



The Parma Polyhedra Library
Java Language Interface
User's Manual*
(version 1.1pre9)

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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.) implemented 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.ParmaPolyhedraLibrary`;
 - 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.
- A *system* of constraints (i.e., an instance of class `parma_polyhedra_library.Constraint_System`) is implemented by extending class `java.util.ArrayList` (note: `java.util.Vector` was used up to version 1.0.) As a consequence, it is possible to iterate over the constraints in the system by using corresponding inherited methods. Similarly, it is possible to modify a system of constraints by using methods such as `add`; be warned, however, that the constraint system obtained from a PPL object is a *copy* of the (C++) data structure used in the object itself: any modification will not directly affect the original PPL object; clearly, the modified constraint system can be used with appropriate methods to, e.g., build a new PPL object or modify an existing one. The same observations apply to systems of congruences and systems of (grid) generators.

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4.1 Modules

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5.1 Namespace List

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7.1 Class List

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8 Module Documentation

8.1 Java Language Interface

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The PPL Java interface package.

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A sequence of artificial parameters.
- enum [`parma_polyhedra_library.Bounded_Integer_Type_Overflow`](#)
Overflow behavior of bounded integer types.
- enum [`parma_polyhedra_library.Bounded_Integer_Type_Representation`](#)
Representation of bounded integer types.
- enum [`parma_polyhedra_library.Bounded_Integer_Type_Width`](#)
Widths of bounded integer types.
- 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.
- enum [`parma_polyhedra_library.Complexity_Class`](#)
Possible Complexities.
- class [`parma_polyhedra_library.Congruence`](#)
A linear congruence.
- class [`parma_polyhedra_library.Congruence_System`](#)
A system of congruences.
- class [`parma_polyhedra_library.Constraint`](#)
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- class [`parma_polyhedra_library.Constraint_System`](#)
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- enum [`parma_polyhedra_library.Control_Parameter_Name`](#)
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- Possible values for MIP problem's control parameters.*

 - enum [parma_polyhedra_library.Degenerate_Element](#)
- Kinds of degenerate abstract elements.*

 - 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](#)
- A topologically closed convex 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.*

 - enum [parma_polyhedra_library.Generator_Type](#)
- The generator type.*

 - 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.*

 - enum [parma_polyhedra_library.Grid_Generator_Type](#)
- The grid generator type.*

 - 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.
 - enum `parma_polyhedra_library.MIP_Problem_Status`

*Possible outcomes of the *MIP_Problem* solver.*
 - enum `parma_polyhedra_library.Optimization_Mode`

Possible optimization modes.
 - 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.
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 - enum `parma_polyhedra_library.PIP_Problem_Control_Parameter_Value`

Possible values for PIP problems' control parameters.
 - enum `parma_polyhedra_library.PIP_Problem_Status`

*Possible outcomes of the *PIP_Problem* solver.*
 - class `parma_polyhedra_library.Poly_Con_Relation`

The relation between a polyhedron and a constraint.
 - enum `parma_polyhedra_library.Relation_Symbol`

Relation symbols.
 - class `parma_polyhedra_library.Timeout_Exception`

Exceptions caused by timeout expiring.
 - class `parma_polyhedra_library.Variable`

A dimension of the vector space.
 - interface `parma_polyhedra_library.Variable_Stringifier`

*An interface for objects converting a *Variable* id to a string.*

8.1.1 Detailed Description

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

9 Namespace Documentation

9.1 Package `parma_polyhedra_library`

The PPL Java interface package.

Classes

- class [Artificial_Parameter](#)
- class [Artificial_Parameter_Sequence](#)
A sequence of artificial parameters.
- enum [Bounded_Integer_Type_Overflow](#)
Overflow behavior of bounded integer types.
- enum [Bounded_Integer_Type_Representation](#)
Representation of bounded integer types.
- enum [Bounded_Integer_Type_Width](#)
Widths of bounded integer types.
- class [By_Reference< T >](#)
An utility class implementing mutable and non-mutable call-by-reference.
- class [Coefficient](#)
A PPL coefficient.
- enum [Complexity_Class](#)
Possible Complexities.
- 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.
- enum [Control_Parameter_Name](#)
Names of MIP problems' control parameters.
- enum [Control_Parameter_Value](#)
Possible values for MIP problem's control parameters.
- enum [Degenerate_Element](#)
Kinds of degenerate abstract elements.
- class [Domain_Error_Exception](#)
Exceptions caused by domain errors.
- class [Polyhedron](#)
The Java base class for (C and NNC) convex polyhedra.
- class [C_Polyhedron](#)
A topologically closed convex polyhedron.
- 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.
- enum [Generator_Type](#)
The generator type.

