

The Parma Polyhedra Library

Java Language Interface

User's Manual*

(version 0.11.1)

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Contents

1	Main Page	1
2	GNU General Public License	2
3	GNU Free Documentation License	12
4	Module Index	17
4.1	Modules	17
5	Namespace Index	17
5.1	Namespace List	17
6	Class Index	17
6.1	Class Hierarchy	17
7	Class Index	19
7.1	Class List	19
8	Module Documentation	22
8.1	Java Language Interface	22
9	Namespace Documentation	30
9.1	parma_polyhedra_library Namespace Reference	30
10	Class Documentation	35
10.1	parma_polyhedra_library::Artificial_Parameter Class Reference	35
10.2	parma_polyhedra_library::Artificial_Parameter_Sequence Class Reference	36
10.3	parma_polyhedra_library::BD_Shape_double Class Reference	36
10.4	parma_polyhedra_library::BD_Shape_mpq_class Class Reference	36
10.5	parma_polyhedra_library::BD_Shape_mpz_class Class Reference	36
10.6	parma_polyhedra_library::By_Reference< T > Class Reference	37
10.7	parma_polyhedra_library::C_Polyhedron Class Reference	37
10.8	parma_polyhedra_library::Coefficient Class Reference	41

10.9	parma_polyhedra_library::Congruence Class Reference	42
10.10	parma_polyhedra_library::Congruence_System Class Reference	43
10.11	parma_polyhedra_library::Constraint Class Reference	44
10.12	parma_polyhedra_library::Constraint_System Class Reference	44
10.13	parma_polyhedra_library::Constraints_Product_C_Polyhedron_Grid Class Reference	45
10.14	parma_polyhedra_library::Domain_Error_Exception Class Reference	45
10.15	parma_polyhedra_library::Double_Box Class Reference	45
10.16	parma_polyhedra_library::Generator Class Reference	46
10.17	parma_polyhedra_library::Generator_System Class Reference	48
10.18	parma_polyhedra_library::Grid Class Reference	48
10.19	parma_polyhedra_library::Grid_Generator Class Reference	49
10.20	parma_polyhedra_library::Grid_Generator_System Class Reference	51
10.21	parma_polyhedra_library::Invalid_Argument_Exception Class Reference	51
10.22	parma_polyhedra_library::IO Class Reference	51
10.23	parma_polyhedra_library::Length_Error_Exception Class Reference	52
10.24	parma_polyhedra_library::Linear_Expression Class Reference	53
10.25	parma_polyhedra_library::Linear_Expression_Coefficient Class Reference	54
10.26	parma_polyhedra_library::Linear_Expression_Difference Class Reference	55
10.27	parma_polyhedra_library::Linear_Expression_Sum Class Reference	56
10.28	parma_polyhedra_library::Linear_Expression_Times Class Reference	57
10.29	parma_polyhedra_library::Linear_Expression_Unary_Minus Class Reference	58
10.30	parma_polyhedra_library::Linear_Expression_Variable Class Reference	59
10.31	parma_polyhedra_library::Logic_Error_Exception Class Reference	60
10.32	parma_polyhedra_library::MIP_Problem Class Reference	60
10.33	parma_polyhedra_library::NNC_Polyhedron Class Reference	67
10.34	parma_polyhedra_library::Octagonal_Shape_double Class Reference	67
10.35	parma_polyhedra_library::Octagonal_Shape_mpq_class Class Reference	67
10.36	parma_polyhedra_library::Octagonal_Shape_mpz_class Class Reference	68
10.37	parma_polyhedra_library::Overflow_Error_Exception Class Reference	68
10.38	parma_polyhedra_library::Pair< K, V > Class Reference	68
10.39	parma_polyhedra_library::Parma_Polyhedra_Library Class Reference	69
10.40	parma_polyhedra_library::Partial_Function Class Reference	72
10.41	parma_polyhedra_library::PIP_Decision_Node Class Reference	73
10.42	parma_polyhedra_library::PIP_Problem Class Reference	74
10.43	parma_polyhedra_library::PIP_Solution_Node Class Reference	79
10.44	parma_polyhedra_library::PIP_Tree_Node Class Reference	80
10.45	parma_polyhedra_library::Pointset_Powerset_C_Polyhedron Class Reference	82
10.46	parma_polyhedra_library::Pointset_Powerset_C_Polyhedron_Iterator Class Reference	83
10.47	parma_polyhedra_library::Pointset_Powerset_NNC_Polyhedron Class Reference	84
10.48	parma_polyhedra_library::Pointset_Powerset_NNC_Polyhedron_Iterator Class Reference	85
10.49	parma_polyhedra_library::Poly_Con_Relation Class Reference	85
10.50	parma_polyhedra_library::Poly_Gen_Relation Class Reference	86
10.51	parma_polyhedra_library::Polyhedron Class Reference	86
10.52	parma_polyhedra_library::Rational_Box Class Reference	109
10.53	parma_polyhedra_library::Timeout_Exception Class Reference	110
10.54	parma_polyhedra_library::Variable Class Reference	110
10.55	parma_polyhedra_library::Variables_Set Class Reference	111

1 Main Page

The Parma Polyhedra Library comes equipped with an interface for the Java language. The Java interface provides access to the numerical abstractions (convex polyhedra, BD shapes, octagonal shapes, etc.) im-

plemented by the PPL library. A general introduction to the numerical abstractions, their representation in the PPL and the operations provided by the PPL is given in the main *PPL user manual*. Here we just describe those aspects that are specific to the Java interface. In the sequel, `prefix` is the path prefix under which the library has been installed (typically `/usr` or `/usr/local`).

Overview

Here is a list of notes with general information and advice on the use of the Java interface.

- When the Parma Polyhedra Library is configured, it will automatically test for the existence of the Java system (unless configuration options are passed to disable the build of the Java interface; see configuration option `--enable-interfaces`). If Java is correctly installed in a standard location, things will be arranged so that the Java interface is built and installed (see configuration option `--with-java` if you need to specify a non-standard location for the Java system).
- The Java interface files are all installed in the directory `prefix/lib/ppl`. Since this includes shared and dynamically loaded libraries, you must make your dynamic linker/loader aware of this fact. If you use a GNU/Linux system, try the commands `man ld.so` and `man ldconfig` for more information.
- Any application using the PPL should:
 - Load the PPL interface library by calling `System.load` and passing the full path of the dynamic shared object;
 - Make sure that only the intended version(s) of the library has been loaded, e.g., by calling static method `version()` in class `parma_polyhedra_library.Parma_Polyhedra_Library`;
 - Starting from version 0.11, initialize the interface by calling static method `initialize_library()`; when all library work is done, finalize the interface by calling `finalize_library()`.
- The numerical abstract domains available to the Java user as Java classes consist of the *simple* domains, *powersets* of a simple domain and *products* of simple domains. Note that the default configuration will only enable a subset of these domains (if you need a different set of domains, see configuration option `--enable-instantiations`).
 - The simple domains are:
 - * convex polyhedra, which consist of `C_Polyhedron` and `NNC_Polyhedron`;
 - * weakly relational, which consist of `BD_Shape_N` and `Octagonal_Shape_N` where `N` is one of the numeric types `signed_char`, `short`, `int`, `long`, `long_long`, `mpz_class`, `mpq_class`;
 - * boxes which consist of `Int8_Box`, `Int16_Box`, `Int32_Box`, `Int64_Box`, `UInt8_Box`, `UInt16_Box`, `UInt32_Box`, `UInt64_Box`, `Float_Box`, `Double_Box`, `Long_Double_Box`, `Z_Box`, `Rational_Box`; and
 - * the Grid domain.
 - The powerset domains are `Pointset_Powerset_S` where `S` is a simple domain.
 - The product domains consist of `Direct_Product_S_T`, `Smash_Product_S_T` and `Constraints_Product_S_T` where `S` and `T` are simple domains.
- In the following, any of the above numerical abstract domains is called a PPL *domain* and any element of a PPL domain is called a *PPL object*.

- A Java program can create a new object for a PPL domain by using the constructors for the class corresponding to the domain.
- For a PPL object with space dimension k , the identifiers used for the PPL variables must lie between 0 and $k - 1$ and correspond to the indices of the associated Cartesian axes. For example, when using methods that combine PPL polyhedra or add constraints or generators to a representation of a PPL polyhedron, the polyhedra referenced and any constraints or generators in the call should follow all the (space) dimension-compatibility rules stated in Section *Representations of Convex Polyhedra* of the main PPL user manual.
- As explained above, a polyhedron has a fixed topology C or NNC , that is determined at the time of its initialization. All subsequent operations on the polyhedron must respect all the topological compatibility rules stated in Section *Representations of Convex Polyhedra* of the main PPL user manual.

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4 Module Index

4.1 Modules

Here is a list of all modules:

Java Language Interface

5 Namespace Index

5.1 Namespace List

Here is a list of all documented namespaces with brief descriptions:

parma_polyhedra_library (The PPL Java interface package) 30

6 Class Index

6.1 Class Hierarchy

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

parma_polyhedra_library::Artificial_Parameter	35
parma_polyhedra_library::Artificial_Parameter_Sequence	36
parma_polyhedra_library::BD_Shape_double	36
parma_polyhedra_library::BD_Shape_mpq_class	36
parma_polyhedra_library::BD_Shape_mpz_class	36
parma_polyhedra_library::By_Reference< T >	37
parma_polyhedra_library::Coefficient	41
parma_polyhedra_library::Congruence	42
parma_polyhedra_library::Congruence_System	43
parma_polyhedra_library::Constraint	44
parma_polyhedra_library::Constraint_System	44
parma_polyhedra_library::Constraints_Product_C_Polyhedron_Grid	45
parma_polyhedra_library::Domain_Error_Exception	45
parma_polyhedra_library::Double_Box	45
parma_polyhedra_library::Generator	46
parma_polyhedra_library::Generator_System	48
parma_polyhedra_library::Grid	48
parma_polyhedra_library::Grid_Generator	49
parma_polyhedra_library::Grid_Generator_System	51
parma_polyhedra_library::Invalid_Argument_Exception	51
parma_polyhedra_library::IO	51

<code>parma_polyhedra_library::Length_Error_Exception</code>	52
<code>parma_polyhedra_library::Linear_Expression</code>	53
<code>parma_polyhedra_library::Linear_Expression_Coefficient</code>	54
<code>parma_polyhedra_library::Linear_Expression_Difference</code>	55
<code>parma_polyhedra_library::Linear_Expression_Sum</code>	56
<code>parma_polyhedra_library::Linear_Expression_Times</code>	57
<code>parma_polyhedra_library::Linear_Expression_Unary_Minus</code>	58
<code>parma_polyhedra_library::Linear_Expression_Variable</code>	59
<code>parma_polyhedra_library::Logic_Error_Exception</code>	60
<code>parma_polyhedra_library::MIP_Problem</code>	60
<code>parma_polyhedra_library::Octagonal_Shape_double</code>	67
<code>parma_polyhedra_library::Octagonal_Shape_mpq_class</code>	67
<code>parma_polyhedra_library::Octagonal_Shape_mpz_class</code>	68
<code>parma_polyhedra_library::Overflow_Error_Exception</code>	68
<code>parma_polyhedra_library::Pair< K, V ></code>	68
<code>parma_polyhedra_library::Parma_Polyhedra_Library</code>	69
<code>parma_polyhedra_library::Partial_Function</code>	72
<code>parma_polyhedra_library::PIP_Problem</code>	74
<code>parma_polyhedra_library::PIP_Tree_Node</code>	80
<code>parma_polyhedra_library::PIP_Decision_Node</code>	73
<code>parma_polyhedra_library::PIP_Solution_Node</code>	79
<code>parma_polyhedra_library::Pointset_Powerset_C_Polyhedron</code>	82
<code>parma_polyhedra_library::Pointset_Powerset_C_Polyhedron_Iterator</code>	83
<code>parma_polyhedra_library::Pointset_Powerset_NNC_Polyhedron</code>	84
<code>parma_polyhedra_library::Pointset_Powerset_NNC_Polyhedron_Iterator</code>	85
<code>parma_polyhedra_library::Poly_Con_Relation</code>	85
<code>parma_polyhedra_library::Poly_Gen_Relation</code>	86
<code>parma_polyhedra_library::Polyhedron</code>	86
<code>parma_polyhedra_library::C_Polyhedron</code>	37

<code>parma_polyhedra_library::C_Polyhedron</code>	37
<code>parma_polyhedra_library::NNC_Polyhedron</code>	67
<code>parma_polyhedra_library::Rational_Box</code>	109
<code>parma_polyhedra_library::Timeout_Exception</code>	110
<code>parma_polyhedra_library::Variable</code>	110
<code>parma_polyhedra_library::Variables_Set</code>	111

7 Class Index

7.1 Class List

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

<code>parma_polyhedra_library::Artificial_Parameter</code>	35
<code>parma_polyhedra_library::Artificial_Parameter_Sequence</code> (A sequence of artificial parameters)	36
<code>parma_polyhedra_library::BD_Shape_double</code> (Java class interfacing C++ Parma_Polyhedra_Library::BD_Shape<double>)	36
<code>parma_polyhedra_library::BD_Shape_mpq_class</code> (Java class interfacing C++ Parma_Polyhedra_Library::BD_Shape<mpq_class>)	36
<code>parma_polyhedra_library::BD_Shape_mpz_class</code> (Java class interfacing C++ Parma_Polyhedra_Library::BD_Shape<mpz_class>)	36
<code>parma_polyhedra_library::By_Reference< T ></code> (An utility class implementing mutable and non-mutable call-by-reference)	37
<code>parma_polyhedra_library::C_Polyhedron</code> (Java class interfacing C++ Parma_Polyhedra_Library::C_Polyhedron)	37
<code>parma_polyhedra_library::Coefficient</code> (A PPL coefficient)	41
<code>parma_polyhedra_library::Congruence</code> (A linear congruence)	42
<code>parma_polyhedra_library::Congruence_System</code> (A system of congruences)	43
<code>parma_polyhedra_library::Constraint</code> (A linear equality or inequality)	44
<code>parma_polyhedra_library::Constraint_System</code> (A system of constraints)	44
<code>parma_polyhedra_library::Constraints_Product_C_Polyhedron_Grid</code> (Java class interfacing C++ Parma_Polyhedra_Library::Constraints_Product<C_Polyhedron,Grid>)	45
<code>parma_polyhedra_library::Domain_Error_Exception</code> (Exceptions caused by domain errors)	45

parma_polyhedra_library::Double_Box (Java class interfacing C++ Parma_Polyhedra_Library::Double_Box)	45
parma_polyhedra_library::Generator (A line, ray, point or closure point)	46
parma_polyhedra_library::Generator_System (A system of generators)	48
parma_polyhedra_library::Grid (Java class interfacing C++ Parma_Polyhedra_Library::Grid)	48
parma_polyhedra_library::Grid_Generator (A grid line, parameter or grid point)	49
parma_polyhedra_library::Grid_Generator_System (A system of grid generators)	51
parma_polyhedra_library::Invalid_Argument_Exception (Exceptions caused by invalid arguments)	51
parma_polyhedra_library::IO (A class collecting I/O functions)	51
parma_polyhedra_library::Length_Error_Exception (Exceptions caused by too big length/size values)	52
parma_polyhedra_library::Linear_Expression (A linear expression)	53
parma_polyhedra_library::Linear_Expression_Coefficient (A linear expression built from a coefficient)	54
parma_polyhedra_library::Linear_Expression_Difference (The difference of two linear expressions)	55
parma_polyhedra_library::Linear_Expression_Sum (The sum of two linear expressions)	56
parma_polyhedra_library::Linear_Expression_Times (The product of a linear expression and a coefficient)	57
parma_polyhedra_library::Linear_Expression_Unary_Minus (The negation of a linear expression)	58
parma_polyhedra_library::Linear_Expression_Variable (A linear expression built from a variable)	59
parma_polyhedra_library::Logic_Error_Exception (Exceptions due to errors in low-level routines)	60
parma_polyhedra_library::MIP_Problem (A Mixed Integer (linear) Programming problem)	60
parma_polyhedra_library::NNC_Polyhedron (Java class interfacing C++ Parma_Polyhedra_Library::NNC_Polyhedron)	67
parma_polyhedra_library::Octagonal_Shape_double (Java class interfacing C++ Parma_Polyhedra_Library::Octagonal_Shape<double>)	67
parma_polyhedra_library::Octagonal_Shape_mpq_class (Java class interfacing C++ Parma_Polyhedra_Library::Octagonal_Shape<mpq_class>)	67

parma_polyhedra_library::Octagonal_Shape_mpz_class (Java class interfacing C++ Parma_Polyhedra_Library::Octagonal_Shape<mpz_class>)	68
parma_polyhedra_library::Overflow_Error_Exception (Exceptions due to overflow errors)	68
parma_polyhedra_library::Pair< K, V > (A pair of values of type K and V)	68
parma_polyhedra_library::Parma_Polyhedra_Library (A class collecting library-level functions)	69
parma_polyhedra_library::Partial_Function (A partial function on space dimension indices)	72
parma_polyhedra_library::PIP_Decision_Node (An internal node of the PIP solution tree)	73
parma_polyhedra_library::PIP_Problem (A Parametric Integer Programming problem)	74
parma_polyhedra_library::PIP_Solution_Node (A leaf node of the PIP solution tree)	79
parma_polyhedra_library::PIP_Tree_Node (A node of the PIP solution tree)	80
parma_polyhedra_library::Pointset_Powerset_C_Polyhedron (A powerset of C_Polyhedron objects)	82
parma_polyhedra_library::Pointset_Powerset_C_Polyhedron_Iterator (An iterator class for the disjuncts of a Pointset_Powerset_C_Polyhedron)	83
parma_polyhedra_library::Pointset_Powerset_NNC_Polyhedron (Java class interfacing C++ Parma_Polyhedra_Library::Pointset_Powerset<NNC_Polyhedron>)	84
parma_polyhedra_library::Pointset_Powerset_NNC_Polyhedron_Iterator (Java class interfacing C++ Parma_Polyhedra_Library::Pointset_Powerset<NNC_Polyhedron>:: iterator)	85
parma_polyhedra_library::Poly_Con_Relation (The relation between a polyhedron and a constraint)	85
parma_polyhedra_library::Poly_Gen_Relation (The relation between a polyhedron and a generator)	86
parma_polyhedra_library::Polyhedron (The Java base class for (C and NNC) convex polyhedra)	86
parma_polyhedra_library::Rational_Box (Java class interfacing C++ Parma_Polyhedra_Library::Rational_Box)	109
parma_polyhedra_library::Timeout_Exception (Exceptions caused by timeout expiring)	110
parma_polyhedra_library::Variable (A dimension of the vector space)	110
parma_polyhedra_library::Variables_Set (A java.util.TreeSet of variables' indexes)	111

8 Module Documentation

8.1 Java Language Interface

Classes

- class `parma_polyhedra_library::Artificial_Parameter_Sequence`
A sequence of artificial parameters.
- class `parma_polyhedra_library::By_Reference< T >`
An utility class implementing mutable and non-mutable call-by-reference.
- class `parma_polyhedra_library::Coefficient`
A PPL coefficient.
- class `parma_polyhedra_library::Congruence`
A linear congruence.
- class `parma_polyhedra_library::Congruence_System`
A system of congruences.
- class `parma_polyhedra_library::Constraint`
A linear equality or inequality.
- class `parma_polyhedra_library::Constraint_System`
A system of constraints.
- class `parma_polyhedra_library::Domain_Error_Exception`
Exceptions caused by domain errors.
- class `parma_polyhedra_library::Polyhedron`
The Java base class for (C and NNC) convex polyhedra.
- class `parma_polyhedra_library::C_Polyhedron`
Java class interfacing C++ Parma_Polyhedra_Library::C_Polyhedron.
- class `parma_polyhedra_library::Pointset_Powerset_C_Polyhedron`
A powerset of `C_Polyhedron` objects.
- class `parma_polyhedra_library::Pointset_Powerset_C_Polyhedron_Iterator`
An iterator class for the disjuncts of a `Pointset_Powerset_C_Polyhedron`.
- class `parma_polyhedra_library::Generator`
A line, ray, point or closure point.
- class `parma_polyhedra_library::Generator_System`
A system of generators.
- class `parma_polyhedra_library::Grid_Generator`
A grid line, parameter or grid point.

- class `parma_polyhedra_library::Grid_Generator_System`
A system of grid generators.
- class `parma_polyhedra_library::Invalid_Argument_Exception`
Exceptions caused by invalid arguments.
- class `parma_polyhedra_library::IO`
A class collecting I/O functions.
- class `parma_polyhedra_library::Length_Error_Exception`
Exceptions caused by too big length/size values.
- class `parma_polyhedra_library::Linear_Expression`
A linear expression.
- class `parma_polyhedra_library::Linear_Expression_Coefficient`
A linear expression built from a coefficient.
- class `parma_polyhedra_library::Linear_Expression_Difference`
The difference of two linear expressions.
- class `parma_polyhedra_library::Linear_Expression_Sum`
The sum of two linear expressions.
- class `parma_polyhedra_library::Linear_Expression_Times`
The product of a linear expression and a coefficient.
- class `parma_polyhedra_library::Linear_Expression_Unary_Minus`
The negation of a linear expression.
- class `parma_polyhedra_library::Linear_Expression_Variable`
A linear expression built from a variable.
- class `parma_polyhedra_library::Logic_Error_Exception`
Exceptions due to errors in low-level routines.
- class `parma_polyhedra_library::MIP_Problem`
A Mixed Integer (linear) Programming problem.
- class `parma_polyhedra_library::Overflow_Error_Exception`
Exceptions due to overflow errors.
- class `parma_polyhedra_library::Pair< K, V >`
A pair of values of type K and V.
- class `parma_polyhedra_library::Parma_Polyhedra_Library`
A class collecting library-level functions.
- class `parma_polyhedra_library::Partial_Function`

A partial function on space dimension indices.

- class `parma_polyhedra_library::PIP_Problem`
A Parametric Integer Programming problem.
- class `parma_polyhedra_library::Poly_Con_Relation`
The relation between a polyhedron and a constraint.
- class `parma_polyhedra_library::Timeout_Exception`
Exceptions caused by timeout expiring.
- class `parma_polyhedra_library::Variable`
A dimension of the vector space.

Namespaces

- namespace `parma_polyhedra_library`
The PPL Java interface package.

