, const ex &b, ex &q, bool check_args)

- Exact polynomial division of $a(X)$ by $b(X)$ in $Q[X]$.*
 - static bool [GiNaC::divide_in_z](#) (const ex &a, const ex &b, ex &q, sym_desc_vec::const_iterator var)
- Exact polynomial division of $a(X)$ by $b(X)$ in $Z[X]$.*
 - static ex [GiNaC::sr_gcd](#) (const ex &a, const ex &b, sym_desc_vec::const_iterator var)
- Compute GCD of multivariate polynomials using the subresultant PRS algorithm.*
 - static ex [GiNaC::interpolate](#) (const ex &gamma, const numeric &xi, const ex &x, int degree_hint=1)
- ξ -adic polynomial interpolation*
 - static bool [GiNaC::heur_gcd_z](#) (ex &res, const ex &a, const ex &b, ex *ca, ex *cb, sym_desc_vec::const_iterator var)
- Compute GCD of multivariate polynomials using the heuristic GCD algorithm.*
 - static bool [GiNaC::heur_gcd](#) (ex &res, const ex &a, const ex &b, ex *ca, ex *cb, sym_desc_vec::const_iterator var)
- Compute GCD of multivariate polynomials using the heuristic GCD algorithm.*
 - static ex [GiNaC::gcd_pf_pow](#) (const ex &a, const ex &b, ex *ca, ex *cb)
 - static ex [GiNaC::gcd_pf_mul](#) (const ex &a, const ex &b, ex *ca, ex *cb)
 - ex [GiNaC::gcd](#) (const ex &a, const ex &b, ex *ca, ex *cb, bool check_args, unsigned options)
- Compute GCD (Greatest Common Divisor) of multivariate polynomials $a(X)$ and $b(X)$ in $Z[X]$.*
 - static ex [GiNaC::gcd_pf_pow_pow](#) (const ex &a, const ex &b, ex *ca, ex *cb)
 - ex [GiNaC::lcm](#) (const ex &a, const ex &b, bool check_args)
- Compute LCM (Least Common Multiple) of multivariate polynomials in $Z[X]$.*
 - static epvector [GiNaC::sqrfree_yun](#) (const ex &a, const symbol &x)
- Compute square-free factorization of multivariate polynomial $a(x)$ using Yun's algorithm.*
 - ex [GiNaC::sqrfree](#) (const ex &a, const lst &l)
- Compute a square-free factorization of a multivariate polynomial in $Q[X]$.*
 - ex [GiNaC::sqrfree_parfrac](#) (const ex &a, const symbol &x)
- Compute square-free partial fraction decomposition of rational function $a(x)$.*
 - static ex [GiNaC::replace_with_symbol](#) (const ex &e, exmap &repl, exmap &rev_lookup, lst &modifier)
- Create a symbol for replacing the expression "e" (or return a previously assigned symbol).*
 - static ex [GiNaC::replace_with_symbol](#) (const ex &e, exmap &repl)
- Create a symbol for replacing the expression "e" (or return a previously assigned symbol).*
 - static ex [GiNaC::frac_cancel](#) (const ex &n, const ex &d)
- Fraction cancellation.*
 - static ex [GiNaC::find_common_factor](#) (const ex &e, ex &factor, exmap &repl)
- Remove the common factor in the terms of a sum 'e' by calculating the GCD, and multiply it into the expression 'factor' (which needs to be initialized to 1, unless you're accumulating factors).*
 - ex [GiNaC::collect_common_factors](#) (const ex &e)
- Collect common factors in sums.*
 - ex [GiNaC::resultant](#) (const ex &e1, const ex &e2, const ex &s)
- Resultant of two expressions e_1, e_2 with respect to symbol s .*

7.62.1 Detailed Description

This file implements several functions that work on univariate and multivariate polynomials and rational functions.

These functions include polynomial quotient and remainder, GCD and LCM computation, square-free factorization and rational function normalization.

7.62.2 Macro Definition Documentation

7.62.2.1 FAST_COMPARE

```
#define FAST_COMPARE 1
```

7.62.2.2 USE_REMEMBER

```
#define USE_REMEMBER 0
```

7.62.2.3 USE_TRIAL_DIVISION

```
#define USE_TRIAL_DIVISION 0
```

7.62.2.4 STATISTICS

```
#define STATISTICS 0
```

7.63 normal.h File Reference

This file defines several functions that work on univariate and multivariate polynomials and rational functions.

```
#include "lst.h"
```

Classes

- struct [GiNaC::gcd_options](#)
Flags to control the behavior of [gcd\(\)](#) and friends.

Namespaces

- namespace [GiNaC](#)

Functions

- ex [GiNaC::quo](#) (const ex &a, const ex &b, const ex &x, bool check_args)
Quotient $q(x)$ of polynomials $a(x)$ and $b(x)$ in $Q[x]$.
- ex [GiNaC::rem](#) (const ex &a, const ex &b, const ex &x, bool check_args)
Remainder $r(x)$ of polynomials $a(x)$ and $b(x)$ in $Q[x]$.
- ex [GiNaC::decomp_rational](#) (const ex &a, const ex &x)
Decompose rational function $a(x)=N(x)/D(x)$ into $P(x)+n(x)/D(x)$ with $\text{degree}(n, x) < \text{degree}(D, x)$.
- ex [GiNaC::prem](#) (const ex &a, const ex &b, const ex &x, bool check_args)
Pseudo-remainder of polynomials $a(x)$ and $b(x)$ in $Q[x]$.
- ex [GiNaC::sprem](#) (const ex &a, const ex &b, const ex &x, bool check_args)
Sparse pseudo-remainder of polynomials $a(x)$ and $b(x)$ in $Q[x]$.
- bool [GiNaC::divide](#) (const ex &a, const ex &b, ex &q, bool check_args)
Exact polynomial division of $a(X)$ by $b(X)$ in $Q[X]$.
- ex [GiNaC::gcd](#) (const ex &a, const ex &b, ex *ca, ex *cb, bool check_args, unsigned options)
Compute GCD (Greatest Common Divisor) of multivariate polynomials $a(X)$ and $b(X)$ in $Z[X]$.
- ex [GiNaC::lcm](#) (const ex &a, const ex &b, bool check_args)
Compute LCM (Least Common Multiple) of multivariate polynomials in $Z[X]$.
- ex [GiNaC::sqrfree](#) (const ex &a, const lst &l)
Compute a square-free factorization of a multivariate polynomial in $Q[X]$.
- ex [GiNaC::sqrfree_parfrac](#) (const ex &a, const symbol &x)
Compute square-free partial fraction decomposition of rational function $a(x)$.
- ex [GiNaC::collect_common_factors](#) (const ex &e)
Collect common factors in sums.
- ex [GiNaC::resultant](#) (const ex &e1, const ex &e2, const ex &s)
Resultant of two expressions $e1, e2$ with respect to symbol s .

7.63.1 Detailed Description

This file defines several functions that work on univariate and multivariate polynomials and rational functions.

These functions include polynomial quotient and remainder, GCD and LCM computation, square-free factorization and rational function normalization.

7.64 numeric.cpp File Reference

This file contains the interface to the underlying bignum package.

```
#include "numeric.h"
#include "ex.h"
#include "operators.h"
#include "archive.h"
#include "utils.h"
#include <limits>
#include <sstream>
#include <stdexcept>
#include <string>
#include <vector>
#include <cln/output.h>
#include <cln/integer_io.h>
```

```
#include <cln/integer_ring.h>
#include <cln/rational_io.h>
#include <cln/rational_ring.h>
#include <cln/lfloat_class.h>
#include <cln/lfloat_io.h>
#include <cln/real_io.h>
#include <cln/real_ring.h>
#include <cln/complex_io.h>
#include <cln/complex_ring.h>
#include <cln/numtheory.h>
```

Classes

- class [GiNaC::lanczos_coeffs](#)

Namespaces

- namespace [GiNaC](#)

Functions

- [GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) (numeric, basic, print_func< print_context >(&numeric::do_print). print_func< print_latex >(&numeric::do_print_latex). print_func< print_csrc >(&numeric::do_print_csrc). print_func< print_csrc_cl_N >(&numeric::do_print_csrc_cl_N). print_func< print_tree >(&numeric::do_print_tree). print_func< print_python_repr >(&numeric::do_print_python_repr))
numeric
default ctor.
- static const cln::cl_F [GiNaC::make_real_float](#) (const cln::cl_idecoded_float &dec)
Construct a floating point number from sign, mantissa, and exponent.
- static const cln::cl_F [GiNaC::read_real_float](#) (std::istream &s)
Read serialized floating point number.
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (numeric)
- static void [GiNaC::write_real_float](#) (std::ostream &s, const cln::cl_R &n)
- static void [GiNaC::print_real_number](#) (const print_context &c, const cln::cl_R &x)
Helper function to print a real number in a nicer way than is CLN's default.
- static void [GiNaC::print_integer_csrc](#) (const print_context &c, const cln::cl_I &x)
Helper function to print integer number in C++ source format.
- static void [GiNaC::print_real_csrc](#) (const print_context &c, const cln::cl_R &x)
Helper function to print real number in C++ source format.
- template<typename T1 , typename T2 >
static bool [GiNaC::coerce](#) (T1 &dst, const T2 &arg)
- template<> bool [GiNaC::coerce< int, cln::cl_I >](#) (int &dst, const cln::cl_I &arg)
Check if CLN integer can be converted into int.
- template<> bool [GiNaC::coerce< unsigned int, cln::cl_I >](#) (unsigned int &dst, const cln::cl_I &arg)
- static void [GiNaC::print_real_cl_N](#) (const print_context &c, const cln::cl_R &x)
Helper function to print real number in C++ source format using cl_N types.
- const numeric [GiNaC::exp](#) (const numeric &x)
Exponential function.
- const numeric [GiNaC::log](#) (const numeric &x)
Natural logarithm.

- const numeric [GiNaC::sin](#) (const numeric &x)
Numeric sine (trigonometric function).
- const numeric [GiNaC::cos](#) (const numeric &x)
Numeric cosine (trigonometric function).
- const numeric [GiNaC::tan](#) (const numeric &x)
Numeric tangent (trigonometric function).
- const numeric [GiNaC::asin](#) (const numeric &x)
Numeric inverse sine (trigonometric function).
- const numeric [GiNaC::acos](#) (const numeric &x)
Numeric inverse cosine (trigonometric function).
- const numeric [GiNaC::atan](#) (const numeric &x)
Numeric arcustangent.
- const numeric [GiNaC::atan](#) (const numeric &y, const numeric &x)
Numeric arcustangent of two arguments, analytically continued in a suitable way.
- const numeric [GiNaC::sinh](#) (const numeric &x)
Numeric hyperbolic sine (trigonometric function).
- const numeric [GiNaC::cosh](#) (const numeric &x)
Numeric hyperbolic cosine (trigonometric function).
- const numeric [GiNaC::tanh](#) (const numeric &x)
Numeric hyperbolic tangent (trigonometric function).
- const numeric [GiNaC::asinh](#) (const numeric &x)
Numeric inverse hyperbolic sine (trigonometric function).
- const numeric [GiNaC::acosh](#) (const numeric &x)
Numeric inverse hyperbolic cosine (trigonometric function).
- const numeric [GiNaC::atanh](#) (const numeric &x)
Numeric inverse hyperbolic tangent (trigonometric function).
- static cln::cl_N [GiNaC::Li2_series](#) (const cln::cl_N &x, const cln::float_format_t &prec)
Numeric evaluation of Dilogarithm within circle of convergence (unit circle) using a power series.
- static cln::cl_N [GiNaC::Li2_projection](#) (const cln::cl_N &x, const cln::float_format_t &prec)
Folds Li2's argument inside a small rectangle to enhance convergence.
- const cln::cl_N [GiNaC::Li2_](#) (const cln::cl_N &value)
Numeric evaluation of Dilogarithm.
- const numeric [GiNaC::Li2](#) (const numeric &x)
- const numeric [GiNaC::zeta](#) (const numeric &x)
Numeric evaluation of Riemann's Zeta function.
- static cln::float_format_t [GiNaC::guess_precision](#) (const cln::cl_N &x)
- const cln::cl_N [GiNaC::lgamma](#) (const cln::cl_N &x)
The Gamma function.
- const numeric [GiNaC::lgamma](#) (const numeric &x)
- const cln::cl_N [GiNaC::tgamma](#) (const cln::cl_N &x)
- const numeric [GiNaC::tgamma](#) (const numeric &x)
- const numeric [GiNaC::psi](#) (const numeric &x)
The psi function (aka polygamma function).
- const numeric [GiNaC::psi](#) (const numeric &n, const numeric &x)
The psi functions (aka polygamma functions).
- const numeric [GiNaC::factorial](#) (const numeric &n)
Factorial combinatorial function.
- const numeric [GiNaC::doublefactorial](#) (const numeric &n)
The double factorial combinatorial function.
- const numeric [GiNaC::binomial](#) (const numeric &n, const numeric &k)
The Binomial coefficients.

- const numeric [GiNaC::bernoulli](#) (const numeric &nn)
Bernoulli number.
- const numeric [GiNaC::fibonacci](#) (const numeric &n)
Fibonacci number.
- const numeric [GiNaC::abs](#) (const numeric &x)
Absolute value.
- const numeric [GiNaC::mod](#) (const numeric &a, const numeric &b)
Modulus (in positive representation).
- const numeric [GiNaC::smod](#) (const numeric &a_, const numeric &b_)
Modulus (in symmetric representation).
- const numeric [GiNaC::irem](#) (const numeric &a, const numeric &b)
Numeric integer remainder.
- const numeric [GiNaC::irem](#) (const numeric &a, const numeric &b, numeric &q)
Numeric integer remainder.
- const numeric [GiNaC::iquo](#) (const numeric &a, const numeric &b)
Numeric integer quotient.
- const numeric [GiNaC::iquo](#) (const numeric &a, const numeric &b, numeric &r)
Numeric integer quotient.
- const numeric [GiNaC::gcd](#) (const numeric &a, const numeric &b)
Greatest Common Divisor.
- const numeric [GiNaC::lcm](#) (const numeric &a, const numeric &b)
Least Common Multiple.
- const numeric [GiNaC::sqrt](#) (const numeric &x)
Numeric square root.
- const numeric [GiNaC::isqrt](#) (const numeric &x)
Integer numeric square root.
- ex [GiNaC::PiEvalf](#) ()
Floating point evaluation of Archimedes' constant Pi.
- ex [GiNaC::EulerEvalf](#) ()
Floating point evaluation of Euler's constant gamma.
- ex [GiNaC::CatalanEvalf](#) ()
Floating point evaluation of Catalan's constant.
- std::ostream & [GiNaC::operator<<](#) (std::ostream &os, const _numeric_digits &e)

Variables

- const numeric [GiNaC::I](#) = numeric(cln::complex(cln::cl_I(0),cln::cl_I(1)))
Imaginary unit.
- _numeric_digits [GiNaC::Digits](#)
Accuracy in decimal digits.

7.64.1 Detailed Description

This file contains the interface to the underlying bignum package.

Its most important design principle is to completely hide the inner working of that other package from the user of [GiNaC](#). It must either provide implementation of arithmetic operators and numerical evaluation of special functions or implement the interface to the bignum package.

7.65 numeric.h File Reference

Makes the interface to the underlying bignum package available.

```
#include "basic.h"
#include "ex.h"
#include "archive.h"
#include <cln/complex.h>
#include <stdexcept>
#include <vector>
```

Classes

- class [GiNaC::numeric_digits](#)
This class is used to instantiate a global singleton object Digits which behaves just like Maple's Digits.
- class [GiNaC::pole_error](#)
Exception class thrown when a singularity is encountered.
- class [GiNaC::numeric](#)
This class is a wrapper around CLN-numbers within the [GiNaC](#) class hierarchy.

Namespaces

- namespace [GiNaC](#)

Typedefs

- typedef void(* [GiNaC::digits_changed_callback](#)) (long)
Function pointer to implement callbacks in the case 'Digits' gets changed.

Functions

- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (numeric)
- const numeric [GiNaC::exp](#) (const numeric &x)
Exponential function.
- const numeric [GiNaC::log](#) (const numeric &x)
Natural logarithm.
- const numeric [GiNaC::sin](#) (const numeric &x)
Numeric sine (trigonometric function).
- const numeric [GiNaC::cos](#) (const numeric &x)
Numeric cosine (trigonometric function).
- const numeric [GiNaC::tan](#) (const numeric &x)
Numeric tangent (trigonometric function).
- const numeric [GiNaC::asin](#) (const numeric &x)
Numeric inverse sine (trigonometric function).
- const numeric [GiNaC::acos](#) (const numeric &x)
Numeric inverse cosine (trigonometric function).
- const numeric [GiNaC::atan](#) (const numeric &x)
Numeric arcustangent.

- const numeric [GiNaC::atan](#) (const numeric &y, const numeric &x)
Numeric arcustangent of two arguments, analytically continued in a suitable way.
- const numeric [GiNaC::sinh](#) (const numeric &x)
Numeric hyperbolic sine (trigonometric function).
- const numeric [GiNaC::cosh](#) (const numeric &x)
Numeric hyperbolic cosine (trigonometric function).
- const numeric [GiNaC::tanh](#) (const numeric &x)
Numeric hyperbolic tangent (trigonometric function).
- const numeric [GiNaC::asinh](#) (const numeric &x)
Numeric inverse hyperbolic sine (trigonometric function).
- const numeric [GiNaC::acosh](#) (const numeric &x)
Numeric inverse hyperbolic cosine (trigonometric function).
- const numeric [GiNaC::atanh](#) (const numeric &x)
Numeric inverse hyperbolic tangent (trigonometric function).
- const numeric [GiNaC::Li2](#) (const numeric &x)
- const numeric [GiNaC::zeta](#) (const numeric &x)
Numeric evaluation of Riemann's Zeta function.
- const numeric [GiNaC::lgamma](#) (const numeric &x)
- const numeric [GiNaC::tgamma](#) (const numeric &x)
- const numeric [GiNaC::psi](#) (const numeric &x)
The psi function (aka polygamma function).
- const numeric [GiNaC::psi](#) (const numeric &n, const numeric &x)
The psi functions (aka polygamma functions).
- const numeric [GiNaC::factorial](#) (const numeric &n)
Factorial combinatorial function.
- const numeric [GiNaC::doublefactorial](#) (const numeric &n)
The double factorial combinatorial function.
- const numeric [GiNaC::binomial](#) (const numeric &n, const numeric &k)
The Binomial coefficients.
- const numeric [GiNaC::bernoulli](#) (const numeric &nn)
Bernoulli number.
- const numeric [GiNaC::fibonacci](#) (const numeric &n)
Fibonacci number.
- const numeric [GiNaC::isqrt](#) (const numeric &x)
Integer numeric square root.
- const numeric [GiNaC::sqrt](#) (const numeric &x)
Numeric square root.
- const numeric [GiNaC::abs](#) (const numeric &x)
Absolute value.
- const numeric [GiNaC::mod](#) (const numeric &a, const numeric &b)
Modulus (in positive representation).
- const numeric [GiNaC::smod](#) (const numeric &a_, const numeric &b_)
Modulus (in symmetric representation).
- const numeric [GiNaC::irem](#) (const numeric &a, const numeric &b)
Numeric integer remainder.
- const numeric [GiNaC::irem](#) (const numeric &a, const numeric &b, numeric &q)
Numeric integer remainder.
- const numeric [GiNaC::iquo](#) (const numeric &a, const numeric &b)
Numeric integer quotient.
- const numeric [GiNaC::iquo](#) (const numeric &a, const numeric &b, numeric &r)
Numeric integer quotient.

- const numeric [GiNaC::gcd](#) (const numeric &a, const numeric &b)
Greatest Common Divisor.
- const numeric [GiNaC::lcm](#) (const numeric &a, const numeric &b)
Least Common Multiple.
- const numeric [GiNaC::pow](#) (const numeric &x, const numeric &y)
- const numeric [GiNaC::inverse](#) (const numeric &x)
- numeric [GiNaC::step](#) (const numeric &x)
- int [GiNaC::csgn](#) (const numeric &x)
- bool [GiNaC::is_zero](#) (const numeric &x)
- bool [GiNaC::is_positive](#) (const numeric &x)
- bool [GiNaC::is_negative](#) (const numeric &x)
- bool [GiNaC::is_integer](#) (const numeric &x)
- bool [GiNaC::is_pos_integer](#) (const numeric &x)
- bool [GiNaC::is_nonneg_integer](#) (const numeric &x)
- bool [GiNaC::is_even](#) (const numeric &x)
- bool [GiNaC::is_odd](#) (const numeric &x)
- bool [GiNaC::is_prime](#) (const numeric &x)
- bool [GiNaC::is_rational](#) (const numeric &x)
- bool [GiNaC::is_real](#) (const numeric &x)
- bool [GiNaC::is_cinteger](#) (const numeric &x)
- bool [GiNaC::is_crational](#) (const numeric &x)
- int [GiNaC::to_int](#) (const numeric &x)
- long [GiNaC::to_long](#) (const numeric &x)
- double [GiNaC::to_double](#) (const numeric &x)
- const numeric [GiNaC::real](#) (const numeric &x)
- const numeric [GiNaC::imag](#) (const numeric &x)
- const numeric [GiNaC::numer](#) (const numeric &x)
- const numeric [GiNaC::denom](#) (const numeric &x)
- ex [GiNaC::PiEvalf](#) ()
Floating point evaluation of Archimedes' constant Pi.
- ex [GiNaC::EulerEvalf](#) ()
Floating point evaluation of Euler's constant gamma.
- ex [GiNaC::CatalanEvalf](#) ()
Floating point evaluation of Catalan's constant.

7.65.1 Detailed Description

Makes the interface to the underlying bignum package available.

7.66 operators.cpp File Reference

Implementation of [GiNaC](#)'s overloaded operators.

```
#include "operators.h"
#include "numeric.h"
#include "add.h"
#include "mul.h"
#include "power.h"
#include "ncmul.h"
#include "relational.h"
#include "print.h"
#include "utils.h"
#include <iostream>
```

Namespaces

- namespace [GiNaC](#)

Enumerations

- enum { [GiNaC::callback_registered](#) = 1 }

Functions

- static const ex [GiNaC::exadd](#) (const ex &lh, const ex &rh)
Used internally by [operator+\(\)](#) to add two ex objects.
- static const ex [GiNaC::exmul](#) (const ex &lh, const ex &rh)
Used internally by [operator\(\)](#) to multiply two ex objects.*
- static const ex [GiNaC::exminus](#) (const ex &lh)
Used internally by [operator-\(\)](#) and friends to change the sign of an argument.
- const ex [GiNaC::operator+](#) (const ex &lh, const ex &rh)
- const ex [GiNaC::operator-](#) (const ex &lh, const ex &rh)
- const ex [GiNaC::operator*](#) (const ex &lh, const ex &rh)
- const ex [GiNaC::operator/](#) (const ex &lh, const ex &rh)
- const numeric [GiNaC::operator+](#) (const numeric &lh, const numeric &rh)
- const numeric [GiNaC::operator-](#) (const numeric &lh, const numeric &rh)
- const numeric [GiNaC::operator*](#) (const numeric &lh, const numeric &rh)
- const numeric [GiNaC::operator/](#) (const numeric &lh, const numeric &rh)
- ex & [GiNaC::operator+=](#) (ex &lh, const ex &rh)
- ex & [GiNaC::operator-=](#) (ex &lh, const ex &rh)
- ex & [GiNaC::operator*=](#) (ex &lh, const ex &rh)
- ex & [GiNaC::operator/=](#) (ex &lh, const ex &rh)
- numeric & [GiNaC::operator+=](#) (numeric &lh, const numeric &rh)
- numeric & [GiNaC::operator-=](#) (numeric &lh, const numeric &rh)
- numeric & [GiNaC::operator*=](#) (numeric &lh, const numeric &rh)
- numeric & [GiNaC::operator/=](#) (numeric &lh, const numeric &rh)
- const ex [GiNaC::operator+](#) (const ex &lh)
- const ex [GiNaC::operator-](#) (const ex &lh)
- const numeric [GiNaC::operator+](#) (const numeric &lh)
- const numeric [GiNaC::operator-](#) (const numeric &lh)
- ex & [GiNaC::operator++](#) (ex &rh)
Expression prefix increment.
- ex & [GiNaC::operator--](#) (ex &rh)
Expression prefix decrement.
- const ex [GiNaC::operator++](#) (ex &lh, int)
Expression postfix increment.
- const ex [GiNaC::operator--](#) (ex &lh, int)
Expression postfix decrement.
- numeric & [GiNaC::operator++](#) (numeric &rh)
Numeric prefix increment.
- numeric & [GiNaC::operator--](#) (numeric &rh)
Numeric prefix decrement.
- const numeric [GiNaC::operator++](#) (numeric &lh, int)
Numeric postfix increment.
- const numeric [GiNaC::operator--](#) (numeric &lh, int)

Numeric postfix decrement.

- const relational [GiNaC::operator==](#) (const ex &lh, const ex &rh)
- const relational [GiNaC::operator!=](#) (const ex &lh, const ex &rh)
- const relational [GiNaC::operator<](#) (const ex &lh, const ex &rh)
- const relational [GiNaC::operator<=](#) (const ex &lh, const ex &rh)
- const relational [GiNaC::operator>](#) (const ex &lh, const ex &rh)
- const relational [GiNaC::operator>=](#) (const ex &lh, const ex &rh)
- static int [GiNaC::my_ios_index](#) ()
- static void [GiNaC::my_ios_callback](#) (std::ios_base::event ev, std::ios_base &s, int i)
- static print_context * [GiNaC::get_print_context](#) (std::ios_base &s)
- static void [GiNaC::set_print_context](#) (std::ios_base &s, const print_context &c)
- static unsigned [GiNaC::get_print_options](#) (std::ios_base &s)
- static void [GiNaC::set_print_options](#) (std::ostream &s, unsigned options)
- std::ostream & [GiNaC::operator<<](#) (std::ostream &os, const ex &e)
- std::ostream & [GiNaC::operator<<](#) (std::ostream &os, const exvector &e)
- std::ostream & [GiNaC::operator<<](#) (std::ostream &os, const exset &e)
- std::ostream & [GiNaC::operator<<](#) (std::ostream &os, const exmap &e)
- std::istream & [GiNaC::operator>>](#) (std::istream &is, ex &e)
- std::ostream & [GiNaC::dflt](#) (std::ostream &os)
- std::ostream & [GiNaC::latex](#) (std::ostream &os)
- std::ostream & [GiNaC::python](#) (std::ostream &os)
- std::ostream & [GiNaC::python_repr](#) (std::ostream &os)
- std::ostream & [GiNaC::tree](#) (std::ostream &os)
- std::ostream & [GiNaC::csrc](#) (std::ostream &os)
- std::ostream & [GiNaC::csrc_float](#) (std::ostream &os)
- std::ostream & [GiNaC::csrc_double](#) (std::ostream &os)
- std::ostream & [GiNaC::csrc_cl_N](#) (std::ostream &os)
- std::ostream & [GiNaC::index_dimensions](#) (std::ostream &os)
- std::ostream & [GiNaC::no_index_dimensions](#) (std::ostream &os)

7.66.1 Detailed Description

Implementation of [GiNaC](#)'s overloaded operators.

7.67 operators.h File Reference

Interface to [GiNaC](#)'s overloaded operators.

```
#include <iosfwd>
```

Namespaces

- namespace [GiNaC](#)

Functions

- const ex [GiNaC::operator+](#) (const ex &lh, const ex &rh)
- const ex [GiNaC::operator-](#) (const ex &lh, const ex &rh)
- const ex [GiNaC::operator*](#) (const ex &lh, const ex &rh)
- const ex [GiNaC::operator/](#) (const ex &lh, const ex &rh)
- const numeric [GiNaC::operator+](#) (const numeric &lh, const numeric &rh)
- const numeric [GiNaC::operator-](#) (const numeric &lh, const numeric &rh)
- const numeric [GiNaC::operator*](#) (const numeric &lh, const numeric &rh)
- const numeric [GiNaC::operator/](#) (const numeric &lh, const numeric &rh)
- ex & [GiNaC::operator+=](#) (ex &lh, const ex &rh)
- ex & [GiNaC::operator-=](#) (ex &lh, const ex &rh)
- ex & [GiNaC::operator*=](#) (ex &lh, const ex &rh)
- ex & [GiNaC::operator/=](#) (ex &lh, const ex &rh)
- numeric & [GiNaC::operator+=](#) (numeric &lh, const numeric &rh)
- numeric & [GiNaC::operator-=](#) (numeric &lh, const numeric &rh)
- numeric & [GiNaC::operator*=](#) (numeric &lh, const numeric &rh)
- numeric & [GiNaC::operator/=](#) (numeric &lh, const numeric &rh)
- const ex [GiNaC::operator+](#) (const ex &lh)
- const ex [GiNaC::operator-](#) (const ex &lh)
- const numeric [GiNaC::operator+](#) (const numeric &lh)
- const numeric [GiNaC::operator-](#) (const numeric &lh)
- ex & [GiNaC::operator++](#) (ex &rh)
- Expression prefix increment.*
- ex & [GiNaC::operator--](#) (ex &rh)
- Expression prefix decrement.*
- const ex [GiNaC::operator++](#) (ex &lh, int)
- Expression postfix increment.*
- const ex [GiNaC::operator--](#) (ex &lh, int)
- Expression postfix decrement.*
- numeric & [GiNaC::operator++](#) (numeric &rh)
- Numeric prefix increment.*
- numeric & [GiNaC::operator--](#) (numeric &rh)
- Numeric prefix decrement.*
- const numeric [GiNaC::operator++](#) (numeric &lh, int)
- Numeric postfix increment.*
- const numeric [GiNaC::operator--](#) (numeric &lh, int)
- Numeric postfix decrement.*
- const relational [GiNaC::operator==](#) (const ex &lh, const ex &rh)
- const relational [GiNaC::operator!=](#) (const ex &lh, const ex &rh)
- const relational [GiNaC::operator<](#) (const ex &lh, const ex &rh)
- const relational [GiNaC::operator<=](#) (const ex &lh, const ex &rh)
- const relational [GiNaC::operator>](#) (const ex &lh, const ex &rh)
- const relational [GiNaC::operator>=](#) (const ex &lh, const ex &rh)
- std::ostream & [GiNaC::operator<<](#) (std::ostream &os, const ex &e)
- std::istream & [GiNaC::operator>>](#) (std::istream &is, ex &e)
- std::ostream & [GiNaC::dflt](#) (std::ostream &os)
- std::ostream & [GiNaC::latex](#) (std::ostream &os)
- std::ostream & [GiNaC::python](#) (std::ostream &os)
- std::ostream & [GiNaC::python_repr](#) (std::ostream &os)
- std::ostream & [GiNaC::tree](#) (std::ostream &os)
- std::ostream & [GiNaC::csrc](#) (std::ostream &os)
- std::ostream & [GiNaC::csrc_float](#) (std::ostream &os)
- std::ostream & [GiNaC::csrc_double](#) (std::ostream &os)
- std::ostream & [GiNaC::csrc_cl_N](#) (std::ostream &os)
- std::ostream & [GiNaC::index_dimensions](#) (std::ostream &os)
- std::ostream & [GiNaC::no_index_dimensions](#) (std::ostream &os)

7.67.1 Detailed Description

Interface to [GiNaC](#)'s overloaded operators.

7.68 power.cpp File Reference

Implementation of [GiNaC](#)'s symbolic exponentiation ($\text{basis}^{\text{exponent}}$).

```
#include "power.h"
#include "expairseq.h"
#include "add.h"
#include "mul.h"
#include "ncmul.h"
#include "numeric.h"
#include "constant.h"
#include "operators.h"
#include "inifcns.h"
#include "matrix.h"
#include "indexed.h"
#include "symbol.h"
#include "lst.h"
#include "archive.h"
#include "utils.h"
#include "relational.h"
#include "compiler.h"
#include <iostream>
#include <limits>
#include <stdexcept>
#include <vector>
#include <algorithm>
```

Namespaces

- namespace [GiNaC](#)

Functions

- [GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) (power, basic, print_func< print_dflt >(&power::do_print_dflt). print_func< print_latex >(&power::do_print_latex). print_func< print_csrc >(&power::do_print_csrc). print_func< print_python >(&power::do_print_python). print_func< print_python_repr >(&power::do_print_python_repr). print_func< print_csrc_cl_N >(&power::do_print_csrc_cl_N)) power
- static void [GiNaC::print_sym_pow](#) (const print_context &c, const symbol &x, int exp)
- bool [GiNaC::tryfactsubs](#) (const ex &origfactor, const ex &patternfactor, int &nummatches, exmap &repls)
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (power)

7.68.1 Detailed Description

Implementation of [GiNaC](#)'s symbolic exponentiation ($\text{basis}^{\text{exponent}}$).

7.69 power.h File Reference

Interface to [GiNaC](#)'s symbolic exponentiation ($\text{basis}^{\text{exponent}}$).

```
#include "basic.h"
#include "ex.h"
#include "archive.h"
```

Classes

- class [GiNaC::power](#)

This class holds a two-component object, a basis and an exponent representing exponentiation.

Namespaces

- namespace [GiNaC](#)

Functions

- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (power)
- ex [GiNaC::pow](#) (const ex &b, const ex &e)
Symbolic exponentiation.
- template<typename T1, typename T2 >
ex [GiNaC::pow](#) (const T1 &b, const T2 &e)
- ex [GiNaC::sqrt](#) (const ex &a)
Square root expression.

7.69.1 Detailed Description

Interface to [GiNaC](#)'s symbolic exponentiation ($\text{basis}^{\text{exponent}}$).

7.70 print.cpp File Reference

Implementation of helper classes for expression output.

```
#include "print.h"
#include <iostream>
```

Namespaces

- namespace [GiNaC](#)

Variables

- unsigned [GiNaC::next_print_context_id](#) = 0
Next free ID for [print_context](#) types.

7.70.1 Detailed Description

Implementation of helper classes for expression output.

7.71 print.h File Reference

Definition of helper classes for expression output.

```
#include "class_info.h"
#include <iosfwd>
#include <memory>
#include <string>
```

Classes

- class [GiNaC::print_context_options](#)
This class stores information about a registered [print_context](#) class.
- class [GiNaC::print_options](#)
Flags to control the behavior of a [print_context](#).
- class [GiNaC::print_context](#)
Base class for [print_contexts](#).
- class [GiNaC::print_dflt](#)
Context for default (ginsh-parsable) output.
- class [GiNaC::print_latex](#)
Context for latex-parsable output.
- class [GiNaC::print_python](#)
Context for python pretty-print output.
- class [GiNaC::print_python_repr](#)
Context for python-parsable output.
- class [GiNaC::print_tree](#)
Context for tree-like output for debugging.
- class [GiNaC::print_csrc](#)
Base context for C source output.
- class [GiNaC::print_csrc_float](#)
Context for C source output using float precision.
- class [GiNaC::print_csrc_double](#)
Context for C source output using double precision.
- class [GiNaC::print_csrc_cl_N](#)
Context for C source output using CLN numbers.
- class [GiNaC::print_functor_impl](#)
Base class for [print_functor](#) handlers.
- class [GiNaC::print_ptrfun_handler< T, C >](#)
*[print_functor](#) handler for pointer-to-functions of class *T*, context type *C**
- class [GiNaC::print_memfun_handler< T, C >](#)
*[print_functor](#) handler for member functions of class *T*, context type *C**
- class [GiNaC::print_functor](#)
This class represents a print method for a certain algebraic class and [print_context](#) type.

Namespaces

- namespace [GiNaC](#)

Macros

- `#define GINAC_DECLARE_PRINT_CONTEXT_COMMON(classname)`
Common part of `GINAC_DECLARE_PRINT_CONTEXT_BASE` and `GINAC_DECLARE_PRINT_CONTEXT_DERIVED`.
- `#define GINAC_DECLARE_PRINT_CONTEXT_BASE(classname)`
- `#define GINAC_DECLARE_PRINT_CONTEXT(classname, surname)`
Macro for inclusion in the declaration of a `print_context` class.
- `#define GINAC_IMPLEMENT_PRINT_CONTEXT(classname, surname)`
Macro for inclusion in the implementation of each `print_context` class.

Typedefs

- `typedef class_info< print_context_options > GiNaC::print_context_class_info`

Functions

- `template<class T >`
`bool GiNaC::is_a (const print_context &obj)`
Check if `obj` is a `T`, including base classes.

7.71.1 Detailed Description

Definition of helper classes for expression output.

7.71.2 Macro Definition Documentation

7.71.2.1 `GINAC_DECLARE_PRINT_CONTEXT_COMMON`

```
#define GINAC_DECLARE_PRINT_CONTEXT_COMMON(  
    classname )
```

Value:

```
public: \
    friend class function_options; \
    friend class registered_class_options; \
    static const GiNaC::print\_context\_class\_info &get_class_info_static(); \
    classname();
```

Common part of `GINAC_DECLARE_PRINT_CONTEXT_BASE` and `GINAC_DECLARE_PRINT_CONTEXT_DERIVED`.

7.71.2.2 GINAC_DECLARE_PRINT_CONTEXT_BASE

```
#define GINAC_DECLARE_PRINT_CONTEXT_BASE(  
    classname )
```

Value:

```
GINAC_DECLARE_PRINT_CONTEXT_COMMON(classname) \  
virtual const GiNaC::print_context_class_info &get_class_info() const { return  
    classname::get_class_info_static(); } \  
virtual const char *class_name() const { return classname::get_class_info_static().options.get_name(); }  
\  
virtual classname * duplicate() const { return new classname(*this); } \  
private:
```

7.71.2.3 GINAC_DECLARE_PRINT_CONTEXT

```
#define GINAC_DECLARE_PRINT_CONTEXT(  
    classname,  
    supertype )
```

Value:

```
GINAC_DECLARE_PRINT_CONTEXT_COMMON(classname) \  
typedef supertype inherited; \  
const GiNaC::print_context_class_info &get_class_info() const override { return  
    classname::get_class_info_static(); } \  
const char *class_name() const override { return classname::get_class_info_static().options.get_name();  
} \  
classname * duplicate() const override { return new classname(*this); } \  
private:
```

Macro for inclusion in the declaration of a `print_context` class.

It declares some functions that are common to all classes derived from 'print_context' as well as all required stuff for the [GiNaC](#) registry.

7.71.2.4 GINAC_IMPLEMENT_PRINT_CONTEXT

```
#define GINAC_IMPLEMENT_PRINT_CONTEXT(  
    classname,  
    supertype )
```

Value:

```
const GiNaC::print_context_class_info &classname::get_class_info_static() \  
{ \  
    static GiNaC::print_context_class_info reg_info =  
        GiNaC::print_context_class_info(GiNaC::print_context_options(#classname, #supertype,  
        GiNaC::next_print_context_id++)); \  
    return reg_info; \  
}
```

Macro for inclusion in the implementation of each `print_context` class.

7.72 pseries.cpp File Reference

Implementation of class for extended truncated power series and methods for series expansion.

```
#include "pseries.h"
#include "add.h"
#include "inifcns.h"
#include "lst.h"
#include "mul.h"
#include "power.h"
#include "relational.h"
#include "operators.h"
#include "symbol.h"
#include "integral.h"
#include "archive.h"
#include "utils.h"
#include <limits>
#include <numeric>
#include <stdexcept>
```

Namespaces

- namespace [GiNaC](#)

Functions

- [GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) (pseries, basic, print_func< print_context >(&pseries::do_print). print_func< print_latex >(&pseries::do_print_latex). print_func< print_tree >(&pseries::do_print_tree). print_func< print_python >(&pseries::do_print_python). print_func< print_python_repr >(&pseries::do_print_python_repr)) pseries
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (pseries)

7.72.1 Detailed Description

Implementation of class for extended truncated power series and methods for series expansion.

7.73 pseries.h File Reference

Interface to class for extended truncated power series.

```
#include "basic.h"
#include "expairseq.h"
```

Classes

- class [GiNaC::pseries](#)

This class holds a extended truncated power series (positive and negative integer powers).