- class [Grid_Generator](#)
A grid line, parameter or grid point.
- class [Grid_Generator_System](#)
A system of grid generators.
- enum [Grid_Generator_Type](#)
The grid generator type.
- 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.
- enum [MIP_Problem_Status](#)
Possible outcomes of the [MIP_Problem](#) solver.
- enum [Optimization_Mode](#)
Possible optimization modes.
- 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.

- enum [PIP_Problem_Control_Parameter_Name](#)
Names of PIP problems' control parameters.
- enum [PIP_Problem_Control_Parameter_Value](#)
Possible values for PIP problems' control parameters.
- enum [PIP_Problem_Status](#)
*Possible outcomes of the *PIP_Problem* solver.*
- class [PIP_Solution_Node](#)
A leaf node of the PIP solution tree.
- class [PIP_Tree_Node](#)
A node of the PIP solution tree.
- class [Poly_Con_Relation](#)
The relation between a polyhedron and a constraint.
- class [Poly_Gen_Relation](#)
The relation between a polyhedron and a generator.
- enum [Relation_Symbol](#)
Relation symbols.
- class [Timeout_Exception](#)
Exceptions caused by timeout expiring.
- class [Variable](#)
A dimension of the vector space.
- interface [Variable_Stringifier](#)
*An interface for objects converting a *Variable* id to a string.*
- class [Variables_Set](#)
*A *java.util.TreeSet* of variables' indexes.*

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.

Inherits `ArrayList< Artificial_Parameter >`.

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.Bounded_Integer_Type_Overflow` Enum Reference

Overflow behavior of bounded integer types.

Public Attributes

- [OVERFLOW_WRAPS](#)
On overflow, wrapping takes place.
- [OVERFLOW_UNDEFINED](#)
On overflow, the result is undefined.

10.3.1 Detailed Description

Overflow behavior of bounded integer types.

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

- `Bounded_Integer_Type_Overflow.java`

10.4 `parma_polyhedra_library.Bounded_Integer_Type_Representation` Enum Reference

Representation of bounded integer types.

Public Attributes

- [UNSIGNED](#)
Unsigned binary.

10.4.1 Detailed Description

Representation of bounded integer types.

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

- `Bounded_Integer_Type_Representation.java`

10.5 `parma_polyhedra_library.Bounded_Integer_Type_Width` Enum Reference

Widths of bounded integer types.

Public Attributes

- [BITS_8](#)
Minimization is requested.
- [BITS_16](#)
16 bits.
- [BITS_32](#)
32 bits.
- [BITS_64](#)
64 bits.

10.5.1 Detailed Description

Widths of bounded integer types.

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

- `Bounded_Integer_Type_Width.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.

10.6.1 Detailed Description

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

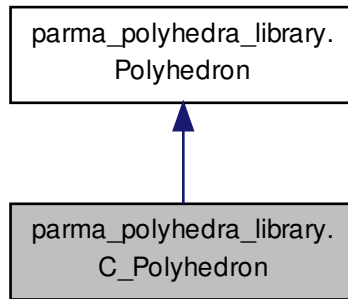
The documentation for this class was generated from the following file:

- `By_Reference.java`

10.7 `parma_polyhedra_library.C_Polyhedron` Class Reference

A topologically closed convex 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

A topologically closed convex polyhedron.

10.7.2 Constructor & Destructor Documentation

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.

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.

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*.

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*.

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.

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

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 <i>this</i> and <i>y</i> are dimension-incompatible.
--	--

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 file:

- 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

parma_polyhedra_library.Coefficient.Coefficient (String s) [inline] Builds a coefficient from the decimal representation in *s*.

Exceptions

<i>java.lang.NumberFormat-Exception</i>	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.Complexity_Class Enum Reference

Possible Complexities.

Public Attributes

- [POLYNOMIAL_COMPLEXITY](#)

Worst-case polynomial complexity.

- [SIMPLEX_COMPLEXITY](#)

Worst-case exponential complexity but typically polynomial behavior.

10.9.1 Detailed Description

Possible Complexities.

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

- Complexity_Class.java

10.10 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.

10.10.1 Detailed Description

A linear congruence.

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

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

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

10.11 parma_polyhedra library.Congruence_System Class Reference

A system of congruences.