Enumerations

- enum `parma_polyhedra_library::Bounded_Integer_Type_Overflow` { `parma_polyhedra_library::OVERFLOW_WRAPS`, `parma_polyhedra_library::OVERFLOW_UNDEFINED`, `parma_polyhedra_library::OVERFLOW_IMPOSSIBLE` }
Overflow behavior of bounded integer types.
- enum `parma_polyhedra_library::Bounded_Integer_Type_Representation` { `parma_polyhedra_library::UNSIGNED`, `parma_polyhedra_library::SIGNED_2_COMPLEMENT` }
Representation of bounded integer types.
- enum `parma_polyhedra_library::Bounded_Integer_Type_Width` { `parma_polyhedra_library::BITS_8`, `parma_polyhedra_library::BITS_16`, `parma_polyhedra_library::BITS_32`, `parma_polyhedra_library::BITS_64`, `parma_polyhedra_library::BITS_128` }
Widths of bounded integer types.
- enum `parma_polyhedra_library::Complexity_Class` { `parma_polyhedra_library::POLYNOMIAL_COMPLEXITY`, `parma_polyhedra_library::SIMPLEX_COMPLEXITY`, `parma_polyhedra_library::ANY_COMPLEXITY` }
Possible Complexities.
- enum `parma_polyhedra_library::Control_Parameter_Name` { `parma_polyhedra_library::PRICING` }
Names of MIP problems' control parameters.
- enum `parma_polyhedra_library::Control_Parameter_Value` { `parma_polyhedra_library::PRICING_STEEPEST_EDGE_FLOAT`, `parma_polyhedra_library::PRICING_STEEPEST_EDGE_EXACT`, `parma_polyhedra_library::PRICING_TEXTBOOK` }

Possible values for MIP problem's control parameters.

- enum `parma_polyhedra_library::Degenerate_Element` { `parma_polyhedra_library::UNIVERSE`, `parma_polyhedra_library::EMPTY` }

Kinds of degenerate abstract elements.

- enum `parma_polyhedra_library::Generator_Type` { `parma_polyhedra_library::LINE`, `parma_polyhedra_library::RAY`, `parma_polyhedra_library::POINT`, `parma_polyhedra_library::CLOSURE_POINT` }

The generator type.

- enum `parma_polyhedra_library::Grid_Generator_Type` { `parma_polyhedra_library::LINE`, `parma_polyhedra_library::PARAMETER`, `parma_polyhedra_library::POINT` }

The grid generator type.

- enum `parma_polyhedra_library::MIP_Problem_Status` { `parma_polyhedra_library::UNFEASIBLE_MIP_PROBLEM`, `parma_polyhedra_library::UNBOUNDED_MIP_PROBLEM`, `parma_polyhedra_library::OPTIMIZED_MIP_PROBLEM` }

Possible outcomes of the MIP_Problem solver.

- enum `parma_polyhedra_library::Optimization_Mode` { `parma_polyhedra_library::MINIMIZATION`, `parma_polyhedra_library::MAXIMIZATION` }

Possible optimization modes.

- enum `parma_polyhedra_library::PIP_Problem_Control_Parameter_Name` { `parma_polyhedra_library::CUTTING_STRATEGY`, `parma_polyhedra_library::PIVOT_ROW_STRATEGY` }

Names of PIP problems' control parameters.

- enum `parma_polyhedra_library::PIP_Problem_Control_Parameter_Value` { `parma_polyhedra_library::CUTTING_STRATEGY_FIRST`, `parma_polyhedra_library::CUTTING_STRATEGY_DEEPEST`, `parma_polyhedra_library::CUTTING_STRATEGY_ALL`, `parma_polyhedra_library::PIVOT_ROW_STRATEGY_FIRST`, `parma_polyhedra_library::PIVOT_ROW_STRATEGY_MAX_COLUMN` }

Possible values for PIP problems' control parameters.

- enum `parma_polyhedra_library::PIP_Problem_Status` { `parma_polyhedra_library::UNFEASIBLE_PIP_PROBLEM`, `parma_polyhedra_library::OPTIMIZED_PIP_PROBLEM` }

Possible outcomes of the PIP_Problem solver.

- enum `parma_polyhedra_library::Relation_Symbol` { `parma_polyhedra_library::LESS_THAN`, `parma_polyhedra_library::LESS_OR_EQUAL`, `parma_polyhedra_library::EQUAL`, `parma_polyhedra_library::GREATER_OR_EQUAL`, `parma_polyhedra_library::GREATER_THAN` }

Relation symbols.

8.1.1 Detailed Description

The Parma Polyhedra Library comes equipped with an interface for the Java language.

8.1.2 Enumeration Type Documentation

8.1.2.1 `enum parma_polyhedra_library::Bounded_Integer_Type_Overflow`

Overflow behavior of bounded integer types.

Enumerator:

OVERFLOW_WRAPS On overflow, wrapping takes place.

OVERFLOW_UNDEFINED On overflow, the result is undefined.

OVERFLOW_IMPOSSIBLE Overflow is impossible.

8.1.2.2 `enum parma_polyhedra_library::Bounded_Integer_Type_Representation`

Representation of bounded integer types.

Enumerator:

UNSIGNED Unsigned binary.

SIGNED_2_COMPLEMENT Signed binary where negative values are represented by the two's complement of the absolute value.

8.1.2.3 `enum parma_polyhedra_library::Bounded_Integer_Type_Width`

Widths of bounded integer types.

Enumerator:

BITS_8 Minimization is requested.

BITS_16 16 bits.

BITS_32 32 bits.

BITS_64 64 bits.

BITS_128 128 bits.

8.1.2.4 `enum parma_polyhedra_library::Complexity_Class`

Possible Complexities.

Enumerator:

POLYNOMIAL_COMPLEXITY Worst-case polynomial complexity.

SIMPLEX_COMPLEXITY Worst-case exponential complexity but typically polynomial behavior.

ANY_COMPLEXITY Any complexity.

8.1.2.5 enum parma_polyhedra_library::Control_Parameter_Name

Names of MIP problems' control parameters.

Enumerator:

PRICING The pricing rule.

8.1.2.6 enum parma_polyhedra_library::Control_Parameter_Value

Possible values for MIP problem's control parameters.

Enumerator:

PRICING_STEEPEST_EDGE_FLOAT Steepest edge pricing method, using floating points (default).

PRICING_STEEPEST_EDGE_EXACT Steepest edge pricing method, using [Coefficient](#).

PRICING_TEXTBOOK Textbook pricing method.

8.1.2.7 enum parma_polyhedra_library::Degenerate_Element

Kinds of degenerate abstract elements.

Enumerator:

UNIVERSE The universe element, i.e., the whole vector space.

EMPTY The empty element, i.e., the empty set.

8.1.2.8 enum parma_polyhedra_library::Generator_Type

The generator type.

Enumerator:

LINE The generator is a line.

RAY The generator is a ray.

POINT The generator is a point.

CLOSURE_POINT The generator is a closure point.

8.1.2.9 enum parma_polyhedra_library::Grid_Generator_Type

The grid generator type.

Enumerator:

LINE The generator is a line.

PARAMETER The generator is a parameter.

POINT The generator is a point.

8.1.2.10 enum parma_polyhedra_library::MIP_Problem_Status

Possible outcomes of the [MIP_Problem](#) solver.

Enumerator:

UNFEASIBLE_MIP_PROBLEM The problem is unfeasible.

UNBOUNDED_MIP_PROBLEM The problem is unbounded.

OPTIMIZED_MIP_PROBLEM The problem has an optimal solution.

8.1.2.11 enum parma_polyhedra_library::Optimization_Mode

Possible optimization modes.

Enumerator:

MINIMIZATION Minimization is requested.

MAXIMIZATION Maximization is requested.

8.1.2.12 enum parma_polyhedra_library::PIP_Problem_Control_Parameter_Name

Names of PIP problems' control parameters.

Enumerator:

CUTTING_STRATEGY The cutting strategy rule.

PIVOT_ROW_STRATEGY The pivot row strategy rule.

8.1.2.13 enum parma_polyhedra_library::PIP_Problem_Control_Parameter_Value

Possible values for PIP problems' control parameters.

Enumerator:

CUTTING_STRATEGY_FIRST Choose the first non-integer row.

CUTTING_STRATEGY_DEEPEST Choose row which generates the deepest cut.

CUTTING_STRATEGY_ALL Always generate all possible cuts.

PIVOT_ROW_STRATEGY_FIRST Choose the first row with negative parameter sign.

PIVOT_ROW_STRATEGY_MAX_COLUMN Choose the row which generates the lexico-maximal pivot column.

8.1.2.14 enum parma_polyhedra_library::PIP_Problem_Status

Possible outcomes of the [PIP_Problem](#) solver.

Enumerator:

UNFEASIBLE_PIP_PROBLEM The problem is unsatisfiable.

OPTIMIZED_PIP_PROBLEM The problem has an optimal solution.

8.1.2.15 enum parma_polyhedra_library::Relation_Symbol

Relation symbols.

Enumerator:

LESS_THAN Less than.

LESS_OR_EQUAL Less than or equal to.

EQUAL Equal to.

GREATER_OR_EQUAL Greater than or equal to.

GREATER_THAN Greater than.

9 Namespace Documentation

9.1 parma_polyhedra_library Namespace Reference

The PPL Java interface package.

Classes

- class [Artificial_Parameter](#)
- class [Artificial_Parameter_Sequence](#)
A sequence of artificial parameters.
- class [BD_Shape_double](#)
Java class interfacing C++ Parma_Polyhedra_Library::BD_Shape<double>
- class [BD_Shape_mpq_class](#)
Java class interfacing C++ Parma_Polyhedra_Library::BD_Shape<mpq_class>
- class [BD_Shape_mpz_class](#)
Java class interfacing C++ Parma_Polyhedra_Library::BD_Shape<mpz_class>
- class [By_Reference< T >](#)
An utility class implementing mutable and non-mutable call-by-reference.
- class [C_Polyhedron](#)
Java class interfacing C++ Parma_Polyhedra_Library::C_Polyhedron.
- class [Coefficient](#)
A PPL coefficient.
- class [Congruence](#)
A linear congruence.
- class [Congruence_System](#)
A system of congruences.
- class [Constraint](#)
A linear equality or inequality.
- class [Constraint_System](#)
A system of constraints.
- class [Constraints_Product_C_Polyhedron_Grid](#)
Java class interfacing C++ Parma_Polyhedra_Library::Constraints_Product<C_Polyhedron,Grid>
- class [Domain_Error_Exception](#)
Exceptions caused by domain errors.
- class [Double_Box](#)
Java class interfacing C++ Parma_Polyhedra_Library::Double_Box.
- class [Polyhedron](#)
The Java base class for (C and NNC) convex polyhedra.
- class [Pointset_Powerset_C_Polyhedron](#)
A powerset of [C_Polyhedron](#) objects.

- class [Pointset_Powerset_C_Polyhedron_Iterator](#)
An iterator class for the disjuncts of a [Pointset_Powerset_C_Polyhedron](#).
- class [Generator](#)
A line, ray, point or closure point.
- class [Generator_System](#)
A system of generators.
- class [Grid](#)
Java class interfacing C++ [Parma_Polyhedra_Library::Grid](#).
- class [Grid_Generator](#)
A grid line, parameter or grid point.
- class [Grid_Generator_System](#)
A system of grid generators.
- class [Invalid_Argument_Exception](#)
Exceptions caused by invalid arguments.
- class [IO](#)
A class collecting I/O functions.
- class [Length_Error_Exception](#)
Exceptions caused by too big length/size values.
- class [Linear_Expression](#)
A linear expression.
- class [Linear_Expression_Coefficient](#)
A linear expression built from a coefficient.
- class [Linear_Expression_Difference](#)
The difference of two linear expressions.
- class [Linear_Expression_Sum](#)
The sum of two linear expressions.
- class [Linear_Expression_Times](#)
The product of a linear expression and a coefficient.
- class [Linear_Expression_Unary_Minus](#)
The negation of a linear expression.
- class [Linear_Expression_Variable](#)
A linear expression built from a variable.
- class [Logic_Error_Exception](#)

Exceptions due to errors in low-level routines.

- class [MIP_Problem](#)
A Mixed Integer (linear) Programming problem.
- class [NNC_Polyhedron](#)
Java class interfacing C++ Parma_Polyhedra_Library::NNC_Polyhedron.
- class [Octagonal_Shape_double](#)
Java class interfacing C++ Parma_Polyhedra_Library::Octagonal_Shape<double>
- class [Octagonal_Shape_mpq_class](#)
Java class interfacing C++ Parma_Polyhedra_Library::Octagonal_Shape<mpq_class>
- class [Octagonal_Shape_mpz_class](#)
Java class interfacing C++ Parma_Polyhedra_Library::Octagonal_Shape<mpz_class>
- class [Overflow_Error_Exception](#)
Exceptions due to overflow errors.
- class [Pair< K, V >](#)
A pair of values of type K and V.
- class [Parma_Polyhedra_Library](#)
A class collecting library-level functions.
- class [Partial_Function](#)
A partial function on space dimension indices.
- class [PIP_Decision_Node](#)
An internal node of the PIP solution tree.
- class [PIP_Problem](#)
A Parametric Integer Programming problem.
- class [PIP_Solution_Node](#)
A leaf node of the PIP solution tree.
- class [PIP_Tree_Node](#)
A node of the PIP solution tree.
- class [Pointset_Powerset_NNC_Polyhedron](#)
Java class interfacing C++ Parma_Polyhedra_Library::Pointset_Powerset<NNC_Polyhedron>
- class [Pointset_Powerset_NNC_Polyhedron_Iterator](#)
Java class interfacing C++ Parma_Polyhedra_Library::Pointset_Powerset<NNC_Polyhedron>:: iterator.
- class [Poly_Con_Relation](#)
The relation between a polyhedron and a constraint.

- class [Poly_Gen_Relation](#)
The relation between a polyhedron and a generator.
- class [Rational_Box](#)
Java class interfacing C++ Parma_Polyhedra_Library::Rational_Box.
- class [Timeout_Exception](#)
Exceptions caused by timeout expiring.
- class [Variable](#)
A dimension of the vector space.
- class [Variables_Set](#)
A java.util.TreeSet of variables' indexes.

Enumerations

- enum [Bounded_Integer_Type_Overflow](#) { [OVERFLOW_WRAPS](#), [OVERFLOW_UNDEFINED](#), [OVERFLOW_IMPOSSIBLE](#) }
Overflow behavior of bounded integer types.
- enum [Bounded_Integer_Type_Representation](#) { [UNSIGNED](#), [SIGNED_2_COMPLEMENT](#) }
Representation of bounded integer types.
- enum [Bounded_Integer_Type_Width](#) { [BITS_8](#), [BITS_16](#), [BITS_32](#), [BITS_64](#), [BITS_128](#) }
Widths of bounded integer types.
- enum [Complexity_Class](#) { [POLYNOMIAL_COMPLEXITY](#), [SIMPLEX_COMPLEXITY](#), [ANY_COMPLEXITY](#) }
Possible Complexities.
- enum [Control_Parameter_Name](#) { [PRICING](#) }
Names of MIP problems' control parameters.
- enum [Control_Parameter_Value](#) { [PRICING_STEEPEST_EDGE_FLOAT](#), [PRICING_STEEPEST_EDGE_EXACT](#), [PRICING_TEXTBOOK](#) }
Possible values for MIP problem's control parameters.
- enum [Degenerate_Element](#) { [UNIVERSE](#), [EMPTY](#) }
Kinds of degenerate abstract elements.
- enum [Generator_Type](#) { [LINE](#), [RAY](#), [POINT](#), [CLOSURE_POINT](#) }
The generator type.
- enum [Grid_Generator_Type](#) { [LINE](#), [PARAMETER](#), [POINT](#) }
The grid generator type.

- enum `MIP_Problem_Status` { `UNFEASIBLE_MIP_PROBLEM`, `UNBOUNDED_MIP_PROBLEM`, `OPTIMIZED_MIP_PROBLEM` }
Possible outcomes of the MIP_Problem solver.
- enum `Optimization_Mode` { `MINIMIZATION`, `MAXIMIZATION` }
Possible optimization modes.
- enum `PIP_Problem_Control_Parameter_Name` { `CUTTING_STRATEGY`, `PIVOT_ROW_STRATEGY` }
Names of PIP problems' control parameters.
- enum `PIP_Problem_Control_Parameter_Value` { `CUTTING_STRATEGY_FIRST`, `CUTTING_STRATEGY_DEEPEST`, `CUTTING_STRATEGY_ALL`, `PIVOT_ROW_STRATEGY_FIRST`, `PIVOT_ROW_STRATEGY_MAX_COLUMN` }
Possible values for PIP problems' control parameters.
- enum `PIP_Problem_Status` { `UNFEASIBLE_PIP_PROBLEM`, `OPTIMIZED_PIP_PROBLEM` }
Possible outcomes of the PIP_Problem solver.
- enum `Relation_Symbol` { `LESS_THAN`, `LESS_OR_EQUAL`, `EQUAL`, `GREATER_OR_EQUAL`, `GREATER_THAN` }
Relation symbols.

9.1.1 Detailed Description

The PPL Java interface package. All classes, interfaces and enums related to the Parma Polyhedra Library Java interface are included in this package.

10 Class Documentation

10.1 parma_polyhedra_library::Artificial_Parameter Class Reference

Public Member Functions

- `Artificial_Parameter` (`Linear_Expression` e, `Coefficient` d)
Builds an artificial parameter from a linear expression and a denominator.
- `Linear_Expression` `linear_expression` ()
Returns the linear expression in artificial parameter `this`.
- `Coefficient` `denominator` ()
Returns the denominator in artificial parameter `this`.
- native String `ascii_dump` ()

Returns an ascii formatted internal representation of `this`.

- native String [toString\(\)](#)

Returns a string representation of `this`.

10.1.1 Detailed Description

An [Artificial_Parameter](#) object represents the result of the integer division of a [Linear_Expression](#) (on the other parameters, including the previously-defined artificials) by an integer denominator (a [Coefficient](#) object). The dimensions of the artificial parameters (if any) in a tree node have consecutive indices starting from `dim+1`, where the value of `dim` is computed as follows:

- for the tree root node, `dim` is the space dimension of the [PIP_Problem](#);
- for any other node of the tree, it is recursively obtained by adding the value of `dim` computed for the parent node to the number of artificial parameters defined in the parent node.

Since the numbering of dimensions for artificial parameters follows the rule above, the addition of new problem variables and/or new problem parameters to an already solved [PIP_Problem](#) object (as done when incrementally solving a problem) will result in the systematic renumbering of all the existing artificial parameters.

The documentation for this class was generated from the following file:

- [Artificial_Parameter.java](#)

10.2 parma_polyhedra_library::Artificial_Parameter_Sequence Class Reference

A sequence of artificial parameters.

Public Member Functions

- [Artificial_Parameter_Sequence\(\)](#)

Default constructor: builds an empty sequence of artificial parameters.

10.2.1 Detailed Description

A sequence of artificial parameters. An object of the class [Artificial_Parameter_Sequence](#) is a sequence of artificial parameters.

The documentation for this class was generated from the following file:

- [Artificial_Parameter_Sequence.java](#)

10.3 parma_polyhedra_library::BD_Shape_double Class Reference

Java class interfacing C++ `Parma_Polyhedra_Library::BD_Shape<double>`

Inherits `parma_polyhedra_library::PPL_Object`.

10.3.1 Detailed Description

Java class interfacing C++ Parma_Polyhedra_Library::BD_Shape<double>

The documentation for this class was generated from the following file:

- BD_Shape_double.java

10.4 parma_polyhedra_library::BD_Shape_mpq_class Class Reference

Java class interfacing C++ Parma_Polyhedra_Library::BD_Shape<mpq_class>

Inherits parma_polyhedra_library::PPL_Object.

10.4.1 Detailed Description

Java class interfacing C++ Parma_Polyhedra_Library::BD_Shape<mpq_class>

The documentation for this class was generated from the following file:

- BD_Shape_mpq_class.java

10.5 parma_polyhedra_library::BD_Shape_mpz_class Class Reference

Java class interfacing C++ Parma_Polyhedra_Library::BD_Shape<mpz_class>

Inherits parma_polyhedra_library::PPL_Object.

10.5.1 Detailed Description

Java class interfacing C++ Parma_Polyhedra_Library::BD_Shape<mpz_class>

The documentation for this class was generated from the following file:

- BD_Shape_mpz_class.java

10.6 parma_polyhedra_library::By_Reference< T > Class Reference

An utility class implementing mutable and non-mutable call-by-reference.

Public Member Functions

- [By_Reference](#) (T object_value)
Builds an object encapsulating object_value.
- void [set](#) (T y)
Set an object to value object_value.
- T [get](#) ()
Returns the value held by this.

Package Attributes

- `T obj`
Stores the object.

10.6.1 Detailed Description

An utility class implementing mutable and non-mutable call-by-reference.

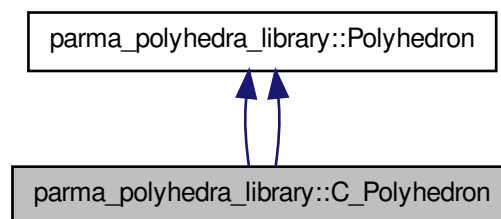
The documentation for this class was generated from the following file:

- `By_Reference.java`

10.7 parma_polyhedra_library::C_Polyhedron Class Reference

Java class interfacing C++ Parma_Polyhedra_Library::C_Polyhedron.

Inheritance diagram for parma_polyhedra_library::C_Polyhedron:



Public Member Functions

Standard Constructors and Destructor

- `C_Polyhedron` (long `d`, `Degenerate_Element` `kind`)
Builds a new C polyhedron of dimension `d`.
- `C_Polyhedron` (`C_Polyhedron` `y`)
Builds a new C polyhedron that is copy of `y`.
- `C_Polyhedron` (`C_Polyhedron` `y`, `Complexity_Class` `complexity`)
Builds a new C polyhedron that is a copy of `ph`.
- `C_Polyhedron` (`Constraint_System` `cs`)
Builds a new C polyhedron from the system of constraints `cs`.
- `C_Polyhedron` (`Congruence_System` `cgs`)

Builds a new C polyhedron from the system of congruences `cgs`.

- native void `free ()`

Releases all resources managed by `this`, also resetting it to a null reference.

Constructors Behaving as Conversion Operators

*Besides the conversions listed here below, the library also provides conversion operators that build a semantic geometric description starting from **any** other semantic geometric description (e.g., `Grid(C_Polyhedron y)`, `C_Polyhedron(BD_Shape_mpq_class y)`, etc.). Clearly, the conversion operators are only available if both the source and the target semantic geometric descriptions have been enabled when configuring the library. The conversions also taking as argument a complexity class sometimes provide non-trivial precision/efficiency trade-offs.*

- `C_Polyhedron(NNC_Polyhedron y)`

Builds a C polyhedron that is a copy of the topological closure of the NNC polyhedron `y`.

- `C_Polyhedron(NNC_Polyhedron y, Complexity_Class complexity)`

Builds a C polyhedron that is a copy of the topological closure of the NNC polyhedron `y`.

- `C_Polyhedron(Generator_System gs)`

Builds a new C polyhedron from the system of generators `gs`.

Other Methods

- native boolean `upper_bound_assign_if_exact(C_Polyhedron y)`

If the upper bound of `this` and `y` is exact it is assigned to `this` and `true` is returned; otherwise `false` is returned.

Static Public Member Functions

- static native `Pair< C_Polyhedron, Pointset_Powerset_NNC_Polyhedron > linear_partition(C_Polyhedron p, C_Polyhedron q)`

Partitions `q` with respect to `p`.

