



The Parma Polyhedra Library  
Java Language Interface  
User's Manual\*  
(version 1.0)

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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.Parma_Polyhedra_Library`;
  - Starting from version 0.11, initialize the interface by calling static method `initialize_library()`; when all library work is done, finalize the interface by calling `finalize_library()`.
- The numerical abstract domains available to the Java user as Java classes consist of the *simple* domains, *powersets* of a simple domain and *products* of simple domains. Note that the default configuration will only enable a subset of these domains (if you need a different set of domains, see configuration option `-enable-instantiations`).
  - The simple domains are:
    - \* convex polyhedra, which consist of `C_Polyhedron` and `NNC_Polyhedron`;
    - \* weakly relational, which consist of `BD_Shape_N` and `Octagonal_Shape_N` where `N` is one of the numeric types `signed_char`, `short`, `int`, `long`, `long_long`, `mpz_class`, `mpq_class`;
    - \* boxes which consist of `Int8_Box`, `Int16_Box`, `Int32_Box`, `Int64_Box`, `UInt8_Box`, `UInt16_Box`, `UInt32_Box`, `UInt64_Box`, `Float_Box`, `Double_Box`, `Long_Double_Box`, `Z_Box`, `Rational_Box`; and
    - \* the Grid domain.
  - The powerset domains are `Pointset_Powerset_S` where `S` is a simple domain.
  - The product domains consist of `Direct_Product_S_T`, `Smash_Product_S_T` and `Constraints_Product_S_T` where `S` and `T` are simple domains.



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

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## 4 Module Index



## 4.1 Modules

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### 5.1 Namespace List

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## 8 Module Documentation

### 8.1 Java Language Interface

#### Namespaces

- package [parma\\_polyhedra\\_library](#)  
*The PPL Java interface package.*

#### Classes

- class [parma\\_polyhedra\\_library.Artificial\\_Parameter\\_Sequence](#)  
*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`  
*A linear equality or inequality.*
- class `parma_polyhedra_library.Constraint_System`  
*A system of constraints.*
- enum `parma_polyhedra_library.Control_Parameter_Name`  
*Names of MIP problems' control parameters.*
- enum `parma_polyhedra_library.Control_Parameter_Value`  
*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.*
- enum `parma_polyhedra_library.PIP_Problem_Control_Parameter_Name`  
*Names of PIP problems' control parameters.*
- 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.*



### 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.*
  - 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.

### 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:

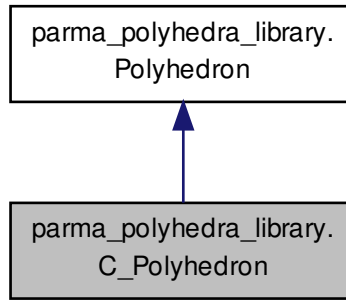
- `By_Reference.java`

## 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

### 10.7.2.1 `parma_polyhedra_library.C_Polyhedron.C_Polyhedron ( long d, Degenerate_Element kind )`

Builds a new C polyhedron of dimension d.

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

### 10.7.2.2 `parma_polyhedra_library.C_Polyhedron.C_Polyhedron ( C_Polyhedron y, Complexity_Class complexity )`

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

The complexity argument is ignored.

### 10.7.2.3 `parma_polyhedra_library.C_Polyhedron.C_Polyhedron ( Constraint_System cs )`

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

The new polyhedron will inherit the space dimension of cs.

### 10.7.2.4 `parma_polyhedra_library.C_Polyhedron.C_Polyhedron ( Congruence_System cgs )`

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

The new polyhedron will inherit the space dimension of cgs.

### 10.7.2.5 `parma_polyhedra_library.C_Polyhedron.C_Polyhedron ( NNC_Polyhedron y, Complexity_Class complexity )`

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

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



### 10.7.2.6 parma\_polyhedra\_library.C\_Polyhedron.C\_Polyhedron ( Generator\_System gs )

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

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

## 10.7.3 Member Function Documentation

### 10.7.3.1 native boolean parma\_polyhedra\_library.C\_Polyhedron.upper\_bound\_assign\_if\_exact ( C\_Polyhedron y )

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

#### Exceptions

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

### 10.7.3.2 static native Pair<C\_Polyhedron, Pointset.Powerset\_NNC\_Polyhedron> parma\_polyhedra\_library.C\_Polyhedron.linear\_partition ( C\_Polyhedron p, C\_Polyhedron q ) [static]

Partitions `q` with respect to `p`.