Namespaces

- namespace [GiNaC](#)

Functions

- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (pseries)
- ex [GiNaC::series_to_poly](#) (const ex &e)
Convert the pseries object embedded in an expression to an ordinary polynomial in the expansion variable.
- bool [GiNaC::is_terminating](#) (const pseries &s)

7.73.1 Detailed Description

Interface to class for extended truncated power series.

7.74 ptr.h File Reference

Reference-counted pointer template.

```
#include "assertion.h"
#include <cstddef>
#include <functional>
#include <iosfwd>
```

Classes

- class [GiNaC::refcounted](#)
Base class for reference-counted objects.
- class [GiNaC::ptr< T >](#)
Class of (intrusively) reference-counted pointers that support copy-on-write semantics.
- struct [std::less< GiNaC::ptr< T > >](#)
Specialization of std::less for ptr<T> to enable ordering of ptr<T> objects (e.g.

Namespaces

- namespace [GiNaC](#)
- namespace [std](#)

7.74.1 Detailed Description

Reference-counted pointer template.

7.75 registrar.cpp File Reference

GiNaC's class registrar (for class basic and all classes derived from it).

```
#include "registrar.h"
#include <map>
#include <stdexcept>
#include <string>
```

Namespaces

- namespace [GiNaC](#)

7.75.1 Detailed Description

GiNaC's class registrar (for class basic and all classes derived from it).

7.76 registrar.h File Reference

GiNaC's class registrar (for class basic and all classes derived from it).

```
#include "class_info.h"
#include "print.h"
#include <list>
#include <string>
#include <typeinfo>
#include <vector>
```

Classes

- struct [GiNaC::return_type_t](#)
To distinguish between different kinds of non-commutative objects.
- class [GiNaC::registered_class_options](#)
This class stores information about a registered [GiNaC](#) class.

Namespaces

- namespace [GiNaC](#)

Macros

- #define [GINAC_DECLARE_REGISTERED_CLASS_COMMON](#)(classname)
Common part of GINAC_DECLARE_REGISTERED_CLASS_NO_CTORS and GINAC_DECLARE_REGISTERED_CLASS.
- #define [GINAC_DECLARE_REGISTERED_CLASS_NO_CTORS](#)(classname, supertype)
Primary macro for inclusion in the declaration of each registered class.
- #define [GINAC_DECLARE_REGISTERED_CLASS](#)(classname, supertype)
Macro for inclusion in the declaration of each registered class.
- #define [GINAC_IMPLEMENT_REGISTERED_CLASS](#)(classname, supertype) [GiNaC::registered_class_info](#) classname::reg_info = [GiNaC::registered_class_info](#)([GiNaC::registered_class_options](#)(#classname, #supertype, typeid(classname)));
Macro for inclusion in the implementation of each registered class.
- #define [GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#)(classname, supertype, options) [GiNaC::registered_class_info](#) classname::reg_info = [GiNaC::registered_class_info](#)([GiNaC::registered_class_options](#)(#classname, #supertype, typeid(classname)).options);
Macro for inclusion in the implementation of each registered class.
- #define [GINAC_IMPLEMENT_REGISTERED_CLASS_OPT_T](#)(classname, supertype, options) [GiNaC::registered_class_info](#) classname::reg_info = [GiNaC::registered_class_info](#)([GiNaC::registered_class_options](#)(#classname, #supertype, typeid(classname)).options);
Macro for inclusion in the implementation of each registered class.

Typedefs

- typedef class_info< registered_class_options > [GiNaC::registered_class_info](#)

Functions

- template<typename T >
return_type_t [GiNaC::make_return_type_t](#) (const unsigned rl=0)
- template<class Alg, class Ctx, class T, class C >
void [GiNaC::set_print_func](#) (void f(const T &, const C &, unsigned))
Add or replace a print method.
- template<class Alg, class Ctx, class T, class C >
void [GiNaC::set_print_func](#) (void(T::*f)(const C &, unsigned))
Add or replace a print method.

7.76.1 Detailed Description

[GiNaC](#)'s class registrar (for class basic and all classes derived from it).

7.76.2 Macro Definition Documentation

7.76.2.1 GINAC_DECLARE_REGISTERED_CLASS_COMMON

```
#define GINAC_DECLARE_REGISTERED_CLASS_COMMON(  
    classname )
```

Value:

```
private: \  
    static GiNaC::registered_class_info reg_info; \  
public: \  
    static GiNaC::registered_class_info &get_class_info_static() { return reg_info; } \  
    class visitor { \  
    public: \  
        virtual void visit(const classname &) = 0; \  
        virtual ~visitor() {}; \  
    };
```

Common part of GINAC_DECLARE_REGISTERED_CLASS_NO_CTORS and GINAC_DECLARE_REGISTERED_CLASS.

7.76.2.2 GINAC_DECLARE_REGISTERED_CLASS_NO_CTORS

```
#define GINAC_DECLARE_REGISTERED_CLASS_NO_CTORS(  
    classname,  
    supertype )
```

Value:

```
GINAC_DECLARE_REGISTERED_CLASS_COMMON(classname) \  
typedef supertype inherited; \  
virtual const GiNaC::registered_class_info &get_class_info() const { return  
    classname::get_class_info_static(); } \  
virtual GiNaC::registered_class_info &get_class_info() { return classname::get_class_info_static(); } \  
virtual const char *class_name() const { return classname::get_class_info_static().options.get_name(); } \  
private:
```

Primary macro for inclusion in the declaration of each registered class.

7.76.2.3 GINAC_DECLARE_REGISTERED_CLASS

```
#define GINAC_DECLARE_REGISTERED_CLASS(  
    classname,  
    supertype )
```

Value:

```
GINAC_DECLARE_REGISTERED_CLASS_COMMON(classname) \  
template<class B, typename... Args> friend B & dynallocate(Args &&... args); \  
typedef supertype inherited; \  
classname(); \  
classname * duplicate() const override { \  
    classname * bp = new classname(*this); \  
    bp->setflag(GiNaC::status_flags::dynallocated); \  
    return bp; \  
} \  
void accept(GiNaC::visitor & v) const override \  
{ \  
    if (visitor *p = dynamic_cast<visitor *>(&v)) \  
        p->visit(*this); \  
    else \  
        inherited::accept(v); \  
} \  
const GiNaC::registered_class_info &get_class_info() const override { return  
    classname::get_class_info_static(); } \
```

```

    GiNaC::registered_class_info &get_class_info() override { return classname::get_class_info_static(); } \
    const char *class_name() const override { return classname::get_class_info_static().options.get_name(); \
    } \
protected: \
    int compare_same_type(const GiNaC::basic & other) const override; \
private:

```

Macro for inclusion in the declaration of each registered class.

It declares some functions that are common to all classes derived from 'basic' as well as all required stuff for the [GiNaC](#) class registry (mainly needed for archiving).

7.76.2.4 GINAC_IMPLEMENT_REGISTERED_CLASS

```

#define GINAC_IMPLEMENT_REGISTERED_CLASS( \
    classname, \
    supertype ) GiNaC::registered_class_info classname::reg_info = GiNaC::registered_class_info(GiNaC \
    #supertype, typeid(classname));

```

Macro for inclusion in the implementation of each registered class.

7.76.2.5 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT

```

#define GINAC_IMPLEMENT_REGISTERED_CLASS_OPT( \
    classname, \
    supertype, \
    options ) GiNaC::registered_class_info classname::reg_info = GiNaC::registered_class_info(GiNaC \
    #supertype, typeid(classname)).options);

```

Macro for inclusion in the implementation of each registered class.

Additional options can be specified.

7.76.2.6 GINAC_IMPLEMENT_REGISTERED_CLASS_OPT_T

```

#define GINAC_IMPLEMENT_REGISTERED_CLASS_OPT_T( \
    classname, \
    supertype, \
    options ) GiNaC::registered_class_info classname::reg_info = GiNaC::registered_class_info(GiNaC \
    #supertype, typeid(classname)).options);

```

Macro for inclusion in the implementation of each registered class.

Additional options can be specified.

7.77 relational.cpp File Reference

Implementation of relations between expressions.

```
#include "relational.h"
#include "operators.h"
#include "numeric.h"
#include "archive.h"
#include "utils.h"
#include "hash_seed.h"
#include <iostream>
#include <stdexcept>
```

Namespaces

- namespace [GiNaC](#)

Functions

- [GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) (relational, basic, print_func< print_context >(&relational::do_print). print_func< print_tree >(&relational::do_print_tree). print_func< print_python_repr >(&relational::do_print_python_repr)) relational
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (relational)
- static void [GiNaC::print_operator](#) (const print_context &c, relational::operators o)

7.77.1 Detailed Description

Implementation of relations between expressions.

7.78 relational.h File Reference

Interface to relations between expressions.

```
#include "basic.h"
#include "ex.h"
#include "archive.h"
```

Classes

- class [GiNaC::relational](#)
This class holds a relation consisting of two expressions and a logical relation between them.
- struct [GiNaC::relational::safe_bool_helper](#)

Namespaces

- namespace [GiNaC](#)

Functions

- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (relational)

7.78.1 Detailed Description

Interface to relations between expressions.

7.79 remember.cpp File Reference

Implementation of helper classes for using the remember option in [GiNaC](#) functions.

```
#include "function.h"
#include "utils.h"
#include "remember.h"
#include <stdexcept>
```

Namespaces

- namespace [GiNaC](#)

7.79.1 Detailed Description

Implementation of helper classes for using the remember option in [GiNaC](#) functions.

7.80 remember.h File Reference

Interface to helper classes for using the remember option in [GiNaC](#) functions.

```
#include <iosfwd>
#include <list>
#include <vector>
```

Classes

- class [GiNaC::remember_table_entry](#)
A single entry in the remember table of a function.
- class [GiNaC::remember_table_list](#)
A list of entries in the remember table having some least significant bits of the hashvalue in common.
- class [GiNaC::remember_table](#)
The remember table is organized like an n-fold associative cache in a microprocessor.

Namespaces

- namespace [GiNaC](#)

7.80.1 Detailed Description

Interface to helper classes for using the remember option in [GiNaC](#) functions.

7.81 structure.h File Reference

Wrapper template for making [GiNaC](#) classes out of C++ structures.

```
#include "ex.h"
#include "ncmul.h"
#include "numeric.h"
#include "operators.h"
#include "print.h"
#include <functional>
```

Classes

- class [GiNaC::compare_all_equal< T >](#)
Comparison policy: all structures of one type are equal.
- class [GiNaC::compare_std_less< T >](#)
Comparison policy: use std::equal_to/std::less (defaults to operators == and <) to compare structures.
- class [GiNaC::compare_bitwise< T >](#)
Comparison policy: use bit-wise comparison to compare structures.
- class [GiNaC::structure< T, ComparisonPolicy >](#)
Wrapper template for making [GiNaC](#) classes out of C++ structures.

Namespaces

- namespace [GiNaC](#)

7.81.1 Detailed Description

Wrapper template for making [GiNaC](#) classes out of C++ structures.

7.82 symbol.cpp File Reference

Implementation of [GiNaC](#)'s symbolic objects.

```
#include "symbol.h"
#include "lst.h"
#include "archive.h"
#include "utils.h"
#include "hash_seed.h"
#include "inifcns.h"
#include <map>
#include <stdexcept>
#include <string>
```

Namespaces

- namespace [GiNaC](#)

Functions

- [GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) (symbol, basic, print_func< print_context >(&symbol::do_print). print_func< print_latex >(&symbol::do_print_latex). print_func< print_tree >(&symbol::do_print_tree). print_func< print_python_repr >(&symbol::do_print_python_repr)) symbol
- static const std::string & [GiNaC::get_default_TeX_name](#) (const std::string &name)
Return default TeX name for symbol.
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (symbol)
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (realsymbol)
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (possymbol)

7.82.1 Detailed Description

Implementation of [GiNaC](#)'s symbolic objects.

7.83 symbol.h File Reference

Interface to [GiNaC](#)'s symbolic objects.

```
#include "basic.h"
#include "ex.h"
#include "ptr.h"
#include "archive.h"
#include <string>
#include <typeinfo>
```

Classes

- class [GiNaC::symbol](#)
Basic CAS symbol.
- class [GiNaC::realsymbol](#)
Specialization of symbol to real domain.
- class [GiNaC::possymbol](#)
Specialization of symbol to real positive domain.

Namespaces

- namespace [GiNaC](#)

Functions

- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (symbol)
- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (realsymbol)
- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (possymbol)

7.83.1 Detailed Description

Interface to [GiNaC](#)'s symbolic objects.

7.84 symmetry.cpp File Reference

Implementation of [GiNaC](#)'s symmetry definitions.

```
#include "symmetry.h"
#include "lst.h"
#include "add.h"
#include "numeric.h"
#include "operators.h"
#include "archive.h"
#include "utils.h"
#include "hash_seed.h"
#include <functional>
#include <iostream>
#include <limits>
#include <stdexcept>
```

Classes

- class [GiNaC::sy_is_less](#)
- class [GiNaC::sy_swap](#)

Namespaces

- namespace [GiNaC](#)

Functions

- [GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) (symmetry, basic, print_func< print_context >(&symmetry::do_print). print_func< print_tree >(&symmetry::do_print_tree)) symmetry
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (symmetry)
- static const symmetry & [GiNaC::index0](#) ()
- static const symmetry & [GiNaC::index1](#) ()
- static const symmetry & [GiNaC::index2](#) ()
- static const symmetry & [GiNaC::index3](#) ()
- const symmetry & [GiNaC::not_symmetric](#) ()
- const symmetry & [GiNaC::symmetric2](#) ()
- const symmetry & [GiNaC::symmetric3](#) ()
- const symmetry & [GiNaC::symmetric4](#) ()
- const symmetry & [GiNaC::antisymmetric2](#) ()
- const symmetry & [GiNaC::antisymmetric3](#) ()
- const symmetry & [GiNaC::antisymmetric4](#) ()
- int [GiNaC::canonicalize](#) (exvector::iterator v, const symmetry &symm)
Canonicalize the order of elements of an expression vector, according to the symmetry properties defined in a symmetry tree.
- static ex [GiNaC::symm](#) (const ex &e, exvector::const_iterator first, exvector::const_iterator [last](#), bool asymmetric)
- ex [GiNaC::symmetrize](#) (const ex &e, exvector::const_iterator first, exvector::const_iterator [last](#))
Symmetrize expression over a set of objects (symbols, indices).
- ex [GiNaC::antisymmetrize](#) (const ex &e, exvector::const_iterator first, exvector::const_iterator [last](#))
Antisymmetrize expression over a set of objects (symbols, indices).
- ex [GiNaC::symmetrize_cyclic](#) (const ex &e, exvector::const_iterator first, exvector::const_iterator [last](#))
Symmetrize expression by cyclic permutation over a set of objects (symbols, indices).

7.84.1 Detailed Description

Implementation of [GiNaC](#)'s symmetry definitions.

7.85 symmetry.h File Reference

Interface to [GiNaC](#)'s symmetry definitions.

```
#include "ex.h"
#include "archive.h"
#include <set>
```

Classes

- class [GiNaC::symmetry](#)
This class describes the symmetry of a group of indices.

Namespaces

- namespace [GiNaC](#)

Functions

- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (symmetry)
- symmetry [GiNaC::sy_none](#) ()
- symmetry [GiNaC::sy_none](#) (const symmetry &c1, const symmetry &c2)
- symmetry [GiNaC::sy_none](#) (const symmetry &c1, const symmetry &c2, const symmetry &c3)
- symmetry [GiNaC::sy_none](#) (const symmetry &c1, const symmetry &c2, const symmetry &c3, const symmetry &c4)
- symmetry [GiNaC::sy_symm](#) ()
- symmetry [GiNaC::sy_symm](#) (const symmetry &c1, const symmetry &c2)
- symmetry [GiNaC::sy_symm](#) (const symmetry &c1, const symmetry &c2, const symmetry &c3)
- symmetry [GiNaC::sy_symm](#) (const symmetry &c1, const symmetry &c2, const symmetry &c3, const symmetry &c4)
- symmetry [GiNaC::sy_anti](#) ()
- symmetry [GiNaC::sy_anti](#) (const symmetry &c1, const symmetry &c2)
- symmetry [GiNaC::sy_anti](#) (const symmetry &c1, const symmetry &c2, const symmetry &c3)
- symmetry [GiNaC::sy_anti](#) (const symmetry &c1, const symmetry &c2, const symmetry &c3, const symmetry &c4)
- symmetry [GiNaC::sy_cycl](#) ()
- symmetry [GiNaC::sy_cycl](#) (const symmetry &c1, const symmetry &c2)
- symmetry [GiNaC::sy_cycl](#) (const symmetry &c1, const symmetry &c2, const symmetry &c3)
- symmetry [GiNaC::sy_cycl](#) (const symmetry &c1, const symmetry &c2, const symmetry &c3, const symmetry &c4)
- const symmetry & [GiNaC::not_symmetric](#) ()
- const symmetry & [GiNaC::symmetric2](#) ()
- const symmetry & [GiNaC::symmetric3](#) ()
- const symmetry & [GiNaC::symmetric4](#) ()
- const symmetry & [GiNaC::antisymmetric2](#) ()
- const symmetry & [GiNaC::antisymmetric3](#) ()
- const symmetry & [GiNaC::antisymmetric4](#) ()
- int [GiNaC::canonicalize](#) (exvector::iterator v, const symmetry &symm)
Canonicalize the order of elements of an expression vector, according to the symmetry properties defined in a symmetry tree.
- ex [GiNaC::symmetrize](#) (const ex &e, exvector::const_iterator first, exvector::const_iterator last)
Symmetrize expression over a set of objects (symbols, indices).
- ex [GiNaC::symmetrize](#) (const ex &e, const exvector &v)
Symmetrize expression over a set of objects (symbols, indices).
- ex [GiNaC::antisymmetrize](#) (const ex &e, exvector::const_iterator first, exvector::const_iterator last)
Antisymmetrize expression over a set of objects (symbols, indices).
- ex [GiNaC::antisymmetrize](#) (const ex &e, const exvector &v)
Antisymmetrize expression over a set of objects (symbols, indices).
- ex [GiNaC::symmetrize_cyclic](#) (const ex &e, exvector::const_iterator first, exvector::const_iterator last)
Symmetrize expression by cyclic permutation over a set of objects (symbols, indices).
- ex [GiNaC::symmetrize_cyclic](#) (const ex &e, const exvector &v)
Symmetrize expression by cyclic permutation over a set of objects (symbols, indices).

7.85.1 Detailed Description

Interface to [GiNaC](#)'s symmetry definitions.

7.86 tensor.cpp File Reference

Implementation of [GiNaC](#)'s special tensors.

```
#include "tensor.h"
#include "idx.h"
#include "indexed.h"
#include "symmetry.h"
#include "relational.h"
#include "operators.h"
#include "lst.h"
#include "numeric.h"
#include "matrix.h"
#include "archive.h"
#include "utils.h"
#include <iostream>
#include <stdexcept>
#include <vector>
```

Namespaces

- namespace [GiNaC](#)

Functions

- [GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) (tensdelta, tensor, print_func< print_dflt >(&tensdelta::do_print). print_func< print_latex >(&tensdelta::do_print_latex)) [GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#)(tensmetric
- [GiNaC::print_func< print_dflt >](#) (&tensmetric::do_print). print_func< print_latex >(&tensmetric
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (minkmetric)
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (tensepsilon)
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (tensdelta)
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (tensmetric)
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (spinmetric)
- ex [GiNaC::delta_tensor](#) (const ex &i1, const ex &i2)
Create a delta tensor with specified indices.
- ex [GiNaC::metric_tensor](#) (const ex &i1, const ex &i2)
Create a symmetric metric tensor with specified indices.
- ex [GiNaC::lorentz_g](#) (const ex &i1, const ex &i2, bool pos_sig=false)
Create a Minkowski metric tensor with specified indices.
- ex [GiNaC::spinor_metric](#) (const ex &i1, const ex &i2)
Create a spinor metric tensor with specified indices.
- ex [GiNaC::epsilon_tensor](#) (const ex &i1, const ex &i2)
Create an epsilon tensor in a Euclidean space with two indices.
- ex [GiNaC::epsilon_tensor](#) (const ex &i1, const ex &i2, const ex &i3)
Create an epsilon tensor in a Euclidean space with three indices.
- ex [GiNaC::lorentz_eps](#) (const ex &i1, const ex &i2, const ex &i3, const ex &i4, bool pos_sig=false)
Create an epsilon tensor in a Minkowski space with four indices.

7.86.1 Detailed Description

Implementation of [GiNaC](#)'s special tensors.

7.87 tensor.h File Reference

Interface to [GiNaC](#)'s special tensors.

```
#include "ex.h"
#include "archive.h"
```

Classes

- class [GiNaC::tensor](#)
This class holds one of [GiNaC](#)'s predefined special tensors such as the delta and the metric tensors.
- class [GiNaC::tensdelta](#)
This class represents the delta tensor.
- class [GiNaC::tensmetric](#)
This class represents a general metric tensor which can be used to raise/lower indices.
- class [GiNaC::minkmetric](#)
This class represents a Minkowski metric tensor.
- class [GiNaC::spinmetric](#)
This class represents an antisymmetric spinor metric tensor which can be used to raise/lower indices of 2-component Weyl spinors.
- class [GiNaC::tensepsilon](#)
This class represents the totally antisymmetric epsilon tensor.

Namespaces

- namespace [GiNaC](#)

Functions

- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (tensdelta)
- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (tensmetric)
- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (minkmetric)
- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (spinmetric)
- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (tensepsilon)
- ex [GiNaC::delta_tensor](#) (const ex &i1, const ex &i2)
Create a delta tensor with specified indices.
- ex [GiNaC::metric_tensor](#) (const ex &i1, const ex &i2)
Create a symmetric metric tensor with specified indices.
- ex [GiNaC::lorentz_g](#) (const ex &i1, const ex &i2, bool pos_sig=false)
Create a Minkowski metric tensor with specified indices.
- ex [GiNaC::spinor_metric](#) (const ex &i1, const ex &i2)
Create a spinor metric tensor with specified indices.
- ex [GiNaC::epsilon_tensor](#) (const ex &i1, const ex &i2)
Create an epsilon tensor in a Euclidean space with two indices.
- ex [GiNaC::epsilon_tensor](#) (const ex &i1, const ex &i2, const ex &i3)
Create an epsilon tensor in a Euclidean space with three indices.
- ex [GiNaC::lorentz_eps](#) (const ex &i1, const ex &i2, const ex &i3, const ex &i4, bool pos_sig=false)
Create an epsilon tensor in a Minkowski space with four indices.

7.87.1 Detailed Description

Interface to [GiNaC](#)'s special tensors.

7.88 utils.cpp File Reference

Implementation of several small and furry utilities needed within [GiNaC](#) but not of any interest to the user of the library.

```
#include "ex.h"
#include "numeric.h"
#include "utils.h"
#include "version.h"
```

Namespaces

- namespace [GiNaC](#)

Functions

- unsigned [GiNaC::log2](#) (unsigned n)
Integer binary logarithm.
- const numeric [GiNaC::multinomial_coefficient](#) (const std::vector< unsigned > &p)
*Compute the multinomial coefficient $n!/(p1!*p2!*...*pk!)$ where $n = p1+p2+...+pk$, i.e.*

Variables

- const int [GiNaC::version_major](#) = GINACLIB_MAJOR_VERSION
- const int [GiNaC::version_minor](#) = GINACLIB_MINOR_VERSION
- const int [GiNaC::version_micro](#) = GINACLIB_MICRO_VERSION
- const numeric * [GiNaC::_num_120_p](#)
- const ex [GiNaC::_ex_120](#) = ex(*_num_120_p)
- const numeric * [GiNaC::_num_60_p](#)
- const ex [GiNaC::_ex_60](#) = ex(*_num_60_p)
- const numeric * [GiNaC::_num_48_p](#)
- const ex [GiNaC::_ex_48](#) = ex(*_num_48_p)
- const numeric * [GiNaC::_num_30_p](#)
- const ex [GiNaC::_ex_30](#) = ex(*_num_30_p)
- const numeric * [GiNaC::_num_25_p](#)
- const ex [GiNaC::_ex_25](#) = ex(*_num_25_p)
- const numeric * [GiNaC::_num_24_p](#)
- const ex [GiNaC::_ex_24](#) = ex(*_num_24_p)
- const numeric * [GiNaC::_num_20_p](#)
- const ex [GiNaC::_ex_20](#) = ex(*_num_20_p)
- const numeric * [GiNaC::_num_18_p](#)
- const ex [GiNaC::_ex_18](#) = ex(*_num_18_p)
- const numeric * [GiNaC::_num_15_p](#)
- const ex [GiNaC::_ex_15](#) = ex(*_num_15_p)

- const numeric * [GiNaC::_num_12_p](#)
- const ex [GiNaC::_ex_12](#) = ex(*_num_12_p)
- const numeric * [GiNaC::_num_11_p](#)
- const ex [GiNaC::_ex_11](#) = ex(*_num_11_p)
- const numeric * [GiNaC::_num_10_p](#)
- const ex [GiNaC::_ex_10](#) = ex(*_num_10_p)
- const numeric * [GiNaC::_num_9_p](#)
- const ex [GiNaC::_ex_9](#) = ex(*_num_9_p)
- const numeric * [GiNaC::_num_8_p](#)
- const ex [GiNaC::_ex_8](#) = ex(*_num_8_p)
- const numeric * [GiNaC::_num_7_p](#)
- const ex [GiNaC::_ex_7](#) = ex(*_num_7_p)
- const numeric * [GiNaC::_num_6_p](#)
- const ex [GiNaC::_ex_6](#) = ex(*_num_6_p)
- const numeric * [GiNaC::_num_5_p](#)
- const ex [GiNaC::_ex_5](#) = ex(*_num_5_p)
- const numeric * [GiNaC::_num_4_p](#)
- const ex [GiNaC::_ex_4](#) = ex(*_num_4_p)
- const numeric * [GiNaC::_num_3_p](#)
- const ex [GiNaC::_ex_3](#) = ex(*_num_3_p)
- const numeric * [GiNaC::_num_2_p](#)
- const ex [GiNaC::_ex_2](#) = ex(*_num_2_p)
- const numeric * [GiNaC::_num_1_p](#)
- const ex [GiNaC::_ex_1](#) = ex(*_num_1_p)
- const numeric * [GiNaC::_num_1_2_p](#)
- const ex [GiNaC::_ex_1_2](#) = ex(*_num_1_2_p)
- const numeric * [GiNaC::_num_1_3_p](#)
- const ex [GiNaC::_ex_1_3](#) = ex(*_num_1_3_p)
- const numeric * [GiNaC::_num_1_4_p](#)
- const ex [GiNaC::_ex_1_4](#) = ex(*_num_1_4_p)
- const numeric * [GiNaC::_num0_p](#)
- const ex [GiNaC::_ex0](#) = ex(*_num0_p)
- const numeric * [GiNaC::_num1_4_p](#)
- const ex [GiNaC::_ex1_4](#) = ex(*_num1_4_p)
- const numeric * [GiNaC::_num1_3_p](#)
- const ex [GiNaC::_ex1_3](#) = ex(*_num1_3_p)
- const numeric * [GiNaC::_num1_2_p](#)
- const ex [GiNaC::_ex1_2](#) = ex(*_num1_2_p)
- const numeric * [GiNaC::_num1_p](#)
- const ex [GiNaC::_ex1](#) = ex(*_num1_p)
- const numeric * [GiNaC::_num2_p](#)
- const ex [GiNaC::_ex2](#) = ex(*_num2_p)
- const numeric * [GiNaC::_num3_p](#)
- const ex [GiNaC::_ex3](#) = ex(*_num3_p)
- const numeric * [GiNaC::_num4_p](#)
- const ex [GiNaC::_ex4](#) = ex(*_num4_p)
- const numeric * [GiNaC::_num5_p](#)
- const ex [GiNaC::_ex5](#) = ex(*_num5_p)
- const numeric * [GiNaC::_num6_p](#)
- const ex [GiNaC::_ex6](#) = ex(*_num6_p)
- const numeric * [GiNaC::_num7_p](#)
- const ex [GiNaC::_ex7](#) = ex(*_num7_p)
- const numeric * [GiNaC::_num8_p](#)
- const ex [GiNaC::_ex8](#) = ex(*_num8_p)
- const numeric * [GiNaC::_num9_p](#)

- const ex [GiNaC::_ex9](#) = ex(*_num9_p)
- const numeric * [GiNaC::_num10_p](#)
- const ex [GiNaC::_ex10](#) = ex(*_num10_p)
- const numeric * [GiNaC::_num11_p](#)
- const ex [GiNaC::_ex11](#) = ex(*_num11_p)
- const numeric * [GiNaC::_num12_p](#)
- const ex [GiNaC::_ex12](#) = ex(*_num12_p)
- const numeric * [GiNaC::_num15_p](#)
- const ex [GiNaC::_ex15](#) = ex(*_num15_p)
- const numeric * [GiNaC::_num18_p](#)
- const ex [GiNaC::_ex18](#) = ex(*_num18_p)
- const numeric * [GiNaC::_num20_p](#)
- const ex [GiNaC::_ex20](#) = ex(*_num20_p)
- const numeric * [GiNaC::_num24_p](#)
- const ex [GiNaC::_ex24](#) = ex(*_num24_p)
- const numeric * [GiNaC::_num25_p](#)
- const ex [GiNaC::_ex25](#) = ex(*_num25_p)
- const numeric * [GiNaC::_num30_p](#)
- const ex [GiNaC::_ex30](#) = ex(*_num30_p)
- const numeric * [GiNaC::_num48_p](#)
- const ex [GiNaC::_ex48](#) = ex(*_num48_p)
- const numeric * [GiNaC::_num60_p](#)
- const ex [GiNaC::_ex60](#) = ex(*_num60_p)
- const numeric * [GiNaC::_num120_p](#)
- const ex [GiNaC::_ex120](#) = ex(*_num120_p)

7.88.1 Detailed Description

Implementation of several small and furry utilities needed within [GiNaC](#) but not of any interest to the user of the library.

7.89 utils.h File Reference

Interface to several small and furry utilities needed within [GiNaC](#) but not of any interest to the user of the library.

```
#include "assertion.h"
#include <functional>
#include <cstdlib>
#include <string>
```

Classes

- class [GiNaC::dunno](#)
Exception class thrown by functions to signal unimplemented functionality so the expression may just be .hold()
- class [GiNaC::basic_partition_generator](#)
Base class for generating all bounded combinatorial partitions of an integer n with exactly m parts in non-decreasing order.
- struct [GiNaC::basic_partition_generator::mpartition2](#)
- class [GiNaC::partition_with_zero_parts_generator](#)
Generate all bounded combinatorial partitions of an integer n with exactly m parts (including zero parts) in non-decreasing order.
- class [GiNaC::partition_generator](#)
Generate all bounded combinatorial partitions of an integer n with exactly m parts (not including zero parts) in non-decreasing order.
- class [GiNaC::composition_generator](#)
Generate all compositions of a partition of an integer n , starting with the compositions which has non-decreasing order.
- struct [GiNaC::composition_generator::coolmulti](#)
- struct [GiNaC::composition_generator::coolmulti::element](#)

Namespaces

- namespace [GiNaC](#)

Macros

- `#define DEFAULT_CTOR(classname) classname::classname() { setflag(status_flags::evaluated | status_↔ flags::expanded); }`
- `#define DEFAULT_COMPARE(classname)`
- `#define DEFAULT_PRINT(classname, text)`
- `#define DEFAULT_PRINT_LATEX(classname, text, latex)`

Functions

- unsigned [GiNaC::log2](#) (unsigned n)
Integer binary logarithm.
- unsigned [GiNaC::rotate_left](#) (unsigned n)
Rotate bits of unsigned value by one bit to the left.
- `template<class T >`
int [GiNaC::compare_pointers](#) (const T *a, const T *b)
Compare two pointers (just to establish some sort of canonical order).
- unsigned [GiNaC::golden_ratio_hash](#) (uintptr_t n)
Truncated multiplication with golden ratio, for computing hash values.
- `template<class It >`
int [GiNaC::permutation_sign](#) (It first, It last)
- `template<class It, class Cmp, class Swap >`
int [GiNaC::permutation_sign](#) (It first, It last, Cmp comp, Swap swapit)
- `template<class It, class Cmp, class Swap >`
void [GiNaC::shaker_sort](#) (It first, It last, Cmp comp, Swap swapit)
- `template<class It, class Swap >`
void [GiNaC::cyclic_permutation](#) (It first, It last, It new_first, Swap swapit)
- const numeric [GiNaC::multinomial_coefficient](#) (const std::vector< unsigned > &p)
*Compute the multinomial coefficient $n!/(p_1! * p_2! * \dots * p_k!)$ where $n = p_1 + p_2 + \dots + p_k$, i.e.*

7.89.1 Detailed Description

Interface to several small and furry utilities needed within [GiNaC](#) but not of any interest to the user of the library.

7.89.2 Macro Definition Documentation

7.89.2.1 DEFAULT_CTOR

```
#define DEFAULT_CTOR(  
    classname ) classname::classname() { setflag(status_flags::evaluated | status_↔  
flags::expanded); }
```

7.89.2.2 DEFAULT_COMPARE

```
#define DEFAULT_COMPARE(  
    classname )
```

Value:

```
int classname::compare_same_type(const basic & other) const \  
{ \  
    /* by default, the objects are always identical */ \  
    return 0; \  
}
```

7.89.2.3 DEFAULT_PRINT

```
#define DEFAULT_PRINT(  
    classname,  
    text )
```

Value:

```
void classname::do_print(const print_context & c, unsigned level) const \  
{ \  
    c.s « text; \  
}
```

7.89.2.4 DEFAULT_PRINT_LATEX

```
#define DEFAULT_PRINT_LATEX(  
    classname,  
    text,  
    latex )
```

Value:

```
DEFAULT_PRINT(classname, text) \  
void classname::do_print_latex(const print_latex & c, unsigned level) const \  
{ \  
    c.s « latex; \  
}
```

7.90 utils_multi_iterator.h File Reference

Utilities for summing over multiple indices.

```
#include <cstdint>
#include <vector>
#include <ostream>
#include <iterator>
```

Classes

- class [GiNaC::has_distance< T >](#)
SFINAE test for distance.
- class [GiNaC::basic_multi_iterator< T >](#)
basic_multi_iterator is a base class.
- class [GiNaC::multi_iterator_ordered< T >](#)
The class multi_iterator_ordered defines a multi_iterator (i_1, i_2, \dots, i_k), such that.
- class [GiNaC::multi_iterator_ordered_eq< T >](#)
The class multi_iterator_ordered_eq defines a multi_iterator (i_1, i_2, \dots, i_k), such that.
- class [GiNaC::multi_iterator_ordered_eq_indv< T >](#)
The class multi_iterator_ordered_eq_indv defines a multi_iterator (i_1, i_2, \dots, i_k), such that.
- class [GiNaC::multi_iterator_counter< T >](#)
The class multi_iterator_counter defines a multi_iterator (i_1, i_2, \dots, i_k), such that.
- class [GiNaC::multi_iterator_counter_indv< T >](#)
The class multi_iterator_counter_indv defines a multi_iterator (i_1, i_2, \dots, i_k), such that.
- class [GiNaC::multi_iterator_permutation< T >](#)
The class multi_iterator_permutation defines a multi_iterator (i_1, i_2, \dots, i_k), for which.
- class [GiNaC::multi_iterator_shuffle< T >](#)
The class multi_iterator_shuffle defines a multi_iterator, which runs over all shuffles of a and b.
- class [GiNaC::multi_iterator_shuffle_prime< T >](#)
The class multi_iterator_shuffle_prime defines a multi_iterator, which runs over all shuffles of a and b, excluding the first one (a,b).

Namespaces

- namespace [GiNaC](#)

Functions

- `template<typename T >`
`std::enable_if< has_distance< T >::value, typename std::iterator_traits< T >::difference_type >::type`
`GiNaC::format_index_value (const T &a, const T &b)`
For printing a multi-index: If the templates are used, where T is an iterator, printing the address where the iterator points to is not meaningful.
- `template<typename T >`
`std::enable_if< !has_distance< T >::value, T >::type GiNaC::format_index_value (const T &a, const T &b)`
For all other cases we simply print the value.
- `template<class T >`
`std::ostream & GiNaC::operator<< (std::ostream &os, const basic_multi_iterator< T > &v)`

Output operator.

- template<class T >
std::ostream & [GiNaC::operator<<](#) (std::ostream &os, const multi_iterator_ordered< T > &v)

Output operator.

- template<class T >
std::ostream & [GiNaC::operator<<](#) (std::ostream &os, const multi_iterator_ordered_eq< T > &v)

Output operator.

- template<class T >
std::ostream & [GiNaC::operator<<](#) (std::ostream &os, const multi_iterator_ordered_eq_indv< T > &v)

Output operator.

- template<class T >
std::ostream & [GiNaC::operator<<](#) (std::ostream &os, const multi_iterator_counter< T > &v)

Output operator.

- template<class T >
std::ostream & [GiNaC::operator<<](#) (std::ostream &os, const multi_iterator_counter_indv< T > &v)

Output operator.

- template<class T >
std::ostream & [GiNaC::operator<<](#) (std::ostream &os, const multi_iterator_permutation< T > &v)

Output operator.

- template<class T >
std::ostream & [GiNaC::operator<<](#) (std::ostream &os, const multi_iterator_shuffle< T > &v)

Output operator.

- template<class T >
std::ostream & [GiNaC::operator<<](#) (std::ostream &os, const multi_iterator_shuffle_prime< T > &v)

Output operator.

7.90.1 Detailed Description

Utilities for summing over multiple indices.

7.91 version.h File Reference

[GiNaC](#) library version information.

Namespaces

- namespace [GiNaC](#)

Macros

- #define [GINACLIB_MAJOR_VERSION](#) 1
- #define [GINACLIB_MINOR_VERSION](#) 8
- #define [GINACLIB_MICRO_VERSION](#) 7
- #define [GINAC_LT_CURRENT](#) 12
- #define [GINAC_LT_REVISION](#) 6
- #define [GINAC_LT_AGE](#) 1
- #define [GINACLIB_ARCHIVE_VERSION](#) 3
- #define [GINACLIB_ARCHIVE_AGE](#) 3
- #define [GINACLIB_STR_HELPER\(x\)](#) #x
- #define [GINACLIB_STR\(x\)](#) [GINACLIB_STR_HELPER\(x\)](#)
- #define [GINACLIB_VERSION](#)

7.91.1 Detailed Description

[GiNaC](#) library version information.

7.91.2 Macro Definition Documentation

7.91.2.1 GINACLIB_MAJOR_VERSION

```
#define GINACLIB_MAJOR_VERSION 1
```

7.91.2.2 GINACLIB_MINOR_VERSION

```
#define GINACLIB_MINOR_VERSION 8
```

7.91.2.3 GINACLIB_MICRO_VERSION

```
#define GINACLIB_MICRO_VERSION 7
```

7.91.2.4 GINAC_LT_CURRENT

```
#define GINAC_LT_CURRENT 12
```

7.91.2.5 GINAC_LT_REVISION

```
#define GINAC_LT_REVISION 6
```

7.91.2.6 GINAC_LT_AGE

```
#define GINAC_LT_AGE 1
```


7.91.2.7 GINACLIB_ARCHIVE_VERSION

```
#define GINACLIB_ARCHIVE_VERSION 3
```

7.91.2.8 GINACLIB_ARCHIVE_AGE

```
#define GINACLIB_ARCHIVE_AGE 3
```

7.91.2.9 GINACLIB_STR_HELPER

```
#define GINACLIB_STR_HELPER(  
    x ) #x
```

7.91.2.10 GINACLIB_STR

```
#define GINACLIB_STR(  
    x ) GINACLIB_STR_HELPER(x)
```

7.91.2.11 GINACLIB_VERSION

```
#define GINACLIB_VERSION
```

Value:

```
GINACLIB_STR(GINACLIB_MAJOR_VERSION) "." \  
GINACLIB_STR(GINACLIB_MINOR_VERSION) "." \  
GINACLIB_STR(GINACLIB_MICRO_VERSION)
```

7.92 wildcard.cpp File Reference

Implementation of [GiNaC](#)'s wildcard objects.

```
#include "wildcard.h"  
#include "archive.h"  
#include "utils.h"  
#include "hash_seed.h"  
#include <iostream>
```

Namespaces

- namespace [GiNaC](#)

Functions

- [GiNaC::GINAC_IMPLEMENT_REGISTERED_CLASS_OPT](#) (wildcard, basic, print_func< print_context >(&wildcard::do_print). print_func< print_tree >(&wildcard::do_print_tree). print_func< print_python_repr >(&wildcard::do_print_python_repr)) wildcard
- [GiNaC::GINAC_BIND_UNARCHIVER](#) (wildcard)
- bool [GiNaC::haswild](#) (const ex &x)

Check whether x has a wildcard anywhere as a subexpression.