Protected Member Functions

- native void `finalize ()`

Releases all resources managed by `this`.

10.7.1 Detailed Description

Java class interfacing C++ Parma_Polyhedra_Library::C_Polyhedron. A topologically closed convex polyhedron.

10.7.2 Constructor & Destructor Documentation

10.7.2.1 parma_polyhedra_library::C_Polyhedron::C_Polyhedron (long *d*, Degenerate_Element *kind*)

Builds a new C polyhedron of dimension *d*.

If *kind* is `EMPTY`, the newly created polyhedron will be empty; otherwise, it will be a universe polyhedron.

10.7.2.2 parma_polyhedra_library::C_Polyhedron::C_Polyhedron (C_Polyhedron *y*, Complexity_Class *complexity*)

Builds a new C polyhedron that is a copy of *ph*.

The complexity argument is ignored.

10.7.2.3 parma_polyhedra_library::C_Polyhedron::C_Polyhedron (Constraint_System *cs*)

Builds a new C polyhedron from the system of constraints *cs*.

The new polyhedron will inherit the space dimension of *cs*.

10.7.2.4 parma_polyhedra_library::C_Polyhedron::C_Polyhedron (Congruence_System *cgs*)

Builds a new C polyhedron from the system of congruences *cgs*.

The new polyhedron will inherit the space dimension of *cgs*.

10.7.2.5 parma_polyhedra_library::C_Polyhedron::C_Polyhedron (NNC_Polyhedron *y*, Complexity_Class *complexity*)

Builds a C polyhedron that is a copy of the topological closure of the NNC polyhedron *y*.

The complexity argument is ignored, since the exact constructor has polynomial complexity.

10.7.2.6 parma_polyhedra_library::C_Polyhedron::C_Polyhedron (Generator_System *gs*)

Builds a new C polyhedron from the system of generators *gs*.

The new polyhedron will inherit the space dimension of *gs*.

10.7.3 Member Function Documentation

10.7.3.1 native boolean parma_polyhedra_library::C_Polyhedron::upper_bound_assign_if_exact (C_Polyhedron y)

If the upper bound of `this` and `y` is exact it is assigned to `this` and `true` is returned; otherwise `false` is returned.

Exceptions

<i>Invalid_Argument_-Exception</i>	Thrown if <code>this</code> and <code>y</code> are dimension-incompatible.
------------------------------------	--

10.7.3.2 static native Pair<C_Polyhedron, Pointset_Powerset_NNC_Polyhedron> parma_polyhedra_library::C_Polyhedron::linear_partition (C_Polyhedron p, C_Polyhedron q) [static]

Partitions `q` with respect to `p`.

Let `p` and `q` be two polyhedra. The function returns a pair object `r` such that

- `r.first` is the intersection of `p` and `q`;
- `r.second` has the property that all its elements are pairwise disjoint and disjoint from `p`;
- the set-theoretical union of `r.first` with all the elements of `r.second` gives `q` (i.e., `r` is the representation of a partition of `q`).

The documentation for this class was generated from the following files:

- C_Polyhedron.java
- Fake_Class_for_Doxygen.java

10.8 parma_polyhedra_library::Coefficient Class Reference

A PPL coefficient.

Public Member Functions

- **Coefficient** (int i)
Builds a coefficient valued i .
- **Coefficient** (long l)
Builds a coefficient valued l .
- **Coefficient** (BigInteger bi)
Builds a coefficient valued bi .

- [Coefficient](#) (String *s*)
Builds a coefficient from the decimal representation in s.
- [Coefficient](#) ([Coefficient](#) *c*)
Builds a copy of c.
- String [toString](#) ()
Returns a String representation of this.
- BigInteger [getBigInteger](#) ()
Returns the value held by this.

Static Public Member Functions

- static native int [bits](#) ()
Returns the number of bits of PPL coefficients; 0 if unbounded.

10.8.1 Detailed Description

A PPL coefficient. Objects of type [Coefficient](#) are used to implement the integral valued coefficients occurring in linear expressions, constraints, generators and so on.

10.8.2 Constructor & Destructor Documentation

10.8.2.1 parma_polyhedra_library::Coefficient::Coefficient (String *s*) [inline]

Builds a coefficient from the decimal representation in *s*.

Exceptions

<code>java.lang.NumberFormatException</code>	Thrown if <i>s</i> does not contain a valid decimal representation.
--	---

The documentation for this class was generated from the following file:

- `Coefficient.java`

10.9 parma_polyhedra_library::Congruence Class Reference

A linear congruence.

Public Member Functions

- [Congruence](#) ([Linear_Expression](#) *e1*, [Linear_Expression](#) *e2*, [Coefficient](#) *m*)
Returns the congruence $e1 = e2 \pmod m$.

- [Linear_Expression left_hand_side \(\)](#)
Returns the left hand side of `this`.
- [Linear_Expression right_hand_side \(\)](#)
Returns the right hand side of `this`.
- [Coefficient modulus \(\)](#)
Returns the relation symbol of `this`.
- native String [ascii_dump \(\)](#)
Returns an ascii formatted internal representation of `this`.
- native String [toString \(\)](#)
Returns a string representation of `this`.

Protected Attributes

- [Coefficient mod](#)
The modulus of the congruence.

Package Attributes

- [Linear_Expression lhs](#)
The value of the left hand side of `this`.
- [Linear_Expression rhs](#)
The value of the right hand side of `this`.

10.9.1 Detailed Description

A linear congruence. An object of the class [Congruence](#) is an object representing a congruence:

$$\bullet \text{ cg} = \sum_{i=0}^{n-1} a_i x_i + b = 0 \pmod{m}$$

where n is the dimension of the space, a_i is the integer coefficient of variable x_i , b is the integer inhomogeneous term and m is the integer modulus; if $m = 0$, then `cg` represents the equality congruence $\sum_{i=0}^{n-1} a_i x_i + b = 0$ and, if $m \neq 0$, then the congruence `cg` is said to be a proper congruence.

The documentation for this class was generated from the following file:

- `Congruence.java`

10.10 parma_polyhedra_library::Congruence_System Class Reference

A system of congruences.

Public Member Functions

- [Congruence_System](#) ()
Default constructor: builds an empty system of congruences.
- native String [ascii_dump](#) ()
Returns an ascii formatted internal representation of `this`.
- native String [toString](#) ()
Returns a string representation of `this`.

10.10.1 Detailed Description

A system of congruences. An object of the class [Congruence_System](#) is a system of congruences, i.e., a multiset of objects of the class [Congruence](#).

The documentation for this class was generated from the following file:

- `Congruence_System.java`

10.11 parma_polyhedra_library::Constraint Class Reference

A linear equality or inequality.

Public Member Functions

- [Constraint](#) ([Linear_Expression](#) le1, [Relation_Symbol](#) rel_sym, [Linear_Expression](#) le2)
Builds a constraint from two linear expressions with a specified relation symbol.
- [Linear_Expression](#) [left_hand_side](#) ()
Returns the left hand side of `this`.
- [Linear_Expression](#) [right_hand_side](#) ()
Returns the right hand side of `this`.
- [Relation_Symbol](#) [kind](#) ()
Returns the relation symbol of `this`.
- native String [ascii_dump](#) ()
Returns an ascii formatted internal representation of `this`.
- native String [toString](#) ()
Returns a string representation of `this`.

10.11.1 Detailed Description

A linear equality or inequality. An object of the class [Constraint](#) is either:

- a linear equality;
- a non-strict linear inequality;
- a strict linear inequality.

The documentation for this class was generated from the following file:

- Constraint.java

10.12 parma_polyhedra_library::Constraint_System Class Reference

A system of constraints.

Public Member Functions

- [Constraint_System](#) ()
Default constructor: builds an empty system of constraints.
- native String [ascii_dump](#) ()
Returns an ascii formatted internal representation of `this`.
- native String [toString](#) ()
Returns a string representation of `this`.

10.12.1 Detailed Description

A system of constraints. An object of the class [Constraint_System](#) is a system of constraints, i.e., a multiset of objects of the class [Constraint](#).

The documentation for this class was generated from the following file:

- Constraint_System.java

10.13 parma_polyhedra_library::Constraints_Product_C_Polyhedron_Grid Class Reference

Java class interfacing C++ Parma_Polyhedra_Library::Constraints_Product<C_Polyhedron,Grid>

Inherits parma_polyhedra_library::PPL_Object.

10.13.1 Detailed Description

Java class interfacing C++ Parma_Polyhedra_Library::Constraints_Product<C_Polyhedron,Grid>

The documentation for this class was generated from the following file:

- Constraints_Product_C_Polyhedron_Grid.java

10.14 parma_polyhedra_library::Domain_Error_Exception Class Reference

Exceptions caused by domain errors.

Public Member Functions

- [Domain_Error_Exception](#) (String s)
Constructor.

10.14.1 Detailed Description

Exceptions caused by domain errors.

The documentation for this class was generated from the following file:

- Domain_Error_Exception.java

10.15 parma_polyhedra_library::Double_Box Class Reference

Java class interfacing C++ Parma_Polyhedra_Library::Double_Box.

Inherits parma_polyhedra_library::PPL_Object.

10.15.1 Detailed Description

Java class interfacing C++ Parma_Polyhedra_Library::Double_Box.

The documentation for this class was generated from the following file:

- Double_Box.java

10.16 parma_polyhedra_library::Generator Class Reference

A line, ray, point or closure point.

Public Member Functions

- [Generator_Type](#) type ()
Returns the generator type.
- [Linear_Expression](#) linear_expression ()
Returns the linear expression in `this`.
- [Coefficient](#) divisor ()
If `this` is either a point or a closure point, returns its divisor.
- native String [ascii_dump](#) ()
Returns an ascii formatted internal representation of `this`.

- native String `toString()`
Returns a string representation of `this`.

Static Public Member Functions

- static `Generator closure_point (Linear_Expression e, Coefficient d)`
Returns the closure point at e / d .
- static `Generator line (Linear_Expression e)`
Returns the line of direction e .
- static `Generator point (Linear_Expression e, Coefficient d)`
Returns the point at e / d .
- static `Generator ray (Linear_Expression e)`
Returns the ray of direction e .

10.16.1 Detailed Description

A line, ray, point or closure point. An object of the class `Generator` is one of the following:

- a line;
- a ray;
- a point;
- a closure point.

10.16.2 Member Function Documentation

10.16.2.1 static `Generator parma_polyhedra_library::Generator::closure_point (Linear_Expression e, Coefficient d)` [`inline, static`]

Returns the closure point at e / d .

Exceptions

<code>RuntimeException</code>	Thrown if d is zero.
-------------------------------	------------------------

10.16.2.2 static `Generator parma_polyhedra_library::Generator::line (Linear_Expression e)` [`inline, static`]

Returns the line of direction e .

Exceptions

<i>RuntimeErrorException</i>	Thrown if the homogeneous part of e represents the origin of the vector space.
------------------------------	--

10.16.2.3 static Generator parma_polyhedra_library::Generator::point (Linear_Expression e , Coefficient d) [inline, static]

Returns the point at e / d .

Exceptions

<i>RuntimeErrorException</i>	Thrown if d is zero.
------------------------------	------------------------

10.16.2.4 static Generator parma_polyhedra_library::Generator::ray (Linear_Expression e) [inline, static]

Returns the ray of direction e .

Exceptions

<i>RuntimeErrorException</i>	Thrown if the homogeneous part of e represents the origin of the vector space.
------------------------------	--

10.16.2.5 Coefficient parma_polyhedra_library::Generator::divisor () [inline]

If `this` is either a point or a closure point, returns its divisor.

Exceptions

<i>RuntimeErrorException</i>	Thrown if <code>this</code> is neither a point nor a closure point.
------------------------------	---

The documentation for this class was generated from the following file:

- Generator.java

10.17 parma_polyhedra_library::Generator_System Class Reference

A system of generators.

Public Member Functions

- [Generator_System](#) ()
Default constructor: builds an empty system of generators.
- native String [ascii_dump](#) ()

Returns an ascii formatted internal representation of `this`.

- native String [toString](#) ()

Returns a string representation of `this`.

10.17.1 Detailed Description

A system of generators. An object of the class [Generator_System](#) is a system of generators, i.e., a multiset of objects of the class [Generator](#) (lines, rays, points and closure points).

The documentation for this class was generated from the following file:

- Generator_System.java

10.18 parma_polyhedra_library::Grid Class Reference

Java class interfacing C++ Parma_Polyhedra_Library::Grid.

Inherits [parma_polyhedra_library::PPL_Object](#).

10.18.1 Detailed Description

Java class interfacing C++ Parma_Polyhedra_Library::Grid.

The documentation for this class was generated from the following file:

- Grid.java

10.19 parma_polyhedra_library::Grid_Generator Class Reference

A grid line, parameter or grid point.

Public Member Functions

- [Grid_Generator_Type](#) type ()

Returns the generator type.

- [Linear_Expression](#) linear_expression ()

Returns the linear expression in `this`.

- [Coefficient](#) divisor ()

If `this` is either a grid point or a parameter, returns its divisor.

- native String [ascii_dump](#) ()

Returns an ascii formatted internal representation of `this`.

- native String [toString](#) ()

Returns a string representation of `this`.

Static Public Member Functions

- static `Grid_Generator grid_line` (`Linear_Expression e`)
Returns the line of direction e .
- static `Grid_Generator parameter` (`Linear_Expression e`, `Coefficient d`)
Returns the parameter at e / d .
- static `Grid_Generator grid_point` (`Linear_Expression e`, `Coefficient d`)
Returns the point at e / d .

10.19.1 Detailed Description

A grid line, parameter or grid point. An object of the class `Grid_Generator` is one of the following:

- a `grid_line`;
- a `parameter`;
- a `grid_point`.

10.19.2 Member Function Documentation

10.19.2.1 static `Grid_Generator parma_polyhedra_library::Grid_Generator::grid_line` (`Linear_Expression e`) [`inline`, `static`]

Returns the line of direction e .

Exceptions

<i>RuntimeErrorException</i>	Thrown if the homogeneous part of e represents the origin of the vector space.
------------------------------	--

10.19.2.2 static `Grid_Generator parma_polyhedra_library::Grid_Generator::parameter` (`Linear_Expression e`, `Coefficient d`) [`inline`, `static`]

Returns the parameter at e / d .

Exceptions

<i>RuntimeErrorException</i>	Thrown if d is zero.
------------------------------	------------------------

10.19.2.3 static `Grid_Generator parma_polyhedra_library::Grid_Generator::grid_point` (`Linear_Expression e`, `Coefficient d`) [`inline`, `static`]

Returns the point at e / d .

Exceptions

<i>RuntimeException</i>	Thrown if <code>d</code> is zero.
-------------------------	-----------------------------------

10.19.2.4 Coefficient parma_polyhedra_library::Grid_Generator::divisor () [inline]

If `this` is either a grid point or a parameter, returns its divisor.

Exceptions

<i>RuntimeException</i>	Thrown if <code>this</code> is a line.
-------------------------	--

The documentation for this class was generated from the following file:

- Grid_Generator.java

10.20 parma_polyhedra_library::Grid_Generator_System Class Reference

A system of grid generators.

Public Member Functions

- [Grid_Generator_System](#) ()
Default constructor: builds an empty system of grid generators.
- native String [ascii_dump](#) ()
Returns an ascii formatted internal representation of `this`.
- native String [toString](#) ()
Returns a string representation of `this`.

10.20.1 Detailed Description

A system of grid generators. An object of the class [Grid_Generator_System](#) is a system of grid generators, i.e., a multiset of objects of the class [Grid_Generator](#).

The documentation for this class was generated from the following file:

- Grid_Generator_System.java

10.21 parma_polyhedra_library::Invalid_Argument_Exception Class Reference

Exceptions caused by invalid arguments.

Public Member Functions

- [Invalid_Argument_Exception](#) (String s)

Constructor.

10.21.1 Detailed Description

Exceptions caused by invalid arguments.

The documentation for this class was generated from the following file:

- Invalid_Argument_Exception.java

10.22 parma_polyhedra_library::IO Class Reference

A class collecting I/O functions.

Static Public Member Functions

- static native String [wrap_string](#) (String str, int indent_depth, int preferred_first_line_length, int preferred_line_length)

Utility function for the wrapping of lines of text.

10.22.1 Detailed Description

A class collecting I/O functions.

10.22.2 Member Function Documentation**10.22.2.1 static native String parma_polyhedra_library::IO::wrap_string (String str, int indent_depth, int preferred_first_line_length, int preferred_line_length) [static]**

Utility function for the wrapping of lines of text.

Parameters

<i>str</i>	The source string holding the lines to wrap.
<i>indent_depth</i>	The indentation depth.
<i>preferred_first_line_length</i>	The preferred length for the first line of text.
<i>preferred_line_length</i>	The preferred length for all the lines but the first one.

Returns

The wrapped string.

The documentation for this class was generated from the following file:

- IO.java

10.23 parma_polyhedra_library::Length_Error_Exception Class Reference

Exceptions caused by too big length/size values.

Public Member Functions

- [Length_Error_Exception](#) (String s)
Constructor.

10.23.1 Detailed Description

Exceptions caused by too big length/size values.

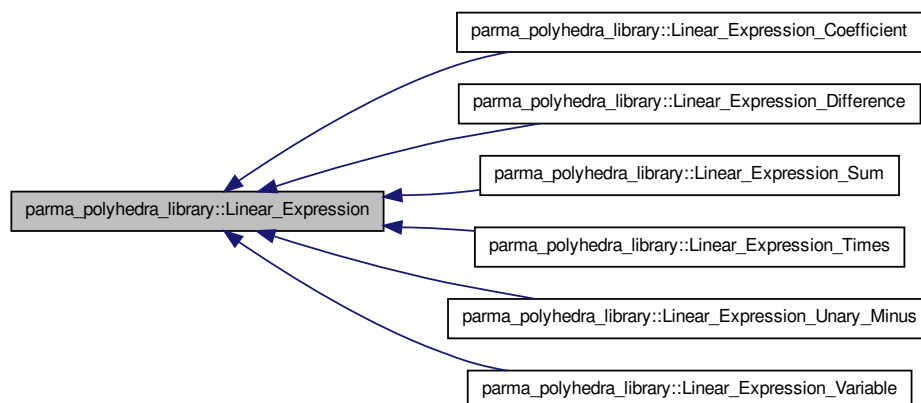
The documentation for this class was generated from the following file:

- Length_Error_Exception.java

10.24 parma_polyhedra_library::Linear_Expression Class Reference

A linear expression.

Inheritance diagram for parma_polyhedra_library::Linear_Expression:



Public Member Functions

- [Linear_Expression sum](#) ([Linear_Expression](#) y)
Returns the sum of this and y.

- [Linear_Expression subtract \(Linear_Expression y\)](#)
Returns the difference of `this` and `y`.
- [Linear_Expression times \(Coefficient c\)](#)
Returns the product of `this` times `c`.
- [Linear_Expression unary_minus \(\)](#)
Returns the negation of `this`.
- abstract [Linear_Expression clone \(\)](#)
Returns a copy of the linear expression.
- native String [ascii_dump \(\)](#)
Returns an `ascii` formatted internal representation of `this`.
- native String [toString \(\)](#)
Returns a string representation of `this`.
- native boolean [is_zero \(\)](#)
Returns `true` if and only if `*this` is 0.
- native boolean [all_homogeneous_terms_are_zero \(\)](#)
Returns `true` if and only if all the homogeneous terms of `*this` are 0.

10.24.1 Detailed Description

A linear expression. An object of the class [Linear_Expression](#) represents a linear expression that can be built from a [Linear_Expression_Variable](#), [Linear_Expression_Coefficient](#), [Linear_Expression_Sum](#), [Linear_Expression_Difference](#), [Linear_Expression_Unary_Minus](#).

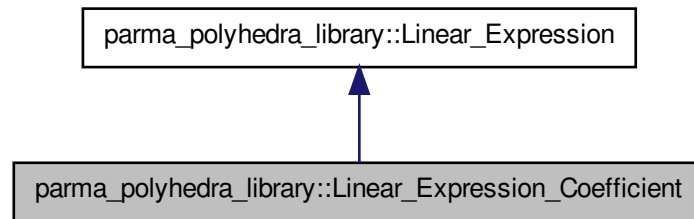
The documentation for this class was generated from the following file:

- [Linear_Expression.java](#)

10.25 parma_polyhedra_library::Linear_Expression_Coefficient Class Reference

A linear expression built from a coefficient.

Inheritance diagram for parma_polyhedra_library::Linear_Expression_Coefficient:



Public Member Functions

- [Linear_Expression_Coefficient \(Coefficient c\)](#)
Builds the object corresponding to a copy of the coefficient c.
- [Coefficient argument \(\)](#)
Returns coefficient representing the linear expression.
- [Linear_Expression_Coefficient clone \(\)](#)
Builds a copy of this.

Protected Attributes

- [Coefficient coeff](#)
The coefficient representing the linear expression.

10.25.1 Detailed Description

A linear expression built from a coefficient.

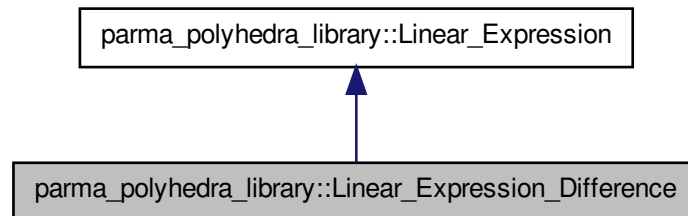
The documentation for this class was generated from the following file:

- Linear_Expression_Coefficient.java

10.26 parma_polyhedra_library::Linear_Expression_Difference Class Reference

The difference of two linear expressions.

Inheritance diagram for parma_polyhedra_library::Linear_Expression_Difference:



Public Member Functions

- [Linear_Expression_Difference](#) ([Linear_Expression](#) x, [Linear_Expression](#) y)
Builds an object that represents the difference of the copy x and y.
- [Linear_Expression left_hand_side](#) ()
Returns the left hand side of this.
- [Linear_Expression right_hand_side](#) ()
Returns the left hand side of this.
- [Linear_Expression_Difference clone](#) ()
Builds a copy of this.

Protected Attributes

- [Linear_Expression lhs](#)
The value of the left hand side of this.
- [Linear_Expression rhs](#)
The value of the right hand side of this.

10.26.1 Detailed Description

The difference of two linear expressions.

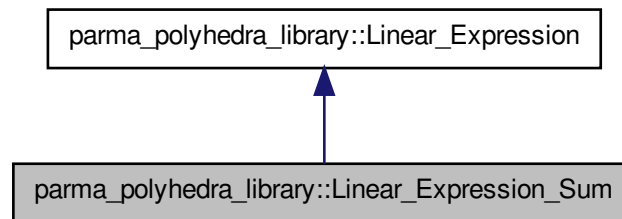
The documentation for this class was generated from the following file:

- [Linear_Expression_Difference.java](#)

10.27 parma_polyhedra_library::Linear_Expression_Sum Class Reference

The sum of two linear expressions.