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

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

The documentation for this class was generated from the following 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

##### 10.8.2.1 **parma\_polyhedra\_library.Coefficient.Coefficient** ( **String** *s* ) [inline]

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

#### Exceptions

<i>java.lang.NumberFormatException</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.



### 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.

### 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.

**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

##### 10.18.2.1 `static Generator parma_polyhedra_library.Generator.closure_point ( Linear_Expression e, Coefficient d )` `[inline], [static]`

Returns the closure point at  $e / d$ .

### Exceptions



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

**10.18.2.2 static Generator** `parma_polyhedra_library.Generator.line ( Linear_Expression e )`  
`[inline], [static]`

Returns the line of direction `e`.

#### Exceptions

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

**10.18.2.3 static Generator** `parma_polyhedra_library.Generator.point ( Linear_Expression e, Coefficient d )`  
`[inline], [static]`

Returns the point at `e / d`.

#### Exceptions

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

**10.18.2.4 static Generator** `parma_polyhedra_library.Generator.ray ( Linear_Expression e )`  
`[inline], [static]`

Returns the ray of direction `e`.

#### Exceptions

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

**10.18.2.5 Coefficient** `parma_polyhedra_library.Generator.divisor ( )` `[inline]`

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

#### Exceptions

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

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

- `Generator.java`

## 10.19 parma\_polyhedra\_library.Generator\_System Class Reference

A system of generators.

### Public Member Functions

- [Generator\\_System \(\)](#)  
*Default constructor: builds an empty system of generators.*



- native String [ascii\\_dump \(\)](#)  
*Returns an ascii formatted internal representation of `this`.*
- native String [toString \(\)](#)  
*Returns a string representation of `this`.*

### 10.19.1 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

##### 10.21.2.1 static `Grid_Generator parma_polyhedra_library.Grid_Generator.grid_line ( Linear_Expression e ) [inline], [static]`

Returns the line of direction *e*.

#### Exceptions

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

##### 10.21.2.2 static `Grid_Generator parma_polyhedra_library.Grid_Generator.parameter ( Linear_Expression e, Coefficient d ) [inline], [static]`

Returns the parameter at  $e / d$ .

#### Exceptions

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

##### 10.21.2.3 static `Grid_Generator parma_polyhedra_library.Grid_Generator.grid_point ( Linear_Expression e, Coefficient d ) [inline], [static]`

Returns the point at  $e / d$ .





**Exceptions**

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

**10.21.2.4 Coefficient parma\_polyhedra\_library.Grid\_Generator.divisor ( ) [inline]**

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

**Exceptions**

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

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

- Grid\_Generator.java

**10.22 parma\_polyhedra\_library.Grid\_Generator\_System Class Reference**

A system of grid generators.

**Public Member Functions**

- [Grid\\_Generator\\_System \( \)](#)  
*Default constructor: builds an empty system of grid generators.*
- native String [ascii\\_dump \( \)](#)  
*Returns an ascii formatted internal representation of `this`.*
- native String [toString \( \)](#)  
*Returns a string representation of `this`.*

**10.22.1 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.

### 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

#### 10.25.2.1 static native String `parma_polyhedra_library.IO.wrap_string ( String str, int indent_depth, int preferred_first_line_length, int preferred_line_length )` [static]

Utility function for the wrapping of lines of text.



**Parameters**

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

**Returns**

The wrapped string.

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

- IO.java

**10.26 parma\_polyhedra\_library.Length\_Error\_Exception Class Reference**

Exceptions caused by too big length/size values.

**Public Member Functions**

- [Length\\_Error\\_Exception](#) (String s)

*Constructor:*

**10.26.1 Detailed Description**

Exceptions caused by too big length/size values.