7.92.1 Detailed Description

Implementation of [GiNaC](#)'s wildcard objects.

7.93 wildcard.h File Reference

Interface to [GiNaC](#)'s wildcard objects.

```
#include "ex.h"
#include "archive.h"
```

Classes

- class [GiNaC::wildcard](#)
This class acts as a wildcard for [subs\(\)](#), [match\(\)](#), [has\(\)](#) and [find\(\)](#).

Namespaces

- namespace [GiNaC](#)

Functions

- [GiNaC::GINAC_DECLARE_UNARCHIVER](#) (wildcard)
- ex [GiNaC::wild](#) (unsigned label=0)
Create a wildcard object with the specified label.
- bool [GiNaC::haswild](#) (const ex &x)
Check whether x has a wildcard anywhere as a subexpression.

7.93.1 Detailed Description

Interface to [GiNaC](#)'s wildcard objects.

Index

[_ex0](#)
 [GiNaC, 301](#)

[_ex1](#)
 [GiNaC, 303](#)

[_ex10](#)
 [GiNaC, 307](#)

[_ex11](#)
 [GiNaC, 307](#)

[_ex12](#)
 [GiNaC, 308](#)

[_ex120](#)
 [GiNaC, 311](#)

[_ex15](#)
 [GiNaC, 308](#)

[_ex18](#)
 [GiNaC, 308](#)

[_ex1_2](#)
 [GiNaC, 303](#)

[_ex1_3](#)
 [GiNaC, 302](#)

[_ex1_4](#)
 [GiNaC, 302](#)

[_ex2](#)
 [GiNaC, 304](#)

[_ex20](#)
 [GiNaC, 309](#)

[_ex24](#)
 [GiNaC, 309](#)

[_ex25](#)
 [GiNaC, 309](#)

[_ex3](#)
 [GiNaC, 305](#)

[_ex30](#)
 [GiNaC, 310](#)

[_ex4](#)
 [GiNaC, 305](#)

[_ex48](#)
 [GiNaC, 310](#)

[_ex5](#)
 [GiNaC, 305](#)

[_ex6](#)
 [GiNaC, 306](#)

[_ex60](#)
 [GiNaC, 310](#)

[_ex7](#)
 [GiNaC, 306](#)

[_ex8](#)
 [GiNaC, 306](#)

[_ex9](#)
 [GiNaC, 307](#)

[_ex_1](#)
 [GiNaC, 300](#)

[_ex_10](#)
 [GiNaC, 297](#)

[_ex_11](#)
 [GiNaC, 296](#)

[_ex_12](#)
 [GiNaC, 296](#)

[_ex_120](#)
 [GiNaC, 293](#)

[_ex_15](#)
 [GiNaC, 296](#)

[_ex_18](#)
 [GiNaC, 295](#)

[_ex_1_2](#)
 [GiNaC, 300](#)

[_ex_1_3](#)
 [GiNaC, 301](#)

[_ex_1_4](#)
 [GiNaC, 301](#)

[_ex_2](#)
 [GiNaC, 299](#)

[_ex_20](#)
 [GiNaC, 295](#)

[_ex_24](#)
 [GiNaC, 295](#)

[_ex_25](#)
 [GiNaC, 294](#)

[_ex_3](#)
 [GiNaC, 299](#)

[_ex_30](#)
 [GiNaC, 294](#)

[_ex_4](#)
 [GiNaC, 299](#)

[_ex_48](#)
 [GiNaC, 294](#)

[_ex_5](#)
 [GiNaC, 298](#)

[_ex_6](#)
 [GiNaC, 298](#)

[_ex_60](#)
 [GiNaC, 293](#)

[_ex_7](#)
 [GiNaC, 298](#)

[_ex_8](#)
 [GiNaC, 297](#)

[_ex_9](#)
 [GiNaC, 297](#)

_iter_rep
 GiNaC::internal::_iter_rep, 314
 _num0_bp
 GiNaC, 291
 _num0_p
 GiNaC, 301
 _num10_p
 GiNaC, 307
 _num11_p
 GiNaC, 307
 _num120_p
 GiNaC, 310
 _num12_p
 GiNaC, 307
 _num15_p
 GiNaC, 308
 _num18_p
 GiNaC, 308
 _num1_2_p
 GiNaC, 303
 _num1_3_p
 GiNaC, 302
 _num1_4_p
 GiNaC, 302
 _num1_p
 GiNaC, 303
 _num20_p
 GiNaC, 308
 _num24_p
 GiNaC, 309
 _num25_p
 GiNaC, 309
 _num2_p
 GiNaC, 304
 _num30_p
 GiNaC, 309
 _num3_p
 GiNaC, 304
 _num48_p
 GiNaC, 310
 _num4_p
 GiNaC, 305
 _num5_p
 GiNaC, 305
 _num60_p
 GiNaC, 310
 _num6_p
 GiNaC, 305
 _num7_p
 GiNaC, 306
 _num8_p
 GiNaC, 306
 _num9_p
 GiNaC, 306
 _num_10_p
 GiNaC, 297
 _num_11_p
 GiNaC, 296
 _num_120_p
 GiNaC, 293
 _num_12_p
 GiNaC, 296
 _num_15_p
 GiNaC, 296
 _num_18_p
 GiNaC, 295
 _num_1_2_p
 GiNaC, 300
 _num_1_3_p
 GiNaC, 300
 _num_1_4_p
 GiNaC, 301
 _num_1_p
 GiNaC, 300
 _num_20_p
 GiNaC, 295
 _num_24_p
 GiNaC, 295
 _num_25_p
 GiNaC, 294
 _num_2_p
 GiNaC, 299
 _num_30_p
 GiNaC, 294
 _num_3_p
 GiNaC, 299
 _num_48_p
 GiNaC, 294
 _num_4_p
 GiNaC, 299
 _num_5_p
 GiNaC, 298
 _num_60_p
 GiNaC, 293
 _num_6_p
 GiNaC, 298
 _num_7_p
 GiNaC, 298
 _num_8_p
 GiNaC, 297
 _num_9_p
 GiNaC, 297
 _numeric_digits
 GiNaC::_numeric_digits, 316
 ~archive
 GiNaC::archive, 338
 ~basic
 GiNaC::basic, 362
 ~basic_multi_iterator
 GiNaC::basic_multi_iterator< T >, 394
 ~compare_all_equal
 GiNaC::compare_all_equal< T >, 438
 ~compare_bitwise
 GiNaC::compare_bitwise< T >, 439
 ~compare_std_less
 GiNaC::compare_std_less< T >, 440

- ~container_storage
 - GiNaC::container_storage< C >, 489
- ~coolmulti
 - GiNaC::composition_generator::coolmulti, 491
- ~element
 - GiNaC::composition_generator::coolmulti::element, 555
- ~function_options
 - GiNaC::function_options, 690
- ~library_init
 - GiNaC::library_init, 818
- ~map_function
 - GiNaC::map_function, 823
- ~print_context
 - GiNaC::print_context, 1035
- ~print_functor_impl
 - GiNaC::print_functor_impl, 1050
- ~ptr
 - GiNaC::ptr< T >, 1090
- ~unarchive_table_t
 - GiNaC::unarchive_table_t, 1267
- ~visitor
 - GiNaC::visitor, 1288
- a
 - GiNaC::archive_node, 353
 - GiNaC::Eisenstein_kernel, 553
 - GiNaC::integral, 784
- abs
 - GiNaC, 242
- abs_conjugate
 - GiNaC, 144
- abs_eval
 - GiNaC, 143
- abs_evalf
 - GiNaC, 143
- abs_expand
 - GiNaC, 143
- abs_expl_derivative
 - GiNaC, 143
- abs_imag_part
 - GiNaC, 144
- abs_info
 - GiNaC, 145
- abs_power
 - GiNaC, 145
- abs_print_csrc_float
 - GiNaC, 144
- abs_print_latex
 - GiNaC, 144
- abs_real_part
 - GiNaC, 144
- accept
 - GiNaC::basic, 369
 - GiNaC::ex, 587
- access_counter
 - GiNaC::remember_table_entry, 1129
- acos
 - GiNaC, 233
- acos_conjugate
 - GiNaC, 186
- acos_deriv
 - GiNaC, 186
- acos_eval
 - GiNaC, 185
- acos_evalf
 - GiNaC, 185
- acosh
 - GiNaC, 236
- acosh_conjugate
 - GiNaC, 195
- acosh_deriv
 - GiNaC, 194
- acosh_eval
 - GiNaC, 194
- acosh_evalf
 - GiNaC, 194
- adaptivesimpson
 - GiNaC, 197
- add
 - GiNaC::add, 325, 326
 - GiNaC::matrix, 837
 - GiNaC::mul, 890
 - GiNaC::numeric, 963
 - GiNaC::scalar_products, 1135
 - GiNaC::symmetry, 1230
- add.cpp, 1299
- add.h, 1300
- add_bool
 - GiNaC::archive_node, 347
- add_callback
 - GiNaC::_numeric_digits, 317
- add_child
 - GiNaC::class_info< OPT >::tree_node, 1266
- add_dyn
 - GiNaC::numeric, 965
- add_entry
 - GiNaC::remember_table, 1124
 - GiNaC::remember_table_list, 1130
- add_ex
 - GiNaC::archive_node, 348
- add_indexed
 - GiNaC::basic, 375
 - GiNaC::matrix, 834
 - GiNaC::structure< T, ComparisonPolicy >, 1175
- add_node
 - GiNaC::archive, 340
- add_reference
 - GiNaC::refcounted, 1103
- add_series
 - GiNaC::pseries, 1082
- add_string
 - GiNaC::archive_node, 348
- add_symbol
 - GiNaC, 213
- add_unsigned
 - GiNaC::archive_node, 348

- add_vectors
 - GiNaC::scalar_products, [1135](#)
- after_i
 - GiNaC::composition_generator::coolmulti, [492](#)
- algebraic
 - GiNaC::has_options, [735](#)
 - GiNaC::subs_options, [1202](#)
- algebraic_match_mul_with_mul
 - GiNaC, [211](#)
- algebraic_subs_mul
 - GiNaC::mul, [888](#)
- all
 - GiNaC::factor_options, [641](#)
- all_index_values_are
 - GiNaC::indexed, [766](#)
- antisymmetric
 - GiNaC::symmetry, [1228](#)
- antisymmetric2
 - GiNaC, [272](#)
- antisymmetric3
 - GiNaC, [272](#)
- antisymmetric4
 - GiNaC, [272](#)
- antisymmetrize
 - GiNaC, [120](#), [273](#), [277](#)
 - GiNaC::ex, [601](#)
- append
 - GiNaC::container< C >, [483](#)
- append_factors
 - GiNaC::ncmul, [944](#)
- archive
 - GiNaC::archive, [338](#)
 - GiNaC::basic, [379](#)
 - GiNaC::clifford, [413](#)
 - GiNaC::color, [434](#)
 - GiNaC::constant, [465](#)
 - GiNaC::container< C >, [480](#)
 - GiNaC::expairseq, [626](#)
 - GiNaC::fderivative, [657](#)
 - GiNaC::function, [678](#)
 - GiNaC::idx, [743](#)
 - GiNaC::indexed, [764](#)
 - GiNaC::integral, [782](#)
 - GiNaC::matrix, [836](#)
 - GiNaC::minkmetric, [855](#)
 - GiNaC::numeric, [962](#)
 - GiNaC::power, [1029](#)
 - GiNaC::pseries, [1079](#)
 - GiNaC::relational, [1116](#)
 - GiNaC::spinidx, [1147](#)
 - GiNaC::symbol, [1217](#)
 - GiNaC::symmetry, [1229](#)
 - GiNaC::tensepsilon, [1249](#)
 - GiNaC::varidx, [1285](#)
 - GiNaC::wildcard, [1293](#)
- archive.cpp, [1300](#)
- archive.h, [1301](#)
 - GINAC_BIND_UNARCHIVER, [1303](#)
 - GINAC_DECLARE_UNARCHIVER, [1302](#)
- archive_atom
 - GiNaC, [58](#)
- archive_ex
 - GiNaC::archive, [338](#)
- archive_node
 - GiNaC::archive_node, [347](#)
 - GiNaC::ex, [605](#)
- archive_node_cit
 - GiNaC::archive_node, [346](#)
- archive_node_id
 - GiNaC, [58](#)
- archived_ex
 - GiNaC::archive::archived_ex, [356](#)
- are_ex_trivially_equal
 - GiNaC, [112](#)
 - GiNaC::ex, [605](#)
- arg1
 - GiNaC::pointer_to_map_function_1arg< T1 >, [989](#)
 - GiNaC::pointer_to_map_function_2args< T1, T2 >, [992](#)
 - GiNaC::pointer_to_map_function_3args< T1, T2, T3 >, [994](#)
 - GiNaC::pointer_to_member_to_map_function_1arg< C, T1 >, [1000](#)
 - GiNaC::pointer_to_member_to_map_function_2args< C, T1, T2 >, [1003](#)
 - GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2, T3 >, [1006](#)
- arg2
 - GiNaC::pointer_to_map_function_2args< T1, T2 >, [992](#)
 - GiNaC::pointer_to_map_function_3args< T1, T2, T3 >, [995](#)
 - GiNaC::pointer_to_member_to_map_function_2args< C, T1, T2 >, [1003](#)
 - GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2, T3 >, [1006](#)
- arg3
 - GiNaC::pointer_to_map_function_3args< T1, T2, T3 >, [995](#)
 - GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2, T3 >, [1006](#)
- argument_type
 - GiNaC::map_function, [823](#)
- asin
 - GiNaC, [233](#)
- asin_conjugate
 - GiNaC, [185](#)
- asin_deriv
 - GiNaC, [184](#)
- asin_eval
 - GiNaC, [184](#)
- asin_evalf
 - GiNaC, [184](#)
- asin_info
 - GiNaC, [185](#)

- asinh
 - GiNaC, [236](#)
- asinh_conjugate
 - GiNaC, [194](#)
- asinh_deriv
 - GiNaC, [193](#)
- asinh_eval
 - GiNaC, [193](#)
- asinh_evalf
 - GiNaC, [193](#)
- assertion.h, [1304](#)
 - GINAC_ASSERT, [1304](#)
- atan
 - GiNaC, [234](#)
- atan2_deriv
 - GiNaC, [188](#)
- atan2_eval
 - GiNaC, [188](#)
- atan2_evalf
 - GiNaC, [188](#)
- atan2_info
 - GiNaC, [188](#)
- atan_conjugate
 - GiNaC, [187](#)
- atan_deriv
 - GiNaC, [187](#)
- atan_eval
 - GiNaC, [186](#)
- atan_evalf
 - GiNaC, [186](#)
- atan_info
 - GiNaC, [187](#)
- atan_series
 - GiNaC, [187](#)
- atanh
 - GiNaC, [236](#)
- atanh_conjugate
 - GiNaC, [196](#)
- atanh_deriv
 - GiNaC, [195](#)
- atanh_eval
 - GiNaC, [195](#)
- atanh_evalf
 - GiNaC, [195](#)
- atanh_series
 - GiNaC, [196](#)
- atend
 - GiNaC::composition_generator, [443](#)
- atomize
 - GiNaC::archive, [341](#)
- atoms
 - GiNaC::archive, [343](#)
- attribute_deprecated
 - compiler.h, [1315](#)
- automatic
 - GiNaC::determinant_algo, [496](#)
 - GiNaC::solve_algo, [1138](#)
- B
 - GiNaC::basic_multi_iterator< T >, [396](#)
- b
 - GiNaC::Eisenstein_kernel, [553](#)
 - GiNaC::integral, [785](#)
- bareiss
 - GiNaC::determinant_algo, [496](#)
 - GiNaC::solve_algo, [1138](#)
- base_and_index
 - GiNaC, [94](#)
- basic
 - GiNaC::basic, [362](#)
- basic.cpp, [1304](#)
- basic.h, [1305](#)
- basic_multi_iterator
 - GiNaC::basic_multi_iterator< T >, [393](#)
- basic_partition_generator
 - GiNaC::basic_partition_generator, [398](#)
- basis
 - GiNaC::power, [1034](#)
- begin
 - GiNaC::archive_node::archive_node_cit_range, [355](#)
 - GiNaC::container< C >, [484](#)
 - GiNaC::ex, [578](#)
- bernoulli
 - GiNaC, [241](#)
- Bernoulli_polynomial
 - GiNaC, [199](#)
- beta_deriv
 - GiNaC, [166](#)
- beta_eval
 - GiNaC, [166](#)
- beta_evalf
 - GiNaC, [166](#)
- beta_series
 - GiNaC, [166](#)
- binomial
 - GiNaC, [241](#)
- binomial_conjugate
 - GiNaC, [154](#)
- binomial_eval
 - GiNaC, [154](#)
- binomial_evalf
 - GiNaC, [153](#)
- binomial_imag_part
 - GiNaC, [154](#)
- binomial_real_part
 - GiNaC, [154](#)
- binomial_sym
 - GiNaC, [153](#)
- bp
 - GiNaC::ex, [607](#)
- c
 - factor.cpp, [1328](#)
 - GiNaC::pointer_to_member_to_map_function< C >, [997](#)
 - GiNaC::pointer_to_member_to_map_function_1arg< C, T1 >, [1000](#)

- GiNaC::pointer_to_member_to_map_function_2args< C, T1, T2 >, [1002](#)
 - GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2, T3 >, [1005](#)
- C_norm
 - GiNaC::Eisenstein_h_kernel, [543](#)
 - GiNaC::Eisenstein_kernel, [554](#)
 - GiNaC::Kronecker_dtau_kernel, [805](#)
 - GiNaC::Kronecker_dz_kernel, [814](#)
 - GiNaC::modular_form_kernel, [866](#)
- cache
 - factor.cpp, [1330](#)
- cache_step_size
 - GiNaC::integration_kernel, [794](#)
- cache_vec
 - integration_kernel.cpp, [1373](#)
- calc_lanczos_A
 - GiNaC::lanczos_coeffs, [816](#)
- calchash
 - GiNaC::basic, [378](#)
 - GiNaC::constant, [466](#)
 - GiNaC::expairseq, [628](#)
 - GiNaC::function, [676](#)
 - GiNaC::idx, [744](#)
 - GiNaC::numeric, [963](#)
 - GiNaC::relational, [1118](#)
 - GiNaC::structure< T, ComparisonPolicy >, [1178](#)
 - GiNaC::symbol, [1218](#)
 - GiNaC::symmetry, [1229](#)
 - GiNaC::wildcard, [1294](#)
- callback_registered
 - GiNaC, [89](#)
- callbacklist
 - GiNaC::_numeric_digits, [317](#)
- can_be_further_expanded
 - GiNaC::mul, [889](#)
- can_make_flat
 - GiNaC::expairseq, [632](#)
 - GiNaC::mul, [887](#)
- canonical
 - GiNaC::relational, [1116](#)
- canonicalize
 - GiNaC, [272](#)
 - GiNaC::expairseq, [634](#)
 - GiNaC::symmetry, [1232](#)
- canonicalize_clifford
 - GiNaC, [99](#)
- Catalan
 - GiNaC, [290](#)
- CatalanEvalf
 - GiNaC, [247](#)
- charpoly
 - GiNaC, [209](#)
 - GiNaC::matrix, [841](#)
- children
 - GiNaC::class_info< OPT >::tree_node, [1266](#)
 - GiNaC::symmetry, [1233](#)
- cinteger
 - GiNaC::info_flags, [772](#)
 - cinteger_polynomial
 - GiNaC::info_flags, [772](#)
 - class_info
 - GiNaC::class_info< OPT >, [400](#)
 - class_info.h, [1306](#)
 - clear
 - GiNaC::archive, [340](#)
 - GiNaC::scalar_products, [1135](#)
 - clear_all_entries
 - GiNaC::remember_table, [1124](#)
 - clearflag
 - GiNaC::basic, [383](#)
 - clifford
 - GiNaC::clifford, [412](#), [413](#)
 - clifford.cpp, [1307](#)
 - clifford.h, [1309](#)
 - clifford_bar
 - GiNaC, [105](#)
 - clifford_inverse
 - GiNaC, [100](#)
 - clifford_max_label
 - GiNaC, [100](#)
 - clifford_moebius_map
 - GiNaC, [103](#)
 - clifford_norm
 - GiNaC, [100](#)
 - clifford_prime
 - GiNaC, [99](#)
 - clifford_star
 - GiNaC, [105](#)
 - clifford_star_bar
 - GiNaC, [99](#)
 - clifford_to_lst
 - GiNaC, [101](#)
 - clifford_unit
 - GiNaC, [95](#)
 - cmgen
 - GiNaC::composition_generator, [443](#)
 - CMPINDICES
 - color.cpp, [1313](#)
 - coeff
 - GiNaC, [116](#)
 - GiNaC::add, [328](#)
 - GiNaC::basic, [370](#)
 - GiNaC::ex, [589](#)
 - GiNaC::expair, [613](#)
 - GiNaC::mul, [879](#)
 - GiNaC::ncmul, [940](#)
 - GiNaC::numeric, [958](#)
 - GiNaC::power, [1024](#)
 - GiNaC::pseries, [1076](#)
 - GiNaC::structure< T, ComparisonPolicy >, [1171](#)
 - GiNaC::symminfo, [1235](#)
 - coefficient_a0
 - GiNaC::Eisenstein_h_kernel, [541](#)
 - coefficient_an
 - GiNaC::Eisenstein_h_kernel, [541](#)

- coeffop
 - GiNaC::pseries, [1082](#)
- coeffs
 - GiNaC::lanczos_coeffs, [816](#)
- coerce
 - GiNaC, [230](#)
- coerce< int, cln::cl_I >
 - GiNaC, [230](#)
- coerce< unsigned int, cln::cl_I >
 - GiNaC, [231](#)
- col
 - GiNaC::matrix, [848](#)
- collect
 - GiNaC, [117](#)
 - GiNaC::basic, [371](#)
 - GiNaC::ex, [590](#)
 - GiNaC::pseries, [1076](#)
 - GiNaC::structure< T, ComparisonPolicy >, [1172](#)
- collect_common_factors
 - GiNaC, [227](#)
- collect_symbols
 - GiNaC, [213](#)
- color
 - GiNaC::color, [433](#), [434](#)
- color.cpp, [1311](#)
 - CMPINDICES, [1313](#)
 - TEST_PERMUTATION, [1312](#)
- color.h, [1313](#)
- color_d
 - GiNaC, [109](#)
- color_f
 - GiNaC, [108](#)
- color_h
 - GiNaC, [109](#)
- color_ONE
 - GiNaC, [107](#)
- color_T
 - GiNaC, [108](#)
- color_trace
 - GiNaC, [110](#), [111](#)
- cols
 - GiNaC, [208](#)
 - GiNaC::matrix, [837](#)
- combine_ex_with_coeff_to_pair
 - GiNaC::add, [333](#)
 - GiNaC::expairseq, [630](#)
 - GiNaC::mul, [885](#)
- combine_indices
 - GiNaC::make_flat_inserter, [821](#)
- combine_overall_coeff
 - GiNaC::expairseq, [631](#)
 - GiNaC::mul, [887](#)
- combine_pair_with_coeff_to_pair
 - GiNaC::add, [333](#)
 - GiNaC::expairseq, [630](#)
 - GiNaC::mul, [886](#)
- combine_same_terms_sorted_seq
 - GiNaC::expairseq, [634](#)
- commutative
 - GiNaC::return_types, [1133](#)
- commutator_sign
 - GiNaC::clifford, [418](#)
- compare
 - GiNaC::basic, [381](#)
 - GiNaC::ex, [599](#)
 - GiNaC::expair, [612](#)
 - GiNaC::numeric, [968](#)
- compare_pointers
 - GiNaC, [284](#)
- compare_same_type
 - GiNaC::basic, [377](#)
- compile_ex
 - GiNaC, [124](#), [125](#)
- compiler.h, [1314](#)
 - attribute_deprecated, [1315](#)
 - likely, [1315](#)
 - unlikely, [1314](#)
- complex
 - GiNaC::domain, [524](#)
- composition
 - GiNaC::composition_generator, [443](#)
- composition_generator
 - GiNaC::composition_generator, [442](#)
- conjugate
 - GiNaC, [114](#)
 - GiNaC::add, [330](#)
 - GiNaC::basic, [377](#)
 - GiNaC::constant, [465](#)
 - GiNaC::container< C >, [480](#)
 - GiNaC::diracgamma5, [507](#)
 - GiNaC::diracgammaL, [512](#)
 - GiNaC::diracgammaR, [517](#)
 - GiNaC::ex, [584](#)
 - GiNaC::expair, [612](#)
 - GiNaC::expairseq, [626](#)
 - GiNaC::function, [677](#)
 - GiNaC::integral, [782](#)
 - GiNaC::matrix, [835](#)
 - GiNaC::mul, [883](#)
 - GiNaC::ncmul, [942](#)
 - GiNaC::numeric, [961](#)
 - GiNaC::power, [1028](#)
 - GiNaC::pseries, [1078](#)
 - GiNaC::realsymbol, [1100](#)
 - GiNaC::spinidx, [1147](#)
 - GiNaC::symbol, [1216](#)
- conjugate_conjugate
 - GiNaC, [139](#)
- conjugate_eval
 - GiNaC, [138](#)
- conjugate_evalf
 - GiNaC, [138](#)
- conjugate_expl_derivative
 - GiNaC, [139](#)
- conjugate_f
 - GiNaC::function_options, [724](#)

- conjugate_func
 - GiNaC::function_options, 695–697, 717
- conjugate_funcp
 - GiNaC, 60
- conjugate_funcp_1
 - GiNaC, 62
- conjugate_funcp_10
 - GiNaC, 77
- conjugate_funcp_11
 - GiNaC, 79
- conjugate_funcp_12
 - GiNaC, 80
- conjugate_funcp_13
 - GiNaC, 82
- conjugate_funcp_14
 - GiNaC, 84
- conjugate_funcp_2
 - GiNaC, 63
- conjugate_funcp_3
 - GiNaC, 65
- conjugate_funcp_4
 - GiNaC, 67
- conjugate_funcp_5
 - GiNaC, 68
- conjugate_funcp_6
 - GiNaC, 70
- conjugate_funcp_7
 - GiNaC, 72
- conjugate_funcp_8
 - GiNaC, 73
- conjugate_funcp_9
 - GiNaC, 75
- conjugate_funcp_exvector
 - GiNaC, 86
- conjugate_imag_part
 - GiNaC, 139
- conjugate_info
 - GiNaC, 140
- conjugate_print_latex
 - GiNaC, 138
- conjugate_real_part
 - GiNaC, 139
- conjugate_use_exvector_args
 - GiNaC::function_options, 728
- conjugateepvector
 - GiNaC, 127
- const_iterator
 - GiNaC::const_iterator, 446
 - GiNaC::container< C >, 476
- const_postorder_iterator
 - GiNaC::const_iterator, 450
 - GiNaC::const_postorder_iterator, 452
- const_preorder_iterator
 - GiNaC::const_iterator, 449
 - GiNaC::const_preorder_iterator, 455, 456
- const_reverse_iterator
 - GiNaC::container< C >, 476
- constant
 - GiNaC::constant, 463
- constant.cpp, 1315
- constant.h, 1316
- construct_from_2_ex
 - GiNaC::expairseq, 632
- construct_from_2_expairseq
 - GiNaC::expairseq, 632
- construct_from_basic
 - GiNaC::ex, 602
- construct_from_double
 - GiNaC::ex, 604
- construct_from_epvector
 - GiNaC::expairseq, 633
- construct_from_expairseq_ex
 - GiNaC::expairseq, 633
- construct_from_exvector
 - GiNaC::expairseq, 633
- construct_from_int
 - GiNaC::ex, 603
- construct_from_long
 - GiNaC::ex, 603
- construct_from_longlong
 - GiNaC::ex, 604
- construct_from_string_and_lst
 - GiNaC::ex, 604
- construct_from_uint
 - GiNaC::ex, 603
- construct_from_ulong
 - GiNaC::ex, 603
- construct_from_ulonglong
 - GiNaC::ex, 604
- cont
 - factor.cpp, 1334
- container
 - GiNaC::container< C >, 476, 477
- container.h, 1317
- container_storage
 - GiNaC::container_storage< C >, 488
- content
 - GiNaC::ex, 595
- contract_with
 - GiNaC::basic, 376
 - GiNaC::cliffordunit, 423
 - GiNaC::diracgamma, 502
 - GiNaC::matrix, 835
 - GiNaC::spinmetric, 1155
 - GiNaC::structure< T, ComparisonPolicy >, 1176
 - GiNaC::su3d, 1184
 - GiNaC::su3f, 1190
 - GiNaC::su3t, 1200
 - GiNaC::tensdelta, 1242
 - GiNaC::tensepsilon, 1249
 - GiNaC::tensmetric, 1256
- convert_H_to_Li
 - GiNaC, 160
- convert_to_poly
 - GiNaC::pseries, 1081
- coolmulti

- GiNaC::composition_generator::coolmulti, [491](#)
- cos
 - GiNaC, [232](#)
- cos_conjugate
 - GiNaC, [182](#)
- cos_deriv
 - GiNaC, [181](#)
- cos_eval
 - GiNaC, [181](#)
- cos_evalf
 - GiNaC, [181](#)
- cos_imag_part
 - GiNaC, [182](#)
- cos_real_part
 - GiNaC, [182](#)
- cosh
 - GiNaC, [235](#)
- cosh_conjugate
 - GiNaC, [191](#)
- cosh_deriv
 - GiNaC, [190](#)
- cosh_eval
 - GiNaC, [190](#)
- cosh_evalf
 - GiNaC, [190](#)
- cosh_imag_part
 - GiNaC, [191](#)
- cosh_real_part
 - GiNaC, [191](#)
- count
 - GiNaC::archive_node::property_info, [1067](#)
 - GiNaC::library_init, [819](#)
- count_dummy_indices
 - GiNaC, [133](#)
- count_factors
 - GiNaC::ncmul, [944](#)
- count_free_indices
 - GiNaC, [133](#)
- covariant
 - GiNaC::varidx, [1287](#)
- crational
 - GiNaC::info_flags, [772](#)
- crational_polynomial
 - GiNaC::info_flags, [772](#)
- crc32
 - GiNaC, [112](#)
- crc32.h, [1317](#)
- crctab
 - GiNaC, [291](#)
- csgn
 - GiNaC, [248](#)
 - GiNaC::numeric, [967](#)
- csgn_conjugate
 - GiNaC, [147](#)
- csgn_eval
 - GiNaC, [147](#)
- csgn_evalf
 - GiNaC, [147](#)
- csgn_imag_part
 - GiNaC, [148](#)
- csgn_power
 - GiNaC, [148](#)
- csgn_real_part
 - GiNaC, [147](#)
- csgn_series
 - GiNaC, [147](#)
- csrc
 - GiNaC, [263](#)
- csrc_cl_N
 - GiNaC, [264](#)
- csrc_double
 - GiNaC, [263](#)
- csrc_float
 - GiNaC, [263](#)
- current_serial
 - GiNaC::function, [683](#)
- current_updated
 - GiNaC::composition_generator, [443](#)
 - GiNaC::partition_generator, [981](#)
 - GiNaC::partition_with_zero_parts_generator, [984](#)
- current_vector
 - GiNaC::lanczos_coeffs, [816](#)
- cyclic
 - GiNaC::symmetry, [1228](#)
- cyclic_permutation
 - GiNaC, [285](#)
- dbgprint
 - GiNaC::basic, [365](#)
 - GiNaC::ex, [581](#)
- dbgprinttree
 - GiNaC::basic, [365](#)
 - GiNaC::ex, [581](#)
- DCOUT
 - factor.cpp, [1327](#)
- DCOUT2
 - factor.cpp, [1327](#)
- DCOUTVAR
 - factor.cpp, [1327](#)
- debugprint
 - GiNaC::scalar_products, [1136](#)
 - GiNaC::spmapkey, [1158](#)
- DECLARE_FUNCTION_10P
 - function.h, [1348](#)
- DECLARE_FUNCTION_11P
 - function.h, [1348](#)
- DECLARE_FUNCTION_12P
 - function.h, [1349](#)
- DECLARE_FUNCTION_13P
 - function.h, [1349](#)
- DECLARE_FUNCTION_14P
 - function.h, [1349](#)
- DECLARE_FUNCTION_1P
 - function.h, [1346](#)
- DECLARE_FUNCTION_2P
 - function.h, [1346](#)
- DECLARE_FUNCTION_3P

- function.h, [1346](#)
- DECLARE_FUNCTION_4P
 - function.h, [1347](#)
- DECLARE_FUNCTION_5P
 - function.h, [1347](#)
- DECLARE_FUNCTION_6P
 - function.h, [1347](#)
- DECLARE_FUNCTION_7P
 - function.h, [1347](#)
- DECLARE_FUNCTION_8P
 - function.h, [1348](#)
- DECLARE_FUNCTION_9P
 - function.h, [1348](#)
- decomp_rational
 - GiNaC, [216](#)
- DEFAULT_COMPARE
 - utils.h, [1419](#)
- DEFAULT_CTOR
 - utils.h, [1419](#)
- default_overall_coeff
 - GiNaC::expairseq, [631](#)
 - GiNaC::mul, [886](#)
- DEFAULT_PRINT
 - utils.h, [1419](#)
- DEFAULT_PRINT_LATEX
 - utils.h, [1419](#)
- deg
 - GiNaC::pole_error, [1008](#)
- deg_a
 - GiNaC::sym_desc, [1207](#)
- deg_b
 - GiNaC::sym_desc, [1207](#)
- degree
 - GiNaC, [115](#)
 - GiNaC::add, [327](#)
 - GiNaC::basic, [370](#)
 - GiNaC::ex, [589](#)
 - GiNaC::integral, [779](#)
 - GiNaC::mul, [878](#)
 - GiNaC::ncmul, [939](#)
 - GiNaC::numeric, [957](#)
 - GiNaC::pole_error, [1008](#)
 - GiNaC::power, [1024](#)
 - GiNaC::pseries, [1075](#)
 - GiNaC::structure< T, ComparisonPolicy >, [1171](#)
- delete_cyclic
 - GiNaC::remember_strategies, [1122](#)
- delete_lfu
 - GiNaC::remember_strategies, [1122](#)
- delete_lru
 - GiNaC::remember_strategies, [1122](#)
- delete_never
 - GiNaC::remember_strategies, [1122](#)
- delta_indent
 - GiNaC::print_tree, [1064](#)
- delta_tensor
 - GiNaC, [279](#)
- denom
 - GiNaC, [116](#), [252](#)
 - GiNaC::ex, [593](#)
 - GiNaC::numeric, [976](#)
- derivative
 - GiNaC::add, [331](#)
 - GiNaC::basic, [372](#)
 - GiNaC::constant, [466](#)
 - GiNaC::fderivative, [658](#)
 - GiNaC::function, [678](#)
 - GiNaC::idx, [744](#)
 - GiNaC::indexed, [765](#)
 - GiNaC::integral, [783](#)
 - GiNaC::mul, [883](#)
 - GiNaC::ncmul, [942](#)
 - GiNaC::numeric, [962](#)
 - GiNaC::power, [1029](#)
 - GiNaC::pseries, [1080](#)
 - GiNaC::structure< T, ComparisonPolicy >, [1172](#)
 - GiNaC::symbol, [1217](#)
- derivative_f
 - GiNaC::function_options, [725](#)
- derivative_func
 - GiNaC::function_options, [705–707](#), [717](#)
- derivative_funcp
 - GiNaC, [61](#)
- derivative_funcp_1
 - GiNaC, [62](#)
- derivative_funcp_10
 - GiNaC, [77](#)
- derivative_funcp_11
 - GiNaC, [79](#)
- derivative_funcp_12
 - GiNaC, [81](#)
- derivative_funcp_13
 - GiNaC, [83](#)
- derivative_funcp_14
 - GiNaC, [85](#)
- derivative_funcp_2
 - GiNaC, [64](#)
- derivative_funcp_3
 - GiNaC, [65](#)
- derivative_funcp_4
 - GiNaC, [67](#)
- derivative_funcp_5
 - GiNaC, [69](#)
- derivative_funcp_6
 - GiNaC, [71](#)
- derivative_funcp_7
 - GiNaC, [72](#)
- derivative_funcp_8
 - GiNaC, [74](#)
- derivative_funcp_9
 - GiNaC, [76](#)
- derivative_funcp_exvector
 - GiNaC, [87](#)
- derivative_map_function
 - GiNaC::derivative_map_function, [494](#)
- derivative_use_exvector_args

- GiNaC::function_options, 728
- derivatives
 - GiNaC::fderivative, 659
- descend
 - GiNaC::const_postorder_iterator, 453
- determinant
 - GiNaC, 209
 - GiNaC::matrix, 840
- determinant_minor
 - GiNaC::matrix, 844
- dflt
 - GiNaC, 262
- diag_matrix
 - GiNaC, 206
- diff
 - GiNaC, 118
 - GiNaC::basic, 380
 - GiNaC::ex, 590
- difference_type
 - GiNaC::const_iterator, 446
 - GiNaC::const_postorder_iterator, 451
 - GiNaC::const_preorder_iterator, 455
- Digits
 - GiNaC, 292
- digits
 - GiNaC::_numeric_digits, 317
- digits_changed_callback
 - GiNaC, 89
- dim
 - GiNaC::idx, 748
 - GiNaC::spmapkey, 1159
- dirac_gamma
 - GiNaC, 95
- dirac_gamma5
 - GiNaC, 96
- dirac_gammaL
 - GiNaC, 96
- dirac_gammaR
 - GiNaC, 96
- dirac_ONE
 - GiNaC, 94
- dirac_slash
 - GiNaC, 97
- dirac_trace
 - GiNaC, 97, 98
- dirichlet_character
 - GiNaC, 199
- div
 - GiNaC::numeric, 964
- div_dyn
 - GiNaC::numeric, 965
- divfree
 - GiNaC::determinant_algo, 496
 - GiNaC::solve_algo, 1138
- divide
 - GiNaC, 217
- divide_in_z
 - GiNaC, 218
- division_free_elimination
 - GiNaC::matrix, 845
- do_not_evalf_params
 - GiNaC::function_options, 721
- do_print
 - GiNaC::add, 334
 - GiNaC::basic, 383
 - GiNaC::basic_log_kernel, 391
 - GiNaC::cliffordunit, 424
 - GiNaC::constant, 467
 - GiNaC::container< C >, 485
 - GiNaC::diracgamma, 502
 - GiNaC::diracgamma5, 507
 - GiNaC::diracgammaL, 513
 - GiNaC::diracgammaR, 518
 - GiNaC::diracone, 522
 - GiNaC::Ebar_kernel, 531
 - GiNaC::Eisenstein_h_kernel, 542
 - GiNaC::Eisenstein_kernel, 553
 - GiNaC::ELi_kernel, 563
 - GiNaC::expairseq, 632
 - GiNaC::fail, 645
 - GiNaC::fderivative, 659
 - GiNaC::idx, 747
 - GiNaC::indexed, 768
 - GiNaC::integral, 783
 - GiNaC::integration_kernel, 794
 - GiNaC::Kronecker_dtau_kernel, 804
 - GiNaC::Kronecker_dz_kernel, 813
 - GiNaC::matrix, 847
 - GiNaC::minkmetric, 856
 - GiNaC::modular_form_kernel, 865
 - GiNaC::mul, 888
 - GiNaC::multiple_polylog_kernel, 930
 - GiNaC::ncmul, 943
 - GiNaC::numeric, 977
 - GiNaC::pseries, 1084
 - GiNaC::relational, 1118
 - GiNaC::spinidx, 1149
 - GiNaC::spinmetric, 1156
 - GiNaC::su3d, 1184
 - GiNaC::su3f, 1190
 - GiNaC::su3one, 1195
 - GiNaC::su3t, 1201
 - GiNaC::symbol, 1219
 - GiNaC::symmetry, 1231
 - GiNaC::tensdelta, 1243
 - GiNaC::tensepsilon, 1250
 - GiNaC::tensmetric, 1257
 - GiNaC::user_defined_kernel, 1276
 - GiNaC::varidx, 1286
 - GiNaC::wildcard, 1294
- do_print_csrc
 - GiNaC::add, 335
 - GiNaC::fderivative, 660
 - GiNaC::idx, 747
 - GiNaC::mul, 889
 - GiNaC::ncmul, 943