Inheritance diagram for parma_polyhedra_library::Linear_Expression_Sum:



Public Member Functions

- [Linear_Expression_Sum](#) ([Linear_Expression](#) x, [Linear_Expression](#) y)
Builds an object that represents the sum of the copy of x and y.
- [Linear_Expression left_hand_side](#) ()
Returns the left hand side of this.
- [Linear_Expression right_hand_side](#) ()
Returns the right hand side of this.
- [Linear_Expression_Sum clone](#) ()
Builds a copy of this.

Protected Attributes

- [Linear_Expression lhs](#)
The value of the left hand side of this.
- [Linear_Expression rhs](#)
The value of the right hand side of this.

10.27.1 Detailed Description

The sum of two linear expressions.

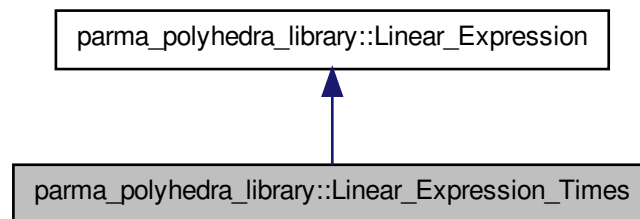
The documentation for this class was generated from the following file:

- [Linear_Expression_Sum.java](#)

10.28 parma_polyhedra_library::Linear_Expression_Times Class Reference

The product of a linear expression and a coefficient.

Inheritance diagram for parma_polyhedra_library::Linear_Expression_Times:



Public Member Functions

- [Linear_Expression_Times](#) (Coefficient c, Variable v)
Builds an object cloning the input arguments.
- [Linear_Expression_Times](#) (Coefficient c, Linear_Expression l)
Builds an object cloning the input arguments.
- [Linear_Expression_Times](#) (Linear_Expression l, Coefficient c)
Builds an object cloning the input arguments.
- [Coefficient](#) coefficient ()
Returns the coefficient of `this`.
- [Linear_Expression](#) linear_expression ()
Returns the linear expression subobject of `this`.
- [Linear_Expression_Times](#) clone ()
Builds a copy of this.

Protected Attributes

- [Coefficient](#) coeff
The value of the coefficient.
- [Linear_Expression](#) lin_expr
The value of the inner linear expression.

10.28.1 Detailed Description

The product of a linear expression and a coefficient.

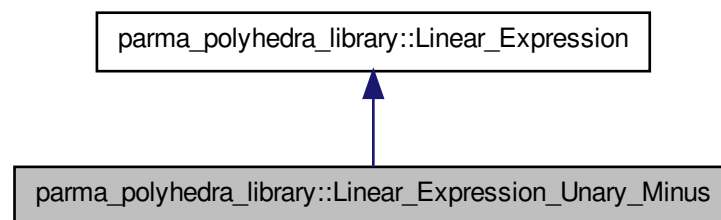
The documentation for this class was generated from the following file:

- Linear_Expression_Times.java

10.29 parma_polyhedra_library::Linear_Expression_Unary_Minus Class Reference

The negation of a linear expression.

Inheritance diagram for parma_polyhedra_library::Linear_Expression_Unary_Minus:



Public Member Functions

- [Linear_Expression_Unary_Minus](#) ([Linear_Expression](#) x)
Builds an object that represents the negation of the copy x.
- [Linear_Expression](#) argument ()
Returns the value that this negates.
- [Linear_Expression_Unary_Minus](#) clone ()
Builds a copy of this.

Protected Attributes

- [Linear_Expression](#) arg
The value that this negates.

10.29.1 Detailed Description

The negation of a linear expression.

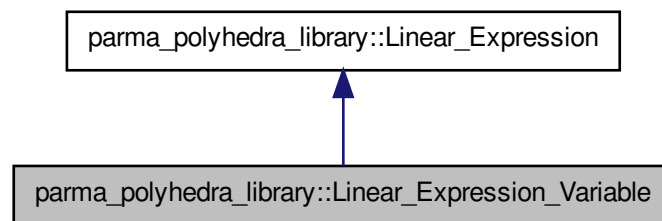
The documentation for this class was generated from the following file:

- Linear_Expression_Unary_Minus.java

10.30 parma_polyhedra_library::Linear_Expression_Variable Class Reference

A linear expression built from a variable.

Inheritance diagram for parma_polyhedra_library::Linear_Expression_Variable:



Public Member Functions

- [Linear_Expression_Variable](#) ([Variable](#) v)
Builds the object associated to the copy of v.
- [Variable](#) argument ()
Returns the variable representing the linear expression.
- [Linear_Expression_Variable](#) clone ()
Builds a copy of this.

10.30.1 Detailed Description

A linear expression built from a variable.

The documentation for this class was generated from the following file:

- Linear_Expression_Variable.java

10.31 parma_polyhedra_library::Logic_Error_Exception Class Reference

Exceptions due to errors in low-level routines.

Public Member Functions

- [Logic_Error_Exception](#) (String s)

Constructor.

10.31.1 Detailed Description

Exceptions due to errors in low-level routines. These exceptions may be generated, for instance, by the inability of querying/controlling the FPU behavior with respect to rounding modes.

The documentation for this class was generated from the following file:

- Logic_Error_Exception.java

10.32 parma_polyhedra_library::MIP_Problem Class Reference

A Mixed Integer (linear) Programming problem.

Inherits parma_polyhedra_library::PPL_Object.

Public Member Functions

Functions that Do Not Modify the MIP_Problem

- native long [max_space_dimension](#) ()
Returns the maximum space dimension an [MIP_Problem](#) can handle.
- native long [space_dimension](#) ()
Returns the space dimension of the MIP problem.
- native [Variables_Set integer_space_dimensions](#) ()
Returns a set containing all the variables' indexes constrained to be integral.
- native [Constraint_System constraints](#) ()
Returns the constraints .
- native [Linear_Expression objective_function](#) ()
Returns the objective function.
- native [Optimization_Mode optimization_mode](#) ()
Returns the optimization mode.
- native String [ascii_dump](#) ()
Returns an ascii formatted internal representation of `this`.
- native String [toString](#) ()
Returns a string representation of `this`.
- native long [total_memory_in_bytes](#) ()
Returns the total size in bytes of the memory occupied by the underlying C++ object.
- native boolean [OK](#) ()
Checks if all the invariants are satisfied.

Functions that May Modify the MIP_Problem

- native void `clear` ()
Resets `this` to be equal to the trivial MIP problem.
- native void `add_space_dimensions_and_embed` (long m)
Adds m new space dimensions and embeds the old MIP problem in the new vector space.
- native void `add_to_integer_space_dimensions` (Variables_Set i_vars)
Sets the variables whose indexes are in set `i_vars` to be integer space dimensions.
- native void `add_constraint` (Constraint c)
Adds a copy of constraint `c` to the MIP problem.
- native void `add_constraints` (Constraint_System cs)
Adds a copy of the constraints in `cs` to the MIP problem.
- native void `set_objective_function` (Linear_Expression obj)
Sets the objective function to `obj`.
- native void `set_optimization_mode` (Optimization_Mode mode)
Sets the optimization mode to `mode`.

Computing the Solution of the MIP_Problem

- native boolean `is_satisfiable` ()
Checks satisfiability of `*this`.
- native `MIP_Problem_Status` `solve` ()
Optimizes the MIP problem.
- native void `evaluate_objective_function` (Generator evaluating_point, Coefficient num, Coefficient den)
Sets `num` and `den` so that $\frac{num}{den}$ is the result of evaluating the objective function on `evaluating_point`.
- native `Generator` `feasible_point` ()
Returns a feasible point for `*this`, if it exists.
- native `Generator` `optimizing_point` ()
Returns an optimal point for `this`, if it exists.
- native void `optimal_value` (Coefficient num, Coefficient den)
Sets `num` and `den` so that $\frac{num}{den}$ is the solution of the optimization problem.

Querying/Setting Control Parameters

- native `Control_Parameter_Value` `get_control_parameter` (Control_Parameter_Name name)
Returns the value of control parameter `name`.
- native void `set_control_parameter` (Control_Parameter_Value value)
Sets control parameter `value`.

Constructors and Destructor

- [MIP_Problem](#) (long dim)
Builds a trivial MIP problem.
- [MIP_Problem](#) (long dim, [Constraint_System](#) cs, [Linear_Expression](#) obj, [Optimization_Mode](#) mode)
Builds an MIP problem having space dimension `dim` from the constraint system `cs`, the objective function `obj` and optimization mode `mode`.
- [MIP_Problem](#) ([MIP_Problem](#) y)
Builds a copy of `y`.
- native void [free](#) ()
Releases all resources managed by `this`, also resetting it to a null reference.
- native void [finalize](#) ()
Releases all resources managed by `this`.

10.32.1 Detailed Description

A Mixed Integer (linear) Programming problem. An object of this class encodes a mixed integer (linear) programming problem. The MIP problem is specified by providing:

- the dimension of the vector space;
- the feasible region, by means of a finite set of linear equality and non-strict inequality constraints;
- the subset of the unknown variables that range over the integers (the other variables implicitly ranging over the reals);
- the objective function, described by a [Linear_Expression](#);
- the optimization mode (either maximization or minimization).

The class provides support for the (incremental) solution of the MIP problem based on variations of the revised simplex method and on branch-and-bound techniques. The result of the resolution process is expressed in terms of an enumeration, encoding the feasibility and the unboundedness of the optimization problem. The class supports simple feasibility tests (i.e., no optimization), as well as the extraction of an optimal (resp., feasible) point, provided the [MIP_Problem](#) is optimizable (resp., feasible).

By exploiting the incremental nature of the solver, it is possible to reuse part of the computational work already done when solving variants of a given [MIP_Problem](#): currently, incremental resolution supports the addition of space dimensions, the addition of constraints, the change of objective function and the change of optimization mode.

10.32.2 Constructor & Destructor Documentation

10.32.2.1 parma_polyhedra_library::MIP_Problem::MIP_Problem (long dim) [inline]

Builds a trivial MIP problem.

A trivial MIP problem requires to maximize the objective function 0 on a vector space under no constraints at all: the origin of the vector space is an optimal solution.

Parameters

<i>dim</i>	The dimension of the vector space enclosing <i>this</i> .
------------	---

Exceptions

<i>std::length_error</i>	Thrown if <i>dim</i> exceeds <code>max_space_dimension()</code> .
--------------------------	---

10.32.2.2 parma_polyhedra_library::MIP_Problem::MIP_Problem (long *dim*, Constraint_System *cs*, Linear_Expression *obj*, Optimization_Mode *mode*) [inline]

Builds an MIP problem having space dimension *dim* from the constraint system *cs*, the objective function *obj* and optimization mode *mode*.

Parameters

<i>dim</i>	The dimension of the vector space enclosing <i>this</i> .
<i>cs</i>	The constraint system defining the feasible region.
<i>obj</i>	The objective function.
<i>mode</i>	The optimization mode.

Exceptions

<i>std::length_error</i>	Thrown if <i>dim</i> exceeds <code>max_space_dimension()</code> .
<i>std::invalid_argument</i>	Thrown if the constraint system contains any strict inequality or if the space dimension of the constraint system (resp., the objective function) is strictly greater than <i>dim</i> .

10.32.3 Member Function Documentation

10.32.3.1 native void parma_polyhedra_library::MIP_Problem::clear ()

Resets *this* to be equal to the trivial MIP problem.

The space dimension is reset to 0.

10.32.3.2 native void parma_polyhedra_library::MIP_Problem::add_space_dimensions_and_embed (long *m*)

Adds *m* new space dimensions and embeds the old MIP problem in the new vector space.

Parameters

<i>m</i>	The number of dimensions to add.
----------	----------------------------------

Exceptions

<i>std::length_error</i>	Thrown if adding <code>m</code> new space dimensions would cause the vector space to exceed dimension <code>max_space_dimension()</code> .
--------------------------	--

The new space dimensions will be those having the highest indexes in the new MIP problem; they are initially unconstrained.

10.32.3.3 native void parma_polyhedra_library::MIP_Problem::add_to_integer_space_dimensions (Variables_Set *i_vars*)

Sets the variables whose indexes are in set `i_vars` to be integer space dimensions.

Exceptions

<i>std::invalid_argument</i>	Thrown if some index in <code>i_vars</code> does not correspond to a space dimension in <code>this</code> .
------------------------------	---

10.32.3.4 native void parma_polyhedra_library::MIP_Problem::add_constraint (Constraint *c*)

Adds a copy of constraint `c` to the MIP problem.

Exceptions

<i>std::invalid_argument</i>	Thrown if the constraint <code>c</code> is a strict inequality or if its space dimension is strictly greater than the space dimension of <code>this</code> .
------------------------------	--

10.32.3.5 native void parma_polyhedra_library::MIP_Problem::add_constraints (Constraint_System *cs*)

Adds a copy of the constraints in `cs` to the MIP problem.

Exceptions

<i>std::invalid_argument</i>	Thrown if the constraint system <code>cs</code> contains any strict inequality or if its space dimension is strictly greater than the space dimension of <code>*this</code> .
------------------------------	---

10.32.3.6 native void parma_polyhedra_library::MIP_Problem::set_objective_function (Linear_Expression *obj*)

Sets the objective function to `obj`.

Exceptions

<i>std::invalid_argument</i>	Thrown if the space dimension of <code>obj</code> is strictly greater than the space dimension of <code>this</code> .
------------------------------	---

10.32.3.7 native boolean parma_polyhedra_library::MIP_Problem::is_satisfiable ()

Checks satisfiability of `*this`.

Returns

`true` if and only if the MIP problem is satisfiable.

10.32.3.8 native MIP_Problem_Status parma_polyhedra_library::MIP_Problem::solve ()

Optimizes the MIP problem.

Returns

An `MIP_Problem_Status` flag indicating the outcome of the optimization attempt (unfeasible, unbounded or optimized problem).

10.32.3.9 native void parma_polyhedra_library::MIP_Problem::evaluate_objective_function (Generator evaluating_point, Coefficient num, Coefficient den)

Sets `num` and `den` so that $\frac{num}{den}$ is the result of evaluating the objective function on `evaluating_point`.

Parameters

<i>evaluating_point</i>	The point on which the objective function will be evaluated.
<i>num</i>	On exit will contain the numerator of the evaluated value.
<i>den</i>	On exit will contain the denominator of the evaluated value.

Exceptions

<i>std::invalid_argument</i>	Thrown if <code>this</code> and <code>evaluating_point</code> are dimension-incompatible or if the generator <code>evaluating_point</code> is not a point.
------------------------------	--

10.32.3.10 native Generator parma_polyhedra_library::MIP_Problem::feasible_point ()

Returns a feasible point for `*this`, if it exists.

Exceptions

<i>std::domain_error</i>	Thrown if the MIP problem is not satisfiable.
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10.32.3.11 native Generator parma_polyhedra_library::MIP_Problem::optimizing_point ()

Returns an optimal point for `this`, if it exists.

Exceptions

<i>std::domain_error</i>	Thrown if <code>this</code> doesn't not have an optimizing point, i.e., if the MIP problem is unbounded or not satisfiable.
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10.32.3.12 native void parma_polyhedra_library::MIP_Problem::optimal_value (Coefficient num, Coefficient den)

Sets `num` and `den` so that $\frac{num}{den}$ is the solution of the optimization problem.

Exceptions

<i>std::domain_error</i>	Thrown if <code>*this</code> doesn't not have an optimizing point, i.e., if the MIP problem is unbounded or not satisfiable.
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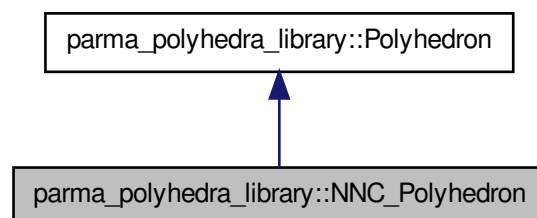
The documentation for this class was generated from the following file:

- MIP_Problem.java

10.33 parma_polyhedra_library::NNC_Polyhedron Class Reference

Java class interfacing C++ Parma_Polyhedra_Library::NNC_Polyhedron.

Inheritance diagram for parma_polyhedra_library::NNC_Polyhedron:



10.33.1 Detailed Description

Java class interfacing C++ Parma_Polyhedra_Library::NNC_Polyhedron.

The documentation for this class was generated from the following file:

- NNC_Polyhedron.java

10.34 parma_polyhedra_library::Octagonal_Shape_double Class Reference

Java class interfacing C++ Parma_Polyhedra_Library::Octagonal_Shape<double>

Inherits parma_polyhedra_library::PPL_Object.

10.34.1 Detailed Description

Java class interfacing C++ Parma_Polyhedra_Library::Octagonal_Shape<double>

The documentation for this class was generated from the following file:

- Octagonal_Shape_double.java

10.35 parma_polyhedra_library::Octagonal_Shape_mpq_class Class Reference

Java class interfacing C++ Parma_Polyhedra_Library::Octagonal_Shape<mpq_class>

Inherits parma_polyhedra_library::PPL_Object.

10.35.1 Detailed Description

Java class interfacing C++ Parma_Polyhedra_Library::Octagonal_Shape<mpq_class>

The documentation for this class was generated from the following file:

- Octagonal_Shape_mpq_class.java

10.36 parma_polyhedra_library::Octagonal_Shape_mpz_class Class Reference

Java class interfacing C++ Parma_Polyhedra_Library::Octagonal_Shape<mpz_class>

Inherits parma_polyhedra_library::PPL_Object.

10.36.1 Detailed Description

Java class interfacing C++ Parma_Polyhedra_Library::Octagonal_Shape<mpz_class>

The documentation for this class was generated from the following file:

- Octagonal_Shape_mpz_class.java

10.37 `parma_polyhedra_library::Overflow_Error_Exception` Class Reference

Exceptions due to overflow errors.

Public Member Functions

- [Overflow_Error_Exception](#) (String s)
Constructor.

10.37.1 Detailed Description

Exceptions due to overflow errors. These exceptions can be obtained when the library has been configured to use integer coefficients having bounded size.

The documentation for this class was generated from the following file:

- `Overflow_Error_Exception.java`

10.38 `parma_polyhedra_library::Pair< K, V >` Class Reference

A pair of values of type K and V.

Public Member Functions

- K [getFirst](#) ()
Returns the object of type K.
- V [getSecond](#) ()
Returns the object of type V.

10.38.1 Detailed Description

A pair of values of type K and V. An object of this class holds an ordered pair of values of type K and V.

The documentation for this class was generated from the following file:

- `Pair.java`

10.39 `parma_polyhedra_library::Parma_Polyhedra_Library` Class Reference

A class collecting library-level functions.

Static Public Member Functions

Library initialization and finalization

- static native void [initialize_library](#) ()

Initializes the Parma Polyhedra Library.

- static native void `finalize_library ()`
Finalizes the Parma Polyhedra Library.

Version Checking

- static native int `version_major ()`
Returns the major number of the PPL version.
- static native int `version_minor ()`
Returns the minor number of the PPL version.
- static native int `version_revision ()`
Returns the revision number of the PPL version.
- static native int `version_beta ()`
Returns the beta number of the PPL version.
- static native String `version ()`
Returns a string containing the PPL version.
- static native String `banner ()`
Returns a string containing the PPL banner.

Floating-point rounding and precision settings.

- static native void `set_rounding_for_PPL ()`
Sets the FPU rounding mode so that the PPL abstractions based on floating point numbers work correctly.
- static native void `restore_pre_PPL_rounding ()`
Sets the FPU rounding mode as it was before initialization of the PPL.
- static native int `irrational_precision ()`
Returns the precision parameter for irrational calculations.
- static native void `set_irrational_precision (int p)`
Sets the precision parameter used for irrational calculations.

Timeout handling

- static native void `set_timeout (int hsecs)`
Sets the timeout for computations whose completion could require an exponential amount of time.
- static native void `reset_timeout ()`
Resets the timeout time so that the computation is not interrupted.
- static native void `set_deterministic_timeout (int weight)`
Sets a threshold for computations whose completion could require an exponential amount of time.
- static native void `reset_deterministic_timeout ()`
Resets the deterministic timeout so that the computation is not interrupted.

10.39.1 Detailed Description

A class collecting library-level functions.

10.39.2 Member Function Documentation

10.39.2.1 static native void parma_polyhedra_library::Parma_Polyhedra_Library::initialize_library () [static]

Initializes the Parma Polyhedra Library.

This method must be called after loading the library and before calling any other method from any other PPL package class.

10.39.2.2 static native void parma_polyhedra_library::Parma_Polyhedra_Library::finalize_library () [static]

Finalizes the Parma Polyhedra Library.

This method must be called when work with the library is done. After finalization, no other library method can be called (except those in class [Parma_Polyhedra_Library](#)), unless the library is re-initialized by calling [initialize_library\(\)](#).

10.39.2.3 static native String parma_polyhedra_library::Parma_Polyhedra_Library::banner () [static]

Returns a string containing the PPL banner.

The banner provides information about the PPL version, the licensing, the lack of any warranty whatsoever, the C++ compiler used to build the library, where to report bugs and where to look for further information.

10.39.2.4 static native void parma_polyhedra_library::Parma_Polyhedra_Library::set_rounding_for_PPL () [static]

Sets the FPU rounding mode so that the PPL abstractions based on floating point numbers work correctly.

This is performed automatically at initialization-time. Calling this function is needed only if [restore_pre_PPL_rounding\(\)](#) has been previously called.

10.39.2.5 static native void parma_polyhedra_library::Parma_Polyhedra_Library::restore_pre_PPL_rounding () [static]

Sets the FPU rounding mode as it was before initialization of the PPL.

After calling this function it is absolutely necessary to call [set_rounding_for_PPL\(\)](#) before using any PPL abstractions based on floating point numbers. This is performed automatically at finalization-time.

10.39.2.6 static native void parma_polyhedra_library::Parma_Polyhedra_Library::set_irrational_precision (int *p*) [static]

Sets the precision parameter used for irrational calculations.

If *p* is less than or equal to `INT_MAX`, sets the precision parameter used for irrational calculations to *p*. Then, in the irrational calculations returning an unbounded rational, (e.g., when computing a square root), the lesser between numerator and denominator will be limited to 2^{**p} .

10.39.2.7 static native void parma_polyhedra_library::Parma_Polyhedra_Library::set_timeout (int *hsecs*) [static]

Sets the timeout for computations whose completion could require an exponential amount of time.

Parameters

<i>hsecs</i>	The number of hundreths of seconds. It must be strictly greater than zero.
--------------	--

Computations taking exponential time will be interrupted some time after *hsecs* hundreths of seconds have elapsed since the call to the timeout setting function, by throwing a [Timeout_Exception](#) object. Otherwise, if the computation completes without being interrupted, then the timeout should be reset by calling [reset_timeout\(\)](#).

10.39.2.8 static native void parma_polyhedra_library::Parma_Polyhedra_Library::set_deterministic_timeout (int *weight*) [static]

Sets a threshold for computations whose completion could require an exponential amount of time.