Inherits `ArrayList< Congruence >`.

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`.

10.11.1 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

10.12 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`.

10.12.1 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](#)

10.13 `parma_polyhedra_library.Constraint_System` Class Reference

A system of constraints.

Inherits `ArrayList< Constraint >`.

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`.

10.13.1 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](#)

10.14 `parma_polyhedra_library.Control_Parameter_Name` Enum Reference

Names of MIP problems' control parameters.

Public Attributes

- [PRICING](#)

The pricing rule.

10.14.1 Detailed Description

Names of MIP problems' control parameters.

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

- `Control_Parameter_Name.java`

10.15 `parma_polyhedra_library.Control_Parameter_Value` Enum Reference

Possible values for MIP problem's control parameters.

Public Attributes

- [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.

10.15.1 Detailed Description

Possible values for MIP problem's control parameters.

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

- `Control_Parameter_Value.java`

10.16 `parma_polyhedra_library.Degenerate_Element` Enum Reference

Kinds of degenerate abstract elements.

Public Attributes

- [UNIVERSE](#)

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

10.16.1 Detailed Description

Kinds of degenerate abstract elements.

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

- `Degenerate_Element.java`

10.17 `parma_polyhedra_library.Domain_Error_Exception` Class Reference

Exceptions caused by domain errors.

Inherits `RuntimeException`.

Public Member Functions

- [Domain_Error_Exception](#) (String s)

Constructor.

10.17.1 Detailed Description

Exceptions caused by domain errors.

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

- Domain_Error_Exception.java

10.18 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 .

10.18.1 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.

10.18.2 Member Function Documentation

static Generator `parma_polyhedra_library.Generator.closure_point (Linear_Expression e, Coefficient d) [inline], [static]` Returns the closure point at e / d .

Exceptions

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

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 <i>e</i> represents the origin of the vector space.
------------------------------	---

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 <i>d</i> is zero.
------------------------------	-----------------------------

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 <i>e</i> represents the origin of the vector space.
------------------------------	---

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 <i>this</i> is neither a point nor a closure point.
------------------------------	---

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

- `Generator.java`

10.19 parma_polyhedra_library.Generator_System Class Reference

A system of generators.

Inherits `ArrayList< Generator >`.

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`.

10.19.1 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

10.20 `parma_polyhedra_library`.Generator_Type Enum Reference

The generator type.

Public Attributes

- [LINE](#)

The generator is a line.

- [RAY](#)

The generator is a ray.

- [POINT](#)

The generator is a point.

10.20.1 Detailed Description

The generator type.

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

- Generator_Type.java

10.21 `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 .

10.21.1 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`.

10.21.2 Member Function Documentation

static `Grid_Generator` `parma_polyhedra_library.Grid_Generator.grid_line` (`Linear_Expression e`)
[inline], [static] Returns the line of direction e .

Exceptions

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

static `Grid_Generator` `parma_polyhedra_library.Grid_Generator.parameter` (`Linear_Expression e`, `Coefficient d`)
[inline], [static] Returns the parameter at e / d .

Exceptions

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

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

`Coefficient` `parma_polyhedra_library.Grid_Generator.divisor` ()
[inline] If `this` is either a grid point or a parameter, returns its divisor.

Exceptions

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

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

- `Grid_Generator.java`

10.22 `parma_polyhedra_library.Grid_Generator_System` Class Reference

A system of grid generators.

Inherits `ArrayList< Grid_Generator >`.

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`.

10.22.1 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`

10.23 `parma_polyhedra_library.Grid_Generator_Type` Enum Reference

The grid generator type.

Public Attributes

- [LINE](#)
The generator is a line.
- [PARAMETER](#)
The generator is a parameter.

10.23.1 Detailed Description

The grid generator type.

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

- `Grid_Generator_Type.java`

10.24 `parma_polyhedra_library.Invalid_Argument_Exception` Class Reference

Exceptions caused by invalid arguments.

Inherits `RuntimeException`.

Public Member Functions

- [Invalid_Argument_Exception](#) (String `s`)
Constructor.

10.24.1 Detailed Description

Exceptions caused by invalid arguments.

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

- [Invalid_Argument_Exception.java](#)

10.25 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.

10.25.1 Detailed Description

A class collecting I/O functions.

10.25.2 Member Function Documentation

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](#)

10.26 parma_polyhedra_library.Length_Error_Exception Class Reference

Exceptions caused by too big length/size values.