- GiNaC::numeric, [977](#)
 - GiNaC::power, [1031](#)
- do_print_csrc_cl_N
 - GiNaC::numeric, [977](#)
 - GiNaC::power, [1032](#)
- do_print_dflt
 - GiNaC::clifford, [417](#)
 - GiNaC::power, [1031](#)
- do_print_latex
 - GiNaC::add, [335](#)
 - GiNaC::clifford, [417](#)
 - GiNaC::cliffordunit, [424](#)
 - GiNaC::constant, [467](#)
 - GiNaC::diracgamma, [502](#)
 - GiNaC::diracgamma5, [507](#)
 - GiNaC::diracgammaL, [513](#)
 - GiNaC::diracgammaR, [518](#)
 - GiNaC::diracone, [522](#)
 - GiNaC::fderivative, [660](#)
 - GiNaC::idx, [748](#)
 - GiNaC::indexed, [769](#)
 - GiNaC::integral, [784](#)
 - GiNaC::matrix, [847](#)
 - GiNaC::minkmetric, [856](#)
 - GiNaC::mul, [889](#)
 - GiNaC::numeric, [977](#)
 - GiNaC::power, [1031](#)
 - GiNaC::pseries, [1085](#)
 - GiNaC::spinidx, [1149](#)
 - GiNaC::spinmetric, [1156](#)
 - GiNaC::su3d, [1184](#)
 - GiNaC::su3f, [1190](#)
 - GiNaC::su3one, [1195](#)
 - GiNaC::su3t, [1201](#)
 - GiNaC::symbol, [1220](#)
 - GiNaC::tensdelta, [1243](#)
 - GiNaC::tensepsilon, [1250](#)
- do_print_python
 - GiNaC::container< C >, [485](#)
 - GiNaC::power, [1031](#)
 - GiNaC::pseries, [1085](#)
- do_print_python_repr
 - GiNaC::add, [335](#)
 - GiNaC::basic, [384](#)
 - GiNaC::constant, [467](#)
 - GiNaC::container< C >, [486](#)
 - GiNaC::matrix, [848](#)
 - GiNaC::mul, [889](#)
 - GiNaC::numeric, [978](#)
 - GiNaC::power, [1032](#)
 - GiNaC::pseries, [1085](#)
 - GiNaC::relational, [1118](#)
 - GiNaC::symbol, [1220](#)
 - GiNaC::wildcard, [1295](#)
- do_print_tree
 - GiNaC::basic, [384](#)
 - GiNaC::clifford, [418](#)
 - GiNaC::constant, [467](#)
 - GiNaC::container< C >, [485](#)
 - GiNaC::expairseq, [632](#)
 - GiNaC::fderivative, [660](#)
 - GiNaC::idx, [748](#)
 - GiNaC::indexed, [769](#)
 - GiNaC::numeric, [978](#)
 - GiNaC::pseries, [1085](#)
 - GiNaC::spinidx, [1149](#)
 - GiNaC::symbol, [1220](#)
 - GiNaC::symmetry, [1231](#)
 - GiNaC::varidx, [1287](#)
 - GiNaC::wildcard, [1294](#)
- do_renaming
 - GiNaC::make_flat_inserter, [821](#)
- domain
 - GiNaC::constant, [469](#)
- dotted
 - GiNaC::spinidx, [1149](#)
- doublefactorial
 - GiNaC, [240](#)
- dummy
 - GiNaC::function_options, [690](#)
- dump_hierarchy
 - GiNaC::class_info< OPT >, [401](#)
- dump_tree
 - GiNaC::class_info< OPT >, [401](#)
- duplicate
 - GiNaC::basic, [363](#)
 - GiNaC::possymbol, [1015](#)
 - GiNaC::print_functor_impl, [1050](#)
 - GiNaC::print_memfun_handler< T, C >, [1054](#)
 - GiNaC::print_ptrfun_handler< T, C >, [1058](#)
 - GiNaC::realsymbol, [1101](#)
- dynallocate
 - GiNaC, [92](#)
- dynallocated
 - GiNaC::status_flags, [1160](#)
- e
 - GiNaC::archive_node, [354](#)
 - GiNaC::const_iterator, [450](#)
 - GiNaC::internal::_iter_rep, [314](#)
- Ebar_kernel
 - GiNaC::Ebar_kernel, [530](#)
- echelon_form
 - GiNaC::matrix, [844](#)
- ef
 - GiNaC::constant, [468](#)
- Eisenstein_h_kernel
 - GiNaC::Eisenstein_h_kernel, [539](#)
- Eisenstein_kernel
 - GiNaC::Eisenstein_kernel, [550](#)
- element
 - GiNaC::composition_generator::coolmulti::element, [555](#)
- ELi_kernel
 - GiNaC::ELi_kernel, [562](#)
- EllipticE_deriv
 - GiNaC, [161](#)

- EllipticE_eval
 - GiNaC, [161](#)
- EllipticE_evalf
 - GiNaC, [161](#)
- EllipticE_print_latex
 - GiNaC, [162](#)
- EllipticE_series
 - GiNaC, [162](#)
- EllipticK_deriv
 - GiNaC, [160](#)
- EllipticK_eval
 - GiNaC, [160](#)
- EllipticK_evalf
 - GiNaC, [160](#)
- EllipticK_print_latex
 - GiNaC, [161](#)
- EllipticK_series
 - GiNaC, [160](#)
- end
 - GiNaC::archive_node::archive_node_cit_range, [355](#)
 - GiNaC::container< C >, [484](#)
 - GiNaC::ex, [578](#)
- ensure_if_modifiable
 - GiNaC::basic, [383](#)
- epp
 - GiNaC, [60](#)
- epsilon_tensor
 - GiNaC, [281](#)
- epvector
 - GiNaC, [60](#)
- equal
 - GiNaC::relational, [1114](#)
- error
 - GiNaC::error_and_integral, [567](#)
- error_and_integral
 - GiNaC::error_and_integral, [566](#)
- eta_conjugate
 - GiNaC, [149](#)
- eta_eval
 - GiNaC, [148](#)
- eta_evalf
 - GiNaC, [148](#)
- eta_imag_part
 - GiNaC, [149](#)
- eta_real_part
 - GiNaC, [149](#)
- eta_series
 - GiNaC, [149](#)
- Euler
 - GiNaC, [290](#)
- EulerEvalf
 - GiNaC, [247](#)
- eval
 - GiNaC, [118](#)
 - GiNaC::add, [328](#)
 - GiNaC::basic, [363](#)
 - GiNaC::ex, [579](#)
 - GiNaC::expairseq, [624](#)
 - GiNaC::fderivative, [656](#)
 - GiNaC::function, [675](#)
 - GiNaC::indexed, [763](#)
 - GiNaC::integral, [779](#)
 - GiNaC::mul, [879](#)
 - GiNaC::ncmul, [940](#)
 - GiNaC::numeric, [958](#)
 - GiNaC::power, [1025](#)
 - GiNaC::pseries, [1077](#)
 - GiNaC::structure< T, ComparisonPolicy >, [1166](#)
 - GiNaC::symbol, [1214](#)
- eval_f
 - GiNaC::function_options, [724](#)
- eval_func
 - GiNaC::function_options, [691–693](#), [716](#)
- eval_funcp
 - GiNaC, [60](#)
- eval_funcp_1
 - GiNaC, [62](#)
- eval_funcp_10
 - GiNaC, [77](#)
- eval_funcp_11
 - GiNaC, [78](#)
- eval_funcp_12
 - GiNaC, [80](#)
- eval_funcp_13
 - GiNaC, [82](#)
- eval_funcp_14
 - GiNaC, [84](#)
- eval_funcp_2
 - GiNaC, [63](#)
- eval_funcp_3
 - GiNaC, [65](#)
- eval_funcp_4
 - GiNaC, [66](#)
- eval_funcp_5
 - GiNaC, [68](#)
- eval_funcp_6
 - GiNaC, [70](#)
- eval_funcp_7
 - GiNaC, [71](#)
- eval_funcp_8
 - GiNaC, [73](#)
- eval_funcp_9
 - GiNaC, [75](#)
- eval_funcp_exvector
 - GiNaC, [86](#)
- eval_indexed
 - GiNaC::basic, [364](#)
 - GiNaC::matrix, [834](#)
 - GiNaC::minkmetric, [855](#)
 - GiNaC::spinmetric, [1155](#)
 - GiNaC::structure< T, ComparisonPolicy >, [1167](#)
 - GiNaC::su3d, [1184](#)
 - GiNaC::su3f, [1190](#)
 - GiNaC::tensdelta, [1242](#)
 - GiNaC::tensepsilon, [1248](#)

- GiNaC::tensmetric, 1256
- eval_integ
 - GiNaC, 118
 - GiNaC::basic, 364
 - GiNaC::ex, 580
 - GiNaC::integral, 782
 - GiNaC::pseries, 1079
- eval_ncmul
 - GiNaC::add, 331
 - GiNaC::basic, 364
 - GiNaC::clifford, 414
 - GiNaC::color, 435
 - GiNaC::ex, 580
 - GiNaC::function, 675
 - GiNaC::integral, 780
 - GiNaC::mul, 884
 - GiNaC::power, 1029
 - GiNaC::relational, 1117
 - GiNaC::structure< T, ComparisonPolicy >, 1167
- eval_use_exvector_args
 - GiNaC::function_options, 727
- evalchildren
 - GiNaC::expairseq, 635
- evalf
 - GiNaC, 118, 208
 - GiNaC::basic, 363
 - GiNaC::constant, 464
 - GiNaC::ex, 579
 - GiNaC::function, 675
 - GiNaC::idx, 743
 - GiNaC::integral, 779
 - GiNaC::mul, 880
 - GiNaC::numeric, 958
 - GiNaC::power, 1025
 - GiNaC::pseries, 1077
 - GiNaC::symbol, 1214
- evalf_f
 - GiNaC::function_options, 724
- evalf_func
 - GiNaC::function_options, 693–695, 716
- evalf_funcp
 - GiNaC, 60
- evalf_funcp_1
 - GiNaC, 62
- evalf_funcp_10
 - GiNaC, 77
- evalf_funcp_11
 - GiNaC, 78
- evalf_funcp_12
 - GiNaC, 80
- evalf_funcp_13
 - GiNaC, 82
- evalf_funcp_14
 - GiNaC, 84
- evalf_funcp_2
 - GiNaC, 63
- evalf_funcp_3
 - GiNaC, 65
- evalf_funcp_4
 - GiNaC, 66
- evalf_funcp_5
 - GiNaC, 68
- evalf_funcp_6
 - GiNaC, 70
- evalf_funcp_7
 - GiNaC, 72
- evalf_funcp_8
 - GiNaC, 73
- evalf_funcp_9
 - GiNaC, 75
- evalf_funcp_exvector
 - GiNaC, 86
- evalf_params_first
 - GiNaC::function_options, 726
- evalf_use_exvector_args
 - GiNaC::function_options, 728
- evalffunctype
 - GiNaC, 59
- evalm
 - GiNaC, 118
 - GiNaC::add, 328
 - GiNaC::basic, 363
 - GiNaC::ex, 580
 - GiNaC::matrix, 833
 - GiNaC::mul, 881
 - GiNaC::ncmul, 941
 - GiNaC::power, 1026
 - GiNaC::pseries, 1079
 - GiNaC::structure< T, ComparisonPolicy >, 1166
- evalpoint
 - factor.cpp, 1333
- evaluate
 - GiNaC::scalar_products, 1136
- evaluated
 - GiNaC::status_flags, 1160
- even
 - GiNaC::info_flags, 772
- ex
 - GiNaC::basic, 384
 - GiNaC::const_iterator, 449
 - GiNaC::ex, 576–578
- ex.cpp, 1318
- ex.h, 1318
- ex_to
 - GiNaC, 123
 - GiNaC::ex, 605
- exadd
 - GiNaC, 252
- excompiler.cpp, 1321
- excompiler.h, 1321
- exhashmap
 - GiNaC, 87
- exmap
 - GiNaC, 59
- exminus
 - GiNaC, 253

- exmul
 - GiNaC, [253](#)
- exp
 - GiNaC, [231](#)
- exp_conjugate
 - GiNaC, [177](#)
- exp_deriv
 - GiNaC, [176](#)
- exp_eval
 - GiNaC, [176](#)
- exp_evalf
 - GiNaC, [175](#)
- exp_expand
 - GiNaC, [176](#)
- exp_imag_part
 - GiNaC, [176](#)
- exp_info
 - GiNaC, [177](#)
- exp_power
 - GiNaC, [177](#)
- exp_real_part
 - GiNaC, [176](#)
- expair
 - GiNaC::expair, [611](#)
- expair.cpp, [1322](#)
- expair.h, [1323](#)
- expair_needs_further_processing
 - GiNaC::expairseq, [631](#)
 - GiNaC::mul, [886](#)
- expairseq
 - GiNaC::expairseq, [622](#), [623](#)
- expairseq.cpp, [1324](#)
- expairseq.h, [1324](#)
- expand
 - GiNaC, [114](#), [208](#)
 - GiNaC::add, [334](#)
 - GiNaC::basic, [371](#)
 - GiNaC::ex, [590](#)
 - GiNaC::expairseq, [628](#)
 - GiNaC::function, [675](#)
 - GiNaC::indexed, [766](#)
 - GiNaC::integral, [781](#)
 - GiNaC::mul, [887](#)
 - GiNaC::ncmul, [940](#)
 - GiNaC::power, [1030](#)
 - GiNaC::pseries, [1078](#)
 - GiNaC::structure< T, ComparisonPolicy >, [1172](#)
- expand_add
 - GiNaC::power, [1032](#)
- expand_add_2
 - GiNaC::power, [1032](#)
- expand_dummy_sum
 - GiNaC, [137](#)
- expand_f
 - GiNaC::function_options, [725](#)
- expand_func
 - GiNaC::function_options, [702–704](#), [717](#)
- expand_funcp
 - GiNaC, [61](#)
- expand_funcp_1
 - GiNaC, [62](#)
- expand_funcp_10
 - GiNaC, [77](#)
- expand_funcp_11
 - GiNaC, [79](#)
- expand_funcp_12
 - GiNaC, [81](#)
- expand_funcp_13
 - GiNaC, [83](#)
- expand_funcp_14
 - GiNaC, [85](#)
- expand_funcp_2
 - GiNaC, [64](#)
- expand_funcp_3
 - GiNaC, [65](#)
- expand_funcp_4
 - GiNaC, [67](#)
- expand_funcp_5
 - GiNaC, [69](#)
- expand_funcp_6
 - GiNaC, [70](#)
- expand_funcp_7
 - GiNaC, [72](#)
- expand_funcp_8
 - GiNaC, [74](#)
- expand_funcp_9
 - GiNaC, [76](#)
- expand_funcp_exvector
 - GiNaC, [87](#)
- expand_function_args
 - GiNaC::expand_options, [640](#)
- expand_indexed
 - GiNaC::expand_options, [640](#)
- expand_map_function
 - GiNaC::expand_map_function, [639](#)
- expand_mul
 - GiNaC::power, [1033](#)
- expand_rename_idx
 - GiNaC::expand_options, [640](#)
- expand_transcendental
 - GiNaC::expand_options, [640](#)
- expand_use_exvector_args
 - GiNaC::function_options, [728](#)
- expandchildren
 - GiNaC::expairseq, [635](#)
 - GiNaC::mul, [889](#)
 - GiNaC::ncmul, [944](#)
- expanded
 - GiNaC::info_flags, [772](#)
 - GiNaC::status_flags, [1160](#)
- expl_derivative
 - GiNaC::function, [680](#)
- expl_derivative_f
 - GiNaC::function_options, [725](#)
- expl_derivative_func
 - GiNaC::function_options, [707–709](#), [717](#)

- expl_derivative_funcp
 - GiNaC, [61](#)
- expl_derivative_funcp_1
 - GiNaC, [63](#)
- expl_derivative_funcp_10
 - GiNaC, [78](#)
- expl_derivative_funcp_11
 - GiNaC, [79](#)
- expl_derivative_funcp_12
 - GiNaC, [81](#)
- expl_derivative_funcp_13
 - GiNaC, [83](#)
- expl_derivative_funcp_14
 - GiNaC, [85](#)
- expl_derivative_funcp_2
 - GiNaC, [64](#)
- expl_derivative_funcp_3
 - GiNaC, [66](#)
- expl_derivative_funcp_4
 - GiNaC, [67](#)
- expl_derivative_funcp_5
 - GiNaC, [69](#)
- expl_derivative_funcp_6
 - GiNaC, [71](#)
- expl_derivative_funcp_7
 - GiNaC, [72](#)
- expl_derivative_funcp_8
 - GiNaC, [74](#)
- expl_derivative_funcp_9
 - GiNaC, [76](#)
- expl_derivative_funcp_exvector
 - GiNaC, [87](#)
- expl_derivative_use_exvector_args
 - GiNaC::function_options, [729](#)
- exponent
 - GiNaC::power, [1034](#)
- exponop
 - GiNaC::pseries, [1082](#)
- exprs
 - GiNaC::archive, [343](#)
- exprseq
 - GiNaC, [60](#)
 - GiNaC::info_flags, [772](#)
- exprseq.cpp, [1325](#)
- exprseq.h, [1326](#)
- exprtable
 - GiNaC::archive, [343](#)
- exset
 - GiNaC, [59](#)
- exvector
 - GiNaC, [59](#)
- exvectorvector
 - GiNaC, [88](#)
- F
 - GiNaC::print_memfun_handler< T, C >, [1054](#)
 - GiNaC::print_ptrfun_handler< T, C >, [1058](#)
- f
 - GiNaC::integral, [785](#)
 - GiNaC::print_memfun_handler< T, C >, [1055](#)
 - GiNaC::print_ptrfun_handler< T, C >, [1059](#)
 - GiNaC::user_defined_kernel, [1277](#)
- factor
 - GiNaC, [127](#)
- factor.cpp, [1326](#)
 - c, [1328](#)
 - cache, [1330](#)
 - cont, [1334](#)
 - DCOUT, [1327](#)
 - DCOUT2, [1327](#)
 - DCOUTVAR, [1327](#)
 - evalpoint, [1333](#)
 - factors, [1330](#)
 - k, [1331](#)
 - last, [1331](#)
 - len, [1331](#)
 - lr, [1330](#)
 - m, [1329](#)
 - modulus, [1334](#)
 - n, [1330](#)
 - one, [1330](#)
 - options, [1334](#)
 - poly, [1332](#)
 - pp, [1334](#)
 - R, [1333](#)
 - r, [1328](#)
 - syms, [1334](#)
 - syms_wox, [1333](#)
 - unit, [1333](#)
 - USE_SAME_DEGREE_FACTOR, [1328](#)
 - value, [1328](#)
 - vn, [1334](#)
 - vnlst, [1334](#)
 - x, [1332](#)
- factor.h, [1335](#)
- factorial
 - GiNaC, [240](#)
- factorial_conjugate
 - GiNaC, [152](#)
- factorial_eval
 - GiNaC, [152](#)
- factorial_evalf
 - GiNaC, [152](#)
- factorial_imag_part
 - GiNaC, [153](#)
- factorial_print_dfft_latex
 - GiNaC, [152](#)
- factorial_real_part
 - GiNaC, [153](#)
- factors
 - factor.cpp, [1330](#)
- fail.cpp, [1335](#)
- fail.h, [1336](#)
- FAST_COMPARE
 - normal.cpp, [1383](#)
- fderivative
 - GiNaC::fderivative, [655](#), [656](#)

- GiNaC::function_options, 723
- fderivative.cpp, 1337
- fderivative.h, 1337
- fibonacci
 - GiNaC, 242
- find
 - GiNaC, 115
 - GiNaC::class_info< OPT >, 401
 - GiNaC::ex, 585
 - GiNaC::unarchive_table_t, 1267
- find_bool
 - GiNaC::archive_node, 348
- find_common_factor
 - GiNaC, 227
- find_dummy_indices
 - GiNaC, 132
- find_ex
 - GiNaC::archive_node, 350
- find_ex_by_loc
 - GiNaC::archive_node, 350
- find_ex_node
 - GiNaC::archive_node, 351
- find_factory_fcn
 - GiNaC, 91
- find_first
 - GiNaC::archive_node, 349
- find_free_and_dummy
 - GiNaC, 131, 132
- find_function
 - GiNaC::function, 681
- find_last
 - GiNaC::archive_node, 350
- find_property_range
 - GiNaC::archive_node, 350
- find_real_imag
 - GiNaC::mul, 888
- find_string
 - GiNaC::archive_node, 349
- find_unsigned
 - GiNaC::archive_node, 349
- find_variant_indices
 - GiNaC, 134
- finished
 - GiNaC::composition_generator::coolmulti, 492
- first
 - GiNaC::class_info< OPT >, 402
- flag_overflow
 - GiNaC::basic_multi_iterator< T >, 397
- flags
 - GiNaC::basic, 384
- flags.h, 1338
- force_include_tgamma
 - GiNaC, 291
- force_include_zeta1
 - GiNaC, 291
- forget
 - GiNaC::archive, 341
 - GiNaC::archive_node, 352
- format_index_value
 - GiNaC, 285, 286
- frac_cancel
 - GiNaC, 226
- fraction_free_elimination
 - GiNaC::matrix, 846
- fsolve
 - GiNaC, 156
- func_arg_info
 - GiNaC, 139
- FUNCP_1P
 - GiNaC, 59
- FUNCP_2P
 - GiNaC, 59
- FUNCP_CUBA
 - GiNaC, 59
- function
 - GiNaC::function, 669–674
 - GiNaC::function_options, 723
- function.cpp, 1339
- function.h, 1339
 - DECLARE_FUNCTION_10P, 1348
 - DECLARE_FUNCTION_11P, 1348
 - DECLARE_FUNCTION_12P, 1349
 - DECLARE_FUNCTION_13P, 1349
 - DECLARE_FUNCTION_14P, 1349
 - DECLARE_FUNCTION_1P, 1346
 - DECLARE_FUNCTION_2P, 1346
 - DECLARE_FUNCTION_3P, 1346
 - DECLARE_FUNCTION_4P, 1347
 - DECLARE_FUNCTION_5P, 1347
 - DECLARE_FUNCTION_6P, 1347
 - DECLARE_FUNCTION_7P, 1347
 - DECLARE_FUNCTION_8P, 1348
 - DECLARE_FUNCTION_9P, 1348
 - is_ex_the_function, 1350
 - REGISTER_FUNCTION, 1350
- function_options
 - GiNaC::function_options, 689
- functions_with_same_name
 - GiNaC::function_options, 729
- G
 - GiNaC, 158
- G2_eval
 - GiNaC, 169
- G2_evalf
 - GiNaC, 169
- G3_eval
 - GiNaC, 170
- G3_evalf
 - GiNaC, 169
- gauss
 - GiNaC::determinant_algo, 496
 - GiNaC::solve_algo, 1138
- gauss_elimination
 - GiNaC::matrix, 845
- gcd
 - GiNaC, 222, 245

- gcd_pf_mul
 - GiNaC, [222](#)
- gcd_pf_pow
 - GiNaC, [221](#)
- gcd_pf_pow_pow
 - GiNaC, [223](#)
- generalised_Bernoulli_number
 - GiNaC, [199](#)
- get
 - GiNaC::composition_generator, [442](#)
 - GiNaC::partition_generator, [981](#)
 - GiNaC::partition_with_zero_parts_generator, [983](#)
- get_all_dummy_indices
 - GiNaC, [136](#)
- get_all_dummy_indices_safely
 - GiNaC, [136](#)
- get_cache_size
 - GiNaC::integration_kernel, [792](#)
- get_class_name
 - GiNaC::structure< T, ComparisonPolicy >, [1166](#)
- get_clifford_comp
 - GiNaC, [101](#)
- get_close_delim
 - GiNaC::container< C >, [477](#)
- get_commutator_sign
 - GiNaC::clifford, [416](#)
- get_default_flags
 - GiNaC::container< C >, [477](#)
- get_default_TeX_name
 - GiNaC, [269](#)
- get_dim
 - GiNaC::idx, [746](#)
- get_dim_uint
 - GiNaC, [95](#)
- get_domain
 - GiNaC::possymbol, [1015](#)
 - GiNaC::realsymbol, [1100](#)
 - GiNaC::symbol, [1218](#)
- get_dummy_indices
 - GiNaC::indexed, [767](#)
- get_ex
 - GiNaC::archive_node, [352](#)
- get_factors
 - GiNaC::ncmul, [944](#)
- get_first_symbol
 - GiNaC, [212](#)
- get_free_indices
 - GiNaC::add, [331](#)
 - GiNaC::basic, [374](#)
 - GiNaC::ex, [598](#)
 - GiNaC::indexed, [764](#)
 - GiNaC::integral, [781](#)
 - GiNaC::mul, [883](#)
 - GiNaC::ncmul, [941](#)
 - GiNaC::structure< T, ComparisonPolicy >, [1175](#)
- get_id
 - GiNaC::print_context_options, [1037](#)
 - GiNaC::registered_class_options, [1105](#)
- get_indices
 - GiNaC::indexed, [767](#)
- get_label
 - GiNaC::wildcard, [1294](#)
- get_last_access
 - GiNaC::remember_table_entry, [1127](#)
- get_metric
 - GiNaC::clifford, [415](#)
- get_name
 - GiNaC::function, [682](#)
 - GiNaC::function_options, [722](#)
 - GiNaC::print_context_options, [1037](#)
 - GiNaC::registered_class_options, [1105](#)
 - GiNaC::symbol, [1219](#)
- get_node
 - GiNaC::archive, [341](#)
- get_nparams
 - GiNaC::function_options, [722](#)
- get_numerical_value
 - GiNaC::Ebar_kernel, [531](#)
 - GiNaC::Eisenstein_h_kernel, [541](#)
 - GiNaC::Eisenstein_kernel, [552](#)
 - GiNaC::ELi_kernel, [563](#)
 - GiNaC::integration_kernel, [792](#)
 - GiNaC::Kronecker_dtau_kernel, [804](#)
 - GiNaC::Kronecker_dz_kernel, [813](#)
 - GiNaC::modular_form_kernel, [864](#)
- get_numerical_value_impl
 - GiNaC::integration_kernel, [793](#)
- get_open_delim
 - GiNaC::container< C >, [477](#)
- get_order
 - GiNaC::lanczos_coeffs, [815](#)
- get_parent
 - GiNaC::class_info< OPT >, [400](#)
- get_parent_name
 - GiNaC::print_context_options, [1037](#)
 - GiNaC::registered_class_options, [1105](#)
- get_point
 - GiNaC::pseries, [1081](#)
- get_pointer
 - GiNaC::ptr< T >, [1092](#)
- get_print_context
 - GiNaC, [261](#)
- get_print_dispatch_table
 - GiNaC::registered_class_options, [1106](#)
- get_print_options
 - GiNaC, [261](#)
- get_properties
 - GiNaC::archive_node, [351](#)
- get_refcount
 - GiNaC::refcounted, [1103](#)
- get_registered_functions
 - GiNaC::function, [682](#)
- get_representation_label
 - GiNaC, [97](#), [110](#)
 - GiNaC::clifford, [415](#)
 - GiNaC::color, [437](#)

- get_result
 - GiNaC::remember_table_entry, [1127](#)
- get_serial
 - GiNaC::function, [682](#)
- get_series_coeff
 - GiNaC::integration_kernel, [793](#)
- get_sign
 - GiNaC::multi_iterator_permutation< T >, [913](#)
- get_struct
 - GiNaC::structure< T, ComparisonPolicy >, [1178](#)
- get_successful_hits
 - GiNaC::remember_table_entry, [1128](#)
- get_symbol_stats
 - GiNaC, [213](#)
- get_symmetry
 - GiNaC::indexed, [768](#)
- get_TeX_name
 - GiNaC::symbol, [1219](#)
- get_top_node
 - GiNaC::archive, [340](#)
- get_type
 - GiNaC::symmetry, [1229](#)
- get_value
 - GiNaC::idx, [745](#)
- get_var
 - GiNaC::pseries, [1080](#)
- get_vector
 - GiNaC::basic_multi_iterator< T >, [394](#)
- gethash
 - GiNaC::basic, [382](#)
 - GiNaC::ex, [602](#)
- GiNaC, [19](#)
 - _ex0, [301](#)
 - _ex1, [303](#)
 - _ex10, [307](#)
 - _ex11, [307](#)
 - _ex12, [308](#)
 - _ex120, [311](#)
 - _ex15, [308](#)
 - _ex18, [308](#)
 - _ex1_2, [303](#)
 - _ex1_3, [302](#)
 - _ex1_4, [302](#)
 - _ex2, [304](#)
 - _ex20, [309](#)
 - _ex24, [309](#)
 - _ex25, [309](#)
 - _ex3, [305](#)
 - _ex30, [310](#)
 - _ex4, [305](#)
 - _ex48, [310](#)
 - _ex5, [305](#)
 - _ex6, [306](#)
 - _ex60, [310](#)
 - _ex7, [306](#)
 - _ex8, [306](#)
 - _ex9, [307](#)
 - _ex_1, [300](#)
 - _ex_10, [297](#)
 - _ex_11, [296](#)
 - _ex_12, [296](#)
 - _ex_120, [293](#)
 - _ex_15, [296](#)
 - _ex_18, [295](#)
 - _ex_1_2, [300](#)
 - _ex_1_3, [301](#)
 - _ex_1_4, [301](#)
 - _ex_2, [299](#)
 - _ex_20, [295](#)
 - _ex_24, [295](#)
 - _ex_25, [294](#)
 - _ex_3, [299](#)
 - _ex_30, [294](#)
 - _ex_4, [299](#)
 - _ex_48, [294](#)
 - _ex_5, [298](#)
 - _ex_6, [298](#)
 - _ex_60, [293](#)
 - _ex_7, [298](#)
 - _ex_8, [297](#)
 - _ex_9, [297](#)
 - _num0_bp, [291](#)
 - _num0_p, [301](#)
 - _num10_p, [307](#)
 - _num11_p, [307](#)
 - _num120_p, [310](#)
 - _num12_p, [307](#)
 - _num15_p, [308](#)
 - _num18_p, [308](#)
 - _num1_2_p, [303](#)
 - _num1_3_p, [302](#)
 - _num1_4_p, [302](#)
 - _num1_p, [303](#)
 - _num20_p, [308](#)
 - _num24_p, [309](#)
 - _num25_p, [309](#)
 - _num2_p, [304](#)
 - _num30_p, [309](#)
 - _num3_p, [304](#)
 - _num48_p, [310](#)
 - _num4_p, [305](#)
 - _num5_p, [305](#)
 - _num60_p, [310](#)
 - _num6_p, [305](#)
 - _num7_p, [306](#)
 - _num8_p, [306](#)
 - _num9_p, [306](#)
 - _num_10_p, [297](#)
 - _num_11_p, [296](#)
 - _num_120_p, [293](#)
 - _num_12_p, [296](#)
 - _num_15_p, [296](#)
 - _num_18_p, [295](#)
 - _num_1_2_p, [300](#)
 - _num_1_3_p, [300](#)
 - _num_1_4_p, [301](#)

- [_num_1_p](#), 300
- [_num_20_p](#), 295
- [_num_24_p](#), 295
- [_num_25_p](#), 294
- [_num_2_p](#), 299
- [_num_30_p](#), 294
- [_num_3_p](#), 299
- [_num_48_p](#), 294
- [_num_4_p](#), 299
- [_num_5_p](#), 298
- [_num_60_p](#), 293
- [_num_6_p](#), 298
- [_num_7_p](#), 298
- [_num_8_p](#), 297
- [_num_9_p](#), 297
- [abs](#), 242
- [abs_conjugate](#), 144
- [abs_eval](#), 143
- [abs_evalf](#), 143
- [abs_expand](#), 143
- [abs_expl_derivative](#), 143
- [abs_imag_part](#), 144
- [abs_info](#), 145
- [abs_power](#), 145
- [abs_print_csrc_float](#), 144
- [abs_print_latex](#), 144
- [abs_real_part](#), 144
- [acos](#), 233
- [acos_conjugate](#), 186
- [acos_deriv](#), 186
- [acos_eval](#), 185
- [acos_evalf](#), 185
- [acosh](#), 236
- [acosh_conjugate](#), 195
- [acosh_deriv](#), 194
- [acosh_eval](#), 194
- [acosh_evalf](#), 194
- [adaptivesimpson](#), 197
- [add_symbol](#), 213
- [algebraic_match_mul_with_mul](#), 211
- [antisymmetric2](#), 272
- [antisymmetric3](#), 272
- [antisymmetric4](#), 272
- [antisymmetrize](#), 120, 273, 277
- [archive_atom](#), 58
- [archive_node_id](#), 58
- [are_ex_trivially_equal](#), 112
- [asin](#), 233
- [asin_conjugate](#), 185
- [asin_deriv](#), 184
- [asin_eval](#), 184
- [asin_evalf](#), 184
- [asin_info](#), 185
- [asinh](#), 236
- [asinh_conjugate](#), 194
- [asinh_deriv](#), 193
- [asinh_eval](#), 193
- [asinh_evalf](#), 193
- [atan](#), 234
- [atan2_deriv](#), 188
- [atan2_eval](#), 188
- [atan2_evalf](#), 188
- [atan2_info](#), 188
- [atan_conjugate](#), 187
- [atan_deriv](#), 187
- [atan_eval](#), 186
- [atan_evalf](#), 186
- [atan_info](#), 187
- [atan_series](#), 187
- [atanh](#), 236
- [atanh_conjugate](#), 196
- [atanh_deriv](#), 195
- [atanh_eval](#), 195
- [atanh_evalf](#), 195
- [atanh_series](#), 196
- [base_and_index](#), 94
- [bernoulli](#), 241
- [Bernoulli_polynomial](#), 199
- [beta_deriv](#), 166
- [beta_eval](#), 166
- [beta_evalf](#), 166
- [beta_series](#), 166
- [binomial](#), 241
- [binomial_conjugate](#), 154
- [binomial_eval](#), 154
- [binomial_evalf](#), 153
- [binomial_imag_part](#), 154
- [binomial_real_part](#), 154
- [binomial_sym](#), 153
- [callback_registered](#), 89
- [canonicalize](#), 272
- [canonicalize_clifford](#), 99
- [Catalan](#), 290
- [CatalanEvalf](#), 247
- [charpoly](#), 209
- [clifford_bar](#), 105
- [clifford_inverse](#), 100
- [clifford_max_label](#), 100
- [clifford_moebius_map](#), 103
- [clifford_norm](#), 100
- [clifford_prime](#), 99
- [clifford_star](#), 105
- [clifford_star_bar](#), 99
- [clifford_to_lst](#), 101
- [clifford_unit](#), 95
- [coeff](#), 116
- [coerce](#), 230
- [coerce< int, cln::cl_I >](#), 230
- [coerce< unsigned int, cln::cl_I >](#), 231
- [collect](#), 117
- [collect_common_factors](#), 227
- [collect_symbols](#), 213
- [color_d](#), 109
- [color_f](#), 108
- [color_h](#), 109
- [color_ONE](#), 107

color_T, 108
color_trace, 110, 111
cols, 208
compare_pointers, 284
compile_ex, 124, 125
conjugate, 114
conjugate_conjugate, 139
conjugate_eval, 138
conjugate_evalf, 138
conjugate_expl_derivative, 139
conjugate_funcp, 60
conjugate_funcp_1, 62
conjugate_funcp_10, 77
conjugate_funcp_11, 79
conjugate_funcp_12, 80
conjugate_funcp_13, 82
conjugate_funcp_14, 84
conjugate_funcp_2, 63
conjugate_funcp_3, 65
conjugate_funcp_4, 67
conjugate_funcp_5, 68
conjugate_funcp_6, 70
conjugate_funcp_7, 72
conjugate_funcp_8, 73
conjugate_funcp_9, 75
conjugate_funcp_exvector, 86
conjugate_imag_part, 139
conjugate_info, 140
conjugate_print_latex, 138
conjugate_real_part, 139
conjugateepvector, 127
convert_H_to_Li, 160
cos, 232
cos_conjugate, 182
cos_deriv, 181
cos_eval, 181
cos_evalf, 181
cos_imag_part, 182
cos_real_part, 182
cosh, 235
cosh_conjugate, 191
cosh_deriv, 190
cosh_eval, 190
cosh_evalf, 190
cosh_imag_part, 191
cosh_real_part, 191
count_dummy_indices, 133
count_free_indices, 133
crc32, 112
crctab, 291
csgn, 248
csgn_conjugate, 147
csgn_eval, 147
csgn_evalf, 147
csgn_imag_part, 148
csgn_power, 148
csgn_real_part, 147
csgn_series, 147
csrc, 263
csrc_cl_N, 264
csrc_double, 263
csrc_float, 263
cyclic_permutation, 285
decomp_rational, 216
degree, 115
delta_tensor, 279
denom, 116, 252
derivative_funcp, 61
derivative_funcp_1, 62
derivative_funcp_10, 77
derivative_funcp_11, 79
derivative_funcp_12, 81
derivative_funcp_13, 83
derivative_funcp_14, 85
derivative_funcp_2, 64
derivative_funcp_3, 65
derivative_funcp_4, 67
derivative_funcp_5, 69
derivative_funcp_6, 71
derivative_funcp_7, 72
derivative_funcp_8, 74
derivative_funcp_9, 76
derivative_funcp_exvector, 87
determinant, 209
dfft, 262
diag_matrix, 206
diff, 118
Digits, 292
digits_changed_callback, 89
dirac_gamma, 95
dirac_gamma5, 96
dirac_gammaL, 96
dirac_gammaR, 96
dirac_ONE, 94
dirac_slash, 97
dirac_trace, 97, 98
dirichlet_character, 199
divide, 217
divide_in_z, 218
doublefactorial, 240
dynallocate, 92
EllipticE_deriv, 161
EllipticE_eval, 161
EllipticE_evalf, 161
EllipticE_print_latex, 162
EllipticE_series, 162
EllipticK_deriv, 160
EllipticK_eval, 160
EllipticK_evalf, 160
EllipticK_print_latex, 161
EllipticK_series, 160
epp, 60
epsilon_tensor, 281
epvector, 60
eta_conjugate, 149
eta_eval, 148

eta_evalf, 148
eta_imag_part, 149
eta_real_part, 149
eta_series, 149
Euler, 290
EulerEvalf, 247
eval, 118
eval_funcp, 60
eval_funcp_1, 62
eval_funcp_10, 77
eval_funcp_11, 78
eval_funcp_12, 80
eval_funcp_13, 82
eval_funcp_14, 84
eval_funcp_2, 63
eval_funcp_3, 65
eval_funcp_4, 66
eval_funcp_5, 68
eval_funcp_6, 70
eval_funcp_7, 71
eval_funcp_8, 73
eval_funcp_9, 75
eval_funcp_exvector, 86
eval_integ, 118
evalf, 118, 208
evalf_funcp, 60
evalf_funcp_1, 62
evalf_funcp_10, 77
evalf_funcp_11, 78
evalf_funcp_12, 80
evalf_funcp_13, 82
evalf_funcp_14, 84
evalf_funcp_2, 63
evalf_funcp_3, 65
evalf_funcp_4, 66
evalf_funcp_5, 68
evalf_funcp_6, 70
evalf_funcp_7, 72
evalf_funcp_8, 73
evalf_funcp_9, 75
evalf_funcp_exvector, 86
evalffunctype, 59
evalm, 118
ex_to, 123
exadd, 252
exhashmap, 87
exmap, 59
exminus, 253
exmul, 253
exp, 231
exp_conjugate, 177
exp_deriv, 176
exp_eval, 176
exp_evalf, 175
exp_expand, 176
exp_imag_part, 176
exp_info, 177
exp_power, 177
exp_real_part, 176
expand, 114, 208
expand_dummy_sum, 137
expand_funcp, 61
expand_funcp_1, 62
expand_funcp_10, 77
expand_funcp_11, 79
expand_funcp_12, 81
expand_funcp_13, 83
expand_funcp_14, 85
expand_funcp_2, 64
expand_funcp_3, 65
expand_funcp_4, 67
expand_funcp_5, 69
expand_funcp_6, 70
expand_funcp_7, 72
expand_funcp_8, 74
expand_funcp_9, 76
expand_funcp_exvector, 87
expl_derivative_funcp, 61
expl_derivative_funcp_1, 63
expl_derivative_funcp_10, 78
expl_derivative_funcp_11, 79
expl_derivative_funcp_12, 81
expl_derivative_funcp_13, 83
expl_derivative_funcp_14, 85
expl_derivative_funcp_2, 64
expl_derivative_funcp_3, 66
expl_derivative_funcp_4, 67
expl_derivative_funcp_5, 69
expl_derivative_funcp_6, 71
expl_derivative_funcp_7, 72
expl_derivative_funcp_8, 74
expl_derivative_funcp_9, 76
expl_derivative_funcp_exvector, 87
exprseq, 60
exset, 59
exvector, 59
exvectorvector, 88
factor, 127
factorial, 240
factorial_conjugate, 152
factorial_eval, 152
factorial_evalf, 152
factorial_imag_part, 153
factorial_print_dflt_latex, 152
factorial_real_part, 153
fibonacci, 242
find, 115
find_common_factor, 227
find_dummy_indices, 132
find_factory_fcn, 91
find_free_and_dummy, 131, 132
find_variant_indices, 134
force_include_tgamma, 291
force_include_zeta1, 291
format_index_value, 285, 286
frac_cancel, 226