Parameters

<i>weight</i>	The maximum computational weight allowed. It must be strictly greater than zero.
---------------	--

Computations taking exponential time will be interrupted some time after reaching the *weight* complexity threshold, by throwing a [Timeout_Exception](#) object. Otherwise, if the computation completes without being interrupted, then the deterministic timeout should be reset by calling [reset_deterministic_timeout\(\)](#).

Note

This "timeout" checking functionality is said to be *deterministic* because it is not based on actual elapsed time. Its behavior will only depend on (some of the) computations performed in the PPL library and it will be otherwise independent from the computation environment (CPU, operating system, compiler, etc.).

Warning

The weight mechanism is under alpha testing. In particular, there is still no clear relation between the weight threshold and the actual computational complexity. As a consequence, client applications should be ready to reconsider the tuning of these weight thresholds when upgrading to newer version of the PPL.

The documentation for this class was generated from the following file:

- Parma_Polyhedra_Library.java

10.40 parma_polyhedra_library::Partial_Function Class Reference

A partial function on space dimension indices.

Inherits parma_polyhedra_library::PPL_Object.

Public Member Functions

- [Partial_Function \(\)](#)
Builds the empty map.
- native void [insert](#) (long i, long j)
Inserts mapping from i to j .
- native boolean [has_empty_codomain](#) ()
Returns `true` if and only if the partial function has an empty codomain (i.e., it is always undefined).
- native long [max_in_codomain](#) ()
Returns the maximum value that belongs to the codomain of the partial function.
- native long [maps](#) (long i)
If the partial function is defined on index i , returns its value.
- native void [free](#) ()
Releases all resources managed by `this`, also resetting it to a null reference.

Protected Member Functions

- native void [finalize](#) ()
Releases all resources managed by `this`.

10.40.1 Detailed Description

A partial function on space dimension indices. This class is used in order to specify how space dimensions should be mapped by methods named `map_space_dimensions`.

10.40.2 Member Function Documentation

10.40.2.1 native boolean parma_polyhedra_library::Partial_Function::has_empty_codomain ()

Returns `true` if and only if the partial function has an empty codomain (i.e., it is always undefined).

This method will always be called before the other methods of the interface. Moreover, if `true` is returned, then none of the other interface methods will be called.

10.40.2.2 native long parma_polyhedra_library::Partial_Function::maps (long *i*)

If the partial function is defined on index *i*, returns its value.

The function returns a negative value if the partial function is not defined on domain value *i*.

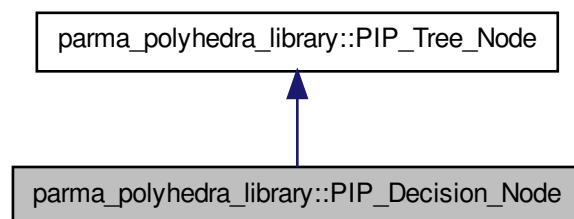
The documentation for this class was generated from the following file:

- Partial_Function.java

10.41 parma_polyhedra_library::PIP_Decision_Node Class Reference

An internal node of the PIP solution tree.

Inheritance diagram for parma_polyhedra_library::PIP_Decision_Node:



Public Member Functions

- native [PIP_Tree_Node child_node](#) (boolean *branch*)

*Returns the true branch (if *branch* is true) or the false branch (if *branch* is false) of this.*

10.41.1 Detailed Description

An internal node of the PIP solution tree.

The documentation for this class was generated from the following file:

- PIP_Decision_Node.java

10.42 parma_polyhedra_library::PIP_Problem Class Reference

A Parametric Integer Programming problem.

Inherits parma_polyhedra_library::PPL_Object.

Public Member Functions

- [PIP_Problem](#) (long dim)
Builds a trivial PIP problem.
- [PIP_Problem](#) (long dim, [Constraint_System](#) cs, [Variables_Set](#) params)
Builds a PIP problem from a sequence of constraints.
- [PIP_Problem](#) ([PIP_Problem](#) y)
Builds a copy of y.
- native void [free](#) ()
Releases all resources managed by this, also resetting it to a null reference.

Functions that Do Not Modify the PIP_Problem

- native long [max_space_dimension](#) ()
Returns the maximum space dimension an [PIP_Problem](#) can handle.
- native long [space_dimension](#) ()
Returns the space dimension of the PIP problem.
- native long [number_of_parameter_space_dimensions](#) ()
Returns the number of parameter space dimensions of the PIP problem.
- native [Variables_Set](#) [parameter_space_dimensions](#) ()
Returns all the parameter space dimensions of problem pip.
- native long [get_big_parameter_dimension](#) ()
Returns the big parameter dimension of PIP problem pip.
- native long [number_of_constraints](#) ()
Returns the number of constraints defining the feasible region of pip.
- native [Constraint](#) [constraint_at_index](#) (long dim)
Returns the i-th constraint defining the feasible region of the PIP problem pip.
- native [Constraint_System](#) [constraints](#) ()
Returns the constraints .

- native String `ascii_dump ()`
Returns an ascii formatted internal representation of `this`.
- native String `toString ()`
Returns a string representation of `this`.
- native long `total_memory_in_bytes ()`
Returns the size in bytes of the memory occupied by the underlying C++ object.
- native long `external_memory_in_bytes ()`
Returns the size in bytes of the memory managed by the underlying C++ object.
- native boolean `OK ()`
Returns true if the pip problem is well formed, i.e., if it satisfies all its implementation invariants; returns 0 and perhaps makes some noise if broken. Useful for debugging purposes.

Functions that May Modify the PIP_Problem

- native void `clear ()`
Resets `this` to be equal to the trivial PIP problem.
- native void `add_space_dimensions_and_embed (long pip_vars, long pip_params)`
Adds `pip_vars + pip_params` new space dimensions and embeds the PIP problem in the new vector space.
- native void `add_to_parameter_space_dimensions (Variables_Set vars)`
Sets the space dimensions in `vars` to be parameter dimensions of the PIP problem.
- native void `set_big_parameter_dimension (long d)`
Sets the big parameter dimension of PIP problem to `d`.
- native void `add_constraint (Constraint c)`
Adds a copy of constraint `c` to the PIP problem.
- native void `add_constraints (Constraint_System cs)`
Adds a copy of the constraints in `cs` to the PIP problem.

Computing the Solution of the PIP_Problem

- native boolean `is_satisfiable ()`
Checks satisfiability of `*this`.
- native `PIP_Problem_Status` `solve ()`
Optimizes the PIP problem.
- native `PIP_Tree_Node` `solution ()`
Returns a solution for the PIP problem, if it exists.
- native `PIP_Tree_Node` `optimizing_solution ()`
Returns an optimizing solution for the PIP problem, if it exists.

Querying/Setting Control Parameters

- native `PIP_Problem_Control_Parameter_Value get_pip_problem_control_parameter (PIP_Problem_Control_Parameter_Name name)`
Returns the value of control parameter name.
- native void `set_pip_problem_control_parameter (PIP_Problem_Control_Parameter_Value value)`
Sets control parameter value.

Protected Member Functions

- native void `finalize ()`
Releases all resources managed by this.

10.42.1 Detailed Description

A Parametric Integer Programming problem. An object of this class encodes a parametric integer (linear) programming problem. The PIP problem is specified by providing:

- the dimension of the vector space;
- the subset of those dimensions of the vector space that are interpreted as integer parameters (the other space dimensions are interpreted as non-parameter integer variables);
- a finite set of linear equality and (strict or non-strict) inequality constraints involving variables and/or parameters; these constraints are used to define:
 - the *feasible region*, if they involve one or more problem variable (and maybe some parameters);
 - the *initial context*, if they only involve the parameters;
- optionally, the so-called *big parameter*, i.e., a problem parameter to be considered arbitrarily big.

Note that all problem variables and problem parameters are assumed to take non-negative integer values, so that there is no need to specify non-negativity constraints.

The class provides support for the (incremental) solution of the PIP problem based on variations of the revised simplex method and on Gomory cut generation techniques.

The solution for a PIP problem is the lexicographic minimum of the integer points of the feasible region, expressed in terms of the parameters. As the problem to be solved only involves non-negative variables and parameters, the problem will always be either unfeasible or optimizable.

As the feasibility and the solution value of a PIP problem depend on the values of the parameters, the solution is a binary decision tree, dividing the context parameter set into subsets. The tree nodes are of two kinds:

- *Decision* nodes. These are internal tree nodes encoding one or more linear tests on the parameters; if all the tests are satisfied, then the solution is the node's *true* child; otherwise, the solution is the node's *false* child;
- *Solution* nodes. These are leaf nodes in the tree, encoding the solution of the problem in the current context subset, where each variable is defined in terms of a linear expression of the parameters. Solution nodes also optionally embed a set of parameter constraints: if all these constraints are satisfied, the solution is described by the node, otherwise the problem has no solution.

It may happen that a decision node has no *false* child. This means that there is no solution if at least one of the corresponding constraints is not satisfied. Decision nodes having two or more linear tests on the parameters cannot have a *false* child. Decision nodes always have a *true* child.

Both kinds of tree nodes may also contain the definition of extra parameters which are artificially introduced by the solver to enforce an integral solution. Such artificial parameters are defined by the integer division of a linear expression on the parameters by an integer coefficient.

By exploiting the incremental nature of the solver, it is possible to reuse part of the computational work already done when solving variants of a given [PIP_Problem](#): currently, incremental resolution supports the addition of space dimensions, the addition of parameters and the addition of constraints.

10.42.2 Constructor & Destructor Documentation

10.42.2.1 parma_polyhedra_library::PIP_Problem::PIP_Problem (long *dim*) [inline]

Builds a trivial PIP problem.

A trivial PIP problem requires to compute the lexicographic minimum on a vector space under no constraints and with no parameters: due to the implicit non-negativity constraints, the origin of the vector space is an optimal solution.

Parameters

<i>dim</i>	The dimension of the vector space enclosing <i>*this</i> (optional argument with default value 0).
------------	--

Exceptions

<i>std::length_error</i>	Thrown if <i>dim</i> exceeds max_space_dimension() .
--------------------------	--

10.42.2.2 parma_polyhedra_library::PIP_Problem::PIP_Problem (long *dim*, Constraint_System *cs*, Variables_Set *params*) [inline]

Builds a PIP problem from a sequence of constraints.

Builds a PIP problem having space dimension *dim* from the constraint system *cs*; the dimensions *vars* are interpreted as parameters.

10.42.3 Member Function Documentation

10.42.3.1 native void parma_polyhedra_library::PIP_Problem::clear ()

Resets *this* to be equal to the trivial PIP problem.

The space dimension is reset to 0.

10.42.3.2 native void parma_polyhedra_library::PIP_Problem::add_space_dimensions_and_embed (long *pip_vars*, long *pip_params*)

Adds `pip_vars` + `pip_params` new space dimensions and embeds the PIP problem in the new vector space.

Parameters

<i>pip_vars</i>	The number of space dimensions to add that are interpreted as PIP problem variables (i.e., non parameters). These are added before adding the <code>pip_params</code> parameters.
<i>pip_params</i>	The number of space dimensions to add that are interpreted as PIP problem parameters. These are added after having added the <code>pip_vars</code> problem variables.

The new space dimensions will be those having the highest indexes in the new PIP problem; they are initially unconstrained.

10.42.3.3 native void parma_polyhedra_library::PIP_Problem::add_constraint (Constraint *c*)

Adds a copy of constraint `c` to the PIP problem.

Exceptions

<i>std::invalid_argument</i>	Thrown if the constraint <code>c</code> is a strict inequality or if its space dimension is strictly greater than the space dimension of <code>this</code> .
------------------------------	--

10.42.3.4 native void parma_polyhedra_library::PIP_Problem::add_constraints (Constraint_System *cs*)

Adds a copy of the constraints in `cs` to the PIP problem.

Exceptions

<i>std::invalid_argument</i>	Thrown if the constraint system <code>cs</code> contains any strict inequality or if its space dimension is strictly greater than the space dimension of <code>*this</code> .
------------------------------	---

10.42.3.5 native boolean parma_polyhedra_library::PIP_Problem::is_satisfiable ()

Checks satisfiability of `*this`.

Returns

`true` if and only if the PIP problem is satisfiable.

10.42.3.6 native PIP_Problem_Status parma_polyhedra_library::PIP_Problem::solve ()

Optimizes the PIP problem.

Solves the PIP problem, returning an exit status.

Returns

UNFEASIBLE_PIP_PROBLEM if the PIP problem is not satisfiable; OPTIMIZED_PIP_PROBLEM if the PIP problem admits an optimal solution.

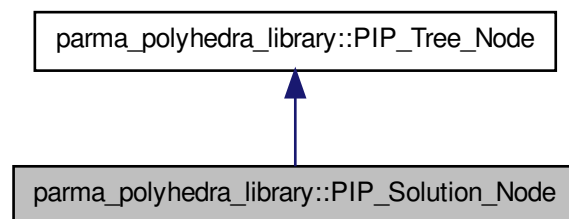
The documentation for this class was generated from the following file:

- PIP_Problem.java

10.43 parma_polyhedra_library::PIP_Solution_Node Class Reference

A leaf node of the PIP solution tree.

Inheritance diagram for parma_polyhedra_library::PIP_Solution_Node:



Public Member Functions

- native [Linear_Expression parametric_values](#) ([Variable](#) var)
Returns the parametric expression of the values of variable `var` in solution node `this`.

10.43.1 Detailed Description

A leaf node of the PIP solution tree.

10.43.2 Member Function Documentation

10.43.2.1 native Linear_Expression parma_polyhedra_library::PIP_Solution_Node::parametric_values (Variable *var*)

Returns the parametric expression of the values of variable *var* in solution node *this*.

The returned parametric expression will only refer to (problem or artificial) parameters.

Parameters

<i>var</i>	The variable being queried.
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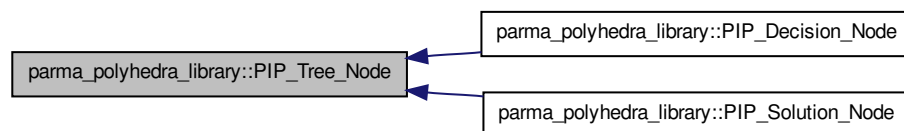
The documentation for this class was generated from the following file:

- PIP_Solution_Node.java

10.44 parma_polyhedra_library::PIP_Tree_Node Class Reference

A node of the PIP solution tree.

Inheritance diagram for parma_polyhedra_library::PIP_Tree_Node:



Public Member Functions

- native [PIP_Solution_Node as_solution](#) ()
*Returns the solution node if *this* is a solution node, and 0 otherwise.*
- native [PIP_Decision_Node as_decision](#) ()
*Returns the decision node if *this* is a decision node, and 0 otherwise.*
- native boolean [OK](#) ()
Returns true if the pip tree is well formed, i.e., if it satisfies all its implementation invariants; returns 0 and perhaps makes some noise if broken. Useful for debugging purposes.
- native long [number_of_artificials](#) ()
Returns the number of artificial parameters in the [PIP_Tree_Node](#).
- native [Artificial_Parameter_Sequence artificials](#) ()
Returns the sequence of (Java) artificial parameters in the [PIP_Tree_Node](#).

- native [Constraint_System](#) `constraints ()`
Returns the system of parameter constraints controlling the [PIP_Tree_Node](#).
- native String `toString ()`
Returns a string representation of `this`.

10.44.1 Detailed Description

A node of the PIP solution tree. This is the base class for the nodes of the binary trees representing the solutions of PIP problems. From this one, two classes are derived:

- [PIP_Decision_Node](#), for the internal nodes of the tree;
- [PIP_Solution_Node](#), for the leaves of the tree.

10.44.2 Member Function Documentation

10.44.2.1 native `Constraint_System` `parma_polyhedra_library::PIP_Tree_Node::constraints ()`

Returns the system of parameter constraints controlling the [PIP_Tree_Node](#).

The indices in the constraints are the same as the original variables and parameters. Coefficients in indices corresponding to variables always are zero.

The documentation for this class was generated from the following file:

- `PIP_Tree_Node.java`

10.45 parma_polyhedra_library::Pointset_Powerset_C_Polyhedron Class Reference

A powerset of [C_Polyhedron](#) objects.

Inherits `parma_polyhedra_library::PPL_Object`, and `parma_polyhedra_library::PPL_Object`.

Public Member Functions

Ad Hoc Functions for `Pointset_Powerset` domains

- native void `omega_reduce ()`
Drops from the sequence of disjuncts in `this` all the non-maximal elements, so that a non-redundant powerset is obtained.
- native long `size ()`
Returns the number of disjuncts.
- native boolean `geometrically_covers (Pointset_Powerset_C_Polyhedron y)`
Returns `true` if and only if `this` geometrically covers `y`.
- native boolean `geometrically_equals (Pointset_Powerset_C_Polyhedron y)`

Returns *true* if and only if *this* is geometrically equal to *y*.

- native [Pointset_Powerset_C_Polyhedron_Iterator begin_iterator \(\)](#)
Returns an iterator referring to the beginning of the sequence of disjuncts of *this*.
- native [Pointset_Powerset_C_Polyhedron_Iterator end_iterator \(\)](#)
Returns an iterator referring to past the end of the sequence of disjuncts of *this*.
- native void [add_disjunct \(C_Polyhedron d\)](#)
Adds to *this* a copy of disjunct *d*.
- native void [drop_disjunct \(Pointset_Powerset_C_Polyhedron_Iterator iter\)](#)
Drops from *this* the disjunct referred by *iter*; returns an iterator referring to the disjunct following the dropped one.
- native void [drop_disjuncts \(Pointset_Powerset_C_Polyhedron_Iterator first, Pointset_Powerset_C_Polyhedron_Iterator last\)](#)
Drops from *this* all the disjuncts from *first* to *last* (excluded).
- native void [pairwise_reduce \(\)](#)
Modifies *this* by (recursively) merging together the pairs of disjuncts whose upper-bound is the same as their set-theoretical union.

10.45.1 Detailed Description

A powerset of [C_Polyhedron](#) objects. Java class interfacing C++ Parma_Polyhedra_Library::Pointset_Powerset<C_Polyhedron>

The powerset domains can be instantiated by taking as a base domain any fixed semantic geometric description (C and NNC polyhedra, BD and octagonal shapes, boxes and grids). An element of the powerset domain represents a disjunctive collection of base objects (its disjuncts), all having the same space dimension.

Besides the methods that are available in all semantic geometric descriptions (whose documentation is not repeated here), the powerset domain also provides several ad hoc methods. In particular, the iterator types allow for the examination and manipulation of the collection of disjuncts.

10.45.2 Member Function Documentation

10.45.2.1 native long parma_polyhedra_library::Pointset_Powerset_C_Polyhedron::size ()

Returns the number of disjuncts.

If present, Omega-redundant elements will be counted too.

The documentation for this class was generated from the following files:

- Fake_Class_for_Doxygen.java
- Pointset_Powerset_C_Polyhedron.java

10.46 parma_polyhedra_library::Pointset_Powerset_C_Polyhedron_Iterator Class Reference

An iterator class for the disjuncts of a [Pointset_Powerset_C_Polyhedron](#).

Inherits `parma_polyhedra_library::PPL_Object`, and `parma_polyhedra_library::PPL_Object`.

Public Member Functions

- [Pointset_Powerset_C_Polyhedron_Iterator](#) ([Pointset_Powerset_C_Polyhedron_Iterator](#) y)
Builds a copy of iterator y.
- native boolean [equals](#) ([Pointset_Powerset_C_Polyhedron_Iterator](#) itr)
Returns true if and only if this and itr are equal.
- native void [next](#) ()
Modifies this so that it refers to the next disjunct.
- native void [prev](#) ()
Modifies this so that it refers to the previous disjunct.
- native [C_Polyhedron](#) [get_disjunct](#) ()
Returns the disjunct referenced by this.
- native void [free](#) ()
Releases resources and resets this to a null reference.

Protected Member Functions

- native void [finalize](#) ()
Releases the resources managed by this.

10.46.1 Detailed Description

An iterator class for the disjuncts of a [Pointset_Powerset_C_Polyhedron](#). Java class interfacing C++ `Parma_Polyhedra_Library::Pointset_Powerset<C_Polyhedron>::iterator`.

10.46.2 Member Function Documentation

10.46.2.1 native C_Polyhedron parma_polyhedra_library::Pointset_Powerset_C_Polyhedron_Iterator::get_disjunct ()

Returns the disjunct referenced by `this`.

Warning

On exit, the [C_Polyhedron](#) disjunct is still owned by the powerset object: any function call on the owning powerset object may invalidate it. Moreover, the disjunct is meant to be immutable and should

not be modified in any way (its resources will be released when deleting the owning powerset). If really needed, the disjunct may be copied into a new object, which will be under control of the user.

The documentation for this class was generated from the following files:

- Fake_Class_for_Doxygen.java
- Pointset_Powerset_C_Polyhedron_Iterator.java

10.47 parma_polyhedra_library::Pointset_Powerset_NNC_Polyhedron Class Reference

Java class interfacing C++ Parma_Polyhedra_Library::Pointset_Powerset<NNC_Polyhedron>

Inherits parma_polyhedra_library::PPL_Object.

10.47.1 Detailed Description

Java class interfacing C++ Parma_Polyhedra_Library::Pointset_Powerset<NNC_Polyhedron>

The documentation for this class was generated from the following file:

- Pointset_Powerset_NNC_Polyhedron.java

10.48 parma_polyhedra_library::Pointset_Powerset_NNC_Polyhedron_Iterator Class Reference

Java class interfacing C++ Parma_Polyhedra_Library::Pointset_Powerset<NNC_Polyhedron>:: iterator.

Inherits parma_polyhedra_library::PPL_Object.

10.48.1 Detailed Description

Java class interfacing C++ Parma_Polyhedra_Library::Pointset_Powerset<NNC_Polyhedron>:: iterator.

The documentation for this class was generated from the following file:

- Pointset_Powerset_NNC_Polyhedron_Iterator.java

10.49 parma_polyhedra_library::Poly_Con_Relation Class Reference

The relation between a polyhedron and a constraint.

Public Member Functions

- [Poly_Con_Relation](#) (int val)
Constructs from a integer value.
- boolean [implies](#) ([Poly_Con_Relation](#) y)
*True if and only if **this* implies y.*

Static Public Member Functions

- static [Poly_Con_Relation nothing \(\)](#)
The assertion that says nothing.
- static [Poly_Con_Relation is_disjoint \(\)](#)
The polyhedron and the set of points satisfying the constraint are disjoint.
- static [Poly_Con_Relation strictly_intersects \(\)](#)
The polyhedron intersects the set of points satisfying the constraint, but it is not included in it.
- static [Poly_Con_Relation is_included \(\)](#)
The polyhedron is included in the set of points satisfying the constraint.
- static [Poly_Con_Relation saturates \(\)](#)
The polyhedron is included in the set of points saturating the constraint.

10.49.1 Detailed Description

The relation between a polyhedron and a constraint. This class implements conjunctions of assertions on the relation between a polyhedron and a constraint.