Inherits RuntimeException.

Public Member Functions

- [Length_Error_Exception](#) (String s)

Constructor.

10.26.1 Detailed Description

Exceptions caused by too big length/size values.

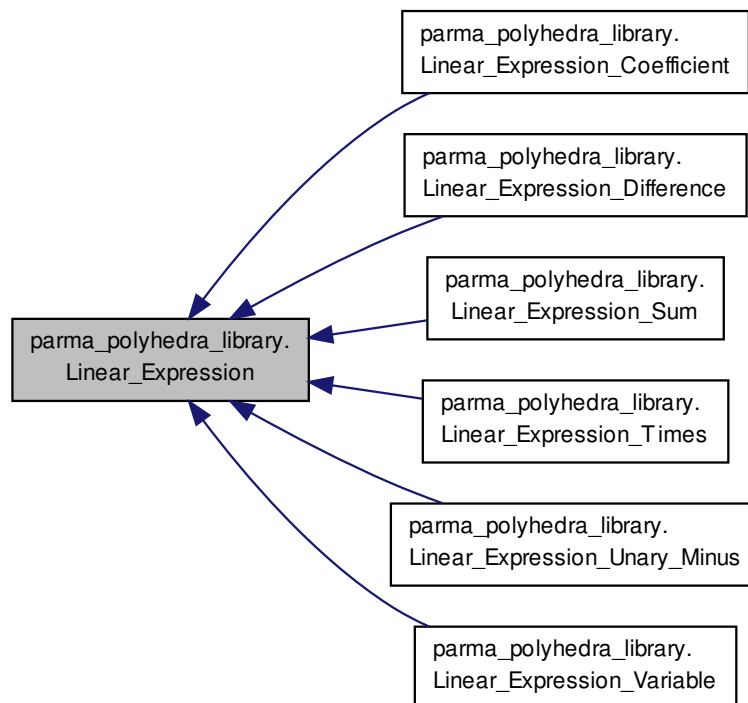
The documentation for this class was generated from the following file:

- `Length_Error_Exception.java`

10.27 `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.

10.27.1 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](#).

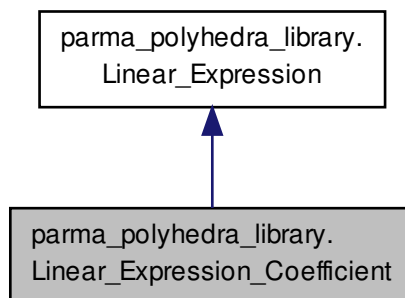
The documentation for this class was generated from the following file:

- [Linear.Expression.java](#)

10.28 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.

10.28.1 Detailed Description

A linear expression built from a coefficient.

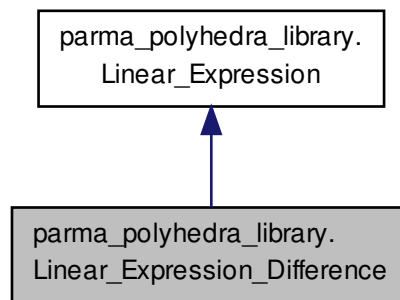
The documentation for this class was generated from the following file:

- `Linear_Expression_Coefficient.java`

10.29 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`.

10.29.1 Detailed Description

The difference of two linear expressions.

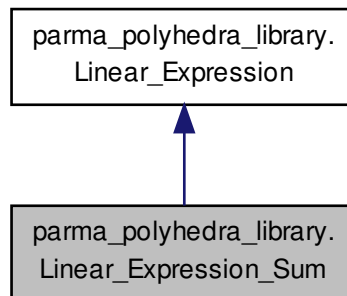
The documentation for this class was generated from the following file:

- `Linear_Expression_Difference.java`

10.30 `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`.

10.30.1 Detailed Description

The sum of two linear expressions.

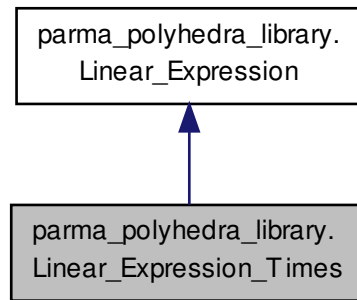
The documentation for this class was generated from the following file:

- `Linear_Expression_Sum.java`

10.31 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.

10.31.1 Detailed Description

The product of a linear expression and a coefficient.