- fsolve, 156
- func_arg_info, 139
- FUNCP_1P, 59
- FUNCP_2P, 59
- FUNCP_CUBA, 59
- G, 158
- G2_eval, 169
- G2_evalf, 169
- G3_eval, 170
- G3_evalf, 169
- gcd, 222, 245
- gcd_pf_mul, 222
- gcd_pf_pow, 221
- gcd_pf_pow_pow, 223
- generalised_Bernoulli_number, 199
- get_all_dummy_indices, 136
- get_all_dummy_indices_safely, 136
- get_clifford_comp, 101
- get_default_TeX_name, 269
- get_dim_uint, 95
- get_first_symbol, 212
- get_print_context, 261
- get_print_options, 261
- get_representation_label, 97, 110
- get_symbol_stats, 213
- GINAC_BIND_UNARCHIVER, 90, 93, 94, 106, 107, 112, 128, 130, 133, 197, 200–203, 205, 211, 212, 229, 265, 266, 268–270, 278, 279, 288, 292
- GINAC_DECLARE_UNARCHIVER, 90, 104, 105, 111, 112, 128, 129, 131, 132, 138, 197, 203–205, 207, 211, 212, 247, 265, 266, 268–270, 274, 282, 283, 289
- GINAC_IMPLEMENT_REGISTERED_CLASS_OPT, 89, 91, 92, 106, 112, 126, 128, 129, 133, 196, 200–203, 205, 210, 212, 228, 264, 266, 268, 270, 278, 288
- golden_ratio_hash, 284
- guess_precision, 238
- H_deriv, 173
- H_eval, 173
- H_evalf, 173
- H_print_latex, 173
- H_series, 173
- has, 115
- hasindex, 136
- haswild, 289
- heur_gcd, 221
- heur_gcd_z, 220
- hold_ncmul, 212
- I, 292
- idx, 291
- idx_symmetrization, 135
- ifactor, 197
- imag, 252
- imag_part, 114
- imag_part_conjugate, 142
- imag_part_eval, 142
- imag_part_evalf, 141
- imag_part_expl_derivative, 142
- imag_part_funcp, 61
- imag_part_funcp_1, 62
- imag_part_funcp_10, 77
- imag_part_funcp_11, 79
- imag_part_funcp_12, 81
- imag_part_funcp_13, 83
- imag_part_funcp_14, 85
- imag_part_funcp_2, 64
- imag_part_funcp_3, 65
- imag_part_funcp_4, 67
- imag_part_funcp_5, 69
- imag_part_funcp_6, 70
- imag_part_funcp_7, 72
- imag_part_funcp_8, 74
- imag_part_funcp_9, 75
- imag_part_funcp_exvector, 86
- imag_part_imag_part, 142
- imag_part_print_latex, 142
- imag_part_real_part, 142
- index0, 270
- index1, 270
- index2, 271
- index3, 271
- index_dimensions, 264
- indices_consistent, 133
- info_funcp, 62
- info_funcp_1, 63
- info_funcp_10, 78
- info_funcp_11, 80
- info_funcp_12, 82
- info_funcp_13, 84
- info_funcp_14, 86
- info_funcp_2, 65
- info_funcp_3, 66
- info_funcp_4, 68
- info_funcp_5, 70
- info_funcp_6, 71
- info_funcp_7, 73
- info_funcp_8, 75
- info_funcp_9, 76
- info_funcp_exvector, 87
- interpolate, 219
- inverse, 209, 248
- iquo, 244, 245
- irem, 243, 244
- is_a, 91, 123, 266
- is_cinteger, 251
- is_clifford_tinfo, 105
- is_color_tinfo, 109
- is_crational, 251
- is_dirac_slash, 94
- is_discriminant_of_quadratic_number_field, 198
- is_dummy_pair, 130
- is_even, 250
- is_exactly_a, 92, 123
- is_integer, 249

is_negative, 249
 is_nonneg_integer, 249
 is_odd, 250
 is_order_function, 159
 is_polynomial, 115
 is_pos_integer, 249
 is_positive, 249
 is_prime, 250
 is_rational, 250
 is_real, 250
 is_terminating, 267
 is_the_function, 129
 is_the_function< G_SERIAL >, 158
 is_the_function< iterated_integral_SERIAL >, 159
 is_the_function< psi_SERIAL >, 159
 is_the_function< zeta_SERIAL >, 157
 is_zero, 121, 248
 isqrt, 246
 iterated_integral, 159
 iterated_integral2_eval, 163
 iterated_integral2_evalf, 162
 iterated_integral3_eval, 163
 iterated_integral3_evalf, 163
 iterated_integral_evalf_impl, 162
 kronecker_symbol, 198
 latex, 262
 lcm, 223, 245
 lcm_of_coefficients_denominators, 214
 lcmcoeff, 214
 ldegree, 116
 lgamma, 238, 239
 lgamma_conjugate, 164
 lgamma_deriv, 164
 lgamma_eval, 163
 lgamma_evalf, 163
 lgamma_series, 164
 lhs, 121
 Li2, 238
 Li2_, 237
 Li2_conjugate, 150
 Li2_deriv, 150
 Li2_eval, 150
 Li2_evalf, 150
 Li2_projection, 237
 Li2_series, 150, 237
 Li3_eval, 151
 Li_deriv, 171
 Li_eval, 170
 Li_evalf, 170
 Li_print_latex, 171
 Li_series, 170
 library_initializer, 291
 link_ex, 125, 126
 log, 231
 log2, 283
 log_conjugate, 179
 log_deriv, 178
 log_eval, 178
 log_evalf, 177
 log_expand, 179
 log_imag_part, 178
 log_info, 179
 log_real_part, 178
 log_series, 178
 lookup_map, 88
 lorentz_eps, 282
 lorentz_g, 280
 lsolve, 156
 lst, 88
 lst_to_clifford, 100, 101
 lst_to_matrix, 206
 make_hash_seed, 129
 make_real_float, 228
 make_return_type_t, 267
 map_eval_integ, 290
 map_evalm, 289
 match, 119
 metric_tensor, 279
 minimal_dim, 131
 mod, 242
 multinomial_coefficient, 283
 multiply_lcm, 214
 my_ios_callback, 261
 my_ios_index, 260
 next_print_context_id, 292
 no_index_dimensions, 264
 nops, 113, 207
 normal, 117
 not_symmetric, 271
 number_of_type, 134
 numer, 116, 252
 numer_denom, 117
 op, 121
 operator!=, 259
 operator<, 260
 operator<<, 90, 113, 247, 262, 286–288
 operator<=, 260
 operator>, 260
 operator>>, 91, 262
 operator>=, 260
 operator*, 254
 operator*==, 255, 256
 operator+, 253, 254, 256, 257
 operator++, 257–259
 operator+==, 255, 256
 operator-, 253, 254, 257
 operator--, 257–259
 operator-=, 255, 256
 operator/, 254, 255
 operator/=, 255, 256
 operator==, 259
 Order_conjugate, 155
 Order_eval, 155
 Order_expl_derivative, 156
 Order_imag_part, 155
 Order_power, 156

- Order_real_part, 155
- Order_series, 155
- paramset, 60
- permutation_sign, 284, 285
- permute_free_index_to_front, 107
- Pi, 290
- PiEvalf, 246
- pow, 247, 265
- power_funcp, 61
- power_funcp_1, 63
- power_funcp_10, 78
- power_funcp_11, 79
- power_funcp_12, 81
- power_funcp_13, 83
- power_funcp_14, 85
- power_funcp_2, 64
- power_funcp_3, 66
- power_funcp_4, 67
- power_funcp_5, 69
- power_funcp_6, 71
- power_funcp_7, 73
- power_funcp_8, 74
- power_funcp_9, 76
- power_funcp_exvector, 87
- prem, 216
- primitive_dirichlet_character, 198
- print_context_class_info, 89
- print_func< print_context >, 129
- print_func< print_dflt >, 93, 106, 278
- print_funcp, 61
- print_funcp_1, 63
- print_funcp_10, 78
- print_funcp_11, 80
- print_funcp_12, 82
- print_funcp_13, 84
- print_funcp_14, 86
- print_funcp_2, 64
- print_funcp_3, 66
- print_funcp_4, 68
- print_funcp_5, 69
- print_funcp_6, 71
- print_funcp_7, 73
- print_funcp_8, 75
- print_funcp_9, 76
- print_funcp_exvector, 87
- print_integer_csrc, 229
- print_operator, 268
- print_real_cl_N, 231
- print_real_csrc, 230
- print_real_number, 229
- print_sym_pow, 264
- product_to_exvector, 135
- psi, 158, 239, 240
- psi1_deriv, 167
- psi1_eval, 167
- psi1_evalf, 167
- psi1_series, 168
- psi2_deriv, 168
- psi2_eval, 168
- psi2_evalf, 168
- psi2_series, 169
- python, 262
- python_repr, 263
- quo, 215
- rank, 210
- read_real_float, 228
- read_unsigned, 90
- real, 252
- real_part, 114
- real_part_conjugate, 141
- real_part_eval, 140
- real_part_evalf, 140
- real_part_expl_derivative, 141
- real_part_funcp, 61
- real_part_funcp_1, 62
- real_part_funcp_10, 77
- real_part_funcp_11, 79
- real_part_funcp_12, 80
- real_part_funcp_13, 82
- real_part_funcp_14, 84
- real_part_funcp_2, 64
- real_part_funcp_3, 65
- real_part_funcp_4, 67
- real_part_funcp_5, 68
- real_part_funcp_6, 70
- real_part_funcp_7, 72
- real_part_funcp_8, 74
- real_part_funcp_9, 75
- real_part_funcp_exvector, 86
- real_part_imag_part, 141
- real_part_print_latex, 140
- real_part_real_part, 141
- reduced_matrix, 207
- reeval_ncmul, 212
- REGISTER_FUNCTION, 140, 141, 143, 145, 146, 148, 149, 151–154, 156, 161, 162, 164, 166, 167, 171, 172, 174, 177, 179, 181, 182, 184–188, 190, 191, 193–196
- registered_class_info, 89
- rem, 215
- remove_dirac_ONE, 99
- rename_dummy_indices, 134
- rename_dummy_indices_uniquely, 136, 137
- replace_with_symbol, 225, 226
- reposition_dummy_indices, 134
- resultant, 227
- rhs, 121
- rotate_left, 283
- rows, 208
- S_deriv, 172
- S_eval, 171
- S_evalf, 171
- S_print_latex, 172
- S_series, 172
- series, 119
- series_funcp, 61

series_funcp_1, 63
 series_funcp_10, 78
 series_funcp_11, 80
 series_funcp_12, 81
 series_funcp_13, 83
 series_funcp_14, 85
 series_funcp_2, 64
 series_funcp_3, 66
 series_funcp_4, 68
 series_funcp_5, 69
 series_funcp_6, 71
 series_funcp_7, 73
 series_funcp_8, 74
 series_funcp_9, 76
 series_funcp_exvector, 87
 series_to_poly, 266
 set_print_context, 261
 set_print_func, 267
 set_print_options, 261
 shaker_sort, 285
 simplify_indexed, 119, 135
 simplify_indexed_product, 135
 sin, 232
 sin_conjugate, 180
 sin_deriv, 180
 sin_eval, 180
 sin_evalf, 179
 sin_imag_part, 180
 sin_real_part, 180
 sinh, 235
 sinh_conjugate, 190
 sinh_deriv, 189
 sinh_eval, 189
 sinh_evalf, 189
 sinh_imag_part, 189
 sinh_real_part, 189
 smod, 243
 spinor_metric, 280
 spmap, 88
 sprem, 217
 sqrfree, 224
 sqrfree_parfrac, 225
 sqrfree_yun, 223
 sqrt, 246, 266
 sr_gcd, 219
 step, 248
 step_conjugate, 146
 step_eval, 145
 step_evalf, 145
 step_imag_part, 146
 step_real_part, 146
 step_series, 146
 sub_matrix, 207
 subs, 122
 subsvalue, 196
 swap, 122, 126
 sy_anti, 275, 276
 sy_cycl, 276, 277
 sy_none, 274
 sy_symm, 275
 sym_desc_vec, 88
 symbolic_matrix, 206, 210
 symm, 273
 symmetric2, 271
 symmetric3, 271
 symmetric4, 271
 symmetrize, 120, 273, 277
 symmetrize_cyclic, 120, 121, 273, 277
 synthesize_func, 58
 tan, 233
 tan_conjugate, 184
 tan_deriv, 183
 tan_eval, 183
 tan_evalf, 182
 tan_imag_part, 183
 tan_real_part, 183
 tan_series, 183
 tanh, 235
 tanh_conjugate, 193
 tanh_deriv, 192
 tanh_eval, 192
 tanh_evalf, 191
 tanh_imag_part, 192
 tanh_real_part, 192
 tanh_series, 192
 tensor, 290
 tgamma, 239
 tgamma_conjugate, 165
 tgamma_deriv, 165
 tgamma_eval, 165
 tgamma_evalf, 164
 tgamma_series, 165
 to_double, 251
 to_int, 251
 to_long, 251
 to_polynomial, 117
 to_rational, 117
 trace, 209
 trace_string, 97
 transpose, 208
 tree, 263
 trig_info, 181
 tryfactsubs, 211
 uintvector, 88
 unarch_table_instance, 289
 unarchive_map_t, 58
 unit_matrix, 206, 210
 unlink_ex, 126
 unsignedvector, 88
 version_major, 293
 version_micro, 293
 version_minor, 293
 wild, 289
 write_real_float, 229
 write_unsigned, 90
 zeta, 157, 238

- zeta1_deriv, [174](#)
- zeta1_eval, [174](#)
- zeta1_evalf, [174](#)
- zeta1_print_latex, [174](#)
- zeta2_deriv, [175](#)
- zeta2_eval, [175](#)
- zeta2_evalf, [175](#)
- zeta2_print_latex, [175](#)
- zetaderiv_deriv, [151](#)
- zetaderiv_eval, [151](#)
- ginac.h, [1350](#)
- GiNaC::numeric_digits, [315](#)
 - _numeric_digits, [316](#)
 - add_callback, [317](#)
 - callbacklist, [317](#)
 - digits, [317](#)
 - operator long, [316](#)
 - operator=, [316](#)
 - print, [317](#)
 - too_late, [317](#)
- GiNaC::add, [318](#)
 - add, [325](#), [326](#)
 - coeff, [328](#)
 - combine_ex_with_coeff_to_pair, [333](#)
 - combine_pair_with_coeff_to_pair, [333](#)
 - conjugate, [330](#)
 - degree, [327](#)
 - derivative, [331](#)
 - do_print, [334](#)
 - do_print_csrc, [335](#)
 - do_print_latex, [335](#)
 - do_print_python_repr, [335](#)
 - eval, [328](#)
 - eval_ncmul, [331](#)
 - evalm, [328](#)
 - expand, [334](#)
 - get_free_indices, [331](#)
 - imag_part, [331](#)
 - info, [327](#)
 - integer_content, [329](#)
 - is_polynomial, [327](#)
 - ldegree, [328](#)
 - max_coefficient, [330](#)
 - mul, [335](#)
 - normal, [329](#)
 - power, [335](#)
 - precedence, [327](#)
 - print_add, [334](#)
 - real_part, [331](#)
 - recombine_pair_to_ex, [333](#)
 - return_type, [332](#)
 - return_type_tinfo, [332](#)
 - series, [329](#)
 - smod, [330](#)
 - split_ex_to_pair, [333](#)
 - thisexpairseq, [332](#)
- GiNaC::archive, [336](#)
 - ~archive, [338](#)
 - add_node, [340](#)
 - archive, [338](#)
 - archive_ex, [338](#)
 - atomize, [341](#)
 - atoms, [343](#)
 - clear, [340](#)
 - exprs, [343](#)
 - exprtable, [343](#)
 - forget, [341](#)
 - get_node, [341](#)
 - get_top_node, [340](#)
 - inv_at_cit, [337](#)
 - inverse_atoms, [343](#)
 - nodes, [343](#)
 - num_expressions, [340](#)
 - operator<<, [342](#)
 - operator>>, [342](#)
 - printraw, [341](#)
 - unarchive_ex, [339](#)
 - unatomize, [342](#)
- GiNaC::archive::archived_ex, [356](#)
 - archived_ex, [356](#)
 - name, [357](#)
 - root, [357](#)
- GiNaC::archive_node, [344](#)
 - a, [353](#)
 - add_bool, [347](#)
 - add_ex, [348](#)
 - add_string, [348](#)
 - add_unsigned, [348](#)
 - archive_node, [347](#)
 - archive_node_cit, [346](#)
 - e, [354](#)
 - find_bool, [348](#)
 - find_ex, [350](#)
 - find_ex_by_loc, [350](#)
 - find_ex_node, [351](#)
 - find_first, [349](#)
 - find_last, [350](#)
 - find_property_range, [350](#)
 - find_string, [349](#)
 - find_unsigned, [349](#)
 - forget, [352](#)
 - get_ex, [352](#)
 - get_properties, [351](#)
 - has_ex, [352](#)
 - has_expression, [353](#)
 - has_same_ex_as, [351](#)
 - operator<<, [353](#)
 - operator>>, [353](#)
 - operator=, [347](#)
 - printraw, [352](#)
 - property_type, [346](#)
 - propinfovector, [346](#)
 - props, [353](#)
 - PTYPE_BOOL, [347](#)
 - PTYPE_NODE, [347](#)
 - PTYPE_STRING, [347](#)

- PTYPE_UNSIGNED, 347
- unarchive, 351
- GiNaC::archive_node::archive_node_cit_range, 354
 - begin, 355
 - end, 355
- GiNaC::archive_node::property, 1065
 - name, 1066
 - property, 1065
 - type, 1065
 - value, 1066
- GiNaC::archive_node::property_info, 1066
 - count, 1067
 - name, 1067
 - property_info, 1067
 - type, 1067
- GiNaC::basic, 357
 - ~basic, 362
 - accept, 369
 - add_indexed, 375
 - archive, 379
 - basic, 362
 - calchash, 378
 - clearflag, 383
 - coeff, 370
 - collect, 371
 - compare, 381
 - compare_same_type, 377
 - conjugate, 377
 - contract_with, 376
 - dbgprint, 365
 - dbgprinttree, 365
 - degree, 370
 - derivative, 372
 - diff, 380
 - do_print, 383
 - do_print_python_repr, 384
 - do_print_tree, 384
 - duplicate, 363
 - ensure_if_modifiable, 383
 - eval, 363
 - eval_indexed, 364
 - eval_integ, 364
 - eval_ncmul, 364
 - evalf, 363
 - evalm, 363
 - ex, 384
 - expand, 371
 - flags, 384
 - get_free_indices, 374
 - gethash, 382
 - has, 368
 - hashvalue, 385
 - hold, 381
 - imag_part, 377
 - info, 365
 - integer_content, 373
 - is_equal, 381
 - is_equal_same_type, 378
 - is_polynomial, 370
 - ldegree, 370
 - let_op, 367
 - map, 369
 - match, 368
 - match_same_type, 368
 - max_coefficient, 374
 - nops, 366
 - normal, 372
 - op, 366
 - operator=, 362
 - operator[], 366, 367
 - precedence, 365
 - print, 364
 - print_dispatch, 378, 379
 - read_archive, 379
 - real_part, 377
 - return_type, 376
 - return_type_tinfo, 377
 - scalar_mul_indexed, 375
 - series, 372
 - setflag, 382
 - smod, 374
 - subs, 369
 - subs_one_level, 380
 - to_polynomial, 373
 - to_rational, 373
- GiNaC::basic_log_kernel, 385
 - do_print, 391
 - series_coeff_impl, 391
- GiNaC::basic_multi_iterator< T >, 391
 - ~basic_multi_iterator, 394
 - B, 396
 - basic_multi_iterator, 393
 - flag_overflow, 397
 - get_vector, 394
 - init, 395
 - N, 396
 - operator<<, 396
 - operator(), 395
 - operator++, 396
 - operator[], 395
 - overflow, 394
 - size, 394
 - v, 397
- GiNaC::basic_partition_generator, 397
 - basic_partition_generator, 398
 - mpgen, 399
- GiNaC::basic_partition_generator::mpartition2, 866
 - m, 867
 - mpartition2, 866
 - n, 867
 - next_partition, 867
 - x, 867
- GiNaC::class_info< OPT >, 399
 - class_info, 400
 - dump_hierarchy, 401
 - dump_tree, 401

- find, [401](#)
- first, [402](#)
- get_parent, [400](#)
- identify_parents, [401](#)
- next, [402](#)
- options, [402](#)
- parent, [402](#)
- parents_identified, [402](#)
- GiNaC::class_info< OPT >::tree_node, [1265](#)
 - add_child, [1266](#)
 - children, [1266](#)
 - info, [1266](#)
 - tree_node, [1265](#)
- GiNaC::clifford, [403](#)
 - archive, [413](#)
 - clifford, [412](#), [413](#)
 - commutator_sign, [418](#)
 - do_print_dflt, [417](#)
 - do_print_latex, [417](#)
 - do_print_tree, [418](#)
 - eval_ncmul, [414](#)
 - get_commutator_sign, [416](#)
 - get_metric, [415](#)
 - get_representation_label, [415](#)
 - let_op, [417](#)
 - match_same_type, [414](#)
 - metric, [418](#)
 - nops, [416](#)
 - op, [416](#)
 - precedence, [413](#)
 - read_archive, [413](#)
 - representation_label, [418](#)
 - return_type, [415](#)
 - return_type_tinfo, [415](#)
 - same_metric, [416](#)
 - subs, [417](#)
 - thiscontainer, [414](#), [415](#)
- GiNaC::cliffordunit, [419](#)
 - contract_with, [423](#)
 - do_print, [424](#)
 - do_print_latex, [424](#)
- GiNaC::color, [424](#)
 - archive, [434](#)
 - color, [433](#), [434](#)
 - eval_ncmul, [435](#)
 - get_representation_label, [437](#)
 - match_same_type, [435](#)
 - read_archive, [435](#)
 - representation_label, [437](#)
 - return_type, [436](#)
 - return_type_tinfo, [436](#)
 - thiscontainer, [436](#)
- GiNaC::compare_all_equal< T >, [437](#)
 - ~compare_all_equal, [438](#)
 - struct_compare, [438](#)
 - struct_is_equal, [438](#)
- GiNaC::compare_bitwise< T >, [439](#)
 - ~compare_bitwise, [439](#)
 - struct_compare, [439](#)
 - struct_is_equal, [439](#)
- GiNaC::composition_generator, [441](#)
 - atend, [443](#)
 - cmgen, [443](#)
 - composition, [443](#)
 - composition_generator, [442](#)
 - current_updated, [443](#)
 - get, [442](#)
 - next, [442](#)
 - trivial, [443](#)
- GiNaC::composition_generator::coolmulti, [491](#)
 - ~coolmulti, [491](#)
 - after_i, [492](#)
 - coolmulti, [491](#)
 - finished, [492](#)
 - head, [492](#)
 - i, [492](#)
 - next_permutation, [492](#)
- GiNaC::composition_generator::coolmulti::element, [554](#)
 - ~element, [555](#)
 - element, [555](#)
 - next, [555](#)
 - value, [555](#)
- GiNaC::const_iterator, [444](#)
 - const_iterator, [446](#)
 - const_postorder_iterator, [450](#)
 - const_preorder_iterator, [449](#)
 - difference_type, [446](#)
 - e, [450](#)
 - ex, [449](#)
 - i, [450](#)
 - iterator_category, [445](#)
 - operator!=, [448](#)
 - operator<, [449](#)
 - operator<=, [449](#)
 - operator>, [449](#)
 - operator>=, [449](#)
 - operator*, [446](#)
 - operator+, [447](#), [450](#)
 - operator++, [447](#)
 - operator+=, [447](#)
 - operator-, [448](#), [450](#)
 - operator->, [447](#)
 - operator--, [448](#)
 - operator-=, [448](#)
 - operator==, [448](#)
 - operator[], [447](#)
 - pointer, [446](#)
 - reference, [446](#)
 - value_type, [445](#)
- GiNaC::const_postorder_iterator, [451](#)
 - const_postorder_iterator, [452](#)
 - descend, [453](#)

- difference_type, 451
- increment, 453
- iterator_category, 451
- operator!=, 453
- operator*, 452
- operator++, 453
- operator->, 452
- operator==, 453
- pointer, 452
- reference, 452
- s, 454
- value_type, 451
- GiNaC::const_preorder_iterator, 454
 - const_preorder_iterator, 455, 456
 - difference_type, 455
 - increment, 457
 - iterator_category, 455
 - operator!=, 457
 - operator*, 456
 - operator++, 456
 - operator->, 456
 - operator==, 456
 - pointer, 455
 - reference, 455
 - s, 457
 - value_type, 455
- GiNaC::constant, 458
 - archive, 465
 - calchash, 466
 - conjugate, 465
 - constant, 463
 - derivative, 466
 - do_print, 467
 - do_print_latex, 467
 - do_print_python_repr, 467
 - do_print_tree, 467
 - domain, 469
 - ef, 468
 - evalf, 464
 - imag_part, 465
 - info, 464
 - is_equal_same_type, 466
 - is_polynomial, 464
 - name, 468
 - next_serial, 468
 - number, 468
 - read_archive, 465
 - real_part, 465
 - serial, 468
 - TeX_name, 468
- GiNaC::container< C >, 469
 - append, 483
 - archive, 480
 - begin, 484
 - conjugate, 480
 - const_iterator, 476
 - const_reverse_iterator, 476
 - container, 476, 477
 - do_print, 485
 - do_print_python, 485
 - do_print_python_repr, 486
 - do_print_tree, 485
 - end, 484
 - get_close_delim, 477
 - get_default_flags, 477
 - get_open_delim, 477
 - imag_part, 481
 - info, 477
 - is_equal_same_type, 481
 - let_op, 479
 - nops, 478
 - op, 478
 - precedence, 478
 - prepend, 483
 - printseq, 482
 - rbegin, 485
 - read_archive, 479
 - real_part, 480
 - remove_all, 484
 - remove_first, 483
 - remove_last, 483
 - rend, 485
 - sort, 484
 - sort_, 482
 - STLT, 475
 - subs, 479
 - subchildren, 486
 - thiscontainer, 481, 482
 - unique, 484
 - unique_, 483, 486
- GiNaC::container_storage< C >, 487
 - ~container_storage, 489
 - container_storage, 488
 - reserve, 489
 - seq, 490
 - STLT, 488
- GiNaC::derivative_map_function, 493
 - derivative_map_function, 494
 - operator(), 494
 - s, 495
- GiNaC::determinant_algo, 495
 - automatic, 496
 - bareiss, 496
 - divfree, 496
 - gauss, 496
 - laplace, 496
- GiNaC::diracgamma, 496
 - contract_with, 502
 - do_print, 502
 - do_print_latex, 502
- GiNaC::diracgamma5, 503
 - conjugate, 507
 - do_print, 507
 - do_print_latex, 507
- GiNaC::diracgammaL, 508
 - conjugate, 512

- do_print, 513
- do_print_latex, 513
- GiNaC::diracgammaR, 513
 - conjugate, 517
 - do_print, 518
 - do_print_latex, 518
- GiNaC::diracone, 518
 - do_print, 522
 - do_print_latex, 522
- GiNaC::do_taylor, 523
- GiNaC::domain, 523
 - complex, 524
 - positive, 524
 - real, 524
- GiNaC::dunno, 524
- GiNaC::Ebar_kernel, 524
 - do_print, 531
 - Ebar_kernel, 530
 - get_numerical_value, 531
 - is_numeric, 530
 - let_op, 530
 - m, 532
 - n, 532
 - nops, 530
 - op, 530
 - series_coeff_impl, 531
 - x, 532
 - y, 532
- GiNaC::Eisenstein_h_kernel, 533
 - C_norm, 543
 - coefficient_a0, 541
 - coefficient_an, 541
 - do_print, 542
 - Eisenstein_h_kernel, 539
 - get_numerical_value, 541
 - is_numeric, 540
 - k, 542
 - Laurent_series, 540
 - let_op, 540
 - N, 542
 - nops, 539
 - op, 540
 - q_expansion_modular_form, 542
 - r, 543
 - s, 543
 - series, 539
 - uses_Laurent_series, 541
- GiNaC::Eisenstein_kernel, 544
 - a, 553
 - b, 553
 - C_norm, 554
 - do_print, 553
 - Eisenstein_kernel, 550
 - get_numerical_value, 552
 - is_numeric, 551
 - K, 554
 - k, 553
 - Laurent_series, 552
 - let_op, 551
 - N, 553
 - nops, 551
 - op, 551
 - q_expansion_modular_form, 552
 - series, 550
 - uses_Laurent_series, 552
- GiNaC::ELi_kernel, 556
 - do_print, 563
 - ELi_kernel, 562
 - get_numerical_value, 563
 - is_numeric, 562
 - let_op, 562
 - m, 564
 - n, 564
 - nops, 562
 - op, 562
 - series_coeff_impl, 563
 - x, 564
 - y, 564
- GiNaC::error_and_integral, 566
 - error, 567
 - error_and_integral, 566
 - integral, 567
- GiNaC::error_and_integral_is_less, 567
 - operator(), 567
- GiNaC::eval_integ_map_function, 568
 - operator(), 569
- GiNaC::evalf_map_function, 569
 - operator(), 570
- GiNaC::evalm_map_function, 571
 - operator(), 572
- GiNaC::ex, 572
 - accept, 587
 - antisymmetrize, 601
 - archive_node, 605
 - are_ex_trivially_equal, 605
 - begin, 578
 - bp, 607
 - coeff, 589
 - collect, 590
 - compare, 599
 - conjugate, 584
 - construct_from_basic, 602
 - construct_from_double, 604
 - construct_from_int, 603
 - construct_from_long, 603
 - construct_from_longlong, 604
 - construct_from_string_and_lst, 604
 - construct_from_uint, 603
 - construct_from_ulong, 603
 - construct_from_ulonglong, 604
 - content, 595
 - dbgprint, 581
 - dbgprinttree, 581
 - degree, 589
 - denom, 593
 - diff, 590

end, 578
 eval, 579
 eval_integ, 580
 eval_ncmul, 580
 evalf, 579
 evalm, 580
 ex, 576–578
 ex_to, 605
 expand, 590
 find, 585
 get_free_indices, 598
 gethash, 602
 has, 585
 imag_part, 585
 info, 581
 integer_content, 595
 is_a, 607
 is_equal, 599
 is_exactly_a, 607
 is_polynomial, 588
 is_zero, 600
 is_zero_matrix, 600
 lcoeff, 589
 ldegree, 589
 let_op, 583
 lhs, 584
 makewritable, 604
 map, 587
 match, 585, 586
 max_coefficient, 597
 nops, 582
 normal, 592
 numer, 593
 numer_denom, 594
 op, 582
 operator[], 583, 584
 postorder_begin, 579
 postorder_end, 579
 preorder_begin, 579
 preorder_end, 579
 primpart, 596
 print, 580
 real_part, 584
 return_type, 602
 return_type_tinfo, 602
 rhs, 584
 series, 591
 share, 605
 simplify_indexed, 598, 599
 smod, 597
 subs, 586, 587
 swap, 578
 symmetrize, 601
 symmetrize_cyclic, 601, 602
 tcoeff, 590
 to_polynomial, 593
 to_rational, 592
 traverse, 588
 traverse_postorder, 588
 traverse_preorder, 588
 unit, 594
 unitcontprim, 597
 GiNaC::ex_base_is_less, 608
 operator(), 608
 GiNaC::ex_is_equal, 608
 operator(), 608
 GiNaC::ex_is_less, 609
 operator(), 609
 GiNaC::ex_swap, 609
 operator(), 609
 GiNaC::expair, 610
 coeff, 613
 compare, 612
 conjugate, 612
 expair, 611
 is_canonical_numeric, 612
 is_equal, 611
 is_less, 611
 print, 612
 rest, 613
 swap, 612
 GiNaC::expair_is_less, 613
 operator(), 614
 GiNaC::expair_rest_is_less, 614
 operator(), 614
 GiNaC::expair_swap, 615
 operator(), 615
 GiNaC::expairseq, 616
 archive, 626
 calchash, 628
 can_make_flat, 632
 canonicalize, 634
 combine_ex_with_coeff_to_pair, 630
 combine_overall_coeff, 631
 combine_pair_with_coeff_to_pair, 630
 combine_same_terms_sorted_seq, 634
 conjugate, 626
 construct_from_2_ex, 632
 construct_from_2_expairseq, 632
 construct_from_epvector, 633
 construct_from_expairseq_ex, 633
 construct_from_exvector, 633
 default_overall_coeff, 631
 do_print, 632
 do_print_tree, 632
 eval, 624
 evalchildren, 635
 expair_needs_further_processing, 631
 expairseq, 622, 623
 expand, 628
 expandchildren, 635
 info, 623
 is_canonical, 635
 is_equal_same_type, 627
 make_flat, 634
 map, 624

- match, 625
- nops, 623
- op, 624
- overall_coeff, 637
- precedence, 623
- printpair, 629
- printseq, 629
- read_archive, 627
- recombine_pair_to_ex, 630
- return_type, 627
- seq, 636
- split_ex_to_pair, 629
- subs, 626
- subchildren, 636
- thisexpairseq, 628, 629
- to_polynomial, 625
- to_rational, 625
- GiNaC::expand_map_function, 637
 - expand_map_function, 639
 - operator(), 639
 - options, 639
- GiNaC::expand_options, 639
 - expand_function_args, 640
 - expand_indexed, 640
 - expand_rename_idx, 640
 - expand_transcendental, 640
- GiNaC::factor_options, 640
 - all, 641
 - polynomial, 641
- GiNaC::fail, 641
 - do_print, 645
 - return_type, 645
- GiNaC::fderivative, 646
 - archive, 657
 - derivative, 658
 - derivatives, 659
 - do_print, 659
 - do_print_csrc, 660
 - do_print_latex, 660
 - do_print_tree, 660
 - eval, 656
 - fderivative, 655, 656
 - is_equal_same_type, 658
 - match_same_type, 659
 - parameter_set, 660
 - print, 656
 - read_archive, 658
 - series, 657
 - thiscontainer, 657
- GiNaC::function, 661
 - archive, 678
 - calchash, 676
 - conjugate, 677
 - current_serial, 683
 - derivative, 678
 - eval, 675
 - eval_ncmul, 675
 - evalf, 675
 - expand, 675
 - expl_derivative, 680
 - find_function, 681
 - function, 669–674
 - get_name, 682
 - get_registered_functions, 682
 - get_serial, 682
 - imag_part, 677
 - info, 678
 - is_equal_same_type, 679
 - lookup_remember_table, 681
 - match_same_type, 679
 - pderivative, 680
 - power, 681
 - precedence, 674
 - print, 674
 - read_archive, 678
 - real_part, 677
 - register_new, 681
 - registered_functions, 680
 - remember_table_entry, 682
 - return_type, 679
 - return_type_tinfo, 680
 - serial, 683
 - series, 676
 - store_remember_table, 681
 - thiscontainer, 676, 677
- GiNaC::function_options, 683
 - ~function_options, 690
 - conjugate_f, 724
 - conjugate_func, 695–697, 717
 - conjugate_use_exvector_args, 728
 - derivative_f, 725
 - derivative_func, 705–707, 717
 - derivative_use_exvector_args, 728
 - do_not_evalf_params, 721
 - dummy, 690
 - eval_f, 724
 - eval_func, 691–693, 716
 - eval_use_exvector_args, 727
 - evalf_f, 724
 - evalf_func, 693–695, 716
 - evalf_params_first, 726
 - evalf_use_exvector_args, 728
 - expand_f, 725
 - expand_func, 702–704, 717
 - expand_use_exvector_args, 728
 - expl_derivative_f, 725
 - expl_derivative_func, 707–709, 717
 - expl_derivative_use_exvector_args, 729
 - fderivative, 723
 - function, 723
 - function_options, 689
 - functions_with_same_name, 729
 - get_name, 722
 - get_nparams, 722
 - has_derivative, 722
 - has_power, 723

- imag_part_f, 725
- imag_part_func, 700–702, 717
- imag_part_use_exvector_args, 728
- info_f, 726
- info_func, 714–716, 718
- info_use_exvector_args, 729
- initialize, 690
- latex_name, 690
- name, 724
- nparams, 724
- overloaded, 722
- power_f, 725
- power_func, 709–711, 718
- power_use_exvector_args, 729
- print_dispatch_table, 726
- print_func, 718–721
- print_use_exvector_args, 729
- real_part_f, 725
- real_part_func, 698–700, 717
- real_part_use_exvector_args, 728
- remember, 722
- remember_assoc_size, 727
- remember_size, 727
- remember_strategy, 727
- return_type, 726
- return_type_tinfo, 727
- series_f, 726
- series_func, 712–714, 718
- series_use_exvector_args, 729
- set_name, 690
- set_print_func, 723
- set_return_type, 721
- set_symmetry, 722
- symtree, 730
- test_and_set_nparams, 723
- TeX_name, 724
- use_remember, 727
- use_return_type, 726
- GiNaC::G2_SERIAL, 730
 - serial, 730
- GiNaC::G3_SERIAL, 731
 - serial, 731
- GiNaC::gcd_options, 731
 - no_heur_gcd, 732
 - no_part_factored, 732
 - use_sr_gcd, 732
- GiNaC::gcdheu_failed, 732
- GiNaC::has_distance < T >, 732
 - no_type, 733
 - test, 734
 - value, 733
 - yes_type, 733
- GiNaC::has_options, 734
 - algebraic, 735
- GiNaC::idx, 736
 - archive, 743
 - calchash, 744
 - derivative, 744
 - dim, 748
 - do_print, 747
 - do_print_csrc, 747
 - do_print_latex, 748
 - do_print_tree, 748
 - evalf, 743
 - get_dim, 746
 - get_value, 745
 - idx, 741
 - info, 742
 - is_dim_numeric, 746
 - is_dim_symbolic, 746
 - is_dummy_pair_same_type, 745
 - is_numeric, 745
 - is_symbolic, 745
 - map, 742
 - match_same_type, 744
 - minimal_dim, 747
 - nops, 742
 - op, 742
 - print_index, 747
 - read_archive, 743
 - replace_dim, 746
 - subs, 743
 - value, 748
- GiNaC::idx_is_equal_ignore_dim, 749
 - operator(), 749
- GiNaC::indexed, 750
 - all_index_values_are, 766
 - archive, 764
 - derivative, 765
 - do_print, 768
 - do_print_latex, 769
 - do_print_tree, 769
 - eval, 763
 - expand, 766
 - get_dummy_indices, 767
 - get_free_indices, 764
 - get_indices, 767
 - get_symmetry, 768
 - has_dummy_index_for, 767
 - imag_part, 764
 - indexed, 758–763
 - info, 763
 - precedence, 763
 - print_indexed, 768
 - printindices, 768
 - read_archive, 765
 - real_part, 764
 - reposition_dummy_indices, 770
 - return_type, 766
 - return_type_tinfo, 766
 - simplify_indexed, 769
 - simplify_indexed_product, 770
 - symtree, 770
 - thiscontainer, 765, 766
 - validate, 769
- GiNaC::info_flags, 771