The documentation for this class was generated from the following file:

- Poly_Con_Relation.java

10.50 parma_polyhedra_library::Poly_Gen_Relation Class Reference

The relation between a polyhedron and a generator.

Public Member Functions

- [Poly_Gen_Relation \(int val\)](#)
Constructs from a integer value.
- boolean [implies \(Poly_Gen_Relation y\)](#)
True if and only if `*this` implies `y`.

Static Public Member Functions

- static [Poly_Gen_Relation nothing \(\)](#)
The assertion that says nothing.
- static [Poly_Gen_Relation subsumes \(\)](#)
Adding the generator would not change the polyhedron.

10.50.1 Detailed Description

The relation between a polyhedron and a generator. This class implements conjunctions of assertions on the relation between a polyhedron and a generator.

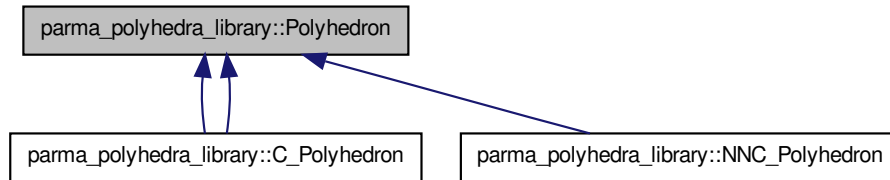
The documentation for this class was generated from the following file:

- Poly_Gen_Relation.java

10.51 parma_polyhedra_library::Polyhedron Class Reference

The Java base class for (C and NNC) convex polyhedra.

Inheritance diagram for parma_polyhedra_library::Polyhedron:



Public Member Functions

Member Functions that Do Not Modify the Polyhedron

- native long [space_dimension](#) ()
Returns the dimension of the vector space enclosing this.
- native long [affine_dimension](#) ()
Returns 0, if this is empty; otherwise, returns the affine dimension of this.
- native [Constraint_System constraints](#) ()
Returns the system of constraints.
- native [Congruence_System congruences](#) ()
Returns a system of (equality) congruences satisfied by this.
- native [Constraint_System minimized_constraints](#) ()
Returns the system of constraints, with no redundant constraint.
- native [Congruence_System minimized_congruences](#) ()
Returns a system of (equality) congruences satisfied by this, with no redundant congruences and having the same affine dimension as this.
- native boolean [is_empty](#) ()
Returns true if and only if this is an empty polyhedron.

- native boolean `is_universe ()`
Returns true if and only if this is a universe polyhedron.
- native boolean `is_bounded ()`
Returns true if and only if this is a bounded polyhedron.
- native boolean `is_discrete ()`
Returns true if and only if this is discrete.
- native boolean `is_topologically_closed ()`
Returns true if and only if this is a topologically closed subset of the vector space.
- native boolean `contains_integer_point ()`
Returns true if and only if this contains at least one integer point.
- native boolean `constrains (Variable var)`
Returns true if and only if var is constrained in this.
- native boolean `bounds_from_above (Linear_Expression expr)`
Returns true if and only if expr is bounded from above in this.
- native boolean `bounds_from_below (Linear_Expression expr)`
Returns true if and only if expr is bounded from below in this.
- native boolean `maximize (Linear_Expression expr, Coefficient sup_n, Coefficient sup_d, By_Reference< Boolean > maximum)`
Returns true if and only if this is not empty and expr is bounded from above in this, in which case the supremum value is computed.
- native boolean `minimize (Linear_Expression expr, Coefficient inf_n, Coefficient inf_d, By_Reference< Boolean > minimum)`
Returns true if and only if this is not empty and expr is bounded from below in this, in which case the infimum value is computed.
- native boolean `maximize (Linear_Expression expr, Coefficient sup_n, Coefficient sup_d, By_Reference< Boolean > maximum, Generator g)`
Returns true if and only if this is not empty and expr is bounded from above in this, in which case the supremum value and a point where expr reaches it are computed.
- native boolean `minimize (Linear_Expression expr, Coefficient inf_n, Coefficient inf_d, By_Reference< Boolean > minimum, Generator g)`
Returns true if and only if this is not empty and expr is bounded from below in this, in which case the infimum value and a point where expr reaches it are computed.
- native `Poly_Con_Relation relation_with (Constraint c)`
Returns the relations holding between the polyhedron this and the constraint c.
- native `Poly_Gen_Relation relation_with (Generator g)`
Returns the relations holding between the polyhedron this and the generator g.
- native `Poly_Con_Relation relation_with (Congruence c)`
Returns the relations holding between the polyhedron this and the congruence c.
- native boolean `contains (Polyhedron y)`

Returns true if and only if this contains y.

- native boolean `strictly_contains` (Polyhedron y)
Returns true if and only if this strictly contains y.
- native boolean `is_disjoint_from` (Polyhedron y)
Returns true if and only if this and y are disjoint.
- native boolean `equals` (Polyhedron y)
Returns true if and only if this and y are equal.
- boolean `equals` (Object y)
Returns true if and only if this and y are equal.
- native int `hashCode` ()
Returns a hash code for this.
- native long `external_memory_in_bytes` ()
Returns the size in bytes of the memory managed by this.
- native long `total_memory_in_bytes` ()
Returns the total size in bytes of the memory occupied by this.
- native String `toString` ()
Returns a string representing this.
- native String `ascii_dump` ()
Returns a string containing a low-level representation of this.
- native boolean `OK` ()
Checks if all the invariants are satisfied.

Space Dimension Preserving Member Functions that May Modify the Polyhedron

- native void `add_constraint` (Constraint c)
Adds a copy of constraint c to the system of constraints of this (without minimizing the result).
- native void `add_congruence` (Congruence cg)
Adds a copy of congruence cg to this, if cg can be exactly represented by a polyhedron.
- native void `add_constraints` (Constraint_System cs)
Adds a copy of the constraints in cs to the system of constraints of this (without minimizing the result).
- native void `add_congruences` (Congruence_System cgs)
Adds a copy of the congruences in cgs to this, if all the congruences can be exactly represented by a polyhedron.
- native void `refine_with_constraint` (Constraint c)
Uses a copy of constraint c to refine this.
- native void `refine_with_congruence` (Congruence cg)
Uses a copy of congruence cg to refine this.
- native void `refine_with_constraints` (Constraint_System cs)

Uses a copy of the constraints in `cs` to refine `this`.

- native void `refine_with_congruences` (`Congruence_System` `cgs`)
Uses a copy of the congruences in `cgs` to refine `this`.
- native void `intersection_assign` (`Polyhedron` `y`)
Assigns to `this` the intersection of `this` and `y`. The result is not guaranteed to be minimized.
- native void `upper_bound_assign` (`Polyhedron` `y`)
Assigns to `this` the upper bound of `this` and `y`.
- native void `difference_assign` (`Polyhedron` `y`)
Assigns to `this` the poly-difference of `this` and `y`. The result is not guaranteed to be minimized.
- native void `time_elapse_assign` (`Polyhedron` `y`)
Assigns to `this` the result of computing the time-elapse between `this` and `y`.
- native void `topological_closure_assign` ()
Assigns to `this` its topological closure.
- native boolean `simplify_using_context_assign` (`Polyhedron` `y`)
Assigns to `this` a meet-preserving simplification of `this` with respect to `y`. If `false` is returned, then the intersection is empty.
- native void `affine_image` (`Variable` `var`, `Linear_Expression` `expr`, `Coefficient` `denominator`)
Assigns to `this` the affine image of `this` under the function mapping variable `var` to the affine expression specified by `expr` and `denominator`.
- native void `affine_preimage` (`Variable` `var`, `Linear_Expression` `expr`, `Coefficient` `denominator`)
Assigns to `this` the affine preimage of `this` under the function mapping variable `var` to the affine expression specified by `expr` and `denominator`.
- native void `bounded_affine_image` (`Variable` `var`, `Linear_Expression` `lb_expr`, `Linear_Expression` `ub_expr`, `Coefficient` `denominator`)
Assigns to `this` the image of `this` with respect to the bounded affine relation $\frac{lb_expr}{denominator} \leq var' \leq \frac{ub_expr}{denominator}$.
- native void `bounded_affine_preimage` (`Variable` `var`, `Linear_Expression` `lb_expr`, `Linear_Expression` `ub_expr`, `Coefficient` `denominator`)
Assigns to `this` the preimage of `this` with respect to the bounded affine relation $\frac{lb_expr}{denominator} \leq var' \leq \frac{ub_expr}{denominator}$.
- native void `generalized_affine_image` (`Variable` `var`, `Relation_Symbol` `relsym`, `Linear_Expression` `expr`, `Coefficient` `denominator`)
Assigns to `this` the image of `this` with respect to the generalized affine relation $var' \bowtie \frac{expr}{denominator}$, where $\bowtie$ is the relation symbol encoded by `relsym`.
- native void `generalized_affine_preimage` (`Variable` `var`, `Relation_Symbol` `relsym`, `Linear_Expression` `expr`, `Coefficient` `denominator`)
Assigns to `this` the preimage of `this` with respect to the generalized affine relation $var' \bowtie \frac{expr}{denominator}$, where $\bowtie$ is the relation symbol encoded by `relsym`.
- native void `generalized_affine_image` (`Linear_Expression` `lhs`, `Relation_Symbol` `relsym`, `Linear_Expression` `rhs`)
Assigns to `this` the image of `this` with respect to the generalized affine relation $lhs' \bowtie rhs$, where $\bowtie$ is the relation symbol encoded by `relsym`.

- native void `generalized_affine_preimage` (`Linear_Expression` lhs, `Relation_Symbol` relsym, `Linear_Expression` rhs)
Assigns to `this` the preimage of `this` with respect to the generalized affine relation $\text{lhs}' \bowtie \text{rhs}$, where $\bowtie$ is the relation symbol encoded by `relsym`.
- native void `unconstrain_space_dimension` (`Variable` var)
Computes the cylindrification of `this` with respect to space dimension `var`, assigning the result to `this`.
- native void `unconstrain_space_dimensions` (`Variables_Set` vars)
Computes the cylindrification of `this` with respect to the set of space dimensions `vars`, assigning the result to `this`.
- native void `widening_assign` (`Polyhedron` y, `By_Reference`< Integer > tp)
Assigns to `this` the result of computing the H79-widening between `this` and `y`.

Member Functions that May Modify the Dimension of the Vector Space

- native void `swap` (`Polyhedron` y)
Swaps `this` with polyhedron `y`. (`this` and `y` can be dimension-incompatible.)
- native void `add_space_dimensions_and_embed` (long m)
Adds `m` new space dimensions and embeds the old polyhedron in the new vector space.
- native void `add_space_dimensions_and_project` (long m)
Adds `m` new space dimensions to the polyhedron and does not embed it in the new vector space.
- native void `concatenate_assign` (`Polyhedron` y)
Assigns to `this` the concatenation of `this` and `y`, taken in this order.
- native void `remove_space_dimensions` (`Variables_Set` vars)
Removes all the specified dimensions from the vector space.
- native void `remove_higher_space_dimensions` (long new_dimension)
Removes the higher dimensions of the vector space so that the resulting space will have dimension `new_dimension`.
- native void `expand_space_dimension` (`Variable` var, long m)
Creates `m` copies of the space dimension corresponding to `var`.
- native void `fold_space_dimensions` (`Variables_Set` vars, `Variable` dest)
Folds the space dimensions in `vars` into `dest`.
- native void `map_space_dimensions` (`Partial_Function` pfunc)
Remaps the dimensions of the vector space according to a partial function.

Ad Hoc Functions for (C or NNC) Polyhedra

The functions listed here below, being specific of the polyhedron domains, do not have a correspondence in other semantic geometric descriptions.

- native `Generator_System generators` ()
Returns the system of generators.

- native `Generator_System minimized_generators ()`
Returns the system of generators, with no redundant generator.
- native void `add_generator (Generator g)`
Adds a copy of generator `g` to the system of generators of `this` (without minimizing the result).
- native void `add_generators (Generator_System gs)`
Adds a copy of the generators in `gs` to the system of generators of `this` (without minimizing the result).
- native void `poly_hull_assign (Polyhedron y)`
Same as `upper_bound_assign`.
- native void `poly_difference_assign (Polyhedron y)`
Same as `difference_assign`.
- native void `BHRZ03_widening_assign (Polyhedron y, By_Reference< Integer > tp)`
Assigns to `this` the result of computing the BHRZ03-widening between `this` and `y`.
- native void `H79_widening_assign (Polyhedron y, By_Reference< Integer > tp)`
Assigns to `this` the result of computing the H79-widening between `this` and `y`.
- native void `limited_BHRZ03_extrapolation_assign (Polyhedron y, Constraint_System cs, By_Reference< Integer > tp)`
Improves the result of the BHRZ03-widening computation by also enforcing those constraints in `cs` that are satisfied by all the points of `this`.
- native void `limited_H79_extrapolation_assign (Polyhedron y, Constraint_System cs, By_Reference< Integer > tp)`
Improves the result of the H79-widening computation by also enforcing those constraints in `cs` that are satisfied by all the points of `this`.
- native void `bounded_BHRZ03_extrapolation_assign (Polyhedron y, Constraint_System cs, By_Reference< Integer > tp)`
Improves the result of the BHRZ03-widening computation by also enforcing those constraints in `cs` that are satisfied by all the points of `this`, plus all the constraints of the form $\pm x \leq r$ and $\pm x < r$, with $r \in \mathbb{Q}$, that are satisfied by all the points of `this`.
- native void `bounded_H79_extrapolation_assign (Polyhedron y, Constraint_System cs, By_Reference< Integer > tp)`
Improves the result of the H79-widening computation by also enforcing those constraints in `cs` that are satisfied by all the points of `this`, plus all the constraints of the form $\pm x \leq r$ and $\pm x < r$, with $r \in \mathbb{Q}$, that are satisfied by all the points of `this`.

10.51.1 Detailed Description

The Java base class for (C and NNC) convex polyhedra. Java class interfacing C++ Parma_Polyhedra_Library::Polyhedron.

The base class `Polyhedron` provides declarations for most of the methods common to classes `C_Polyhedron` and `NNC_Polyhedron`. Note that the user should always use the derived classes. Moreover, C and NNC polyhedra can not be freely interchanged: as specified in the main manual, most library functions require their arguments to be topologically compatible.

10.51.2 Member Function Documentation

10.51.2.1 native boolean parma_polyhedra_library::Polyhedron::constrains (Variable *var*)

Returns `true` if and only if `var` is constrained in `this`.

Exceptions

<i>Invalid_Argument_-Exception</i>	Thrown if <code>var</code> is not a space dimension of <code>this</code> .
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10.51.2.2 native boolean parma_polyhedra_library::Polyhedron::bounds_from_above (Linear_Expression *expr*)

Returns `true` if and only if `expr` is bounded from above in `this`.

Exceptions

<i>Invalid_Argument_-Exception</i>	Thrown if <code>expr</code> and <code>this</code> are dimension-incompatible.
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10.51.2.3 native boolean parma_polyhedra_library::Polyhedron::bounds_from_below (Linear_Expression *expr*)

Returns `true` if and only if `expr` is bounded from below in `this`.

Exceptions

<i>Invalid_Argument_-Exception</i>	Thrown if <code>expr</code> and <code>this</code> are dimension-incompatible.
------------------------------------	---

10.51.2.4 native boolean parma_polyhedra_library::Polyhedron::maximize (Linear_Expression *expr*, Coefficient *sup_n*, Coefficient *sup_d*, By_Reference< Boolean > *maximum*)

Returns `true` if and only if `this` is not empty and `expr` is bounded from above in `this`, in which case the supremum value is computed.

Parameters

<i>expr</i>	The linear expression to be maximized subject to <code>this</code> ;
<i>sup_n</i>	The numerator of the supremum value;
<i>sup_d</i>	The denominator of the supremum value;
<i>maximum</i>	<code>true</code> if and only if the supremum is also the maximum value.

Exceptions

<i>Invalid_Argument_-Exception</i>	Thrown if <code>expr</code> and <code>this</code> are dimension-incompatible.
------------------------------------	---

If `this` is empty or `expr` is not bounded from above, `false` is returned and `sup_n`, `sup_d` and `maximum` are left untouched.

10.51.2.5 native boolean parma_polyhedra_library::Polyhedron::minimize (Linear_Expression *expr*, Coefficient *inf_n*, Coefficient *inf_d*, By_Reference< Boolean > *minimum*)

Returns `true` if and only if `this` is not empty and `expr` is bounded from below in `this`, in which case the infimum value is computed.

Parameters

<i>expr</i>	The linear expression to be minimized subject to <code>this</code> ;
<i>inf_n</i>	The numerator of the infimum value;
<i>inf_d</i>	The denominator of the infimum value;
<i>minimum</i>	<code>true</code> if and only if the infimum is also the minimum value.

Exceptions

<i>Invalid_Argument_-Exception</i>	Thrown if <code>expr</code> and <code>this</code> are dimension-incompatible.
------------------------------------	---

If `this` is empty or `expr` is not bounded from below, `false` is returned and `inf_n`, `inf_d` and `minimum` are left untouched.

10.51.2.6 native boolean parma_polyhedra_library::Polyhedron::maximize (Linear_Expression *expr*, Coefficient *sup_n*, Coefficient *sup_d*, By_Reference< Boolean > *maximum*, Generator *g*)

Returns `true` if and only if `this` is not empty and `expr` is bounded from above in `this`, in which case the supremum value and a point where `expr` reaches it are computed.

Parameters

<i>expr</i>	The linear expression to be maximized subject to <code>this</code> ;
<i>sup_n</i>	The numerator of the supremum value;
<i>sup_d</i>	The denominator of the supremum value;
<i>maximum</i>	<code>true</code> if and only if the supremum is also the maximum value;
<i>g</i>	When maximization succeeds, will be assigned the point or closure point where <code>expr</code> reaches its supremum value.

Exceptions

<i>Invalid_Argument_-Exception</i>	Thrown if <code>expr</code> and <code>this</code> are dimension-incompatible.
------------------------------------	---

If `this` is empty or `expr` is not bounded from above, `false` is returned and `sup_n`, `sup_d`, `maximum` and `g` are left untouched.

10.51.2.7 native boolean parma_polyhedra_library::Polyhedron::minimize (Linear_Expression *expr*, Coefficient *inf_n*, Coefficient *inf_d*, By_Reference< Boolean > *minimum*, Generator *g*)

Returns `true` if and only if `this` is not empty and `expr` is bounded from below in `this`, in which case the infimum value and a point where `expr` reaches it are computed.

Parameters

<i>expr</i>	The linear expression to be minimized subject to <code>this</code> ;
<i>inf_n</i>	The numerator of the infimum value;
<i>inf_d</i>	The denominator of the infimum value;
<i>minimum</i>	<code>true</code> if and only if the infimum is also the minimum value;
<i>g</i>	When minimization succeeds, will be assigned a point or closure point where <code>expr</code> reaches its infimum value.

Exceptions

<i>Invalid_Argument_-Exception</i>	Thrown if <code>expr</code> and <code>this</code> are dimension-incompatible.
------------------------------------	---

If `this` is empty or `expr` is not bounded from below, `false` is returned and `inf_n`, `inf_d`, `minimum` and `g` are left untouched.

10.51.2.8 native Poly_Con_Relation parma_polyhedra_library::Polyhedron::relation_with (Constraint *c*)

Returns the relations holding between the polyhedron `this` and the constraint `c`.

Exceptions

<i>Invalid_Argument_-Exception</i>	Thrown if <code>this</code> and constraint <code>c</code> are dimension-incompatible.
------------------------------------	---

10.51.2.9 native Poly_Gen_Relation parma_polyhedra_library::Polyhedron::relation_with (Generator *c*)

Returns the relations holding between the polyhedron `this` and the generator `g`.

Exceptions

<i>Invalid_Argument_-Exception</i>	Thrown if <code>this</code> and generator <code>g</code> are dimension-incompatible.
------------------------------------	--

10.51.2.10 native Poly_Con_Relation parma_polyhedra_library::Polyhedron::relation_with (Congruence *c*)

Returns the relations holding between the polyhedron `this` and the congruence `c`.

Exceptions

<i>Invalid_Argument_Exception</i>	Thrown if <code>this</code> and congruence <code>c</code> are dimension-incompatible.
-----------------------------------	---

10.51.2.11 native boolean parma_polyhedra_library::Polyhedron::contains (Polyhedron *y*)

Returns `true` if and only if `this` contains `y`.

Exceptions

<i>Invalid_Argument_Exception</i>	Thrown if <code>this</code> and <code>y</code> are topology-incompatible or dimension-incompatible.
-----------------------------------	---

10.51.2.12 native boolean parma_polyhedra_library::Polyhedron::strictly_contains (Polyhedron *y*)

Returns `true` if and only if `this` strictly contains `y`.

Exceptions

<i>Invalid_Argument_Exception</i>	Thrown if <code>this</code> and <code>y</code> are topology-incompatible or dimension-incompatible.
-----------------------------------	---

10.51.2.13 native boolean parma_polyhedra_library::Polyhedron::is_disjoint_from (Polyhedron *y*)

Returns `true` if and only if `this` and `y` are disjoint.

Exceptions

<i>Invalid_Argument_Exception</i>	Thrown if <code>x</code> and <code>y</code> are topology-incompatible or dimension-incompatible.
-----------------------------------	--

10.51.2.14 native int parma_polyhedra_library::Polyhedron::hashCode ()

Returns a hash code for `this`.

If `x` and `y` are such that `x == y`, then `x.hash_code() == y.hash_code()`.

10.51.2.15 native String parma_polyhedra_library::Polyhedron::ascii_dump ()

Returns a string containing a low-level representation of `this`.

Useful for debugging purposes.

10.51.2.16 native void parma_polyhedra_library::Polyhedron::add_constraint (Constraint *c*)

Adds a copy of constraint `c` to the system of constraints of `this` (without minimizing the result).

Parameters

<i>c</i>	The constraint that will be added to the system of constraints of <code>this</code> .
----------	---

Exceptions

<i>Invalid_Argument_-Exception</i>	Thrown if <code>this</code> and constraint <code>c</code> are topology-incompatible or dimension-incompatible.
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10.51.2.17 native void parma_polyhedra_library::Polyhedron::add_congruence (Congruence *cg*)

Adds a copy of congruence `cg` to `this`, if `cg` can be exactly represented by a polyhedron.

Exceptions

<i>Invalid_Argument_-Exception</i>	Thrown if <code>this</code> and congruence <code>cg</code> are dimension-incompatible, of if <code>cg</code> is a proper congruence which is neither a tautology, nor a contradiction.
------------------------------------	--

10.51.2.18 native void parma_polyhedra_library::Polyhedron::add_constraints (Constraint_System *cs*)

Adds a copy of the constraints in `cs` to the system of constraints of `this` (without minimizing the result).

Parameters

<i>cs</i>	Contains the constraints that will be added to the system of constraints of <code>this</code> .
-----------	---

Exceptions

<i>Invalid_Argument_-Exception</i>	Thrown if <code>this</code> and <code>cs</code> are topology-incompatible or dimension-incompatible.
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10.51.2.19 native void parma_polyhedra_library::Polyhedron::add_congruences (Congruence_System *cgs*)

Adds a copy of the congruences in *cgs* to *this*, if all the congruences can be exactly represented by a polyhedron.