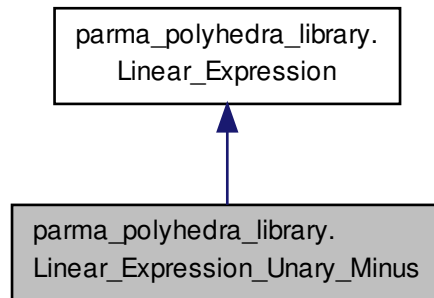
The documentation for this class was generated from the following file:

- [Linear_Expression_Times.java](#)

10.32 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.

10.32.1 Detailed Description

The negation of a linear expression.

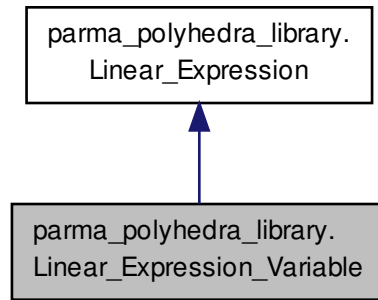
The documentation for this class was generated from the following file:

- `Linear_Expression_Unary_Minus.java`

10.33 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.

10.33.1 Detailed Description

A linear expression built from a variable.

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

- Linear_Expression_Variable.java

10.34 parma_polyhedra_library.Logic_Error_Exception Class Reference

Exceptions due to errors in low-level routines.

Inherits RuntimeException.

Public Member Functions

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

10.34.1 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

10.35 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.

Additional Inherited Members

10.35.1 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.

10.35.2 Constructor & Destructor Documentation

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 <code>this</code> .
------------	---

Exceptions

Length_Error_Exception	Thrown if <code>dim</code> exceeds <code>max_space_dimension()</code> .
--	---

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 <code>this</code> .
<i>cs</i>	The constraint system defining the feasible region.
<i>obj</i>	The objective function.
<i>mode</i>	The optimization mode.

Exceptions

Length_Error_Exception	Thrown if <code>dim</code> exceeds <code>max_space_dimension()</code> .
Invalid_Argument_Exception	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 <code>dim</code> .

10.35.3 Member Function Documentation

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.

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

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> .
--	--

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

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>Invalid Argument_-Exception</i>	Thrown if some index in <i>i_vars</i> does not correspond to a space dimension in <i>this</i> .
------------------------------------	---

native void parma_polyhedra_library.MIP_Problem.add_constraint (Constraint *c*) Adds a copy of constraint *c* to the MIP problem.

Exceptions

<i>Invalid Argument_-Exception</i>	Thrown if the constraint <i>c</i> is a strict inequality or if its space dimension is strictly greater than the space dimension of <i>this</i> .
------------------------------------	--

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>Invalid Argument_-Exception</i>	Thrown if the constraint system <i>cs</i> contains any strict inequality or if its space dimension is strictly greater than the space dimension of <i>this</i> .
------------------------------------	--

native void parma_polyhedra_library.MIP_Problem.set_objective_function (Linear_Expression *obj*) Sets the objective function to *obj*.

Exceptions

<i>Invalid Argument_-Exception</i>	Thrown if the space dimension of <i>obj</i> is strictly greater than the space dimension of <i>this</i> .
------------------------------------	---

native boolean parma_polyhedra_library.MIP_Problem.is_satisfiable () Checks satisfiability of *this*.

Returns

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

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).

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

native Generator parma_polyhedra_library.MIP_Problem.feasible_point () Returns a feasible point for *this*, if it exists.

Exceptions

<i>Domain_Error_Exception</i>	Thrown if the MIP problem is not satisfiable.
---	---

native Generator parma_polyhedra_library.MIP_Problem.optimizing_point () Returns an optimal point for *this*, if it exists.

Exceptions

<i>Domain_Error_Exception</i>	Thrown if <i>this</i> doesn't not have an optimizing point, i.e., if the MIP problem is unbounded or not satisfiable.
---	---

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>Domain_Error_Exception</i>	Thrown if <i>this</i> doesn't not have an optimizing point, i.e., if the MIP problem is unbounded or not satisfiable.
---	---

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

- MIP_Problem.java

10.36 parma_polyhedra_library.MIP_Problem.Status Enum Reference

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

Public Attributes

- [UNFEASIBLE_MIP_PROBLEM](#)

The problem is unfeasible.

- [UNBOUNDED_MIP_PROBLEM](#)

The problem is unbounded.

10.36.1 Detailed Description

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

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

- [MIP_Problem_Status.java](#)

10.37 [parma_polyhedra_library.Optimization_Mode](#) Enum Reference

Possible optimization modes.