- cinteger, 772
- cinteger_polynomial, 772
- crational, 772
- crational_polynomial, 772
- even, 772
- expanded, 772
- exprseq, 772
- has_indices, 772
- idx, 772
- indefinite, 772
- indexed, 772
- integer, 772
- integer_polynomial, 772
- list, 772
- negative, 772
- negint, 772
- nonnegative, 772
- nonnegint, 772
- numeric, 772
- odd, 772
- polynomial, 772
- posint, 772
- positive, 772
- prime, 772
- rational, 772
- rational_function, 772
- rational_polynomial, 772
- real, 772
- relation, 772
- relation_equal, 772
- relation_greater, 772
- relation_greater_or_equal, 772
- relation_less, 772
- relation_less_or_equal, 772
- relation_not_equal, 772
- symbol, 772
- GiNaC::integral, 772
 - a, 784
 - archive, 782
 - b, 785
 - conjugate, 782
 - degree, 779
 - derivative, 783
 - do_print, 783
 - do_print_latex, 784
 - eval, 779
 - eval_integ, 782
 - eval_ncmul, 780
 - evalf, 779
 - expand, 781
 - f, 785
 - get_free_indices, 781
 - integral, 778
 - ldegree, 780
 - let_op, 781
 - max_integration_level, 784
 - nops, 780
 - op, 780
 - precedence, 779
 - read_archive, 782
 - relative_integration_error, 784
 - return_type, 781
 - return_type_tinfo, 782
 - series, 783
 - x, 784
- GiNaC::integration_kernel, 785
 - cache_step_size, 794
 - do_print, 794
 - get_cache_size, 792
 - get_numerical_value, 792
 - get_numerical_value_impl, 793
 - get_series_coeff, 793
 - has_trailing_zero, 791
 - is_numeric, 791
 - Laurent_series, 791
 - series, 790
 - series_coeff, 793
 - series_coeff_impl, 792
 - series_vec, 794
 - set_cache_step, 793
 - uses_Laurent_series, 792
- GiNaC::internal, 311
- GiNaC::internal::iter_rep, 313
 - _iter_rep, 314
 - e, 314
 - i, 315
 - i_end, 315
 - operator!=, 314
 - operator==, 314
- GiNaC::is_not_a_clifford, 794
 - operator(), 795
- GiNaC::is_summation_idx, 795
 - operator(), 795
- GiNaC::iterated_integral2_SERIAL, 796
 - serial, 796
- GiNaC::iterated_integral3_SERIAL, 796
 - serial, 797
- GiNaC::Kronecker_dtau_kernel, 797
 - C_norm, 805
 - do_print, 804
 - get_numerical_value, 804
 - is_numeric, 803
 - K, 805
 - Kronecker_dtau_kernel, 803
 - let_op, 803
 - n, 805
 - nops, 803
 - op, 803
 - series_coeff_impl, 804
 - z, 805
- GiNaC::Kronecker_dz_kernel, 806
 - C_norm, 814
 - do_print, 813
 - get_numerical_value, 813
 - is_numeric, 812
 - K, 814

- Kronecker_dz_kernel, 812
- let_op, 812
- n, 814
- nops, 812
- op, 812
- series_coeff_impl, 813
- tau, 814
- z_j, 814
- GiNaC::lanczos_coeffs, 815
 - calc_lanczos_A, 816
 - coeffs, 816
 - current_vector, 816
 - get_order, 815
 - lanczos_coeffs, 815
 - sufficiently_accurate, 815
- GiNaC::library_init, 817
 - ~library_init, 818
 - count, 819
 - init_unarchivers, 819
 - library_init, 818
- GiNaC::make_flat_inserter, 819
 - combine_indices, 821
 - do_renaming, 821
 - handle_factor, 820
 - make_flat_inserter, 820
 - used_indices, 821
- GiNaC::map_function, 822
 - ~map_function, 823
 - argument_type, 823
 - operator(), 823
 - result_type, 823
- GiNaC::matrix, 824
 - add, 837
 - add_indexed, 834
 - archive, 836
 - charpoly, 841
 - col, 848
 - cols, 837
 - conjugate, 835
 - contract_with, 835
 - determinant, 840
 - determinant_minor, 844
 - division_free_elimination, 845
 - do_print, 847
 - do_print_latex, 847
 - do_print_python_repr, 848
 - echelon_form, 844
 - eval_indexed, 834
 - evalm, 833
 - fraction_free_elimination, 846
 - gauss_elimination, 845
 - imag_part, 835
 - inverse, 842
 - is_zero_matrix, 844
 - let_op, 833
 - m, 848
 - markowitz_elimination, 846
 - match_same_type, 836
 - matrix, 830, 832
 - mul, 838
 - mul_scalar, 838
 - nops, 833
 - op, 833
 - operator(), 839
 - pivot, 846
 - pow, 838
 - print_elements, 847
 - rank, 843, 844
 - read_archive, 836
 - real_part, 835
 - return_type, 836
 - row, 848
 - rows, 837
 - scalar_mul_indexed, 834
 - set, 840
 - solve, 843
 - sub, 837
 - subs, 834
 - trace, 841
 - transpose, 840
- GiNaC::minkmetric, 849
 - archive, 855
 - do_print, 856
 - do_print_latex, 856
 - eval_indexed, 855
 - info, 854
 - minkmetric, 854
 - pos_sig, 856
 - read_archive, 855
 - return_type, 856
- GiNaC::modular_form_kernel, 857
 - C_norm, 866
 - do_print, 865
 - get_numerical_value, 864
 - is_numeric, 864
 - k, 865
 - Laurent_series, 864
 - let_op, 864
 - modular_form_kernel, 863
 - nops, 863
 - op, 863
 - P, 866
 - q_expansion_modular_form, 865
 - series, 863
 - uses_Laurent_series, 865
- GiNaC::mul, 868
 - add, 890
 - algebraic_subs_mul, 888
 - can_be_further_expanded, 889
 - can_make_flat, 887
 - coeff, 879
 - combine_ex_with_coeff_to_pair, 885
 - combine_overall_coeff, 887
 - combine_pair_with_coeff_to_pair, 886
 - conjugate, 883
 - default_overall_coeff, 886

- degree, 878
- derivative, 883
- do_print, 888
- do_print_csrc, 889
- do_print_latex, 889
- do_print_python_repr, 889
- eval, 879
- eval_ncmul, 884
- evalf, 880
- evalm, 881
- expair_needs_further_processing, 886
- expand, 887
- expandchildren, 889
- find_real_imag, 888
- get_free_indices, 883
- has, 879
- imag_part, 880
- info, 878
- integer_content, 882
- is_polynomial, 878
- ldegree, 879
- max_coefficient, 883
- mul, 876, 877
- ncmul, 890
- normal, 881
- power, 890
- precedence, 877
- print_overall_coeff, 888
- real_part, 880
- recombine_pair_to_ex, 886
- return_type, 884
- return_type_tinfo, 884
- series, 881
- smod, 882
- split_ex_to_pair, 885
- thisexpairseq, 884, 885
- GiNaC::multi_iterator_counter< T >, 891
 - init, 893
 - multi_iterator_counter, 893
 - operator<<, 894
 - operator++, 893
- GiNaC::multi_iterator_counter_indv< T >, 894
 - init, 897
 - multi_iterator_counter_indv, 896, 897
 - Nv, 898
 - operator<<, 898
 - operator++, 897
- GiNaC::multi_iterator_ordered< T >, 898
 - init, 901
 - multi_iterator_ordered, 900, 901
 - operator<<, 902
 - operator++, 901
- GiNaC::multi_iterator_ordered_eq< T >, 902
 - init, 905
 - multi_iterator_ordered_eq, 904
 - operator<<, 905
 - operator++, 905
- GiNaC::multi_iterator_ordered_eq_indv< T >, 906
 - init, 909
 - multi_iterator_ordered_eq_indv, 908
 - Nv, 909
 - operator<<, 909
 - operator++, 909
- GiNaC::multi_iterator_permutation< T >, 910
 - get_sign, 913
 - init, 913
 - multi_iterator_permutation, 912
 - operator<<, 914
 - operator++, 913
- GiNaC::multi_iterator_shuffle< T >, 914
 - init, 917
 - multi_iterator_shuffle, 917
 - N_internal, 918
 - operator<<, 918
 - operator++, 917
 - v_internal, 918
 - v_orig, 918
- GiNaC::multi_iterator_shuffle_prime< T >, 919
 - init, 922
 - multi_iterator_shuffle_prime, 922
 - operator<<, 922
- GiNaC::multiple_polylog_kernel, 923
 - do_print, 930
 - is_numeric, 929
 - let_op, 929
 - multiple_polylog_kernel, 929
 - nops, 929
 - op, 929
 - series_coeff_impl, 930
 - z, 930
- GiNaC::ncmul, 931
 - append_factors, 944
 - coeff, 940
 - conjugate, 942
 - count_factors, 944
 - degree, 939
 - derivative, 942
 - do_print, 943
 - do_print_csrc, 943
 - eval, 940
 - evalm, 941
 - expand, 940
 - expandchildren, 944
 - get_factors, 944
 - get_free_indices, 941
 - hold_ncmul, 945
 - imag_part, 942
 - info, 939
 - ldegree, 940
 - ncmul, 938, 939
 - power, 945
 - precedence, 939
 - real_part, 942
 - reeval_ncmul, 945
 - return_type, 943
 - return_type_tinfo, 943

- thiscontainer, [941](#), [942](#)
- GiNaC::normal_map_function, [945](#)
- operator(), [946](#)
- GiNaC::numeric, [947](#)
- add, [963](#)
 - add_dyn, [965](#)
 - archive, [962](#)
 - calchash, [963](#)
 - coeff, [958](#)
 - compare, [968](#)
 - conjugate, [961](#)
 - csgn, [967](#)
 - degree, [957](#)
 - denom, [976](#)
 - derivative, [962](#)
 - div, [964](#)
 - div_dyn, [965](#)
 - do_print, [977](#)
 - do_print_csrc, [977](#)
 - do_print_csrc_cl_N, [977](#)
 - do_print_latex, [977](#)
 - do_print_python_repr, [978](#)
 - do_print_tree, [978](#)
 - eval, [958](#)
 - evalf, [958](#)
 - has, [958](#)
 - imag, [975](#)
 - imag_part, [961](#)
 - info, [956](#)
 - int_length, [976](#)
 - integer_content, [960](#)
 - inverse, [967](#)
 - is_cinteger, [971](#)
 - is_crational, [971](#)
 - is_equal, [968](#)
 - is_equal_same_type, [962](#)
 - is_even, [970](#)
 - is_integer, [969](#)
 - is_negative, [969](#)
 - is_nonneg_integer, [970](#)
 - is_odd, [970](#)
 - is_polynomial, [957](#)
 - is_pos_integer, [969](#)
 - is_positive, [969](#)
 - is_prime, [970](#)
 - is_rational, [971](#)
 - is_real, [971](#)
 - is_zero, [968](#)
 - ldegree, [957](#)
 - max_coefficient, [961](#)
 - mul, [964](#)
 - mul_dyn, [965](#)
 - normal, [959](#)
 - numer, [976](#)
 - numeric, [954](#)–[956](#)
 - operator!=, [972](#)
 - operator<, [972](#)
 - operator<=, [972](#)
 - operator>, [974](#)
 - operator>=, [974](#)
 - operator=, [966](#), [967](#)
 - operator==, [972](#)
 - power, [964](#)
 - power_dyn, [966](#)
 - precedence, [956](#)
 - print_numeric, [976](#)
 - read_archive, [962](#)
 - real, [975](#)
 - real_part, [961](#)
 - smod, [960](#)
 - step, [967](#)
 - sub, [963](#)
 - sub_dyn, [965](#)
 - subs, [959](#)
 - to_cl_N, [975](#)
 - to_double, [975](#)
 - to_int, [974](#)
 - to_long, [974](#)
 - to_polynomial, [960](#)
 - to_rational, [959](#)
 - value, [978](#)
- GiNaC::op0_is_equal, [979](#)
- operator(), [979](#)
- GiNaC::partition_generator, [979](#)
- current_updated, [981](#)
 - get, [981](#)
 - next, [981](#)
 - partition, [981](#)
 - partition_generator, [981](#)
- GiNaC::partition_with_zero_parts_generator, [982](#)
- current_updated, [984](#)
 - get, [983](#)
 - m, [984](#)
 - next, [984](#)
 - partition, [984](#)
 - partition_with_zero_parts_generator, [983](#)
- GiNaC::pointer_to_map_function, [985](#)
- operator(), [986](#)
 - pointer_to_map_function, [986](#)
 - ptr, [987](#)
- GiNaC::pointer_to_map_function_1arg< T1 >, [987](#)
- arg1, [989](#)
 - operator(), [989](#)
 - pointer_to_map_function_1arg, [989](#)
 - ptr, [989](#)
- GiNaC::pointer_to_map_function_2args< T1, T2 >, [990](#)
- arg1, [992](#)
 - arg2, [992](#)
 - operator(), [991](#)
 - pointer_to_map_function_2args, [991](#)
 - ptr, [992](#)
- GiNaC::pointer_to_map_function_3args< T1, T2, T3 >, [992](#)
- arg1, [994](#)
 - arg2, [995](#)

- arg3, 995
- operator(), 994
- pointer_to_map_function_3args, 994
- ptr, 994
- GiNaC::pointer_to_member_to_map_function< C >, 995
- c, 997
- operator(), 997
- pointer_to_member_to_map_function, 997
- ptr, 997
- GiNaC::pointer_to_member_to_map_function_1arg< C, T1 >, 998
- arg1, 1000
- c, 1000
- operator(), 999
- pointer_to_member_to_map_function_1arg, 999
- ptr, 1000
- GiNaC::pointer_to_member_to_map_function_2args< C, T1, T2 >, 1000
- arg1, 1003
- arg2, 1003
- c, 1002
- operator(), 1002
- pointer_to_member_to_map_function_2args, 1002
- ptr, 1002
- GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2, T3 >, 1003
- arg1, 1006
- arg2, 1006
- arg3, 1006
- c, 1005
- operator(), 1005
- pointer_to_member_to_map_function_3args, 1005
- ptr, 1005
- GiNaC::pole_error, 1007
- deg, 1008
- degree, 1008
- pole_error, 1008
- GiNaC::possymbol, 1009
- duplicate, 1015
- get_domain, 1015
- possymbol, 1015
- GiNaC::power, 1016
- archive, 1029
- basis, 1034
- coeff, 1024
- conjugate, 1028
- degree, 1024
- derivative, 1029
- do_print_csrc, 1031
- do_print_csrc_cl_N, 1032
- do_print_dflt, 1031
- do_print_latex, 1031
- do_print_python, 1031
- do_print_python_repr, 1032
- eval, 1025
- eval_ncmul, 1029
- evalf, 1025
- evalm, 1026
- expand, 1030
- expand_add, 1032
- expand_add_2, 1032
- expand_mul, 1033
- exponent, 1034
- has, 1027
- imag_part, 1028
- info, 1023
- is_polynomial, 1024
- ldegree, 1024
- map, 1023
- mul, 1033
- nops, 1023
- normal, 1027
- op, 1023
- power, 1022
- precedence, 1022
- print_power, 1030
- read_archive, 1029
- real_part, 1028
- return_type, 1030
- return_type_tinfo, 1030
- series, 1026
- subs, 1026
- to_polynomial, 1028
- to_rational, 1027
- GiNaC::print_context, 1034
- ~print_context, 1035
- options, 1035
- print_context, 1035
- s, 1035
- GiNaC::print_context_options, 1036
- get_id, 1037
- get_name, 1037
- get_parent_name, 1037
- id, 1038
- name, 1037
- parent_name, 1037
- print_context_options, 1036
- GiNaC::print_csrc, 1038
- print_csrc, 1039
- GiNaC::print_csrc_cl_N, 1040
- print_csrc_cl_N, 1041
- GiNaC::print_csrc_double, 1042
- print_csrc_double, 1043
- GiNaC::print_csrc_float, 1044
- print_csrc_float, 1045
- GiNaC::print_dflt, 1046
- print_dflt, 1047
- GiNaC::print_functor, 1047
- impl, 1049
- is_valid, 1049
- operator(), 1049
- operator=, 1048
- print_functor, 1048
- GiNaC::print_functor_impl, 1050
- ~print_functor_impl, 1050

- duplicate, 1050
- operator(), 1051
- GiNaC::print_latex, 1051
- print_latex, 1052
- GiNaC::print_memfun_handler< T, C >, 1053
 - duplicate, 1054
 - F, 1054
 - f, 1055
 - operator(), 1055
 - print_memfun_handler, 1054
- GiNaC::print_options, 1055
- print_index_dimensions, 1057
- GiNaC::print_ptrfun_handler< T, C >, 1057
 - duplicate, 1058
 - F, 1058
 - f, 1059
 - operator(), 1059
 - print_ptrfun_handler, 1058
- GiNaC::print_python, 1060
- print_python, 1061
- GiNaC::print_python_repr, 1061
- print_python_repr, 1062
- GiNaC::print_tree, 1063
 - delta_indent, 1064
 - print_tree, 1064
- GiNaC::pseries, 1068
 - add_series, 1082
 - archive, 1079
 - coeff, 1076
 - coeffop, 1082
 - collect, 1076
 - conjugate, 1078
 - convert_to_poly, 1081
 - degree, 1075
 - derivative, 1080
 - do_print, 1084
 - do_print_latex, 1085
 - do_print_python, 1085
 - do_print_python_repr, 1085
 - do_print_tree, 1085
 - eval, 1077
 - eval_integ, 1079
 - evalf, 1077
 - evalm, 1079
 - expand, 1078
 - exponop, 1082
 - get_point, 1081
 - get_var, 1080
 - imag_part, 1079
 - is_compatible_to, 1081
 - is_terminating, 1082
 - is_zero, 1081
 - ldegree, 1076
 - mul_const, 1083
 - mul_series, 1083
 - nops, 1075
 - normal, 1078
 - op, 1075
 - point, 1086
 - power_const, 1084
 - precedence, 1075
 - print_series, 1084
 - pseries, 1074
 - read_archive, 1080
 - real_part, 1079
 - seq, 1086
 - series, 1077
 - shift_exponents, 1084
 - subs, 1077
 - var, 1086
- GiNaC::psi1_SERIAL, 1086
 - serial, 1087
- GiNaC::psi2_SERIAL, 1087
 - serial, 1088
- GiNaC::ptr< T >, 1088
 - ~ptr, 1090
 - get_pointer, 1092
 - makewritable, 1091
 - operator!=, 1092, 1093
 - operator<<, 1093
 - operator*, 1091
 - operator->, 1091
 - operator=, 1090
 - operator==, 1091–1093
 - p, 1093
 - ptr, 1090
 - std::less< ptr< T > >, 1092
 - swap, 1091
- GiNaC::realsymbol, 1094
 - conjugate, 1100
 - duplicate, 1101
 - get_domain, 1100
 - imag_part, 1101
 - real_part, 1100
 - realsymbol, 1099, 1100
- GiNaC::refcounted, 1102
 - add_reference, 1103
 - get_refcount, 1103
 - refcount, 1104
 - refcounted, 1103
 - remove_reference, 1103
 - set_refcount, 1104
- GiNaC::registered_class_options, 1104
 - get_id, 1105
 - get_name, 1105
 - get_parent_name, 1105
 - get_print_dispatch_table, 1106
 - name, 1107
 - parent_name, 1107
 - print_dispatch_table, 1107
 - print_func, 1106
 - registered_class_options, 1105
 - set_print_func, 1106
 - tinfo_key, 1107
- GiNaC::relational, 1108
 - archive, 1116

- calchash, 1118
- canonical, 1116
- do_print, 1118
- do_print_python_repr, 1118
- equal, 1114
- eval_ncmul, 1117
- greater, 1114
- greater_or_equal, 1114
- info, 1115
- less, 1114
- less_or_equal, 1114
- lh, 1120
- lhs, 1118
- make_safe_bool, 1119
- map, 1115
- match_same_type, 1117
- nops, 1115
- not_equal, 1114
- o, 1120
- op, 1115
- operator safe_bool, 1119
- operator!, 1119
- operators, 1114
- precedence, 1114
- read_archive, 1116
- relational, 1114
- return_type, 1117
- return_type_tinfo, 1117
- rh, 1120
- rhs, 1119
- safe_bool, 1114
- subs, 1116
- GiNaC::relational::safe_bool_helper, 1133
- nonnull, 1134
- GiNaC::remember_strategies, 1120
 - delete_cyclic, 1122
 - delete_lfu, 1122
 - delete_lru, 1122
 - delete_never, 1122
- GiNaC::remember_table, 1122
 - add_entry, 1124
 - clear_all_entries, 1124
 - init_table, 1125
 - lookup_entry, 1124
 - max_assoc_size, 1125
 - remember_strategy, 1125
 - remember_table, 1123
 - remember_tables, 1124
 - show_statistics, 1124
 - table_size, 1125
- GiNaC::remember_table_entry, 1126
 - access_counter, 1129
 - get_last_access, 1127
 - get_result, 1127
 - get_successful_hits, 1128
 - hashvalue, 1128
 - is_equal, 1127
 - last_access, 1128
 - remember_table_entry, 1127
 - result, 1128
 - seq, 1128
 - successful_hits, 1128
- GiNaC::remember_table_list, 1129
 - add_entry, 1130
 - lookup_entry, 1130
 - max_assoc_size, 1131
 - remember_strategy, 1131
 - remember_table_list, 1130
- GiNaC::return_type_t, 1131
 - operator!=, 1132
 - operator<, 1132
 - operator==, 1132
 - rl, 1132
 - tinfo, 1132
- GiNaC::return_types, 1133
 - commutative, 1133
 - noncommutative, 1133
 - noncommutative_composite, 1133
- GiNaC::scalar_products, 1134
 - add, 1135
 - add_vectors, 1135
 - clear, 1135
 - debugprint, 1136
 - evaluate, 1136
 - is_defined, 1135
 - spm, 1136
- GiNaC::series_options, 1137
 - suppress_branchcut, 1137
- GiNaC::solve_algo, 1137
 - automatic, 1138
 - bareiss, 1138
 - divfree, 1138
 - gauss, 1138
 - markowitz, 1138
- GiNaC::spinidx, 1139
 - archive, 1147
 - conjugate, 1147
 - do_print, 1149
 - do_print_latex, 1149
 - do_print_tree, 1149
 - dotted, 1149
 - is_dotted, 1148
 - is_dummy_pair_same_type, 1146
 - is_undotted, 1148
 - match_same_type, 1147
 - read_archive, 1147
 - spinidx, 1146
 - toggle_dot, 1148
 - toggle_variance_dot, 1148
- GiNaC::spinmetric, 1150
 - contract_with, 1155
 - do_print, 1156
 - do_print_latex, 1156
 - eval_indexed, 1155
 - info, 1155
- GiNaC::spmapkey, 1156

- debugprint, 1158
- dim, 1159
- operator<, 1158
- operator==, 1158
- spmapkey, 1157, 1158
- v1, 1158
- v2, 1159
- GiNaC::status_flags, 1159
 - dynallocated, 1160
 - evaluated, 1160
 - expanded, 1160
 - has_indices, 1160
 - has_no_indices, 1160
 - hash_calculated, 1160
 - is_negative, 1160
 - is_positive, 1160
 - not_shareable, 1160
 - purely_indefinite, 1160
- GiNaC::structure< T, ComparisonPolicy >, 1160
 - add_indexed, 1175
 - calchash, 1178
 - coeff, 1171
 - collect, 1172
 - contract_with, 1176
 - degree, 1171
 - derivative, 1172
 - eval, 1166
 - eval_indexed, 1167
 - eval_ncmul, 1167
 - evalm, 1166
 - expand, 1172
 - get_class_name, 1166
 - get_free_indices, 1175
 - get_struct, 1178
 - has, 1169
 - info, 1168
 - integer_content, 1174
 - is_equal_same_type, 1177
 - ldegree, 1171
 - let_op, 1169
 - map, 1171
 - match, 1170
 - match_same_type, 1170
 - max_coefficient, 1175
 - nops, 1168
 - normal, 1173
 - obj, 1179
 - op, 1168
 - operator->, 1178
 - operator[], 1168, 1169
 - precedence, 1168
 - print, 1167
 - return_type, 1177
 - return_type_tinfo, 1177
 - scalar_mul_indexed, 1176
 - series, 1173
 - smod, 1174
 - structure, 1166
 - subs, 1170
 - to_polynomial, 1174
 - to_rational, 1173
- GiNaC::su3d, 1179
 - contract_with, 1184
 - do_print, 1184
 - do_print_latex, 1184
 - eval_indexed, 1184
 - return_type, 1184
- GiNaC::su3f, 1185
 - contract_with, 1190
 - do_print, 1190
 - do_print_latex, 1190
 - eval_indexed, 1190
 - return_type, 1190
- GiNaC::su3one, 1191
 - do_print, 1195
 - do_print_latex, 1195
- GiNaC::su3t, 1196
 - contract_with, 1200
 - do_print, 1201
 - do_print_latex, 1201
- GiNaC::subs_options, 1201
 - algebraic, 1202
 - no_index_renaming, 1202
 - no_pattern, 1202
 - pattern_is_not_product, 1202
 - pattern_is_product, 1202
 - really_subs_idx, 1202
 - subs_algebraic, 1202
 - subs_no_pattern, 1202
- GiNaC::sy_is_less, 1202
 - operator(), 1202
 - sy_is_less, 1202
 - v, 1203
- GiNaC::sy_swap, 1203
 - operator(), 1203
 - swapped, 1204
 - sy_swap, 1203
 - v, 1204
- GiNaC::sym_desc, 1204
 - deg_a, 1207
 - deg_b, 1207
 - ldeg_a, 1207
 - ldeg_b, 1207
 - max_deg, 1207
 - max_lcnops, 1207
 - operator<, 1206
 - sym, 1206
 - sym_desc, 1206
- GiNaC::symbol, 1208
 - archive, 1217
 - calchash, 1218
 - conjugate, 1216
 - derivative, 1217
 - do_print, 1219
 - do_print_latex, 1220
 - do_print_python_repr, 1220

- do_print_tree, 1220
- eval, 1214
- evalf, 1214
- get_domain, 1218
- get_name, 1219
- get_TeX_name, 1219
- imag_part, 1216
- info, 1214
- is_equal_same_type, 1218
- is_polynomial, 1216
- name, 1220
- next_serial, 1221
- normal, 1215
- read_archive, 1217
- real_part, 1216
- serial, 1220
- series, 1214
- set_name, 1219
- set_TeX_name, 1219
- subs, 1215
- symbol, 1213
- TeX_name, 1221
- to_polynomial, 1216
- to_rational, 1215
- GiNaC::symbolset, 1221
 - has, 1222
 - insert_symbols, 1222
 - s, 1222
 - symbolset, 1222
- GiNaC::symmetry, 1223
 - add, 1230
 - antisymmetric, 1228
 - archive, 1229
 - calchash, 1229
 - canonicalize, 1232
 - children, 1233
 - cyclic, 1228
 - do_print, 1231
 - do_print_tree, 1231
 - get_type, 1229
 - has_cyclic, 1231
 - has_nonsymmetric, 1231
 - has_symmetry, 1230
 - indices, 1232
 - none, 1228
 - read_archive, 1229
 - set_type, 1230
 - sy_is_less, 1232
 - sy_swap, 1232
 - symmetric, 1228
 - symmetry, 1228
 - symmetry_type, 1228
 - type, 1232
 - validate, 1230
- GiNaC::symminfo, 1233
 - coeff, 1235
 - num, 1236
 - orig, 1235
 - symminfo, 1235
 - symmterm, 1235
- GiNaC::symminfo_is_less_by_orig, 1236
 - operator(), 1236
- GiNaC::symminfo_is_less_by_symmterm, 1236
 - operator(), 1237
- GiNaC::tensdelta, 1237
 - contract_with, 1242
 - do_print, 1243
 - do_print_latex, 1243
 - eval_indexed, 1242
 - info, 1242
 - return_type, 1242
- GiNaC::tensepsilon, 1243
 - archive, 1249
 - contract_with, 1249
 - do_print, 1250
 - do_print_latex, 1250
 - eval_indexed, 1248
 - info, 1248
 - minkowski, 1250
 - pos_sig, 1250
 - read_archive, 1249
 - return_type, 1249
 - tensepsilon, 1248
- GiNaC::tensmetric, 1251
 - contract_with, 1256
 - do_print, 1257
 - eval_indexed, 1256
 - info, 1256
 - return_type, 1257
- GiNaC::tensor, 1258
 - replace_contr_index, 1262
 - return_type, 1262
- GiNaC::terminfo, 1263
 - orig, 1264
 - symm, 1264
 - terminfo, 1264
- GiNaC::terminfo_is_less, 1264
 - operator(), 1264
- GiNaC::unarchive_table_t, 1266
 - ~unarchive_table_t, 1267
 - find, 1267
 - insert, 1267
 - unarch_map, 1268
 - unarchive_table_t, 1267
 - usecount, 1268
- GiNaC::user_defined_kernel, 1268
 - do_print, 1276
 - f, 1277
 - is_numeric, 1276
 - Laurent_series, 1276
 - let_op, 1275
 - nops, 1275
 - op, 1275
 - user_defined_kernel, 1275
 - uses_Laurent_series, 1276
 - x, 1277

- GiNaC::varidx, [1277](#)
 - archive, [1285](#)
 - covariant, [1287](#)
 - do_print, [1286](#)
 - do_print_tree, [1287](#)
 - is_contravariant, [1286](#)
 - is_covariant, [1286](#)
 - is_dummy_pair_same_type, [1285](#)
 - match_same_type, [1285](#)
 - read_archive, [1285](#)
 - toggle_variance, [1286](#)
 - varidx, [1284](#)
- GiNaC::visitor, [1287](#)
 - ~visitor, [1288](#)
- GiNaC::wildcard, [1288](#)
 - archive, [1293](#)
 - calchash, [1294](#)
 - do_print, [1294](#)
 - do_print_python_repr, [1295](#)
 - do_print_tree, [1294](#)
 - get_label, [1294](#)
 - label, [1295](#)
 - match, [1293](#)
 - read_archive, [1293](#)
 - wildcard, [1293](#)
- GiNaC::zeta1_SERIAL, [1295](#)
 - serial, [1296](#)
- GiNaC::zeta2_SERIAL, [1296](#)
 - serial, [1297](#)
- GINAC_ASSERT
 - assertion.h, [1304](#)
- GINAC_BIND_UNARCHIVER
 - archive.h, [1303](#)
 - GiNaC, [90](#), [93](#), [94](#), [106](#), [107](#), [112](#), [128](#), [130](#), [133](#), [197](#), [200–203](#), [205](#), [211](#), [212](#), [229](#), [265](#), [266](#), [268–270](#), [278](#), [279](#), [288](#), [292](#)
- GINAC_DECLARE_PRINT_CONTEXT
 - print.h, [1399](#)
- GINAC_DECLARE_PRINT_CONTEXT_BASE
 - print.h, [1398](#)
- GINAC_DECLARE_PRINT_CONTEXT_COMMON
 - print.h, [1398](#)
- GINAC_DECLARE_REGISTERED_CLASS
 - registrar.h, [1404](#)
- GINAC_DECLARE_REGISTERED_CLASS_COMMON
 - registrar.h, [1403](#)
- GINAC_DECLARE_REGISTERED_CLASS_NO_CTORS
 - registrar.h, [1404](#)
- GINAC_DECLARE_UNARCHIVER
 - archive.h, [1302](#)
 - GiNaC, [90](#), [104](#), [105](#), [111](#), [112](#), [128](#), [129](#), [131](#), [132](#), [138](#), [197](#), [203–205](#), [207](#), [211](#), [212](#), [247](#), [265](#), [266](#), [268–270](#), [274](#), [282](#), [283](#), [289](#)
- GINAC_IMPLEMENT_PRINT_CONTEXT
 - print.h, [1399](#)
- GINAC_IMPLEMENT_REGISTERED_CLASS
 - registrar.h, [1405](#)
- GINAC_IMPLEMENT_REGISTERED_CLASS_OPT
 - GiNaC, [89](#), [91](#), [92](#), [106](#), [112](#), [126](#), [128](#), [129](#), [133](#), [196](#), [200–203](#), [205](#), [210](#), [212](#), [228](#), [264](#), [266](#), [268](#), [270](#), [278](#), [288](#)
 - registrar.h, [1405](#)
- GINAC_IMPLEMENT_REGISTERED_CLASS_OPT_T
 - registrar.h, [1405](#)
- GINAC_LT_AGE
 - version.h, [1422](#)
- GINAC_LT_CURRENT
 - version.h, [1422](#)
- GINAC_LT_REVISION
 - version.h, [1422](#)
- GINACLIB_ARCHIVE_AGE
 - version.h, [1423](#)
- GINACLIB_ARCHIVE_VERSION
 - version.h, [1422](#)
- GINACLIB_MAJOR_VERSION
 - version.h, [1422](#)
- GINACLIB_MICRO_VERSION
 - version.h, [1422](#)
- GINACLIB_MINOR_VERSION
 - version.h, [1422](#)
- GINACLIB_STR
 - version.h, [1423](#)
- GINACLIB_STR_HELPER
 - version.h, [1423](#)
- GINACLIB_VERSION
 - version.h, [1423](#)
- golden_ratio_hash
 - GiNaC, [284](#)
- greater
 - GiNaC::relational, [1114](#)
- greater_or_equal
 - GiNaC::relational, [1114](#)
- guess_precision
 - GiNaC, [238](#)
- H_deriv
 - GiNaC, [173](#)
- H_eval
 - GiNaC, [173](#)
- H_evalf
 - GiNaC, [173](#)
- H_print_latex
 - GiNaC, [173](#)
- H_series
 - GiNaC, [173](#)
- handle_factor
 - GiNaC::make_flat_inserter, [820](#)
- has
 - GiNaC, [115](#)
 - GiNaC::basic, [368](#)
 - GiNaC::ex, [585](#)
 - GiNaC::mul, [879](#)
 - GiNaC::numeric, [958](#)
 - GiNaC::power, [1027](#)
 - GiNaC::structure< T, ComparisonPolicy >, [1169](#)
 - GiNaC::symbolset, [1222](#)
- has_cyclic

- GiNaC::symmetry, [1231](#)
- has_derivative
 - GiNaC::function_options, [722](#)
- has_dummy_index_for
 - GiNaC::indexed, [767](#)
- has_ex
 - GiNaC::archive_node, [352](#)
- has_expression
 - GiNaC::archive_node, [353](#)
- has_indices
 - GiNaC::info_flags, [772](#)
 - GiNaC::status_flags, [1160](#)
- has_no_indices
 - GiNaC::status_flags, [1160](#)
- has_nonsymmetric
 - GiNaC::symmetry, [1231](#)
- has_power
 - GiNaC::function_options, [723](#)
- has_same_ex_as
 - GiNaC::archive_node, [351](#)
- has_symmetry
 - GiNaC::symmetry, [1230](#)
- has_trailing_zero
 - GiNaC::integration_kernel, [791](#)
- hash_calculated
 - GiNaC::status_flags, [1160](#)
- hash_map.h, [1351](#)
- hash_seed.h, [1352](#)
- hashvalue
 - GiNaC::basic, [385](#)
 - GiNaC::remember_table_entry, [1128](#)
- hasindex
 - GiNaC, [136](#)
- haswild
 - GiNaC, [289](#)
- head
 - GiNaC::composition_generator::coolmulti, [492](#)
- heur_gcd
 - GiNaC, [221](#)
- heur_gcd_z
 - GiNaC, [220](#)
- hold
 - GiNaC::basic, [381](#)
- hold_ncmul
 - GiNaC, [212](#)
 - GiNaC::ncmul, [945](#)
- I
 - GiNaC, [292](#)
- i
 - GiNaC::composition_generator::coolmulti, [492](#)
 - GiNaC::const_iterator, [450](#)
 - GiNaC::internal::_iter_rep, [315](#)
- i_end
 - GiNaC::internal::_iter_rep, [315](#)
- id
 - GiNaC::print_context_options, [1038](#)
- identify_parents
 - GiNaC::class_info< OPT >, [401](#)
- idx
 - GiNaC, [291](#)
 - GiNaC::idx, [741](#)
 - GiNaC::info_flags, [772](#)
- idx.cpp, [1352](#)
- idx.h, [1353](#)
- idx_symmetrization
 - GiNaC, [135](#)
- ifactor
 - GiNaC, [197](#)
- imag
 - GiNaC, [252](#)
 - GiNaC::numeric, [975](#)
- imag_part
 - GiNaC, [114](#)
 - GiNaC::add, [331](#)
 - GiNaC::basic, [377](#)
 - GiNaC::constant, [465](#)
 - GiNaC::container< C >, [481](#)
 - GiNaC::ex, [585](#)
 - GiNaC::function, [677](#)
 - GiNaC::indexed, [764](#)
 - GiNaC::matrix, [835](#)
 - GiNaC::mul, [880](#)
 - GiNaC::ncmul, [942](#)
 - GiNaC::numeric, [961](#)
 - GiNaC::power, [1028](#)
 - GiNaC::pseries, [1079](#)
 - GiNaC::realsymbol, [1101](#)
 - GiNaC::symbol, [1216](#)
- imag_part_conjugate
 - GiNaC, [142](#)
- imag_part_eval
 - GiNaC, [142](#)
- imag_part_evalf
 - GiNaC, [141](#)
- imag_part_expl_derivative
 - GiNaC, [142](#)
- imag_part_f
 - GiNaC::function_options, [725](#)
- imag_part_func
 - GiNaC::function_options, [700–702, 717](#)
- imag_part_funcp
 - GiNaC, [61](#)
- imag_part_funcp_1
 - GiNaC, [62](#)
- imag_part_funcp_10
 - GiNaC, [77](#)
- imag_part_funcp_11
 - GiNaC, [79](#)
- imag_part_funcp_12
 - GiNaC, [81](#)
- imag_part_funcp_13
 - GiNaC, [83](#)
- imag_part_funcp_14
 - GiNaC, [85](#)
- imag_part_funcp_2
 - GiNaC, [64](#)