Parameters

<i>cgs</i>	The congruences to be added.
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Exceptions

<i>Invalid_Argument_Exception</i>	Thrown if <i>this</i> and <i>cgs</i> are dimension-incompatible, or if there exists in <i>cgs</i> a proper congruence which is neither a tautology, nor a contradiction.
-----------------------------------	--

10.51.2.20 native void parma_polyhedra_library::Polyhedron::refine_with_constraint (Constraint *c*)

Uses a copy of constraint *c* to refine *this*.

Exceptions

<i>Invalid_Argument_Exception</i>	Thrown if <i>this</i> and constraint <i>c</i> are dimension-incompatible.
-----------------------------------	---

10.51.2.21 native void parma_polyhedra_library::Polyhedron::refine_with_congruence (Congruence *cg*)

Uses a copy of congruence *cg* to refine *this*.

Exceptions

<i>Invalid_Argument_Exception</i>	Thrown if <i>this</i> and congruence <i>cg</i> are dimension-incompatible.
-----------------------------------	--

10.51.2.22 native void parma_polyhedra_library::Polyhedron::refine_with_constraints (Constraint_System *cs*)

Uses a copy of the constraints in *cs* to refine *this*.

Parameters

<i>cs</i>	Contains the constraints used to refine the system of constraints of <i>this</i> .
-----------	--

Exceptions

<i>Invalid_Argument_-Exception</i>	Thrown if <code>this</code> and <code>cs</code> are dimension-incompatible.
------------------------------------	---

10.51.2.23 native void parma_polyhedra_library::Polyhedron::refine_with_congruences (Congruence_System cgs)

Uses a copy of the congruences in `cgs` to refine `this`.

Parameters

<code>cgs</code>	Contains the congruences used to refine the system of constraints of <code>this</code> .
------------------	--

Exceptions

<i>Invalid_Argument_-Exception</i>	Thrown if <code>this</code> and <code>cgs</code> are dimension-incompatible.
------------------------------------	--

10.51.2.24 native void parma_polyhedra_library::Polyhedron::intersection_assign (Polyhedron y)

Assigns to `this` the intersection of `this` and `y`. The result is not guaranteed to be minimized.

Exceptions

<i>Invalid_Argument_-Exception</i>	Thrown if <code>this</code> and <code>y</code> are topology-incompatible or dimension-incompatible.
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10.51.2.25 native void parma_polyhedra_library::Polyhedron::upper_bound_assign (Polyhedron y)

Assigns to `this` the upper bound of `this` and `y`.

Exceptions

<i>Invalid_Argument_-Exception</i>	Thrown if <code>this</code> and <code>y</code> are topology-incompatible or dimension-incompatible.
------------------------------------	---

10.51.2.26 native void parma_polyhedra_library::Polyhedron::difference_assign (Polyhedron y)

Assigns to `this` the *poly-difference* of `this` and `y`. The result is not guaranteed to be minimized.

Exceptions

<i>Invalid_Argument_Exception</i>	Thrown if <code>this</code> and <code>y</code> are topology-incompatible or dimension-incompatible.
-----------------------------------	---

10.51.2.27 native void parma_polyhedra_library::Polyhedron::time_elapse_assign (Polyhedron y)

Assigns to `this` the result of computing the *time-elapse* between `this` and `y`.

Exceptions

<i>Invalid_Argument_Exception</i>	Thrown if <code>this</code> and <code>y</code> are topology-incompatible or dimension-incompatible.
-----------------------------------	---

10.51.2.28 native boolean parma_polyhedra_library::Polyhedron::simplify_using_context_assign (Polyhedron y)

Assigns to `this` a *meet-preserving simplification* of `this` with respect to `y`. If `false` is returned, then the intersection is empty.

Exceptions

<i>Invalid_Argument_Exception</i>	Thrown if <code>this</code> and <code>y</code> are topology-incompatible or dimension-incompatible.
-----------------------------------	---

10.51.2.29 native void parma_polyhedra_library::Polyhedron::affine_image (Variable var, Linear_Expression expr, Coefficient denominator)

Assigns to `this` the *affine image* of `this` under the function mapping variable `var` to the affine expression specified by `expr` and `denominator`.

Parameters

<i>var</i>	The variable to which the affine expression is assigned;
<i>expr</i>	The numerator of the affine expression;
<i>denominator</i>	The denominator of the affine expression (optional argument with default value 1).

Exceptions

<i>Invalid_Argument_Exception</i>	Thrown if <code>denominator</code> is zero or if <code>expr</code> and <code>this</code> are dimension-incompatible or if <code>var</code> is not a space dimension of <code>this</code> .
-----------------------------------	--

10.51.2.30 native void parma_polyhedra_library::Polyhedron::affine_preimage (Variable *var*, Linear_Expression *expr*, Coefficient *denominator*)

Assigns to `this` the *affine preimage* of `this` under the function mapping variable `var` to the affine expression specified by `expr` and `denominator`.

Parameters

<i>var</i>	The variable to which the affine expression is substituted;
<i>expr</i>	The numerator of the affine expression;
<i>denominator</i>	The denominator of the affine expression (optional argument with default value 1).

Exceptions

<i>Invalid_Argument_Exception</i>	Thrown if <code>denominator</code> is zero or if <code>expr</code> and <code>this</code> are dimension-incompatible or if <code>var</code> is not a space dimension of <code>this</code> .
-----------------------------------	--

10.51.2.31 native void parma_polyhedra_library::Polyhedron::bounded_affine_image (Variable *var*, Linear_Expression *lb_expr*, Linear_Expression *ub_expr*, Coefficient *denominator*)

Assigns to `this` the image of `this` with respect to the *bounded affine relation* $\frac{lb_expr}{denominator} \leq var' \leq \frac{ub_expr}{denominator}$.

Parameters

<i>var</i>	The variable updated by the affine relation;
<i>lb_expr</i>	The numerator of the lower bounding affine expression;
<i>ub_expr</i>	The numerator of the upper bounding affine expression;
<i>denominator</i>	The (common) denominator for the lower and upper bounding affine expressions (optional argument with default value 1).

Exceptions

<i>Invalid_Argument_Exception</i>	Thrown if <code>denominator</code> is zero or if <code>lb_expr</code> (resp., <code>ub_expr</code>) and <code>this</code> are dimension-incompatible or if <code>var</code> is not a space dimension of <code>this</code> .
-----------------------------------	--

10.51.2.32 native void parma_polyhedra_library::Polyhedron::bounded_affine_preimage (Variable *var*, Linear_Expression *lb_expr*, Linear_Expression *ub_expr*, Coefficient *denominator*)

Assigns to `this` the preimage of `this` with respect to the *bounded affine relation* $\frac{lb_expr}{denominator} \leq var' \leq \frac{ub_expr}{denominator}$.

Parameters

<i>var</i>	The variable updated by the affine relation;
<i>lb_expr</i>	The numerator of the lower bounding affine expression;

<i>ub_expr</i>	The numerator of the upper bounding affine expression;
<i>denominator</i>	The (common) denominator for the lower and upper bounding affine expressions (optional argument with default value 1).

Exceptions

<i>Invalid_Argument_Exception</i>	Thrown if <i>denominator</i> is zero or if <i>lb_expr</i> (resp., <i>ub_expr</i>) and <i>this</i> are dimension-incompatible or if <i>var</i> is not a space dimension of <i>this</i> .
-----------------------------------	--

10.51.2.33 native void parma_polyhedra_library::Polyhedron::generalized_affine_image (Variable *var*, Relation_Symbol *relsym*, Linear_Expression *expr*, Coefficient *denominator*)

Assigns to *this* the image of *this* with respect to the *generalized affine relation* $\text{var}' \bowtie \frac{\text{expr}}{\text{denominator}}$, where $\bowtie$ is the relation symbol encoded by *relsym*.

Parameters

<i>var</i>	The left hand side variable of the generalized affine relation;
<i>relsym</i>	The relation symbol;
<i>expr</i>	The numerator of the right hand side affine expression;
<i>denominator</i>	The denominator of the right hand side affine expression (optional argument with default value 1).

Exceptions

<i>Invalid_Argument_Exception</i>	Thrown if <i>denominator</i> is zero or if <i>expr</i> and <i>this</i> are dimension-incompatible or if <i>var</i> is not a space dimension of <i>this</i> or if <i>this</i> is a C_Polyhedron and <i>relsym</i> is a strict relation symbol.
-----------------------------------	--

10.51.2.34 native void parma_polyhedra_library::Polyhedron::generalized_affine_preimage (Variable *var*, Relation_Symbol *relsym*, Linear_Expression *expr*, Coefficient *denominator*)

Assigns to *this* the preimage of *this* with respect to the *generalized affine relation* $\text{var}' \bowtie \frac{\text{expr}}{\text{denominator}}$, where $\bowtie$ is the relation symbol encoded by *relsym*.

Parameters

<i>var</i>	The left hand side variable of the generalized affine relation;
<i>relsym</i>	The relation symbol;
<i>expr</i>	The numerator of the right hand side affine expression;
<i>denominator</i>	The denominator of the right hand side affine expression (optional argument with default value 1).

Exceptions

<i>Invalid_Argument_-Exception</i>	Thrown if denominator is zero or if <code>expr</code> and <code>this</code> are dimension-incompatible or if <code>var</code> is not a space dimension of <code>this</code> or if <code>this</code> is a <code>C_Polyhedron</code> and <code>relsym</code> is a strict relation symbol.
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10.51.2.35 native void parma_polyhedra_library::Polyhedron::generalized_affine_image (Linear_Expression lhs, Relation_Symbol relsym, Linear_Expression rhs)

Assigns to `this` the image of `this` with respect to the *generalized affine relation* $lhs' \bowtie rhs$, where $\bowtie$ is the relation symbol encoded by `relsym`.

Parameters

<i>lhs</i>	The left hand side affine expression;
<i>relsym</i>	The relation symbol;
<i>rhs</i>	The right hand side affine expression.

Exceptions

<i>Invalid_Argument_-Exception</i>	Thrown if <code>this</code> is dimension-incompatible with <code>lhs</code> or <code>rhs</code> or if <code>this</code> is a <code>C_Polyhedron</code> and <code>relsym</code> is a strict relation symbol.
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10.51.2.36 native void parma_polyhedra_library::Polyhedron::generalized_affine_preimage (Linear_Expression lhs, Relation_Symbol relsym, Linear_Expression rhs)

Assigns to `this` the preimage of `this` with respect to the *generalized affine relation* $lhs' \bowtie rhs$, where $\bowtie$ is the relation symbol encoded by `relsym`.

Parameters

<i>lhs</i>	The left hand side affine expression;
<i>relsym</i>	The relation symbol;
<i>rhs</i>	The right hand side affine expression.

Exceptions

<i>Invalid_Argument_-Exception</i>	Thrown if <code>this</code> is dimension-incompatible with <code>lhs</code> or <code>rhs</code> or if <code>this</code> is a <code>C_Polyhedron</code> and <code>relsym</code> is a strict relation symbol.
------------------------------------	---

10.51.2.37 native void parma_polyhedra_library::Polyhedron::unconstrain_space_dimension (Variable var)

Computes the *cylindrification* of `this` with respect to space dimension `var`, assigning the result to `this`.

Parameters

<i>var</i>	The space dimension that will be unconstrained.
------------	---

Exceptions

<i>Invalid_Argument_Exception</i>	Thrown if <code>var</code> is not a space dimension of <code>this</code> .
-----------------------------------	--

10.51.2.38 native void parma_polyhedra_library::Polyhedron::unconstrain_space_dimensions (Variables_Set vars)

Computes the *cylindrification* of `this` with respect to the set of space dimensions `vars`, assigning the result to `this`.

Parameters

<code>vars</code>	The set of space dimension that will be unconstrained.
-------------------	--

Exceptions

<i>Invalid_Argument_Exception</i>	Thrown if <code>this</code> is dimension-incompatible with one of the Variable objects contained in <code>vars</code> .
-----------------------------------	---

10.51.2.39 native void parma_polyhedra_library::Polyhedron::widening_assign (Polyhedron y, By_Reference< Integer > tp)

Assigns to `this` the result of computing the *H79-widening* between `this` and `y`.

Parameters

<code>y</code>	A polyhedron that <i>must</i> be contained in <code>this</code> ;
<code>tp</code>	A reference to an unsigned variable storing the number of available tokens (to be used when applying the <i>widening with tokens</i> delay technique).

Exceptions

<i>Invalid_Argument_Exception</i>	Thrown if <code>this</code> and <code>y</code> are topology-incompatible or dimension-incompatible.
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10.51.2.40 native void parma_polyhedra_library::Polyhedron::swap (Polyhedron y)

Swaps `this` with polyhedron `y`. (`this` and `y` can be dimension-incompatible.)

Exceptions

<i>Invalid_Argument_Exception</i>	Thrown if <code>x</code> and <code>y</code> are topology-incompatible.
-----------------------------------	--

10.51.2.41 native void parma_polyhedra_library::Polyhedron::add_space_dimensions_and_embed (long *m*)

Adds *m* new space dimensions and embeds the old polyhedron in the new vector space.

Parameters

<i>m</i>	The number of dimensions to add.
----------	----------------------------------

Exceptions

<i>Length_Error_Exception</i>	Thrown if adding <i>m</i> new space dimensions would cause the vector space to exceed dimension <code>max_space_dimension()</code> .
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10.51.2.42 native void parma_polyhedra_library::Polyhedron::add_space_dimensions_and_project (long *m*)

Adds *m* new space dimensions to the polyhedron and does not embed it in the new vector space.

Parameters

<i>m</i>	The number of space dimensions to add.
----------	--

Exceptions

<i>Length_Error_Exception</i>	Thrown if adding <i>m</i> new space dimensions would cause the vector space to exceed dimension <code>max_space_dimension()</code> .
---	--

10.51.2.43 native void parma_polyhedra_library::Polyhedron::concatenate_assign (Polyhedron *y*)

Assigns to `this` the *concatenation* of `this` and *y*, taken in this order.

Exceptions

<i>Invalid_Argument_Exception</i>	Thrown if <code>this</code> and <i>y</i> are topology-incompatible.
<i>Length_Error_Exception</i>	Thrown if the concatenation would cause the vector space to exceed dimension <code>max_space_dimension()</code> .

10.51.2.44 native void parma_polyhedra_library::Polyhedron::remove_space_dimensions (Variables_Set *vars*)

Removes all the specified dimensions from the vector space.

Parameters

<i>vars</i>	The set of Variable objects corresponding to the space dimensions to be removed.
-------------	--

Exceptions

Invalid_Argument_Exception	Thrown if <code>this</code> is dimension-incompatible with one of the Variable objects contained in <code>vars</code> .
--	---

10.51.2.45 native void parma_polyhedra_library::Polyhedron::remove_higher_space_dimensions (long new_dimension)

Removes the higher dimensions of the vector space so that the resulting space will have dimension `new_dimension`.

Exceptions

Invalid_Argument_Exception	Thrown if <code>new_dimensions</code> is greater than the space dimension of <code>this</code> .
--	--

10.51.2.46 native void parma_polyhedra_library::Polyhedron::expand_space_dimension (Variable var, long m)

Creates `m` copies of the space dimension corresponding to `var`.

Parameters

<i>var</i>	The variable corresponding to the space dimension to be replicated;
<i>m</i>	The number of replicas to be created.

Exceptions

Invalid_Argument_Exception	Thrown if <code>var</code> does not correspond to a dimension of the vector space.
Length_Error_Exception	Thrown if adding <code>m</code> new space dimensions would cause the vector space to exceed dimension <code>max_space_dimension()</code> .

10.51.2.47 native void parma_polyhedra_library::Polyhedron::fold_space_dimensions (Variables_Set vars, Variable dest)

Folds the space dimensions in `vars` into `dest`.

Parameters

<i>vars</i>	The set of Variable objects corresponding to the space dimensions to be folded;
<i>dest</i>	The variable corresponding to the space dimension that is the destination of the folding operation.

Exceptions

<i>Invalid_Argument_Exception</i>	Thrown if <code>this</code> is dimension-incompatible with <code>dest</code> or with one of the Variable objects contained in <code>vars</code> . Also thrown if <code>dest</code> is contained in <code>vars</code> .
-----------------------------------	--

10.51.2.48 native void parma_polyhedra_library::Polyhedron::map_space_dimensions (Partial_Function *pfunc*)

Remaps the dimensions of the vector space according to a *partial function*.

Parameters

<i>pfunc</i>	The partial function specifying the destiny of each space dimension.
--------------	--

10.51.2.49 native void parma_polyhedra_library::Polyhedron::add_generator (Generator *g*)

Adds a copy of generator `g` to the system of generators of `this` (without minimizing the result).

Exceptions

<i>Invalid_Argument_Exception</i>	Thrown if <code>this</code> and generator <code>g</code> are topology-incompatible or dimension-incompatible, or if <code>this</code> is an empty polyhedron and <code>g</code> is not a point.
-----------------------------------	---

10.51.2.50 native void parma_polyhedra_library::Polyhedron::add_generators (Generator_System *gs*)

Adds a copy of the generators in `gs` to the system of generators of `this` (without minimizing the result).

Parameters

<i>gs</i>	Contains the generators that will be added to the system of generators of <code>this</code> .
-----------	---

Exceptions

<i>Invalid_Argument_Exception</i>	Thrown if <code>this</code> and <code>gs</code> are topology-incompatible or dimension-incompatible, or if <code>this</code> is empty and the system of generators <code>gs</code> is not empty, but has no points.
-----------------------------------	---

10.51.2.51 native void parma_polyhedra_library::Polyhedron::BHRZ03_widening_assign (Polyhedron *y*, By_Reference< Integer > *tp*)

Assigns to `this` the result of computing the *BHRZ03-widening* between `this` and `y`.

Parameters

<code>y</code>	A polyhedron that <i>must</i> be contained in <code>this</code> ;
<code>tp</code>	A reference to an unsigned variable storing the number of available tokens (to be used when applying the <i>widening with tokens</i> delay technique).

Exceptions

<i>Invalid_Argument_Exception</i>	Thrown if <code>this</code> and <code>y</code> are topology-incompatible or dimension-incompatible.
---	---

10.51.2.52 native void parma_polyhedra_library::Polyhedron::H79_widening_assign (Polyhedron y, By_Reference< Integer > tp)

Assigns to `this` the result of computing the *H79-widening* between `this` and `y`.

Parameters

<code>y</code>	A polyhedron that <i>must</i> be contained in <code>this</code> ;
<code>tp</code>	A reference to an unsigned variable storing the number of available tokens (to be used when applying the <i>widening with tokens</i> delay technique).

Exceptions

<i>Invalid_Argument_Exception</i>	Thrown if <code>this</code> and <code>y</code> are topology-incompatible or dimension-incompatible.
---	---

10.51.2.53 native void parma_polyhedra_library::Polyhedron::limited_BHRZ03_extrapolation_assign (Polyhedron y, Constraint_System cs, By_Reference< Integer > tp)

Improves the result of the *BHRZ03-widening* computation by also enforcing those constraints in `cs` that are satisfied by all the points of `this`.

Parameters

<code>y</code>	A polyhedron that <i>must</i> be contained in <code>this</code> ;
<code>cs</code>	The system of constraints used to improve the widened polyhedron;
<code>tp</code>	A reference to an unsigned variable storing the number of available tokens (to be used when applying the <i>widening with tokens</i> delay technique).

Exceptions

<i>Invalid_Argument_Exception</i>	Thrown if <code>this</code> , <code>y</code> and <code>cs</code> are topology-incompatible or dimension-incompatible.
---	---

10.51.2.54 native void parma_polyhedra_library::Polyhedron::limited_H79_extrapolation_assign (Polyhedron y, Constraint_System cs, By_Reference< Integer > tp)

Improves the result of the *H79-widening* computation by also enforcing those constraints in `cs` that are satisfied by all the points of `this`.

Parameters

<code>y</code>	A polyhedron that <i>must</i> be contained in <code>this</code> ;
<code>cs</code>	The system of constraints used to improve the widened polyhedron;
<code>tp</code>	A reference to an unsigned variable storing the number of available tokens (to be used when applying the <i>widening with tokens</i> delay technique).

Exceptions

<i>Invalid_Argument_Exception</i>	Thrown if <code>this</code> , <code>y</code> and <code>cs</code> are topology-incompatible or dimension-incompatible.
-----------------------------------	---

10.51.2.55 native void parma_polyhedra_library::Polyhedron::bounded_BHRZ03_extrapolation_assign (Polyhedron y, Constraint_System cs, By_Reference< Integer > tp)

Improves the result of the *BHRZ03-widening* computation by also enforcing those constraints in `cs` that are satisfied by all the points of `this`, plus all the constraints of the form $\pm x \leq r$ and $\pm x < r$, with $r \in \mathbb{Q}$, that are satisfied by all the points of `this`.

Parameters

<code>y</code>	A polyhedron that <i>must</i> be contained in <code>this</code> ;
<code>cs</code>	The system of constraints used to improve the widened polyhedron;
<code>tp</code>	A reference to an unsigned variable storing the number of available tokens (to be used when applying the <i>widening with tokens</i> delay technique).

Exceptions

<i>Invalid_Argument_Exception</i>	Thrown if <code>this</code> , <code>y</code> and <code>cs</code> are topology-incompatible or dimension-incompatible.
-----------------------------------	---

10.51.2.56 native void parma_polyhedra_library::Polyhedron::bounded_H79_extrapolation_assign (Polyhedron y, Constraint_System cs, By_Reference< Integer > tp)

Improves the result of the *H79-widening* computation by also enforcing those constraints in `cs` that are satisfied by all the points of `this`, plus all the constraints of the form $\pm x \leq r$ and $\pm x < r$, with $r \in \mathbb{Q}$, that are satisfied by all the points of `this`.

Parameters

<i>y</i>	A polyhedron that <i>must</i> be contained in <code>this</code> ;
<i>cs</i>	The system of constraints used to improve the widened polyhedron;
<i>tp</i>	A reference to an unsigned variable storing the number of available tokens (to be used when applying the <i>widening with tokens</i> delay technique).

Exceptions

<i>Invalid_Argument_-Exception</i>	Thrown if <code>this</code> , <code>y</code> and <code>cs</code> are topology-incompatible or dimension-incompatible.
--	---

The documentation for this class was generated from the following files:

- Fake_Class_for_Doxygen.java
- Polyhedron.java

10.52 parma_polyhedra_library::Rational_Box Class Reference

Java class interfacing C++ Parma_Polyhedra_Library::Rational_Box.

Inherits parma_polyhedra_library::PPL_Object.

10.52.1 Detailed Description

Java class interfacing C++ Parma_Polyhedra_Library::Rational_Box.

The documentation for this class was generated from the following file:

- Rational_Box.java

10.53 parma_polyhedra_library::Timeout_Exception Class Reference

Exceptions caused by timeout expiring.