Public Attributes

- [MINIMIZATION](#)

Minimization is requested.

10.37.1 Detailed Description

Possible optimization modes.

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

- [Optimization_Mode.java](#)

10.38 [parma_polyhedra_library.Overflow_Error_Exception](#) Class Reference

Exceptions due to overflow errors.

Inherits [RuntimeException](#).

Public Member Functions

- [Overflow_Error_Exception](#) (String s)

Constructor.

10.38.1 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](#)

10.39 [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.

10.39.1 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

10.40 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 csecs)
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 unscaled_weight, int scale)
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.

10.40.1 Detailed Description

A class collecting library-level functions.

10.40.2 Member Function Documentation

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.

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\(\)](#).

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.

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.

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.

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 $2**p$.

static native void parma_polyhedra_library.Parma_Polyhedra_Library.set_timeout(int csecs) [static]

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

Parameters

<i>csecs</i>	The number of centiseconds sometimes after which a timeout will occur; it must be strictly greater than zero.
--------------	---

Computations taking exponential time will be interrupted some time after `csecs` centiseconds 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\(\)](#).

static native void parma_polyhedra_library.Parma.Polyhedra.Library.set_deterministic_timeout (int unscaled_weight, int scale) [static] Sets a threshold for computations whose completion could require an exponential amount of time.

If `unscaled_weight` has value u and `scale` has value s , then the (scaled) weight threshold is computed as $w = u \cdot 2^s$. Computations taking exponential time will be interrupted some time after reaching the complexity threshold w , 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()`.

Parameters

<i>unscaled_weight</i>	The unscaled maximum computational weight; it has to be strictly greater than zero.
<i>scale</i>	The scaling factor to be applied to <code>unscaled_weight</code> ; it has to be non-negative.

Exceptions

<i>Invalid_Argument_Exception</i>	Thrown if the computation of the weight threshold exceeds the maximum allowed value.
-----------------------------------	--

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 beta 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`

10.41 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`.

10.41.1 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`.

10.41.2 Member Function Documentation

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.

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`.

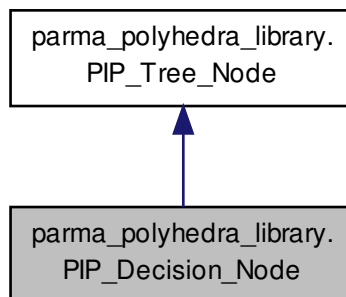
The documentation for this class was generated from the following file:

- `Partial_Function.java`

10.42 `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.

Additional Inherited Members

10.42.1 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](#)

10.43 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](#) ()

- native long `external_memory_in_bytes ()`
Returns the size in bytes of the memory occupied by the underlying C++ object.
- native boolean `OK ()`
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.

10.43.1 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.

10.43.2 Constructor & Destructor Documentation

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 <code>this</code> (optional argument with default value 0).
------------	---

Exceptions

<i>Length_Error_Exception</i>	Thrown if <code>dim</code> exceeds <code>max_space_dimension()</code> .
---	---

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.

10.43.3 Member Function Documentation

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.

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.

native void parma_polyhedra_library.PIP_Problem.add_constraint (Constraint *c*) Adds a copy of constraint `c` to the PIP problem.

Exceptions

<i>Invalid_Argument_Exception</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> .
---	--

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>Invalid_Argument_Exception</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> .
---	--

native boolean parma_polyhedra_library.PIP_Problem.is_satisfiable () Checks satisfiability of `this`.

Returns

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

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

10.44 parma_polyhedra_library.PIP_Problem_Control_Parameter_Name Enum Reference

Names of PIP problems' control parameters.

Public Attributes

- [CUTTING_STRATEGY](#)
The cutting strategy rule.
- [PIVOT_ROW_STRATEGY](#)
The pivot row strategy rule.

10.44.1 Detailed Description

Names of PIP problems' control parameters.

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

- PIP_Problem_Control_Parameter_Name.java

10.45 parma_polyhedra_library.PIP_Problem_Control_Parameter_Value Enum Reference

Possible values for PIP problems' control parameters.

Public Attributes

- [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.

10.45.1 Detailed Description

Possible values for PIP problems' control parameters.

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

- PIP_Problem_Control_Parameter_Value.java

10.46 parma_polyhedra_library.PIP_Problem_Status Enum Reference

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

Public Attributes

- [UNFEASIBLE_PIP_PROBLEM](#)

The problem is unsatisfiable.