- imag_part_funcp_3
 - GiNaC, [65](#)
- imag_part_funcp_4
 - GiNaC, [67](#)
- imag_part_funcp_5
 - GiNaC, [69](#)
- imag_part_funcp_6
 - GiNaC, [70](#)
- imag_part_funcp_7
 - GiNaC, [72](#)
- imag_part_funcp_8
 - GiNaC, [74](#)
- imag_part_funcp_9
 - GiNaC, [75](#)
- imag_part_funcp_exvector
 - GiNaC, [86](#)
- imag_part_imag_part
 - GiNaC, [142](#)
- imag_part_print_latex
 - GiNaC, [142](#)
- imag_part_real_part
 - GiNaC, [142](#)
- imag_part_use_exvector_args
 - GiNaC::function_options, [728](#)
- impl
 - GiNaC::print_functor, [1049](#)
- increment
 - GiNaC::const_postorder_iterator, [453](#)
 - GiNaC::const_preorder_iterator, [457](#)
- indefinite
 - GiNaC::info_flags, [772](#)
- index0
 - GiNaC, [270](#)
- index1
 - GiNaC, [270](#)
- index2
 - GiNaC, [271](#)
- index3
 - GiNaC, [271](#)
- index_dimensions
 - GiNaC, [264](#)
- indexed
 - GiNaC::indexed, [758–763](#)
 - GiNaC::info_flags, [772](#)
- indexed.cpp, [1354](#)
- indexed.h, [1356](#)
- indices
 - GiNaC::symmetry, [1232](#)
- indices_consistent
 - GiNaC, [133](#)
- info
 - GiNaC::add, [327](#)
 - GiNaC::basic, [365](#)
 - GiNaC::class_info< OPT >::tree_node, [1266](#)
 - GiNaC::constant, [464](#)
 - GiNaC::container< C >, [477](#)
 - GiNaC::ex, [581](#)
 - GiNaC::expairseq, [623](#)
 - GiNaC::function, [678](#)
 - GiNaC::idx, [742](#)
 - GiNaC::indexed, [763](#)
 - GiNaC::minkmetric, [854](#)
 - GiNaC::mul, [878](#)
 - GiNaC::ncmul, [939](#)
 - GiNaC::numeric, [956](#)
 - GiNaC::power, [1023](#)
 - GiNaC::relational, [1115](#)
 - GiNaC::spinmetric, [1155](#)
 - GiNaC::structure< T, ComparisonPolicy >, [1168](#)
 - GiNaC::symbol, [1214](#)
 - GiNaC::tensdelta, [1242](#)
 - GiNaC::tensepsilon, [1248](#)
 - GiNaC::tensmetric, [1256](#)
- info_f
 - GiNaC::function_options, [726](#)
- info_func
 - GiNaC::function_options, [714–716, 718](#)
- info_funcp
 - GiNaC, [62](#)
- info_funcp_1
 - GiNaC, [63](#)
- info_funcp_10
 - GiNaC, [78](#)
- info_funcp_11
 - GiNaC, [80](#)
- info_funcp_12
 - GiNaC, [82](#)
- info_funcp_13
 - GiNaC, [84](#)
- info_funcp_14
 - GiNaC, [86](#)
- info_funcp_2
 - GiNaC, [65](#)
- info_funcp_3
 - GiNaC, [66](#)
- info_funcp_4
 - GiNaC, [68](#)
- info_funcp_5
 - GiNaC, [70](#)
- info_funcp_6
 - GiNaC, [71](#)
- info_funcp_7
 - GiNaC, [73](#)
- info_funcp_8
 - GiNaC, [75](#)
- info_funcp_9
 - GiNaC, [76](#)
- info_funcp_exvector
 - GiNaC, [87](#)
- info_use_exvector_args
 - GiNaC::function_options, [729](#)
- inifcns.cpp, [1357](#)
- inifcns.h, [1360](#)
- inifcns_elliptic.cpp, [1362](#)
- inifcns_gamma.cpp, [1363](#)
- inifcns_nstdsums.cpp, [1364](#)

- inifcns_trans.cpp, 1366
- init
 - GiNaC::basic_multi_iterator< T >, 395
 - GiNaC::multi_iterator_counter< T >, 893
 - GiNaC::multi_iterator_counter_indv< T >, 897
 - GiNaC::multi_iterator_ordered< T >, 901
 - GiNaC::multi_iterator_ordered_eq< T >, 905
 - GiNaC::multi_iterator_ordered_eq_indv< T >, 909
 - GiNaC::multi_iterator_permutation< T >, 913
 - GiNaC::multi_iterator_shuffle< T >, 917
 - GiNaC::multi_iterator_shuffle_prime< T >, 922
- init_table
 - GiNaC::remember_table, 1125
- init_unarchivers
 - GiNaC::library_init, 819
- initialize
 - GiNaC::function_options, 690
- insert
 - GiNaC::unarchive_table_t, 1267
- insert_symbols
 - GiNaC::symbolset, 1222
- int_length
 - GiNaC::numeric, 976
- integer
 - GiNaC::info_flags, 772
- integer_content
 - GiNaC::add, 329
 - GiNaC::basic, 373
 - GiNaC::ex, 595
 - GiNaC::mul, 882
 - GiNaC::numeric, 960
 - GiNaC::structure< T, ComparisonPolicy >, 1174
- integer_polynomial
 - GiNaC::info_flags, 772
- integral
 - GiNaC::error_and_integral, 567
 - GiNaC::integral, 778
- integral.cpp, 1369
- integral.h, 1370
- integration_kernel.cpp, 1371
 - cache_vec, 1373
 - order, 1372
 - qbar, 1372
 - x, 1373
- integration_kernel.h, 1373
- interpolate
 - GiNaC, 219
- inv_at_cit
 - GiNaC::archive, 337
- inverse
 - GiNaC, 209, 248
 - GiNaC::matrix, 842
 - GiNaC::numeric, 967
- inverse_atoms
 - GiNaC::archive, 343
- iquo
 - GiNaC, 244, 245
- irem
 - GiNaC, 243, 244
- is_a
 - GiNaC, 91, 123, 266
 - GiNaC::ex, 607
- is_canonical
 - GiNaC::expairseq, 635
- is_canonical_numeric
 - GiNaC::expair, 612
- is_cinteger
 - GiNaC, 251
 - GiNaC::numeric, 971
- is_clifford_tinfo
 - GiNaC, 105
- is_color_tinfo
 - GiNaC, 109
- is_compatible_to
 - GiNaC::pseries, 1081
- is_contravariant
 - GiNaC::varidx, 1286
- is_covariant
 - GiNaC::varidx, 1286
- is_crational
 - GiNaC, 251
 - GiNaC::numeric, 971
- is_defined
 - GiNaC::scalar_products, 1135
- is_dim_numeric
 - GiNaC::idx, 746
- is_dim_symbolic
 - GiNaC::idx, 746
- is_dirac_slash
 - GiNaC, 94
- is_discriminant_of_quadratic_number_field
 - GiNaC, 198
- is_dotted
 - GiNaC::spinidx, 1148
- is_dummy_pair
 - GiNaC, 130
- is_dummy_pair_same_type
 - GiNaC::idx, 745
 - GiNaC::spinidx, 1146
 - GiNaC::varidx, 1285
- is_equal
 - GiNaC::basic, 381
 - GiNaC::ex, 599
 - GiNaC::expair, 611
 - GiNaC::numeric, 968
 - GiNaC::remember_table_entry, 1127
- is_equal_same_type
 - GiNaC::basic, 378
 - GiNaC::constant, 466
 - GiNaC::container< C >, 481
 - GiNaC::expairseq, 627
 - GiNaC::fderivative, 658
 - GiNaC::function, 679
 - GiNaC::numeric, 962
 - GiNaC::structure< T, ComparisonPolicy >, 1177
 - GiNaC::symbol, 1218

- is_even
 - GiNaC, [250](#)
 - GiNaC::numeric, [970](#)
- is_ex_the_function
 - function.h, [1350](#)
- is_exactly_a
 - GiNaC, [92](#), [123](#)
 - GiNaC::ex, [607](#)
- is_integer
 - GiNaC, [249](#)
 - GiNaC::numeric, [969](#)
- is_less
 - GiNaC::expair, [611](#)
- is_negative
 - GiNaC, [249](#)
 - GiNaC::numeric, [969](#)
 - GiNaC::status_flags, [1160](#)
- is_nonneg_integer
 - GiNaC, [249](#)
 - GiNaC::numeric, [970](#)
- is_numeric
 - GiNaC::Ebar_kernel, [530](#)
 - GiNaC::Eisenstein_h_kernel, [540](#)
 - GiNaC::Eisenstein_kernel, [551](#)
 - GiNaC::ELi_kernel, [562](#)
 - GiNaC::idx, [745](#)
 - GiNaC::integration_kernel, [791](#)
 - GiNaC::Kronecker_dtau_kernel, [803](#)
 - GiNaC::Kronecker_dz_kernel, [812](#)
 - GiNaC::modular_form_kernel, [864](#)
 - GiNaC::multiple_polylog_kernel, [929](#)
 - GiNaC::user_defined_kernel, [1276](#)
- is_odd
 - GiNaC, [250](#)
 - GiNaC::numeric, [970](#)
- is_order_function
 - GiNaC, [159](#)
- is_polynomial
 - GiNaC, [115](#)
 - GiNaC::add, [327](#)
 - GiNaC::basic, [370](#)
 - GiNaC::constant, [464](#)
 - GiNaC::ex, [588](#)
 - GiNaC::mul, [878](#)
 - GiNaC::numeric, [957](#)
 - GiNaC::power, [1024](#)
 - GiNaC::symbol, [1216](#)
- is_pos_integer
 - GiNaC, [249](#)
 - GiNaC::numeric, [969](#)
- is_positive
 - GiNaC, [249](#)
 - GiNaC::numeric, [969](#)
 - GiNaC::status_flags, [1160](#)
- is_prime
 - GiNaC, [250](#)
 - GiNaC::numeric, [970](#)
- is_rational
 - GiNaC, [250](#)
 - GiNaC::numeric, [971](#)
- is_real
 - GiNaC, [250](#)
 - GiNaC::numeric, [971](#)
- is_symbolic
 - GiNaC::idx, [745](#)
- is_terminating
 - GiNaC, [267](#)
 - GiNaC::pseries, [1082](#)
- is_the_function
 - GiNaC, [129](#)
- is_the_function< G_SERIAL >
 - GiNaC, [158](#)
- is_the_function< iterated_integral_SERIAL >
 - GiNaC, [159](#)
- is_the_function< psi_SERIAL >
 - GiNaC, [159](#)
- is_the_function< zeta_SERIAL >
 - GiNaC, [157](#)
- is_undotted
 - GiNaC::spinidx, [1148](#)
- is_valid
 - GiNaC::print_functor, [1049](#)
- is_zero
 - GiNaC, [121](#), [248](#)
 - GiNaC::ex, [600](#)
 - GiNaC::numeric, [968](#)
 - GiNaC::pseries, [1081](#)
- is_zero_matrix
 - GiNaC::ex, [600](#)
 - GiNaC::matrix, [844](#)
- isqrt
 - GiNaC, [246](#)
- iterated_integral
 - GiNaC, [159](#)
- iterated_integral2_eval
 - GiNaC, [163](#)
- iterated_integral2_evalf
 - GiNaC, [162](#)
- iterated_integral3_eval
 - GiNaC, [163](#)
- iterated_integral3_evalf
 - GiNaC, [163](#)
- iterated_integral_evalf_impl
 - GiNaC, [162](#)
- iterator_category
 - GiNaC::const_iterator, [445](#)
 - GiNaC::const_postorder_iterator, [451](#)
 - GiNaC::const_preorder_iterator, [455](#)
- K
 - GiNaC::Eisenstein_kernel, [554](#)
 - GiNaC::Kronecker_dtau_kernel, [805](#)
 - GiNaC::Kronecker_dz_kernel, [814](#)
- k
 - factor.cpp, [1331](#)
 - GiNaC::Eisenstein_h_kernel, [542](#)
 - GiNaC::Eisenstein_kernel, [553](#)

- GiNaC::modular_form_kernel, 865
- Kronecker_dtau_kernel
 - GiNaC::Kronecker_dtau_kernel, 803
- Kronecker_dz_kernel
 - GiNaC::Kronecker_dz_kernel, 812
- kronecker_symbol
 - GiNaC, 198
- label
 - GiNaC::wildcard, 1295
- lanczos_coeffs
 - GiNaC::lanczos_coeffs, 815
- laplace
 - GiNaC::determinant_algo, 496
- last
 - factor.cpp, 1331
- last_access
 - GiNaC::remember_table_entry, 1128
- latex
 - GiNaC, 262
- latex_name
 - GiNaC::function_options, 690
- Laurent_series
 - GiNaC::Eisenstein_h_kernel, 540
 - GiNaC::Eisenstein_kernel, 552
 - GiNaC::integration_kernel, 791
 - GiNaC::modular_form_kernel, 864
 - GiNaC::user_defined_kernel, 1276
- lcm
 - GiNaC, 223, 245
- lcm_of_coefficients_denominators
 - GiNaC, 214
- lcmcoeff
 - GiNaC, 214
- lcoeff
 - GiNaC::ex, 589
- ldeg_a
 - GiNaC::sym_desc, 1207
- ldeg_b
 - GiNaC::sym_desc, 1207
- ldegree
 - GiNaC, 116
 - GiNaC::add, 328
 - GiNaC::basic, 370
 - GiNaC::ex, 589
 - GiNaC::integral, 780
 - GiNaC::mul, 879
 - GiNaC::ncmul, 940
 - GiNaC::numeric, 957
 - GiNaC::power, 1024
 - GiNaC::pseries, 1076
 - GiNaC::structure< T, ComparisonPolicy >, 1171
- len
 - factor.cpp, 1331
- less
 - GiNaC::relational, 1114
- less_or_equal
 - GiNaC::relational, 1114
- let_op
 - GiNaC::basic, 367
 - GiNaC::clifford, 417
 - GiNaC::container< C >, 479
 - GiNaC::Ebar_kernel, 530
 - GiNaC::Eisenstein_h_kernel, 540
 - GiNaC::Eisenstein_kernel, 551
 - GiNaC::ELi_kernel, 562
 - GiNaC::ex, 583
 - GiNaC::integral, 781
 - GiNaC::Kronecker_dtau_kernel, 803
 - GiNaC::Kronecker_dz_kernel, 812
 - GiNaC::matrix, 833
 - GiNaC::modular_form_kernel, 864
 - GiNaC::multiple_polylog_kernel, 929
 - GiNaC::structure< T, ComparisonPolicy >, 1169
 - GiNaC::user_defined_kernel, 1275
- lgamma
 - GiNaC, 238, 239
- lgamma_conjugate
 - GiNaC, 164
- lgamma_deriv
 - GiNaC, 164
- lgamma_eval
 - GiNaC, 163
- lgamma_evalf
 - GiNaC, 163
- lgamma_series
 - GiNaC, 164
- lh
 - GiNaC::relational, 1120
- lhs
 - GiNaC, 121
 - GiNaC::ex, 584
 - GiNaC::relational, 1118
- Li2
 - GiNaC, 238
- Li2_
 - GiNaC, 237
- Li2_conjugate
 - GiNaC, 150
- Li2_deriv
 - GiNaC, 150
- Li2_eval
 - GiNaC, 150
- Li2_evalf
 - GiNaC, 150
- Li2_projection
 - GiNaC, 237
- Li2_series
 - GiNaC, 150, 237
- Li3_eval
 - GiNaC, 151
- Li_deriv
 - GiNaC, 171
- Li_eval
 - GiNaC, 170
- Li_evalf
 - GiNaC, 170

- Li_print_latex
 - GiNaC, 171
- Li_series
 - GiNaC, 170
- library_init
 - GiNaC::library_init, 818
- library_initializer
 - GiNaC, 291
- likely
 - compiler.h, 1315
- link_ex
 - GiNaC, 125, 126
- list
 - GiNaC::info_flags, 772
- log
 - GiNaC, 231
- log2
 - GiNaC, 283
- log_conjugate
 - GiNaC, 179
- log_deriv
 - GiNaC, 178
- log_eval
 - GiNaC, 178
- log_evalf
 - GiNaC, 177
- log_expand
 - GiNaC, 179
- log_imag_part
 - GiNaC, 178
- log_info
 - GiNaC, 179
- log_real_part
 - GiNaC, 178
- log_series
 - GiNaC, 178
- lookup_entry
 - GiNaC::remember_table, 1124
 - GiNaC::remember_table_list, 1130
- lookup_map
 - GiNaC, 88
- lookup_remember_table
 - GiNaC::function, 681
- lorentz_eps
 - GiNaC, 282
- lorentz_g
 - GiNaC, 280
- lr
 - factor.cpp, 1330
- lsolve
 - GiNaC, 156
- lst
 - GiNaC, 88
- lst.cpp, 1375
- lst.h, 1375
- lst_to_clifford
 - GiNaC, 100, 101
- lst_to_matrix
 - GiNaC, 206
- m
 - factor.cpp, 1329
 - GiNaC::basic_partition_generator::mpartition2, 867
 - GiNaC::Ebar_kernel, 532
 - GiNaC::ELi_kernel, 564
 - GiNaC::matrix, 848
 - GiNaC::partition_with_zero_parts_generator, 984
- make_flat
 - GiNaC::expairseq, 634
- make_flat_inserter
 - GiNaC::make_flat_inserter, 820
- make_hash_seed
 - GiNaC, 129
- make_real_float
 - GiNaC, 228
- make_return_type_t
 - GiNaC, 267
- make_safe_bool
 - GiNaC::relational, 1119
- makewritable
 - GiNaC::ptr< T >, 1091
- makewriteable
 - GiNaC::ex, 604
- map
 - GiNaC::basic, 369
 - GiNaC::ex, 587
 - GiNaC::expairseq, 624
 - GiNaC::idx, 742
 - GiNaC::power, 1023
 - GiNaC::relational, 1115
 - GiNaC::structure< T, ComparisonPolicy >, 1171
- map_eval_integ
 - GiNaC, 290
- map_evalm
 - GiNaC, 289
- markowitz
 - GiNaC::solve_algo, 1138
- markowitz_elimination
 - GiNaC::matrix, 846
- match
 - GiNaC, 119
 - GiNaC::basic, 368
 - GiNaC::ex, 585, 586
 - GiNaC::expairseq, 625
 - GiNaC::structure< T, ComparisonPolicy >, 1170
 - GiNaC::wildcard, 1293
- match_same_type
 - GiNaC::basic, 368
 - GiNaC::clifford, 414
 - GiNaC::color, 435
 - GiNaC::fderivative, 659
 - GiNaC::function, 679
 - GiNaC::idx, 744
 - GiNaC::matrix, 836
 - GiNaC::relational, 1117
 - GiNaC::spinidx, 1147

- GiNaC::structure< T, ComparisonPolicy >, 1170
 - GiNaC::varidx, 1285
- matrix
 - GiNaC::matrix, 830, 832
- matrix.cpp, 1376
- matrix.h, 1377
- max_assoc_size
 - GiNaC::remember_table, 1125
 - GiNaC::remember_table_list, 1131
- max_coefficient
 - GiNaC::add, 330
 - GiNaC::basic, 374
 - GiNaC::ex, 597
 - GiNaC::mul, 883
 - GiNaC::numeric, 961
 - GiNaC::structure< T, ComparisonPolicy >, 1175
- max_deg
 - GiNaC::sym_desc, 1207
- max_integration_level
 - GiNaC::integral, 784
- max_lcnops
 - GiNaC::sym_desc, 1207
- metric
 - GiNaC::clifford, 418
- metric_tensor
 - GiNaC, 279
- minimal_dim
 - GiNaC, 131
 - GiNaC::idx, 747
- minkmetric
 - GiNaC::minkmetric, 854
- minkowski
 - GiNaC::tensepsilon, 1250
- mod
 - GiNaC, 242
- modular_form_kernel
 - GiNaC::modular_form_kernel, 863
- modulus
 - factor.cpp, 1334
- mpartition2
 - GiNaC::basic_partition_generator::mpartition2, 866
- mpgen
 - GiNaC::basic_partition_generator, 399
- mul
 - GiNaC::add, 335
 - GiNaC::matrix, 838
 - GiNaC::mul, 876, 877
 - GiNaC::numeric, 964
 - GiNaC::power, 1033
- mul.cpp, 1378
- mul.h, 1379
- mul_const
 - GiNaC::pseries, 1083
- mul_dyn
 - GiNaC::numeric, 965
- mul_scalar
 - GiNaC::matrix, 838
- mul_series
 - GiNaC::pseries, 1083
- multi_iterator_counter
 - GiNaC::multi_iterator_counter< T >, 893
- multi_iterator_counter_indv
 - GiNaC::multi_iterator_counter_indv< T >, 896, 897
- multi_iterator_ordered
 - GiNaC::multi_iterator_ordered< T >, 900, 901
- multi_iterator_ordered_eq
 - GiNaC::multi_iterator_ordered_eq< T >, 904
- multi_iterator_ordered_eq_indv
 - GiNaC::multi_iterator_ordered_eq_indv< T >, 908
- multi_iterator_permutation
 - GiNaC::multi_iterator_permutation< T >, 912
- multi_iterator_shuffle
 - GiNaC::multi_iterator_shuffle< T >, 917
- multi_iterator_shuffle_prime
 - GiNaC::multi_iterator_shuffle_prime< T >, 922
- multinomial_coefficient
 - GiNaC, 283
- multiple_polylog_kernel
 - GiNaC::multiple_polylog_kernel, 929
- multiply_lcm
 - GiNaC, 214
- my_ios_callback
 - GiNaC, 261
- my_ios_index
 - GiNaC, 260
- N
 - GiNaC::basic_multi_iterator< T >, 396
 - GiNaC::Eisenstein_h_kernel, 542
 - GiNaC::Eisenstein_kernel, 553
- n
 - factor.cpp, 1330
 - GiNaC::basic_partition_generator::mpartition2, 867
 - GiNaC::Ebar_kernel, 532
 - GiNaC::ELi_kernel, 564
 - GiNaC::Kronecker_dtau_kernel, 805
 - GiNaC::Kronecker_dz_kernel, 814
- N_internal
 - GiNaC::multi_iterator_shuffle< T >, 918
- name
 - GiNaC::archive::archived_ex, 357
 - GiNaC::archive_node::property, 1066
 - GiNaC::archive_node::property_info, 1067
 - GiNaC::constant, 468
 - GiNaC::function_options, 724
 - GiNaC::print_context_options, 1037
 - GiNaC::registered_class_options, 1107
 - GiNaC::symbol, 1220
- ncmul
 - GiNaC::mul, 890
 - GiNaC::ncmul, 938, 939
- ncmul.cpp, 1380
- ncmul.h, 1381
- negative

- GiNaC::info_flags, 772
- negint
 - GiNaC::info_flags, 772
- next
 - GiNaC::class_info< OPT >, 402
 - GiNaC::composition_generator, 442
 - GiNaC::composition_generator::coolmulti::element, 555
 - GiNaC::partition_generator, 981
 - GiNaC::partition_with_zero_parts_generator, 984
- next_partition
 - GiNaC::basic_partition_generator::mpartition2, 867
- next_permutation
 - GiNaC::composition_generator::coolmulti, 492
- next_print_context_id
 - GiNaC, 292
- next_serial
 - GiNaC::constant, 468
 - GiNaC::symbol, 1221
- no_heur_gcd
 - GiNaC::gcd_options, 732
- no_index_dimensions
 - GiNaC, 264
- no_index_renaming
 - GiNaC::subs_options, 1202
- no_part_factored
 - GiNaC::gcd_options, 732
- no_pattern
 - GiNaC::subs_options, 1202
- no_type
 - GiNaC::has_distance< T >, 733
- nodes
 - GiNaC::archive, 343
- noncommutative
 - GiNaC::return_types, 1133
- noncommutative_composite
 - GiNaC::return_types, 1133
- none
 - GiNaC::symmetry, 1228
- nonnegative
 - GiNaC::info_flags, 772
- nonnegint
 - GiNaC::info_flags, 772
- nonnull
 - GiNaC::relational::safe_bool_helper, 1134
- nops
 - GiNaC, 113, 207
 - GiNaC::basic, 366
 - GiNaC::clifford, 416
 - GiNaC::container< C >, 478
 - GiNaC::Ebar_kernel, 530
 - GiNaC::Eisenstein_h_kernel, 539
 - GiNaC::Eisenstein_kernel, 551
 - GiNaC::ELi_kernel, 562
 - GiNaC::ex, 582
 - GiNaC::expairseq, 623
 - GiNaC::idx, 742
 - GiNaC::integral, 780
 - GiNaC::Kronecker_dtau_kernel, 803
 - GiNaC::Kronecker_dz_kernel, 812
 - GiNaC::matrix, 833
 - GiNaC::modular_form_kernel, 863
 - GiNaC::multiple_polylog_kernel, 929
 - GiNaC::power, 1023
 - GiNaC::pseries, 1075
 - GiNaC::relational, 1115
 - GiNaC::structure< T, ComparisonPolicy >, 1168
 - GiNaC::user_defined_kernel, 1275
- normal
 - GiNaC, 117
 - GiNaC::add, 329
 - GiNaC::basic, 372
 - GiNaC::ex, 592
 - GiNaC::mul, 881
 - GiNaC::numeric, 959
 - GiNaC::power, 1027
 - GiNaC::pseries, 1078
 - GiNaC::structure< T, ComparisonPolicy >, 1173
 - GiNaC::symbol, 1215
- normal.cpp, 1381
 - FAST_COMPARE, 1383
 - STATISTICS, 1384
 - USE_REMEMBER, 1384
 - USE_TRIAL_DIVISION, 1384
- normal.h, 1384
- not_equal
 - GiNaC::relational, 1114
- not_shareable
 - GiNaC::status_flags, 1160
- not_symmetric
 - GiNaC, 271
- nparams
 - GiNaC::function_options, 724
- num
 - GiNaC::symminfo, 1236
- num_expressions
 - GiNaC::archive, 340
- number
 - GiNaC::constant, 468
- number_of_type
 - GiNaC, 134
- numer
 - GiNaC, 116, 252
 - GiNaC::ex, 593
 - GiNaC::numeric, 976
- numer_denom
 - GiNaC, 117
 - GiNaC::ex, 594
- numeric
 - GiNaC::info_flags, 772
 - GiNaC::numeric, 954–956
- numeric.cpp, 1385
- numeric.h, 1389
- Nv
 - GiNaC::multi_iterator_counter_indv< T >, 898

- GiNaC::multi_iterator_ordered_eq_indv< T >, 909
- o
- GiNaC::relational, 1120
- obj
 - GiNaC::structure< T, ComparisonPolicy >, 1179
- odd
 - GiNaC::info_flags, 772
- one
 - factor.cpp, 1330
- op
 - GiNaC, 121
 - GiNaC::basic, 366
 - GiNaC::clifford, 416
 - GiNaC::container< C >, 478
 - GiNaC::Ebar_kernel, 530
 - GiNaC::Eisenstein_h_kernel, 540
 - GiNaC::Eisenstein_kernel, 551
 - GiNaC::ELi_kernel, 562
 - GiNaC::ex, 582
 - GiNaC::expairseq, 624
 - GiNaC::idx, 742
 - GiNaC::integral, 780
 - GiNaC::Kronecker_dtau_kernel, 803
 - GiNaC::Kronecker_dz_kernel, 812
 - GiNaC::matrix, 833
 - GiNaC::modular_form_kernel, 863
 - GiNaC::multiple_polylog_kernel, 929
 - GiNaC::power, 1023
 - GiNaC::pseries, 1075
 - GiNaC::relational, 1115
 - GiNaC::structure< T, ComparisonPolicy >, 1168
 - GiNaC::user_defined_kernel, 1275
- operator long
 - GiNaC::_numeric_digits, 316
- operator safe_bool
 - GiNaC::relational, 1119
- operator!
 - GiNaC::relational, 1119
- operator!=
 - GiNaC, 259
 - GiNaC::const_iterator, 448
 - GiNaC::const_postorder_iterator, 453
 - GiNaC::const_preorder_iterator, 457
 - GiNaC::internal::_iter_rep, 314
 - GiNaC::numeric, 972
 - GiNaC::ptr< T >, 1092, 1093
 - GiNaC::return_type_t, 1132
- operator<
 - GiNaC, 260
 - GiNaC::const_iterator, 449
 - GiNaC::numeric, 972
 - GiNaC::return_type_t, 1132
 - GiNaC::spmapkey, 1158
 - GiNaC::sym_desc, 1206
- operator<<
 - GiNaC, 90, 113, 247, 262, 286–288
 - GiNaC::archive, 342
 - GiNaC::archive_node, 353
- GiNaC::basic_multi_iterator< T >, 396
- GiNaC::multi_iterator_counter< T >, 894
- GiNaC::multi_iterator_counter_indv< T >, 898
- GiNaC::multi_iterator_ordered< T >, 902
- GiNaC::multi_iterator_ordered_eq< T >, 905
- GiNaC::multi_iterator_ordered_eq_indv< T >, 909
- GiNaC::multi_iterator_permutation< T >, 914
- GiNaC::multi_iterator_shuffle< T >, 918
- GiNaC::multi_iterator_shuffle_prime< T >, 922
- GiNaC::ptr< T >, 1093
- operator<=
 - GiNaC, 260
 - GiNaC::const_iterator, 449
 - GiNaC::numeric, 972
- operator>
 - GiNaC, 260
 - GiNaC::const_iterator, 449
 - GiNaC::numeric, 974
- operator>>
 - GiNaC, 91, 262
 - GiNaC::archive, 342
 - GiNaC::archive_node, 353
- operator>=
 - GiNaC, 260
 - GiNaC::const_iterator, 449
 - GiNaC::numeric, 974
- operator*
 - GiNaC, 254
 - GiNaC::const_iterator, 446
 - GiNaC::const_postorder_iterator, 452
 - GiNaC::const_preorder_iterator, 456
 - GiNaC::ptr< T >, 1091
- operator*=
 - GiNaC, 255, 256
- operator()
 - GiNaC::basic_multi_iterator< T >, 395
 - GiNaC::derivative_map_function, 494
 - GiNaC::error_and_integral_is_less, 567
 - GiNaC::eval_integ_map_function, 569
 - GiNaC::evalf_map_function, 570
 - GiNaC::evalm_map_function, 572
 - GiNaC::ex_base_is_less, 608
 - GiNaC::ex_is_equal, 608
 - GiNaC::ex_is_less, 609
 - GiNaC::ex_swap, 609
 - GiNaC::expair_is_less, 614
 - GiNaC::expair_rest_is_less, 614
 - GiNaC::expair_swap, 615
 - GiNaC::expand_map_function, 639
 - GiNaC::idx_is_equal_ignore_dim, 749
 - GiNaC::is_not_a_clifford, 795
 - GiNaC::is_summation_idx, 795
 - GiNaC::map_function, 823
 - GiNaC::matrix, 839
 - GiNaC::normal_map_function, 946
 - GiNaC::op0_is_equal, 979
 - GiNaC::pointer_to_map_function, 986

GiNaC::pointer_to_map_function_1arg< T1 >, 989
 GiNaC::pointer_to_map_function_2args< T1, T2 >, 991
 GiNaC::pointer_to_map_function_3args< T1, T2, T3 >, 994
 GiNaC::pointer_to_member_to_map_function< C >, 997
 GiNaC::pointer_to_member_to_map_function_1arg< C, T1 >, 999
 GiNaC::pointer_to_member_to_map_function_2args< C, T1, T2 >, 1002
 GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2, T3 >, 1005
 GiNaC::print_functor, 1049
 GiNaC::print_functor_impl, 1051
 GiNaC::print_memfun_handler< T, C >, 1055
 GiNaC::print_ptrfun_handler< T, C >, 1059
 GiNaC::sy_is_less, 1202
 GiNaC::sy_swap, 1203
 GiNaC::symminfo_is_less_by_orig, 1236
 GiNaC::symminfo_is_less_by_symmterm, 1237
 GiNaC::terminfo_is_less, 1264
 std::equal_to< GiNaC::ex >, 565
 std::hash< GiNaC::ex >, 735
 std::less< GiNaC::ptr< T > >, 817
 operator+
 GiNaC, 253, 254, 256, 257
 GiNaC::const_iterator, 447, 450
 operator++
 GiNaC, 257–259
 GiNaC::basic_multi_iterator< T >, 396
 GiNaC::const_iterator, 447
 GiNaC::const_postorder_iterator, 453
 GiNaC::const_preorder_iterator, 456
 GiNaC::multi_iterator_counter< T >, 893
 GiNaC::multi_iterator_counter_indv< T >, 897
 GiNaC::multi_iterator_ordered< T >, 901
 GiNaC::multi_iterator_ordered_eq< T >, 905
 GiNaC::multi_iterator_ordered_eq_indv< T >, 909
 GiNaC::multi_iterator_permutation< T >, 913
 GiNaC::multi_iterator_shuffle< T >, 917
 operator+=
 GiNaC, 255, 256
 GiNaC::const_iterator, 447
 operator-
 GiNaC, 253, 254, 257
 GiNaC::const_iterator, 448, 450
 operator->
 GiNaC::const_iterator, 447
 GiNaC::const_postorder_iterator, 452
 GiNaC::const_preorder_iterator, 456
 GiNaC::ptr< T >, 1091
 GiNaC::structure< T, ComparisonPolicy >, 1178
 operator--
 GiNaC, 257–259
 GiNaC::const_iterator, 448
 operator-=
 GiNaC, 255, 256
 GiNaC::const_iterator, 448
 operator/
 GiNaC, 254, 255
 operator/=
 GiNaC, 255, 256
 operator=
 GiNaC::numeric_digits, 316
 GiNaC::archive_node, 347
 GiNaC::basic, 362
 GiNaC::numeric, 966, 967
 GiNaC::print_functor, 1048
 GiNaC::ptr< T >, 1090
 operator==
 GiNaC, 259
 GiNaC::const_iterator, 448
 GiNaC::const_postorder_iterator, 453
 GiNaC::const_preorder_iterator, 456
 GiNaC::internal::_iter_rep, 314
 GiNaC::numeric, 972
 GiNaC::ptr< T >, 1091–1093
 GiNaC::return_type_t, 1132
 GiNaC::spmapkey, 1158
 operator[]
 GiNaC::basic, 366, 367
 GiNaC::basic_multi_iterator< T >, 395
 GiNaC::const_iterator, 447
 GiNaC::ex, 583, 584
 GiNaC::structure< T, ComparisonPolicy >, 1168, 1169
 operators
 GiNaC::relational, 1114
 operators.cpp, 1391
 operators.h, 1393
 options
 factor.cpp, 1334
 GiNaC::class_info< OPT >, 402
 GiNaC::expand_map_function, 639
 GiNaC::print_context, 1035
 order
 integration_kernel.cpp, 1372
 Order_conjugate
 GiNaC, 155
 Order_eval
 GiNaC, 155
 Order_expl_derivative
 GiNaC, 156
 Order_imag_part
 GiNaC, 155
 Order_power
 GiNaC, 156
 Order_real_part
 GiNaC, 155
 Order_series
 GiNaC, 155
 orig
 GiNaC::symminfo, 1235
 GiNaC::terminfo, 1264

- overall_coeff
 - GiNaC::expairseq, [637](#)
- overflow
 - GiNaC::basic_multi_iterator< T >, [394](#)
- overloaded
 - GiNaC::function_options, [722](#)
- P
 - GiNaC::modular_form_kernel, [866](#)
- p
 - GiNaC::ptr< T >, [1093](#)
- parameter_set
 - GiNaC::fderivative, [660](#)
- paramset
 - GiNaC, [60](#)
- parent
 - GiNaC::class_info< OPT >, [402](#)
- parent_name
 - GiNaC::print_context_options, [1037](#)
 - GiNaC::registered_class_options, [1107](#)
- parents_identified
 - GiNaC::class_info< OPT >, [402](#)
- partition
 - GiNaC::partition_generator, [981](#)
 - GiNaC::partition_with_zero_parts_generator, [984](#)
- partition_generator
 - GiNaC::partition_generator, [981](#)
- partition_with_zero_parts_generator
 - GiNaC::partition_with_zero_parts_generator, [983](#)
- pattern_is_not_product
 - GiNaC::subs_options, [1202](#)
- pattern_is_product
 - GiNaC::subs_options, [1202](#)
- pderivative
 - GiNaC::function, [680](#)
- permutation_sign
 - GiNaC, [284](#), [285](#)
- permute_free_index_to_front
 - GiNaC, [107](#)
- Pi
 - GiNaC, [290](#)
- PiEvalf
 - GiNaC, [246](#)
- pivot
 - GiNaC::matrix, [846](#)
- point
 - GiNaC::pseries, [1086](#)
- pointer
 - GiNaC::const_iterator, [446](#)
 - GiNaC::const_postorder_iterator, [452](#)
 - GiNaC::const_preorder_iterator, [455](#)
- pointer_to_map_function
 - GiNaC::pointer_to_map_function, [986](#)
- pointer_to_map_function_1arg
 - GiNaC::pointer_to_map_function_1arg< T1 >, [989](#)
- pointer_to_map_function_2args
 - GiNaC::pointer_to_map_function_2args< T1, T2 >, [991](#)
- pointer_to_map_function_3args
 - GiNaC::pointer_to_map_function_3args< T1, T2, T3 >, [994](#)
- pointer_to_member_to_map_function
 - GiNaC::pointer_to_member_to_map_function< C >, [997](#)
- pointer_to_member_to_map_function_1arg
 - GiNaC::pointer_to_member_to_map_function_1arg< C, T1 >, [999](#)
- pointer_to_member_to_map_function_2args
 - GiNaC::pointer_to_member_to_map_function_2args< C, T1, T2 >, [1002](#)
- pointer_to_member_to_map_function_3args
 - GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2, T3 >, [1005](#)
- pole_error
 - GiNaC::pole_error, [1008](#)
- poly
 - factor.cpp, [1332](#)
- polynomial
 - GiNaC::factor_options, [641](#)
 - GiNaC::info_flags, [772](#)
- pos_sig
 - GiNaC::minkmetric, [856](#)
 - GiNaC::tensepsilon, [1250](#)
- posint
 - GiNaC::info_flags, [772](#)
- positive
 - GiNaC::domain, [524](#)
 - GiNaC::info_flags, [772](#)
- possymbol
 - GiNaC::possymbol, [1015](#)
- postorder_begin
 - GiNaC::ex, [579](#)
- postorder_end
 - GiNaC::ex, [579](#)
- pow
 - GiNaC, [247](#), [265](#)
 - GiNaC::matrix, [838](#)
- power
 - GiNaC::add, [335](#)
 - GiNaC::function, [681](#)
 - GiNaC::mul, [890](#)
 - GiNaC::ncmul, [945](#)
 - GiNaC::numeric, [964](#)
 - GiNaC::power, [1022](#)
- power.cpp, [1395](#)
- power.h, [1396](#)
- power_const
 - GiNaC::pseries, [1084](#)
- power_dyn
 - GiNaC::numeric, [966](#)
- power_f
 - GiNaC::function_options, [725](#)
- power_func
 - GiNaC::function_options, [709–711](#), [718](#)
- power_funcp
 - GiNaC, [61](#)