Public Member Functions

- [`Timeout\_Exception`](#) (String `s`)
Constructor.

10.53.1 Detailed Description

Exceptions caused by timeout expiring.

The documentation for this class was generated from the following file:

- Timeout_Exception.java

10.54 parma_polyhedra_library::Variable Class Reference

A dimension of the vector space.

Public Member Functions

- [Variable](#) (int *i*)
Builds the variable corresponding to the Cartesian axis of index i.
- int [id](#) ()
Returns the index of the Cartesian axis associated to this.
- int [compareTo](#) ([Variable](#) *v*)
Returns a negative number if this comes first than v, a zero if this equals v, a positive number if if this comes first than v.

10.54.1 Detailed Description

A dimension of the vector space. An object of the class [Variable](#) represents a dimension of the space, that is one of the Cartesian axes. Variables are used as basic blocks in order to build more complex linear expressions. Each variable is identified by a non-negative integer, representing the index of the corresponding Cartesian axis (the first axis has index 0).

10.54.2 Constructor & Destructor Documentation**10.54.2.1 parma_polyhedra_library::Variable::Variable (int *i*) [inline]**

Builds the variable corresponding to the Cartesian axis of index *i*.

Exceptions

<i>RuntimeException</i>	Thrown if <i>i</i> is has negative value.
-------------------------	---

The documentation for this class was generated from the following file:

- [Variable.java](#)

10.55 parma_polyhedra_library::Variables_Set Class Reference

A java.util.TreeSet of variables' indexes.

Public Member Functions

- [Variables_Set](#) ()
Builds the empty set of variable indexes.

10.55.1 Detailed Description

A java.util.TreeSet of variables' indexes.

The documentation for this class was generated from the following file:

- Variables_Set.java

Index

- add_congruence
 - parma_polyhedra_library::Polyhedron, [97](#)
- add_congruences
 - parma_polyhedra_library::Polyhedron, [97](#)
- add_constraint
 - parma_polyhedra_library::MIP_Problem, [64](#)
 - parma_polyhedra_library::PIP_Problem, [78](#)
 - parma_polyhedra_library::Polyhedron, [96](#)
- add_constraints
 - parma_polyhedra_library::MIP_Problem, [65](#)
 - parma_polyhedra_library::PIP_Problem, [79](#)
 - parma_polyhedra_library::Polyhedron, [97](#)
- add_generator
 - parma_polyhedra_library::Polyhedron, [106](#)
- add_generators
 - parma_polyhedra_library::Polyhedron, [107](#)
- add_space_dimensions_and_embed
 - parma_polyhedra_library::MIP_Problem, [64](#)
 - parma_polyhedra_library::PIP_Problem, [78](#)
 - parma_polyhedra_library::Polyhedron, [104](#)
- add_space_dimensions_and_project
 - parma_polyhedra_library::Polyhedron, [104](#)
- add_to_integer_space_dimensions
 - parma_polyhedra_library::MIP_Problem, [64](#)
- affine_image
 - parma_polyhedra_library::Polyhedron, [100](#)
- affine_preimage
 - parma_polyhedra_library::Polyhedron, [100](#)
- ANY_COMPLEXITY
 - PPL_Java_interface, [27](#)
- ascii_dump
 - parma_polyhedra_library::Polyhedron, [96](#)
- banner
 - parma_polyhedra_library::Parma_Polyhedra_Library, [parma_polyhedra_library::PIP_Tree_Node, 82](#)
 - [70](#)
- BHRZ03_widening_assign
 - parma_polyhedra_library::Polyhedron, [107](#)
- BITS_128
 - PPL_Java_interface, [27](#)
- BITS_16
 - PPL_Java_interface, [27](#)
- BITS_32
 - PPL_Java_interface, [27](#)
- BITS_64
 - PPL_Java_interface, [27](#)
- BITS_8
 - PPL_Java_interface, [27](#)
- bounded_affine_image
 - parma_polyhedra_library::Polyhedron, [101](#)
- bounded_affine_preimage
 - parma_polyhedra_library::Polyhedron, [101](#)
- bounded_BHRZ03_extrapolation_assign
 - parma_polyhedra_library::Polyhedron, [108](#)
- bounded_H79_extrapolation_assign
 - parma_polyhedra_library::Polyhedron, [109](#)
- Bounded_Integer_Type_Overflow
 - PPL_Java_interface, [26](#)
- Bounded_Integer_Type_Representation
 - PPL_Java_interface, [26](#)
- Bounded_Integer_Type_Width
 - PPL_Java_interface, [26](#)
- bounds_from_above
 - parma_polyhedra_library::Polyhedron, [92](#)
- bounds_from_below
 - parma_polyhedra_library::Polyhedron, [93](#)
- C_Polyhedron
 - parma_polyhedra_library::C_Polyhedron, [39, 40](#)
- clear
 - parma_polyhedra_library::MIP_Problem, [64](#)
 - parma_polyhedra_library::PIP_Problem, [78](#)
- CLOSURE_POINT
 - PPL_Java_interface, [28](#)
- closure_point
 - parma_polyhedra_library::Generator, [47](#)
- Coefficient
 - parma_polyhedra_library::Coefficient, [42](#)
- Complexity_Class
 - PPL_Java_interface, [27](#)
- concatenate_assign
 - parma_polyhedra_library::Polyhedron, [105](#)
- constrains
 - parma_polyhedra_library::Polyhedron, [92](#)
- constraints
- contains
 - parma_polyhedra_library::Polyhedron, [95](#)
- Control_Parameter_Name
 - PPL_Java_interface, [27](#)
- Control_Parameter_Value
 - PPL_Java_interface, [27](#)
- CUTTING_STRATEGY
 - PPL_Java_interface, [29](#)
- CUTTING_STRATEGY_ALL
 - PPL_Java_interface, [29](#)
- CUTTING_STRATEGY_DEEPEST
 - PPL_Java_interface, [29](#)
- CUTTING_STRATEGY_FIRST
 - PPL_Java_interface, [29](#)
- Degenerate_Element

- PPL_Java_interface, 27
- difference_assign
 - parma_polyhedra_library::Polyhedron, 99
- divisor
 - parma_polyhedra_library::Generator, 48
 - parma_polyhedra_library::Grid_Generator, 50
- EMPTY
 - PPL_Java_interface, 28
- EQUAL
 - PPL_Java_interface, 30
- evaluate_objective_function
 - parma_polyhedra_library::MIP_Problem, 65
- expand_space_dimension
 - parma_polyhedra_library::Polyhedron, 106
- feasible_point
 - parma_polyhedra_library::MIP_Problem, 66
- finalize_library
 - parma_polyhedra_library::Parma_Polyhedra_Library, 70
- fold_space_dimensions
 - parma_polyhedra_library::Polyhedron, 106
- generalized_affine_image
 - parma_polyhedra_library::Polyhedron, 101, 102
- generalized_affine_preimage
 - parma_polyhedra_library::Polyhedron, 102, 103
- Generator_Type
 - PPL_Java_interface, 28
- get_disjunct
 - parma_polyhedra_library::Pointset_Powerset_C_Polyhedron_Iterator, 84
- GREATER_OR_EQUAL
 - PPL_Java_interface, 30
- GREATER_THAN
 - PPL_Java_interface, 30
- Grid_Generator_Type
 - PPL_Java_interface, 28
- grid_line
 - parma_polyhedra_library::Grid_Generator, 50
- grid_point
 - parma_polyhedra_library::Grid_Generator, 50
- H79_widening_assign
 - parma_polyhedra_library::Polyhedron, 107
- has_empty_codomain
 - parma_polyhedra_library::Partial_Function, 73
- hashCode
 - parma_polyhedra_library::Polyhedron, 96
- initialize_library
 - parma_polyhedra_library::Parma_Polyhedra_Library, 70
- intersection_assign
 - parma_polyhedra_library::Polyhedron, 99
- is_disjoint_from
 - parma_polyhedra_library::Polyhedron, 96
- is_satisfiable
 - parma_polyhedra_library::MIP_Problem, 65
 - parma_polyhedra_library::PIP_Problem, 79
- Java Language Interface, 22
- LESS_OR_EQUAL
 - PPL_Java_interface, 30
- LESS_THAN
 - PPL_Java_interface, 30
- limited_BHRZ03_extrapolation_assign
 - parma_polyhedra_library::Polyhedron, 108
- limited_H79_extrapolation_assign
 - parma_polyhedra_library::Polyhedron, 108
- LINE
 - PPL_Java_interface, 28
- linear_partition
 - parma_polyhedra_library::C_Polyhedron, 40
- map_space_dimensions
 - parma_polyhedra_library::Polyhedron, 106
- maps
 - parma_polyhedra_library::Partial_Function, 73
- MAXIMIZATION
 - PPL_Java_interface, 29
- maximize
 - parma_polyhedra_library::Polyhedron, 93, 94
- MINIMIZATION
 - PPL_Java_interface, 29
- minimize
 - parma_polyhedra_library::Polyhedron, 93, 94
- MIP_Problem
 - parma_polyhedra_library::MIP_Problem, 63
- MIP_Problem_Status
 - PPL_Java_interface, 28
- optimal_value
 - parma_polyhedra_library::MIP_Problem, 66
- Optimization_Mode
 - PPL_Java_interface, 28
- OPTIMIZED_MIP_PROBLEM
 - PPL_Java_interface, 28
- OPTIMIZED_PIP_PROBLEM
 - PPL_Java_interface, 29
- optimizing_point
 - parma_polyhedra_library::MIP_Problem, 66
- OVERFLOW_IMPOSSIBLE
- OVERFLOW_UNDEFINED

- PPL_Java_interface, 26
- OVERFLOW_WRAPS
 - PPL_Java_interface, 26
- PARAMETER
 - PPL_Java_interface, 28
- parameter
 - parma_polyhedra_library::Grid_Generator, 50
- parametric_values
 - parma_polyhedra_library::PIP_Solution_Node, 80
- parma_polyhedra_library, 30
- parma_polyhedra_library::Artificial_Parameter, 35
- parma_polyhedra_library::Artificial_Parameter_Sequence, 36
- parma_polyhedra_library::BD_Shape_double, 36
- parma_polyhedra_library::BD_Shape_mpq_class, 36
- parma_polyhedra_library::BD_Shape_mpz_class, 36
- parma_polyhedra_library::By_Reference< T >, 37
- parma_polyhedra_library::C_Polyhedron, 37
 - C_Polyhedron, 39, 40
 - linear_partition, 40
 - upper_bound_assign_if_exact, 40
- parma_polyhedra_library::Coefficient, 41
 - Coefficient, 42
- parma_polyhedra_library::Congruence, 42
- parma_polyhedra_library::Congruence_System, 43
- parma_polyhedra_library::Constraint, 44
- parma_polyhedra_library::Constraint_System, 44
- parma_polyhedra_library::Constraints_Product_C_-Polyhedron_Grid, 45
- parma_polyhedra_library::Domain_Error_Exception, 45
- parma_polyhedra_library::Double_Box, 45
- parma_polyhedra_library::Generator, 46
 - closure_point, 47
 - divisor, 48
 - line, 47
 - point, 47
 - ray, 47
- parma_polyhedra_library::Generator_System, 48
- parma_polyhedra_library::Grid, 48
- parma_polyhedra_library::Grid_Generator, 49
 - divisor, 50
 - grid_line, 50
 - grid_point, 50
 - parameter, 50
- parma_polyhedra_library::Grid_Generator_System, 51
- parma_polyhedra_library::Invalid_Argument_Exception, 51
- parma_polyhedra_library::IO, 51
 - wrap_string, 52
- parma_polyhedra_library::Length_Error_Exception, 52
- parma_polyhedra_library::Linear_Expression, 53
- parma_polyhedra_library::Linear_Expression_Coefficient, 54
- parma_polyhedra_library::Linear_Expression_Difference, 55
- parma_polyhedra_library::Linear_Expression_Sum, 56
- parma_polyhedra_library::Linear_Expression_Times, 57
- parma_polyhedra_library::Linear_Expression_Unary_Minus, 58
- parma_polyhedra_library::Linear_Expression_Variable, 59
- parma_polyhedra_library::Logic_Error_Exception, 60
- parma_polyhedra_library::MIP_Problem, 60
 - add_constraint, 64
 - add_constraints, 65
 - add_space_dimensions_and_embed, 64
 - add_to_integer_space_dimensions, 64
 - clear, 64
 - evaluate_objective_function, 65
 - feasible_point, 66
 - is_satisfiable, 65
 - MIP_Problem, 63
 - optimal_value, 66
 - optimizing_point, 66
 - set_objective_function, 65
 - solve, 65
- parma_polyhedra_library::NNC_Polyhedron, 67
- parma_polyhedra_library::Octagonal_Shape_double, 67
- parma_polyhedra_library::Octagonal_Shape_mpq_class, 67
- parma_polyhedra_library::Octagonal_Shape_mpz_class, 68
- parma_polyhedra_library::Overflow_Error_Exception, 68
- parma_polyhedra_library::Pair< K, V >, 68
- parma_polyhedra_library::Parma_Polyhedra_Library, 69
 - banner, 70
 - finalize_library, 70
 - initialize_library, 70
 - restore_pre_PPL_rounding, 71
 - set_deterministic_timeout, 72
 - set_irrational_precision, 71
 - set_rounding_for_PPL, 71
 - set_timeout, 71
- parma_polyhedra_library::Partial_Function, 72
 - has_empty_codomain, 73
 - maps, 73
- parma_polyhedra_library::PIP_Decision_Node, 73

- parma_polyhedra_library::PIP_Problem, 74
 - add_constraint, 78
 - add_constraints, 79
 - add_space_dimensions_and_embed, 78
 - clear, 78
 - is_satisfiable, 79
 - PIP_Problem, 77, 78
 - solve, 79
- parma_polyhedra_library::PIP_Solution_Node, 79
 - parametric_values, 80
- parma_polyhedra_library::PIP_Tree_Node, 80
 - constraints, 82
- parma_polyhedra_library::Pointset_Powerset_C_Polyhedron, 82
 - size, 83
- parma_polyhedra_library::Pointset_Powerset_C_Polyhedron_
 - Iterator, 83
 - get_disjunct, 84
- parma_polyhedra_library::Pointset_Powerset_NNC_
 - Polyhedron, 84
- parma_polyhedra_library::Pointset_Powerset_NNC_
 - Polyhedron_Iterator, 85
- parma_polyhedra_library::Poly_Con_Relation, 85
- parma_polyhedra_library::Poly_Gen_Relation, 86
- parma_polyhedra_library::Polyhedron, 86
 - add_congruence, 97
 - add_congruences, 97
 - add_constraint, 96
 - add_constraints, 97
 - add_generator, 106
 - add_generators, 107
 - add_space_dimensions_and_embed, 104
 - add_space_dimensions_and_project, 104
 - affine_image, 100
 - affine_preimage, 100
 - ascii_dump, 96
 - BHRZ03_widening_assign, 107
 - bounded_affine_image, 101
 - bounded_affine_preimage, 101
 - bounded_BHRZ03_extrapolation_assign, 108
 - bounded_H79_extrapolation_assign, 109
 - bounds_from_above, 92
 - bounds_from_below, 93
 - concatenate_assign, 105
 - constrains, 92
 - contains, 95
 - difference_assign, 99
 - expand_space_dimension, 106
 - fold_space_dimensions, 106
 - generalized_affine_image, 101, 102
 - generalized_affine_preimage, 102, 103
 - H79_widening_assign, 107
 - hashCode, 96
 - intersection_assign, 99
 - is_disjoint_from, 96
 - limited_BHRZ03_extrapolation_assign, 108
 - limited_H79_extrapolation_assign, 108
 - map_space_dimensions, 106
 - maximize, 93, 94
 - minimize, 93, 94
 - refine_with_congruence, 98
 - refine_with_congruences, 98
 - refine_with_constraint, 98
 - refine_with_constraints, 98
 - relation_with, 95
 - remove_higher_space_dimensions, 105
 - remove_space_dimensions, 105
 - simplify_using_context_assign, 100
 - strictly_contains, 96
 - swap, 104
 - time_elapse_assign, 99
 - unconstrain_space_dimension, 103
 - unconstrain_space_dimensions, 103
 - upper_bound_assign, 99
 - widening_assign, 104
- parma_polyhedra_library::Rational_Box, 109
- parma_polyhedra_library::Timeout_Exception, 110
- parma_polyhedra_library::Variable, 110
 - Variable, 111
- parma_polyhedra_library::Variables_Set, 111
- PIP_Problem
 - parma_polyhedra_library::PIP_Problem, 77, 78
- PIP_Problem_Control_Parameter_Name
 - PPL_Java_interface, 29
- PIP_Problem_Control_Parameter_Value
 - PPL_Java_interface, 29
- PIP_Problem_Status
 - PPL_Java_interface, 29
- PIVOT_ROW_STRATEGY
 - PPL_Java_interface, 29
- PIVOT_ROW_STRATEGY_FIRST
 - PPL_Java_interface, 29
- PIVOT_ROW_STRATEGY_MAX_COLUMN
 - PPL_Java_interface, 29
- POINT
 - PPL_Java_interface, 28
- point
 - parma_polyhedra_library::Generator, 47
- POLYNOMIAL_COMPLEXITY
 - PPL_Java_interface, 27
- PPL_Java_interface
 - ANY_COMPLEXITY, 27
 - BITS_128, 27
 - BITS_16, 27
 - BITS_32, 27
 - BITS_64, 27
 - BITS_8, 27
 - CLOSURE_POINT, 28

- CUTTING_STRATEGY, 29
- CUTTING_STRATEGY_ALL, 29
- CUTTING_STRATEGY_DEEPEST, 29
- CUTTING_STRATEGY_FIRST, 29
- EMPTY, 28
- EQUAL, 30
- GREATER_OR_EQUAL, 30
- GREATER_THAN, 30
- LESS_OR_EQUAL, 30
- LESS_THAN, 30
- LINE, 28
- MAXIMIZATION, 29
- MINIMIZATION, 29
- OPTIMIZED_MIP_PROBLEM, 28
- OPTIMIZED_PIP_PROBLEM, 29
- OVERFLOW_IMPOSSIBLE, 26
- OVERFLOW_UNDEFINED, 26
- OVERFLOW_WRAPS, 26
- PARAMETER, 28
- PIVOT_ROW_STRATEGY, 29
- PIVOT_ROW_STRATEGY_FIRST, 29
- PIVOT_ROW_STRATEGY_MAX_COLUMN, 29
- POINT, 28
- POLYNOMIAL_COMPLEXITY, 27
- PRICING, 27
- PRICING_STEEPEST_EDGE_EXACT, 27
- PRICING_STEEPEST_EDGE_FLOAT, 27
- PRICING_TEXTBOOK, 27
- RAY, 28
 - PPL_Java_interface, 27
- SIGNED_2_COMPLEMENT, 26
- SIMPLEX_COMPLEXITY, 27
- UNBOUNDED_MIP_PROBLEM, 28
- UNFEASIBLE_MIP_PROBLEM, 28
- UNFEASIBLE_PIP_PROBLEM, 29
- UNIVERSE, 28
- UNSIGNED, 26
- PPL_Java_interface
 - Bounded_Integer_Type_Overflow, 26
 - Bounded_Integer_Type_Representation, 26
 - Bounded_Integer_Type_Width, 26
 - Complexity_Class, 27
 - Control_Parameter_Name, 27
 - Control_Parameter_Value, 27
 - Degenerate_Element, 27
 - Generator_Type, 28
 - Grid_Generator_Type, 28
 - MIP_Problem_Status, 28
 - Optimization_Mode, 28
 - PIP_Problem_Control_Parameter_Name, 29
 - PIP_Problem_Control_Parameter_Value, 29
 - PIP_Problem_Status, 29
 - Relation_Symbol, 29
 - PPL_Java_interface, 27
- PRICING
 - PPL_Java_interface, 27
- PRICING_STEEPEST_EDGE_EXACT
 - PPL_Java_interface, 27
- PRICING_STEEPEST_EDGE_FLOAT
 - PPL_Java_interface, 27
- PRICING_TEXTBOOK
 - PPL_Java_interface, 27
- RAY
 - PPL_Java_interface, 28
- ray
 - parma_polyhedra_library::Generator, 47
- refine_with_congruence
 - parma_polyhedra_library::Polyhedron, 98
- refine_with_congruences
 - parma_polyhedra_library::Polyhedron, 98
- refine_with_constraint
 - parma_polyhedra_library::Polyhedron, 98
- refine_with_constraints
 - parma_polyhedra_library::Polyhedron, 98
- Relation_Symbol
 - PPL_Java_interface, 29
- relation_with
 - parma_polyhedra_library::Polyhedron, 95
- remove_higher_space_dimensions
 - parma_polyhedra_library::Polyhedron, 105
- remove_space_dimensions
 - parma_polyhedra_library::Polyhedron, 105
- restore_pre_PPL_rounding
 - parma_polyhedra_library::Parma_Polyhedra_Library, 71
- set_deterministic_timeout
 - parma_polyhedra_library::Parma_Polyhedra_Library, 72
- set_irrational_precision
 - parma_polyhedra_library::Parma_Polyhedra_Library, 71
- set_objective_function
 - parma_polyhedra_library::MIP_Problem, 65
- set_rounding_for_PPL
 - parma_polyhedra_library::Parma_Polyhedra_Library, 71
- set_timeout
 - parma_polyhedra_library::Parma_Polyhedra_Library, 71
- SIGNED_2_COMPLEMENT
 - PPL_Java_interface, 26
- SIMPLEX_COMPLEXITY
 - PPL_Java_interface, 27
- simplify_using_context_assign
 - parma_polyhedra_library::Polyhedron, 100
- size

- parma_polyhedra_library::Pointset_Powerset_
C_Polyhedron, 83
- solve
 - parma_polyhedra_library::MIP_Problem, 65
 - parma_polyhedra_library::PIP_Problem, 79
- strictly_contains
 - parma_polyhedra_library::Polyhedron, 96
- swap
 - parma_polyhedra_library::Polyhedron, 104
- time_elapse_assign
 - parma_polyhedra_library::Polyhedron, 99
- UNBOUNDED_MIP_PROBLEM
 - PPL_Java_interface, 28
- unconstrain_space_dimension
 - parma_polyhedra_library::Polyhedron, 103
- unconstrain_space_dimensions
 - parma_polyhedra_library::Polyhedron, 103
- UNFEASIBLE_MIP_PROBLEM
 - PPL_Java_interface, 28
- UNFEASIBLE_PIP_PROBLEM
 - PPL_Java_interface, 29
- UNIVERSE
 - PPL_Java_interface, 28
- UNSIGNED
 - PPL_Java_interface, 26
- upper_bound_assign
 - parma_polyhedra_library::Polyhedron, 99
- upper_bound_assign_if_exact
 - parma_polyhedra_library::C_Polyhedron, 40
- Variable
 - parma_polyhedra_library::Variable, 111
- widening_assign
 - parma_polyhedra_library::Polyhedron, 104
- wrap_string
 - parma_polyhedra_library::IO, 52