10.46.1 Detailed Description

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

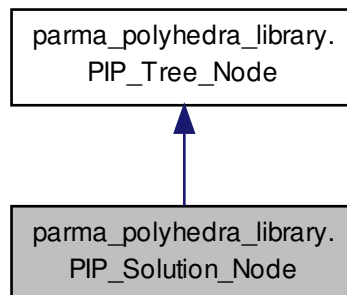
The documentation for this enum was generated from the following file:

- PIP_Problem_Status.java

10.47 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`.

Additional Inherited Members

10.47.1 Detailed Description

A leaf node of the PIP solution tree.

10.47.2 Member Function Documentation

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

<code>var</code>	The variable being queried.
------------------	-----------------------------

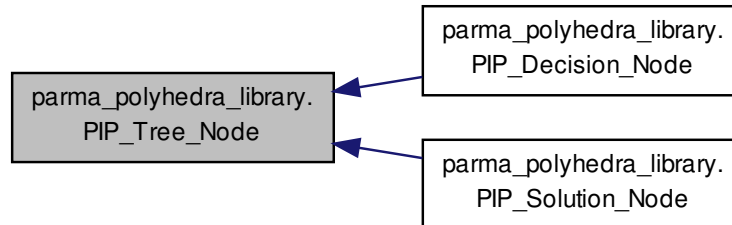
The documentation for this class was generated from the following file:

- `PIP_Solution_Node.java`

10.48 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`.

Additional Inherited Members

10.48.1 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.

10.48.2 Member Function Documentation

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](#)

10.49 parma_polyhedra_library.Pointset_Powerset_C_Polyhedron Class Reference

A powerset of [C_Polyhedron](#) objects.

Inherits [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.

Additional Inherited Members

10.49.1 Detailed Description

A powerset of [C.Polyhedron](#) objects.

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.

10.49.2 Member Function Documentation

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 file:

- Fake_Class_for_Doxygen.java

10.50 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](#).

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.

10.50.1 Detailed Description

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

10.50.2 Member Function Documentation

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 file:

- Fake_Class_for_Doxygen.java

10.51 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.

10.51.1 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

10.52 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.

10.52.1 Detailed Description

The relation between a polyhedron and a generator.

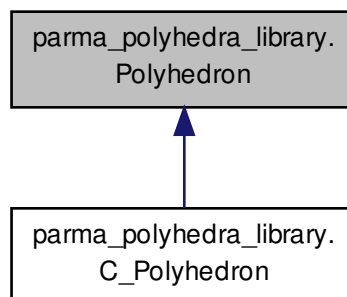
This class implements conjunctions of assertions on the relation between a polyhedron and a generator.
The documentation for this class was generated from the following file:

- [Poly_Gen_Relation.java](#)

10.53 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 c)`
- 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 $lhs' \bowtie rhs$, 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.

Additional Inherited Members

10.53.1 Detailed Description

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

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.

10.53.2 Member Function Documentation

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> .
---	--

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.
---	---

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.
---	---

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.

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.

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.

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.

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.
---	---

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.
---	--

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.
---	---

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.
---	---

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.
---	---

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.
---	--

native int `parma_polyhedra_library.Polyhedron.hashCode ()` Returns a hash code for `this`.

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

native String `parma_polyhedra_library.Polyhedron.ascii_dump ()` Returns a string containing a low-level representation of `this`.

Useful for debugging purposes.

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 <i>this</i> .
----------	---

Exceptions

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

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 <i>this</i> and congruence <i>cg</i> are dimension-incompatible, or if <i>cg</i> is a proper congruence which is neither a tautology, nor a contradiction.
------------------------------------	--

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 <i>this</i> .
-----------	---

Exceptions

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

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.
------------	------------------------------

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.
------------------------------------	--

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 <code>this</code> and constraint <code>c</code> are dimension-incompatible.
---	---

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 <code>this</code> and congruence <code>cg</code> are dimension-incompatible.
---	--

native void parma_polyhedra_library.Polyhedron.refine_with_constraints (Constraint_System cs) Uses a copy of the constraints in `cs` to refine `this`.