- power_funcp_1
 - GiNaC, [63](#)
- power_funcp_10
 - GiNaC, [78](#)
- power_funcp_11
 - GiNaC, [79](#)
- power_funcp_12
 - GiNaC, [81](#)
- power_funcp_13
 - GiNaC, [83](#)
- power_funcp_14
 - GiNaC, [85](#)
- power_funcp_2
 - GiNaC, [64](#)
- power_funcp_3
 - GiNaC, [66](#)
- power_funcp_4
 - GiNaC, [67](#)
- power_funcp_5
 - GiNaC, [69](#)
- power_funcp_6
 - GiNaC, [71](#)
- power_funcp_7
 - GiNaC, [73](#)
- power_funcp_8
 - GiNaC, [74](#)
- power_funcp_9
 - GiNaC, [76](#)
- power_funcp_exvector
 - GiNaC, [87](#)
- power_use_exvector_args
 - GiNaC::function_options, [729](#)
- pp
 - factor.cpp, [1334](#)
- precedence
 - GiNaC::add, [327](#)
 - GiNaC::basic, [365](#)
 - GiNaC::clifford, [413](#)
 - GiNaC::container< C >, [478](#)
 - GiNaC::expairseq, [623](#)
 - GiNaC::function, [674](#)
 - GiNaC::indexed, [763](#)
 - GiNaC::integral, [779](#)
 - GiNaC::mul, [877](#)
 - GiNaC::ncmul, [939](#)
 - GiNaC::numeric, [956](#)
 - GiNaC::power, [1022](#)
 - GiNaC::pseries, [1075](#)
 - GiNaC::relational, [1114](#)
 - GiNaC::structure< T, ComparisonPolicy >, [1168](#)
- prem
 - GiNaC, [216](#)
- preorder_begin
 - GiNaC::ex, [579](#)
- preorder_end
 - GiNaC::ex, [579](#)
- prepend
 - GiNaC::container< C >, [483](#)
- prime
 - GiNaC::info_flags, [772](#)
- primitive_dirichlet_character
 - GiNaC, [198](#)
- primpart
 - GiNaC::ex, [596](#)
- print
 - GiNaC::_numeric_digits, [317](#)
 - GiNaC::basic, [364](#)
 - GiNaC::ex, [580](#)
 - GiNaC::expair, [612](#)
 - GiNaC::fderivative, [656](#)
 - GiNaC::function, [674](#)
 - GiNaC::structure< T, ComparisonPolicy >, [1167](#)
- print.cpp, [1396](#)
- print.h, [1397](#)
 - GINAC_DECLARE_PRINT_CONTEXT, [1399](#)
 - GINAC_DECLARE_PRINT_CONTEXT_BASE, [1398](#)
 - GINAC_DECLARE_PRINT_CONTEXT_COMMON, [1398](#)
 - GINAC_IMPLEMENT_PRINT_CONTEXT, [1399](#)
- print_add
 - GiNaC::add, [334](#)
- print_context
 - GiNaC::print_context, [1035](#)
- print_context_class_info
 - GiNaC, [89](#)
- print_context_options
 - GiNaC::print_context_options, [1036](#)
- print_csrc
 - GiNaC::print_csrc, [1039](#)
- print_csrc_cl_N
 - GiNaC::print_csrc_cl_N, [1041](#)
- print_csrc_double
 - GiNaC::print_csrc_double, [1043](#)
- print_csrc_float
 - GiNaC::print_csrc_float, [1045](#)
- print_dflt
 - GiNaC::print_dflt, [1047](#)
- print_dispatch
 - GiNaC::basic, [378](#), [379](#)
- print_dispatch_table
 - GiNaC::function_options, [726](#)
 - GiNaC::registered_class_options, [1107](#)
- print_elements
 - GiNaC::matrix, [847](#)
- print_func
 - GiNaC::function_options, [718–721](#)
 - GiNaC::registered_class_options, [1106](#)
- print_func< print_context >
 - GiNaC, [129](#)
- print_func< print_dflt >
 - GiNaC, [93](#), [106](#), [278](#)
- print_funcp
 - GiNaC, [61](#)
- print_funcp_1
 - GiNaC, [63](#)

- print_funcp_10
 - GiNaC, [78](#)
- print_funcp_11
 - GiNaC, [80](#)
- print_funcp_12
 - GiNaC, [82](#)
- print_funcp_13
 - GiNaC, [84](#)
- print_funcp_14
 - GiNaC, [86](#)
- print_funcp_2
 - GiNaC, [64](#)
- print_funcp_3
 - GiNaC, [66](#)
- print_funcp_4
 - GiNaC, [68](#)
- print_funcp_5
 - GiNaC, [69](#)
- print_funcp_6
 - GiNaC, [71](#)
- print_funcp_7
 - GiNaC, [73](#)
- print_funcp_8
 - GiNaC, [75](#)
- print_funcp_9
 - GiNaC, [76](#)
- print_funcp_exvector
 - GiNaC, [87](#)
- print_functor
 - GiNaC::print_functor, [1048](#)
- print_index
 - GiNaC::idx, [747](#)
- print_index_dimensions
 - GiNaC::print_options, [1057](#)
- print_indexed
 - GiNaC::indexed, [768](#)
- print_integer_csrc
 - GiNaC, [229](#)
- print_latex
 - GiNaC::print_latex, [1052](#)
- print_memfun_handler
 - GiNaC::print_memfun_handler< T, C >, [1054](#)
- print_numeric
 - GiNaC::numeric, [976](#)
- print_operator
 - GiNaC, [268](#)
- print_overall_coeff
 - GiNaC::mul, [888](#)
- print_power
 - GiNaC::power, [1030](#)
- print_ptrfun_handler
 - GiNaC::print_ptrfun_handler< T, C >, [1058](#)
- print_python
 - GiNaC::print_python, [1061](#)
- print_python_repr
 - GiNaC::print_python_repr, [1062](#)
- print_real_cl_N
 - GiNaC, [231](#)
- print_real_csrc
 - GiNaC, [230](#)
- print_real_number
 - GiNaC, [229](#)
- print_series
 - GiNaC::pseries, [1084](#)
- print_sym_pow
 - GiNaC, [264](#)
- print_tree
 - GiNaC::print_tree, [1064](#)
- print_use_exvector_args
 - GiNaC::function_options, [729](#)
- printindices
 - GiNaC::indexed, [768](#)
- printpair
 - GiNaC::expairseq, [629](#)
- printraw
 - GiNaC::archive, [341](#)
 - GiNaC::archive_node, [352](#)
- printseq
 - GiNaC::container< C >, [482](#)
 - GiNaC::expairseq, [629](#)
- product_to_exvector
 - GiNaC, [135](#)
- property
 - GiNaC::archive_node::property, [1065](#)
- property_info
 - GiNaC::archive_node::property_info, [1067](#)
- property_type
 - GiNaC::archive_node, [346](#)
- propinfovector
 - GiNaC::archive_node, [346](#)
- props
 - GiNaC::archive_node, [353](#)
- pseries
 - GiNaC::pseries, [1074](#)
- pseries.cpp, [1400](#)
- pseries.h, [1400](#)
- psi
 - GiNaC, [158](#), [239](#), [240](#)
- psi1_deriv
 - GiNaC, [167](#)
- psi1_eval
 - GiNaC, [167](#)
- psi1_evalf
 - GiNaC, [167](#)
- psi1_series
 - GiNaC, [168](#)
- psi2_deriv
 - GiNaC, [168](#)
- psi2_eval
 - GiNaC, [168](#)
- psi2_evalf
 - GiNaC, [168](#)
- psi2_series
 - GiNaC, [169](#)
- ptr
 - GiNaC::pointer_to_map_function, [987](#)

- GiNaC::pointer_to_map_function_1arg< T1 >, 989
- GiNaC::pointer_to_map_function_2args< T1, T2 >, 992
- GiNaC::pointer_to_map_function_3args< T1, T2, T3 >, 994
- GiNaC::pointer_to_member_to_map_function< C >, 997
- GiNaC::pointer_to_member_to_map_function_1arg< C, T1 >, 1000
- GiNaC::pointer_to_member_to_map_function_2args< C, T1, T2 >, 1002
- GiNaC::pointer_to_member_to_map_function_3args< C, T1, T2, T3 >, 1005
- GiNaC::ptr< T >, 1090
- ptr.h, 1401
- PTYPE_BOOL
 - GiNaC::archive_node, 347
- PTYPE_NODE
 - GiNaC::archive_node, 347
- PTYPE_STRING
 - GiNaC::archive_node, 347
- PTYPE_UNSIGNED
 - GiNaC::archive_node, 347
- purely_indefinite
 - GiNaC::status_flags, 1160
- python
 - GiNaC, 262
- python_repr
 - GiNaC, 263
- q_expansion_modular_form
 - GiNaC::Eisenstein_h_kernel, 542
 - GiNaC::Eisenstein_kernel, 552
 - GiNaC::modular_form_kernel, 865
- qbar
 - integration_kernel.cpp, 1372
- quo
 - GiNaC, 215
- R
 - factor.cpp, 1333
- r
 - factor.cpp, 1328
 - GiNaC::Eisenstein_h_kernel, 543
- rank
 - GiNaC, 210
 - GiNaC::matrix, 843, 844
- rational
 - GiNaC::info_flags, 772
- rational_function
 - GiNaC::info_flags, 772
- rational_polynomial
 - GiNaC::info_flags, 772
- rbegin
 - GiNaC::container< C >, 485
- read_archive
 - GiNaC::basic, 379
 - GiNaC::clifford, 413
 - GiNaC::color, 435
 - GiNaC::constant, 465
 - GiNaC::container< C >, 479
 - GiNaC::expairseq, 627
 - GiNaC::fderivative, 658
 - GiNaC::function, 678
 - GiNaC::idx, 743
 - GiNaC::indexed, 765
 - GiNaC::integral, 782
 - GiNaC::matrix, 836
 - GiNaC::minkmetric, 855
 - GiNaC::numeric, 962
 - GiNaC::power, 1029
 - GiNaC::pseries, 1080
 - GiNaC::relational, 1116
 - GiNaC::spinidx, 1147
 - GiNaC::symbol, 1217
 - GiNaC::symmetry, 1229
 - GiNaC::tensepsilon, 1249
 - GiNaC::varidx, 1285
 - GiNaC::wildcard, 1293
- read_real_float
 - GiNaC, 228
- read_unsigned
 - GiNaC, 90
- real
 - GiNaC, 252
 - GiNaC::domain, 524
 - GiNaC::info_flags, 772
 - GiNaC::numeric, 975
- real_part
 - GiNaC, 114
 - GiNaC::add, 331
 - GiNaC::basic, 377
 - GiNaC::constant, 465
 - GiNaC::container< C >, 480
 - GiNaC::ex, 584
 - GiNaC::function, 677
 - GiNaC::indexed, 764
 - GiNaC::matrix, 835
 - GiNaC::mul, 880
 - GiNaC::ncmul, 942
 - GiNaC::numeric, 961
 - GiNaC::power, 1028
 - GiNaC::pseries, 1079
 - GiNaC::realsymbol, 1100
 - GiNaC::symbol, 1216
- real_part_conjugate
 - GiNaC, 141
- real_part_eval
 - GiNaC, 140
- real_part_evalf
 - GiNaC, 140
- real_part_expl_derivative
 - GiNaC, 141
- real_part_f
 - GiNaC::function_options, 725
- real_part_func

- GiNaC::function_options, 698–700, 717
- real_part_funcp
 - GiNaC, 61
- real_part_funcp_1
 - GiNaC, 62
- real_part_funcp_10
 - GiNaC, 77
- real_part_funcp_11
 - GiNaC, 79
- real_part_funcp_12
 - GiNaC, 80
- real_part_funcp_13
 - GiNaC, 82
- real_part_funcp_14
 - GiNaC, 84
- real_part_funcp_2
 - GiNaC, 64
- real_part_funcp_3
 - GiNaC, 65
- real_part_funcp_4
 - GiNaC, 67
- real_part_funcp_5
 - GiNaC, 68
- real_part_funcp_6
 - GiNaC, 70
- real_part_funcp_7
 - GiNaC, 72
- real_part_funcp_8
 - GiNaC, 74
- real_part_funcp_9
 - GiNaC, 75
- real_part_funcp_exvector
 - GiNaC, 86
- real_part_imag_part
 - GiNaC, 141
- real_part_print_latex
 - GiNaC, 140
- real_part_real_part
 - GiNaC, 141
- real_part_use_exvector_args
 - GiNaC::function_options, 728
- really_subs_idx
 - GiNaC::subs_options, 1202
- realsymbol
 - GiNaC::realsymbol, 1099, 1100
- recombine_pair_to_ex
 - GiNaC::add, 333
 - GiNaC::expairseq, 630
 - GiNaC::mul, 886
- reduced_matrix
 - GiNaC, 207
- reeval_ncmul
 - GiNaC, 212
 - GiNaC::ncmul, 945
- refcount
 - GiNaC::refcounted, 1104
- refcounted
 - GiNaC::refcounted, 1103
- reference
 - GiNaC::const_iterator, 446
 - GiNaC::const_postorder_iterator, 452
 - GiNaC::const_preorder_iterator, 455
- REGISTER_FUNCTION
 - function.h, 1350
 - GiNaC, 140, 141, 143, 145, 146, 148, 149, 151–154, 156, 161, 162, 164, 166, 167, 171, 172, 174, 177, 179, 181, 182, 184–188, 190, 191, 193–196
- register_new
 - GiNaC::function, 681
- registered_class_info
 - GiNaC, 89
- registered_class_options
 - GiNaC::registered_class_options, 1105
- registered_functions
 - GiNaC::function, 680
- registrar.cpp, 1402
- registrar.h, 1402
 - GINAC_DECLARE_REGISTERED_CLASS, 1404
 - GINAC_DECLARE_REGISTERED_CLASS_COMMON, 1403
 - GINAC_DECLARE_REGISTERED_CLASS_NO_CTORS, 1404
 - GINAC_IMPLEMENT_REGISTERED_CLASS, 1405
 - GINAC_IMPLEMENT_REGISTERED_CLASS_OPT, 1405
 - GINAC_IMPLEMENT_REGISTERED_CLASS_OPT_T, 1405
- relation
 - GiNaC::info_flags, 772
- relation_equal
 - GiNaC::info_flags, 772
- relation_greater
 - GiNaC::info_flags, 772
- relation_greater_or_equal
 - GiNaC::info_flags, 772
- relation_less
 - GiNaC::info_flags, 772
- relation_less_or_equal
 - GiNaC::info_flags, 772
- relation_not_equal
 - GiNaC::info_flags, 772
- relational
 - GiNaC::relational, 1114
- relational.cpp, 1406
- relational.h, 1406
- relative_integration_error
 - GiNaC::integral, 784
- rem
 - GiNaC, 215
- remember
 - GiNaC::function_options, 722
- remember.cpp, 1407
- remember.h, 1407
- remember_assoc_size

- GiNaC::function_options, [727](#)
- remember_size
 - GiNaC::function_options, [727](#)
- remember_strategy
 - GiNaC::function_options, [727](#)
 - GiNaC::remember_table, [1125](#)
 - GiNaC::remember_table_list, [1131](#)
- remember_table
 - GiNaC::remember_table, [1123](#)
- remember_table_entry
 - GiNaC::function, [682](#)
 - GiNaC::remember_table_entry, [1127](#)
- remember_table_list
 - GiNaC::remember_table_list, [1130](#)
- remember_tables
 - GiNaC::remember_table, [1124](#)
- remove_all
 - GiNaC::container< C >, [484](#)
- remove_dirac_ONE
 - GiNaC, [99](#)
- remove_first
 - GiNaC::container< C >, [483](#)
- remove_last
 - GiNaC::container< C >, [483](#)
- remove_reference
 - GiNaC::refcounted, [1103](#)
- rename_dummy_indices
 - GiNaC, [134](#)
- rename_dummy_indices_uniquely
 - GiNaC, [136](#), [137](#)
- rend
 - GiNaC::container< C >, [485](#)
- replace_contr_index
 - GiNaC::tensor, [1262](#)
- replace_dim
 - GiNaC::idx, [746](#)
- replace_with_symbol
 - GiNaC, [225](#), [226](#)
- reposition_dummy_indices
 - GiNaC, [134](#)
 - GiNaC::indexed, [770](#)
- representation_label
 - GiNaC::clifford, [418](#)
 - GiNaC::color, [437](#)
- reserve
 - GiNaC::container_storage< C >, [489](#)
- rest
 - GiNaC::expair, [613](#)
- result
 - GiNaC::remember_table_entry, [1128](#)
- result_type
 - GiNaC::map_function, [823](#)
- resultant
 - GiNaC, [227](#)
- return_type
 - GiNaC::add, [332](#)
 - GiNaC::basic, [376](#)
 - GiNaC::clifford, [415](#)
 - GiNaC::color, [436](#)
 - GiNaC::ex, [602](#)
 - GiNaC::expairseq, [627](#)
 - GiNaC::fail, [645](#)
 - GiNaC::function, [679](#)
 - GiNaC::function_options, [726](#)
 - GiNaC::indexed, [766](#)
 - GiNaC::integral, [781](#)
 - GiNaC::matrix, [836](#)
 - GiNaC::minkmetric, [856](#)
 - GiNaC::mul, [884](#)
 - GiNaC::ncmul, [943](#)
 - GiNaC::power, [1030](#)
 - GiNaC::relational, [1117](#)
 - GiNaC::structure< T, ComparisonPolicy >, [1177](#)
 - GiNaC::su3d, [1184](#)
 - GiNaC::su3f, [1190](#)
 - GiNaC::tensdelta, [1242](#)
 - GiNaC::tensepsilon, [1249](#)
 - GiNaC::tensmetric, [1257](#)
 - GiNaC::tensor, [1262](#)
- return_type_tinfo
 - GiNaC::add, [332](#)
 - GiNaC::basic, [377](#)
 - GiNaC::clifford, [415](#)
 - GiNaC::color, [436](#)
 - GiNaC::ex, [602](#)
 - GiNaC::function, [680](#)
 - GiNaC::function_options, [727](#)
 - GiNaC::indexed, [766](#)
 - GiNaC::integral, [782](#)
 - GiNaC::mul, [884](#)
 - GiNaC::ncmul, [943](#)
 - GiNaC::power, [1030](#)
 - GiNaC::relational, [1117](#)
 - GiNaC::structure< T, ComparisonPolicy >, [1177](#)
- rh
 - GiNaC::relational, [1120](#)
- rhs
 - GiNaC, [121](#)
 - GiNaC::ex, [584](#)
 - GiNaC::relational, [1119](#)
- rl
 - GiNaC::return_type_t, [1132](#)
- root
 - GiNaC::archive::archived_ex, [357](#)
- rotate_left
 - GiNaC, [283](#)
- row
 - GiNaC::matrix, [848](#)
- rows
 - GiNaC, [208](#)
 - GiNaC::matrix, [837](#)
- s
 - GiNaC::const_postorder_iterator, [454](#)
 - GiNaC::const_preorder_iterator, [457](#)
 - GiNaC::derivative_map_function, [495](#)
 - GiNaC::Eisenstein_h_kernel, [543](#)

- GiNaC::print_context, [1035](#)
 - GiNaC::symbolset, [1222](#)
- S_deriv
 - GiNaC, [172](#)
- S_eval
 - GiNaC, [171](#)
- S_evalf
 - GiNaC, [171](#)
- S_print_latex
 - GiNaC, [172](#)
- S_series
 - GiNaC, [172](#)
- safe_bool
 - GiNaC::relational, [1114](#)
- same_metric
 - GiNaC::clifford, [416](#)
- scalar_mul_indexed
 - GiNaC::basic, [375](#)
 - GiNaC::matrix, [834](#)
 - GiNaC::structure< T, ComparisonPolicy >, [1176](#)
- seq
 - GiNaC::container_storage< C >, [490](#)
 - GiNaC::expairseq, [636](#)
 - GiNaC::pseries, [1086](#)
 - GiNaC::remember_table_entry, [1128](#)
- serial
 - GiNaC::constant, [468](#)
 - GiNaC::function, [683](#)
 - GiNaC::G2_SERIAL, [730](#)
 - GiNaC::G3_SERIAL, [731](#)
 - GiNaC::iterated_integral2_SERIAL, [796](#)
 - GiNaC::iterated_integral3_SERIAL, [797](#)
 - GiNaC::psi1_SERIAL, [1087](#)
 - GiNaC::psi2_SERIAL, [1088](#)
 - GiNaC::symbol, [1220](#)
 - GiNaC::zeta1_SERIAL, [1296](#)
 - GiNaC::zeta2_SERIAL, [1297](#)
- series
 - GiNaC, [119](#)
 - GiNaC::add, [329](#)
 - GiNaC::basic, [372](#)
 - GiNaC::Eisenstein_h_kernel, [539](#)
 - GiNaC::Eisenstein_kernel, [550](#)
 - GiNaC::ex, [591](#)
 - GiNaC::fderivative, [657](#)
 - GiNaC::function, [676](#)
 - GiNaC::integral, [783](#)
 - GiNaC::integration_kernel, [790](#)
 - GiNaC::modular_form_kernel, [863](#)
 - GiNaC::mul, [881](#)
 - GiNaC::power, [1026](#)
 - GiNaC::pseries, [1077](#)
 - GiNaC::structure< T, ComparisonPolicy >, [1173](#)
 - GiNaC::symbol, [1214](#)
- series_coeff
 - GiNaC::integration_kernel, [793](#)
- series_coeff_impl
 - GiNaC::basic_log_kernel, [391](#)
- GiNaC::Ebar_kernel, [531](#)
 - GiNaC::ELi_kernel, [563](#)
 - GiNaC::integration_kernel, [792](#)
 - GiNaC::Kronecker_dtau_kernel, [804](#)
 - GiNaC::Kronecker_dz_kernel, [813](#)
 - GiNaC::multiple_polylog_kernel, [930](#)
- series_f
 - GiNaC::function_options, [726](#)
- series_func
 - GiNaC::function_options, [712–714](#), [718](#)
- series_funcp
 - GiNaC, [61](#)
- series_funcp_1
 - GiNaC, [63](#)
- series_funcp_10
 - GiNaC, [78](#)
- series_funcp_11
 - GiNaC, [80](#)
- series_funcp_12
 - GiNaC, [81](#)
- series_funcp_13
 - GiNaC, [83](#)
- series_funcp_14
 - GiNaC, [85](#)
- series_funcp_2
 - GiNaC, [64](#)
- series_funcp_3
 - GiNaC, [66](#)
- series_funcp_4
 - GiNaC, [68](#)
- series_funcp_5
 - GiNaC, [69](#)
- series_funcp_6
 - GiNaC, [71](#)
- series_funcp_7
 - GiNaC, [73](#)
- series_funcp_8
 - GiNaC, [74](#)
- series_funcp_9
 - GiNaC, [76](#)
- series_funcp_exvector
 - GiNaC, [87](#)
- series_to_poly
 - GiNaC, [266](#)
- series_use_exvector_args
 - GiNaC::function_options, [729](#)
- series_vec
 - GiNaC::integration_kernel, [794](#)
- set
 - GiNaC::matrix, [840](#)
- set_cache_step
 - GiNaC::integration_kernel, [793](#)
- set_name
 - GiNaC::function_options, [690](#)
 - GiNaC::symbol, [1219](#)
- set_print_context
 - GiNaC, [261](#)
- set_print_func

- GiNaC, [267](#)
 - GiNaC::function_options, [723](#)
 - GiNaC::registered_class_options, [1106](#)
- set_print_options
 - GiNaC, [261](#)
- set_refcount
 - GiNaC::refcounted, [1104](#)
- set_return_type
 - GiNaC::function_options, [721](#)
- set_symmetry
 - GiNaC::function_options, [722](#)
- set_TeX_name
 - GiNaC::symbol, [1219](#)
- set_type
 - GiNaC::symmetry, [1230](#)
- setflag
 - GiNaC::basic, [382](#)
- shaker_sort
 - GiNaC, [285](#)
- share
 - GiNaC::ex, [605](#)
- shift_exponents
 - GiNaC::pseries, [1084](#)
- show_statistics
 - GiNaC::remember_table, [1124](#)
- simplify_indexed
 - GiNaC, [119](#), [135](#)
 - GiNaC::ex, [598](#), [599](#)
 - GiNaC::indexed, [769](#)
- simplify_indexed_product
 - GiNaC, [135](#)
 - GiNaC::indexed, [770](#)
- sin
 - GiNaC, [232](#)
- sin_conjugate
 - GiNaC, [180](#)
- sin_deriv
 - GiNaC, [180](#)
- sin_eval
 - GiNaC, [180](#)
- sin_evalf
 - GiNaC, [179](#)
- sin_imag_part
 - GiNaC, [180](#)
- sin_real_part
 - GiNaC, [180](#)
- sinh
 - GiNaC, [235](#)
- sinh_conjugate
 - GiNaC, [190](#)
- sinh_deriv
 - GiNaC, [189](#)
- sinh_eval
 - GiNaC, [189](#)
- sinh_evalf
 - GiNaC, [189](#)
- sinh_imag_part
 - GiNaC, [189](#)
- sinh_real_part
 - GiNaC, [189](#)
- size
 - GiNaC::basic_multi_iterator< T >, [394](#)
- smod
 - GiNaC, [243](#)
 - GiNaC::add, [330](#)
 - GiNaC::basic, [374](#)
 - GiNaC::ex, [597](#)
 - GiNaC::mul, [882](#)
 - GiNaC::numeric, [960](#)
 - GiNaC::structure< T, ComparisonPolicy >, [1174](#)
- solve
 - GiNaC::matrix, [843](#)
- sort
 - GiNaC::container< C >, [484](#)
- sort_
 - GiNaC::container< C >, [482](#)
- spinidx
 - GiNaC::spinidx, [1146](#)
- spinor_metric
 - GiNaC, [280](#)
- split_ex_to_pair
 - GiNaC::add, [333](#)
 - GiNaC::expairseq, [629](#)
 - GiNaC::mul, [885](#)
- spm
 - GiNaC::scalar_products, [1136](#)
- spmap
 - GiNaC, [88](#)
- spmapkey
 - GiNaC::spmapkey, [1157](#), [1158](#)
- sprem
 - GiNaC, [217](#)
- sqrfree
 - GiNaC, [224](#)
- sqrfree_parfrac
 - GiNaC, [225](#)
- sqrfree_yun
 - GiNaC, [223](#)
- sqrt
 - GiNaC, [246](#), [266](#)
- sr_gcd
 - GiNaC, [219](#)
- STATISTICS
 - normal.cpp, [1384](#)
- std, [311](#)
 - swap, [311](#)
- std::equal_to< GiNaC::ex >, [564](#)
 - operator(), [565](#)
- std::hash< GiNaC::ex >, [735](#)
 - operator(), [735](#)
- std::less< GiNaC::ptr< T > >, [816](#)
 - operator(), [817](#)
- std::less< ptr< T > >
 - GiNaC::ptr< T >, [1092](#)
- step
 - GiNaC, [248](#)

- GiNaC::numeric, 967
- step_conjugate
 - GiNaC, 146
- step_eval
 - GiNaC, 145
- step_evalf
 - GiNaC, 145
- step_imag_part
 - GiNaC, 146
- step_real_part
 - GiNaC, 146
- step_series
 - GiNaC, 146
- STLT
 - GiNaC::container< C >, 475
 - GiNaC::container_storage< C >, 488
- store_remember_table
 - GiNaC::function, 681
- struct_compare
 - GiNaC::compare_all_equal< T >, 438
 - GiNaC::compare_bitwise< T >, 439
 - GiNaC::compare_std_less< T >, 441
- struct_is_equal
 - GiNaC::compare_all_equal< T >, 438
 - GiNaC::compare_bitwise< T >, 439
 - GiNaC::compare_std_less< T >, 440
- structure
 - GiNaC::structure< T, ComparisonPolicy >, 1166
- structure.h, 1408
- sub
 - GiNaC::matrix, 837
 - GiNaC::numeric, 963
- sub_dyn
 - GiNaC::numeric, 965
- sub_matrix
 - GiNaC, 207
- subs
 - GiNaC, 122
 - GiNaC::basic, 369
 - GiNaC::clifford, 417
 - GiNaC::container< C >, 479
 - GiNaC::ex, 586, 587
 - GiNaC::expairseq, 626
 - GiNaC::idx, 743
 - GiNaC::matrix, 834
 - GiNaC::numeric, 959
 - GiNaC::power, 1026
 - GiNaC::pseries, 1077
 - GiNaC::relational, 1116
 - GiNaC::structure< T, ComparisonPolicy >, 1170
 - GiNaC::symbol, 1215
- subs_algebraic
 - GiNaC::subs_options, 1202
- subs_no_pattern
 - GiNaC::subs_options, 1202
- subs_one_level
 - GiNaC::basic, 380
- subchildren
 - GiNaC::container< C >, 486
- GiNaC::expairseq, 636
- subvalue
 - GiNaC, 196
- successful_hits
 - GiNaC::remember_table_entry, 1128
- sufficiently_accurate
 - GiNaC::lanczos_coeffs, 815
- suppress_branchcut
 - GiNaC::series_options, 1137
- swap
 - GiNaC, 122, 126
 - GiNaC::ex, 578
 - GiNaC::expair, 612
 - GiNaC::ptr< T >, 1091
 - std, 311
- swapped
 - GiNaC::sy_swap, 1204
- sy_anti
 - GiNaC, 275, 276
- sy_cycl
 - GiNaC, 276, 277
- sy_is_less
 - GiNaC::sy_is_less, 1202
 - GiNaC::symmetry, 1232
- sy_none
 - GiNaC, 274
- sy_swap
 - GiNaC::sy_swap, 1203
 - GiNaC::symmetry, 1232
- sy_symm
 - GiNaC, 275
- sym
 - GiNaC::sym_desc, 1206
- sym_desc
 - GiNaC::sym_desc, 1206
- sym_desc_vec
 - GiNaC, 88
- symbol
 - GiNaC::info_flags, 772
 - GiNaC::symbol, 1213
- symbol.cpp, 1409
- symbol.h, 1409
- symbolic_matrix
 - GiNaC, 206, 210
- symbolset
 - GiNaC::symbolset, 1222
- symm
 - GiNaC, 273
 - GiNaC::terminfo, 1264
- symmetric
 - GiNaC::symmetry, 1228
- symmetric2
 - GiNaC, 271
- symmetric3
 - GiNaC, 271
- symmetric4
 - GiNaC, 271

- symmetrize
 - GiNaC, [120](#), [273](#), [277](#)
 - GiNaC::ex, [601](#)
- symmetrize_cyclic
 - GiNaC, [120](#), [121](#), [273](#), [277](#)
 - GiNaC::ex, [601](#), [602](#)
- symmetry
 - GiNaC::symmetry, [1228](#)
- symmetry.cpp, [1410](#)
- symmetry.h, [1411](#)
- symmetry_type
 - GiNaC::symmetry, [1228](#)
- symminfo
 - GiNaC::symminfo, [1235](#)
- symmterm
 - GiNaC::symminfo, [1235](#)
- syms
 - factor.cpp, [1334](#)
- syms_wox
 - factor.cpp, [1333](#)
- symtree
 - GiNaC::function_options, [730](#)
 - GiNaC::indexed, [770](#)
- synthesize_func
 - GiNaC, [58](#)
- table_size
 - GiNaC::remember_table, [1125](#)
- tan
 - GiNaC, [233](#)
- tan_conjugate
 - GiNaC, [184](#)
- tan_deriv
 - GiNaC, [183](#)
- tan_eval
 - GiNaC, [183](#)
- tan_evalf
 - GiNaC, [182](#)
- tan_imag_part
 - GiNaC, [183](#)
- tan_real_part
 - GiNaC, [183](#)
- tan_series
 - GiNaC, [183](#)
- tanh
 - GiNaC, [235](#)
- tanh_conjugate
 - GiNaC, [193](#)
- tanh_deriv
 - GiNaC, [192](#)
- tanh_eval
 - GiNaC, [192](#)
- tanh_evalf
 - GiNaC, [191](#)
- tanh_imag_part
 - GiNaC, [192](#)
- tanh_real_part
 - GiNaC, [192](#)
- tanh_series
 - GiNaC, [192](#)
- tau
 - GiNaC::Kronecker_dz_kernel, [814](#)
- tcoeff
 - GiNaC::ex, [590](#)
- tensepsilon
 - GiNaC::tensepsilon, [1248](#)
- tensor
 - GiNaC, [290](#)
- tensor.cpp, [1413](#)
- tensor.h, [1414](#)
- terminfo
 - GiNaC::terminfo, [1264](#)
- test
 - GiNaC::has_distance< T >, [734](#)
- test_and_set_nparams
 - GiNaC::function_options, [723](#)
- TEST_PERMUTATION
 - color.cpp, [1312](#)
- TeX_name
 - GiNaC::constant, [468](#)
 - GiNaC::function_options, [724](#)
 - GiNaC::symbol, [1221](#)
- tgamma
 - GiNaC, [239](#)
- tgamma_conjugate
 - GiNaC, [165](#)
- tgamma_deriv
 - GiNaC, [165](#)
- tgamma_eval
 - GiNaC, [165](#)
- tgamma_evalf
 - GiNaC, [164](#)
- tgamma_series
 - GiNaC, [165](#)
- thiscontainer
 - GiNaC::clifford, [414](#), [415](#)
 - GiNaC::color, [436](#)
 - GiNaC::container< C >, [481](#), [482](#)
 - GiNaC::fderivative, [657](#)
 - GiNaC::function, [676](#), [677](#)
 - GiNaC::indexed, [765](#), [766](#)
 - GiNaC::ncmul, [941](#), [942](#)
- thisexpairseq
 - GiNaC::add, [332](#)
 - GiNaC::expairseq, [628](#), [629](#)
 - GiNaC::mul, [884](#), [885](#)
- tinfo
 - GiNaC::return_type_t, [1132](#)
- tinfo_key
 - GiNaC::registered_class_options, [1107](#)
- to_cl_N
 - GiNaC::numeric, [975](#)
- to_double
 - GiNaC, [251](#)
 - GiNaC::numeric, [975](#)
- to_int
 - GiNaC, [251](#)

- GiNaC::numeric, 974
- to_long
 - GiNaC, 251
 - GiNaC::numeric, 974
- to_polynomial
 - GiNaC, 117
 - GiNaC::basic, 373
 - GiNaC::ex, 593
 - GiNaC::expairseq, 625
 - GiNaC::numeric, 960
 - GiNaC::power, 1028
 - GiNaC::structure< T, ComparisonPolicy >, 1174
 - GiNaC::symbol, 1216
- to_rational
 - GiNaC, 117
 - GiNaC::basic, 373
 - GiNaC::ex, 592
 - GiNaC::expairseq, 625
 - GiNaC::numeric, 959
 - GiNaC::power, 1027
 - GiNaC::structure< T, ComparisonPolicy >, 1173
 - GiNaC::symbol, 1215
- toggle_dot
 - GiNaC::spinidx, 1148
- toggle_variance
 - GiNaC::varidx, 1286
- toggle_variance_dot
 - GiNaC::spinidx, 1148
- too_late
 - GiNaC::_numeric_digits, 317
- trace
 - GiNaC, 209
 - GiNaC::matrix, 841
- trace_string
 - GiNaC, 97
- transpose
 - GiNaC, 208
 - GiNaC::matrix, 840
- traverse
 - GiNaC::ex, 588
- traverse_postorder
 - GiNaC::ex, 588
- traverse_preorder
 - GiNaC::ex, 588
- tree
 - GiNaC, 263
- tree_node
 - GiNaC::class_info< OPT >::tree_node, 1265
- trig_info
 - GiNaC, 181
- trivial
 - GiNaC::composition_generator, 443
- tryfactsubs
 - GiNaC, 211
- type
 - GiNaC::archive_node::property, 1065
 - GiNaC::archive_node::property_info, 1067
 - GiNaC::symmetry, 1232
- uintvector
 - GiNaC, 88
- unarch_map
 - GiNaC::unarchive_table_t, 1268
- unarch_table_instance
 - GiNaC, 289
- unarchive
 - GiNaC::archive_node, 351
- unarchive_ex
 - GiNaC::archive, 339
- unarchive_map_t
 - GiNaC, 58
- unarchive_table_t
 - GiNaC::unarchive_table_t, 1267
- unatomize
 - GiNaC::archive, 342
- unique
 - GiNaC::container< C >, 484
- unique_
 - GiNaC::container< C >, 483, 486
- unit
 - factor.cpp, 1333
 - GiNaC::ex, 594
- unit_matrix
 - GiNaC, 206, 210
- unitcontprim
 - GiNaC::ex, 597
- unlikely
 - compiler.h, 1314
- unlink_ex
 - GiNaC, 126
- unsignedvector
 - GiNaC, 88
- USE_REMEMBER
 - normal.cpp, 1384
- use_remember
 - GiNaC::function_options, 727
- use_return_type
 - GiNaC::function_options, 726
- USE_SAME_DEGREE_FACTOR
 - factor.cpp, 1328
- use_sr_gcd
 - GiNaC::gcd_options, 732
- USE_TRIAL_DIVISION
 - normal.cpp, 1384
- usecount
 - GiNaC::unarchive_table_t, 1268
- used_indices
 - GiNaC::make_flat_inserter, 821
- user_defined_kernel
 - GiNaC::user_defined_kernel, 1275
- uses_Laurent_series
 - GiNaC::Eisenstein_h_kernel, 541
 - GiNaC::Eisenstein_kernel, 552
 - GiNaC::integration_kernel, 792
 - GiNaC::modular_form_kernel, 865
 - GiNaC::user_defined_kernel, 1276
- utils.cpp, 1415

- utils.h, [1417](#)
 - DEFAULT_COMPARE, [1419](#)
 - DEFAULT_CTOR, [1419](#)
 - DEFAULT_PRINT, [1419](#)
 - DEFAULT_PRINT_LATEX, [1419](#)
- utils_multi_iterator.h, [1420](#)
- v
 - GiNaC::basic_multi_iterator< T >, [397](#)
 - GiNaC::sy_is_less, [1203](#)
 - GiNaC::sy_swap, [1204](#)
- v1
 - GiNaC::spmapkey, [1158](#)
- v2
 - GiNaC::spmapkey, [1159](#)
- v_internal
 - GiNaC::multi_iterator_shuffle< T >, [918](#)
- v_orig
 - GiNaC::multi_iterator_shuffle< T >, [918](#)
- validate
 - GiNaC::indexed, [769](#)
 - GiNaC::symmetry, [1230](#)
- value
 - factor.cpp, [1328](#)
 - GiNaC::archive_node::property, [1066](#)
 - GiNaC::composition_generator::coolmulti::element, [555](#)
 - GiNaC::has_distance< T >, [733](#)
 - GiNaC::idx, [748](#)
 - GiNaC::numeric, [978](#)
- value_type
 - GiNaC::const_iterator, [445](#)
 - GiNaC::const_postorder_iterator, [451](#)
 - GiNaC::const_preorder_iterator, [455](#)
- var
 - GiNaC::pseries, [1086](#)
- varidx
 - GiNaC::varidx, [1284](#)
- version.h, [1421](#)
 - GINAC_LT_AGE, [1422](#)
 - GINAC_LT_CURRENT, [1422](#)
 - GINAC_LT_REVISION, [1422](#)
 - GINACLIB_ARCHIVE_AGE, [1423](#)
 - GINACLIB_ARCHIVE_VERSION, [1422](#)
 - GINACLIB_MAJOR_VERSION, [1422](#)
 - GINACLIB_MICRO_VERSION, [1422](#)
 - GINACLIB_MINOR_VERSION, [1422](#)
 - GINACLIB_STR, [1423](#)
 - GINACLIB_STR_HELPER, [1423](#)
 - GINACLIB_VERSION, [1423](#)
- version_major
 - GiNaC, [293](#)
- version_micro
 - GiNaC, [293](#)
- version_minor
 - GiNaC, [293](#)
- vn
 - factor.cpp, [1334](#)
- vnlst
 - factor.cpp, [1334](#)
- wild
 - GiNaC, [289](#)
- wildcard
 - GiNaC::wildcard, [1293](#)
- wildcard.cpp, [1423](#)
- wildcard.h, [1424](#)
- write_real_float
 - GiNaC, [229](#)
- write_unsigned
 - GiNaC, [90](#)
- x
 - factor.cpp, [1332](#)
 - GiNaC::basic_partition_generator::mpartition2, [867](#)
 - GiNaC::Ebar_kernel, [532](#)
 - GiNaC::ELi_kernel, [564](#)
 - GiNaC::integral, [784](#)
 - GiNaC::user_defined_kernel, [1277](#)
 - integration_kernel.cpp, [1373](#)
- y
 - GiNaC::Ebar_kernel, [532](#)
 - GiNaC::ELi_kernel, [564](#)
- yes_type
 - GiNaC::has_distance< T >, [733](#)
- z
 - GiNaC::Kronecker_dtau_kernel, [805](#)
 - GiNaC::multiple_polylog_kernel, [930](#)
- z_j
 - GiNaC::Kronecker_dz_kernel, [814](#)
- zeta
 - GiNaC, [157](#), [238](#)
- zeta1_deriv
 - GiNaC, [174](#)
- zeta1_eval
 - GiNaC, [174](#)
- zeta1_evalf
 - GiNaC, [174](#)
- zeta1_print_latex
 - GiNaC, [174](#)
- zeta2_deriv
 - GiNaC, [175](#)
- zeta2_eval
 - GiNaC, [175](#)
- zeta2_evalf
 - GiNaC, [175](#)
- zeta2_print_latex
 - GiNaC, [175](#)
- zetaderiv_deriv
 - GiNaC, [151](#)
- zetaderiv_eval
 - GiNaC, [151](#)