Parameters

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

Exceptions

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

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.
---	--

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.
---	---

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.
---	---

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.
-----------------------------------	---

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.
-----------------------------------	---

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.
-----------------------------------	---

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> .
-----------------------------------	--

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> .
-------------------------------------	--

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> .
-------------------------------------	--

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 <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> .
-------------------------------------	--

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* $var' \bowtie \frac{expr}{denominator}$, 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 <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> or if <code>this</code> is a <code>C_Polyhedron</code> and <code>relsym</code> is a strict relation symbol.
------------------------------------	--

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 <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> or if <code>this</code> is a <code>C_Polyhedron</code> and <code>relsym</code> is a strict relation symbol.
------------------------------------	--

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* $\text{lhs}' \bowtie \text{rhs}$, 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.
------------------------------------	---

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* $\text{lhs}' \bowtie \text{rhs}$, 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.
-------------------------------------	---

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> .
-------------------------------------	--

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

<i>vars</i>	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 <code>Variable</code> objects contained in <code>vars</code> .
-------------------------------------	--

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

<i>y</i>	A polyhedron that <i>must</i> be contained in <code>this</code> ;
<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> and <code>y</code> are topology-incompatible or dimension-incompatible.
-------------------------------------	---

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.
-------------------------------------	--

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> .
---	--

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> .
---	--

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 <i>this</i> 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> .

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

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

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

<i>Invalid Argument - Exception</i>	Thrown if <code>new_dimensions</code> is greater than the space dimension of <code>this</code> .
---	--

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

<i>Invalid Argument - Exception</i>	Thrown if <i>var</i> does not correspond to a dimension of the vector space.
<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> .

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 <i>dest</i> or with one of the Variable objects contained in <i>vars</i> . Also thrown if <i>dest</i> is contained in <i>vars</i> .
---	--

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.
--------------	--

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

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 <i>this</i> .
-----------	---

Exceptions

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

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

<i>y</i>	A polyhedron that <i>must</i> be contained in <i>this</i> ;
<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 <i>this</i> and <i>y</i> are topology-incompatible or dimension-incompatible.
------------------------------------	---

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

<i>y</i>	A polyhedron that <i>must</i> be contained in <i>this</i> ;
<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 <i>this</i> and <i>y</i> are topology-incompatible or dimension-incompatible.
------------------------------------	---

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

<i>y</i>	A polyhedron that <i>must</i> be contained in <i>this</i> ;
<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.
-------------------------------------	---

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.
-------------------------------------	---

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.
-------------------------------------	---

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

<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

Invalid_Argument_-Exception	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 file:

- `Fake_Class_for_Doxygen.java`

10.54 `parma_polyhedra_library.Relation_Symbol` Enum Reference

Relation symbols.

Public Attributes

- [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.

10.54.1 Detailed Description

Relation symbols.

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

- `Relation_Symbol.java`

10.55 `parma_polyhedra_library.Timeout_Exception` Class Reference

Exceptions caused by timeout expiring.

Inherits `RuntimeException`.

Public Member Functions

- [Timeout_Exception](#) (String `s`)
Constructor.

10.55.1 Detailed Description

Exceptions caused by timeout expiring.

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

- `Timeout_Exception.java`

10.56 `parma_polyhedra_library.Variable` Class Reference

A dimension of the vector space.

Inherits `Comparable< Variable >`.

Public Member Functions

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

Static Public Member Functions

- static native void [setStringifier](#) ([Variable_Stringifier](#) *vs*)
Sets the variable stringifier object.

10.56.1 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).

10.56.2 Constructor & Destructor Documentation

parma_polyhedra_library.Variable.Variable (long *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.
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10.56.3 Member Function Documentation

static native void parma_polyhedra_library.Variable.setStringifier ([Variable_Stringifier](#) *vs*) [static]
Sets the variable stringifier object.

A variable stringifier object provides customization for the `toString` method; if no variable stringifier object is set (or if it is set to a null reference value), the PPL default variable output function will be used.

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

- [Variable.java](#)

10.57 parma_polyhedra_library.Variable_Stringifier Interface Reference

An interface for objects converting a [Variable](#) id to a string.

10.57.1 Detailed Description

An interface for objects converting a [Variable](#) id to a string.

If customized variable output is required, the user should implement this interface and pass a corresponding instance to [Variable](#)'s static method `setStringifier`.

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

- [Variable_Stringifier.java](#)

10.58 parma_polyhedra_library.Variables_Set Class Reference

A java.util.TreeSet of variables' indexes.

Inherits TreeSet< Variable >.

Public Member Functions

- [Variables_Set](#) ()

Builds the empty set of variable indexes.

10.58.1 Detailed Description

A java.util.TreeSet of variables' indexes.

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

- Variables_Set.java

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