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

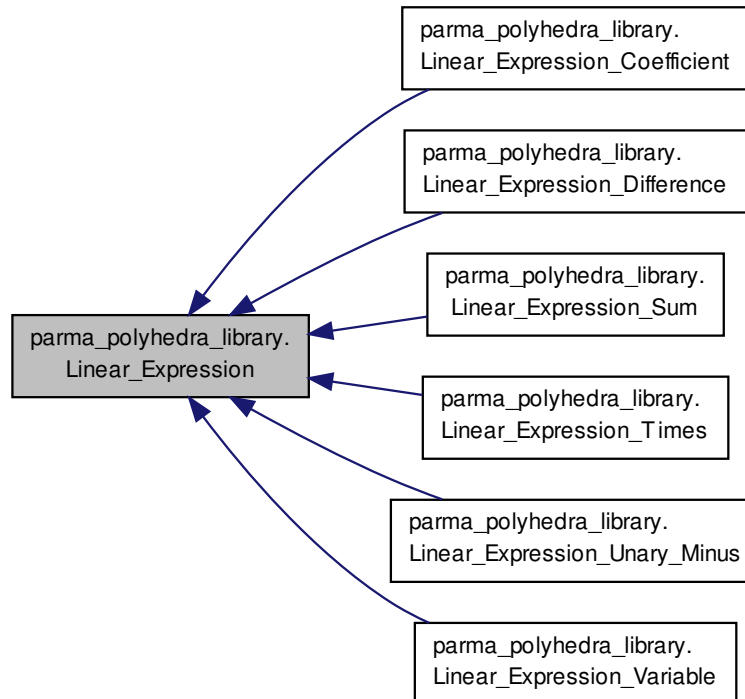
- Length\_Error\_Exception.java

**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](#).

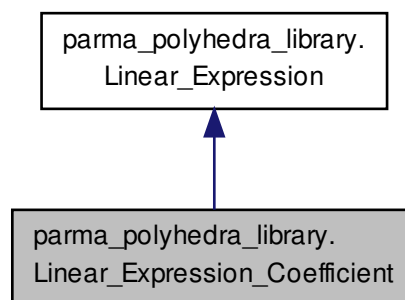
The documentation for this class was generated from the following file:

- [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.

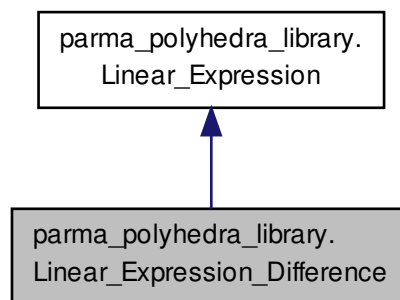
The documentation for this class was generated from the following file:

- `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.

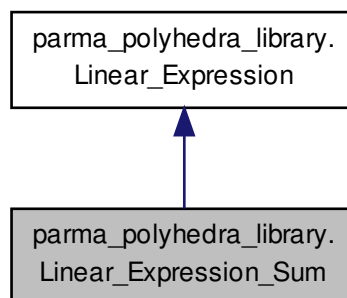
The documentation for this class was generated from the following file:

- 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.

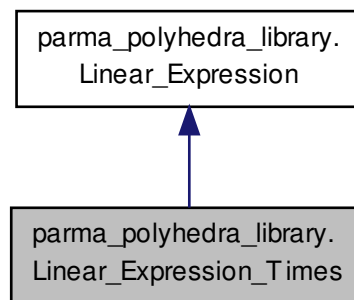
The documentation for this class was generated from the following file:

- `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.

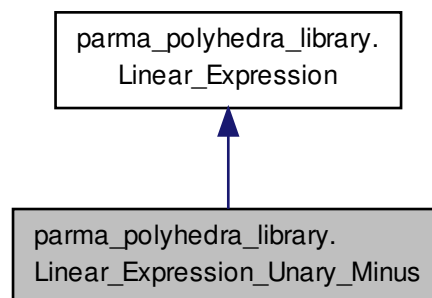
The documentation for this class was generated from the following file:

- `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.

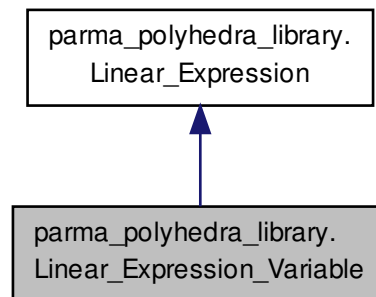
The documentation for this class was generated from the following file:

- `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.



## 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)



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

#### 10.35.2.1 parma\_polyhedra\_library.MIP\_Problem.MIP\_Problem ( long dim ) [inline]

Builds a trivial MIP problem.

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

#### Parameters

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

#### Exceptions

<a href="#">Length_Error_Exception</a>	Thrown if <i>dim</i> exceeds <a href="#">max_space_dimension()</a> .
--	--

#### 10.35.2.2 parma\_polyhedra\_library.MIP\_Problem.MIP\_Problem ( long dim, Constraint\_System cs, Linear\_Expression obj, Optimization\_Mode mode ) [inline]

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



**Parameters**

<i>dim</i>	The dimension of the vector space enclosing <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**

<i><a href="#">Length_Error_Exception</a></i>	Thrown if <code>dim</code> exceeds <code>max_space_dimension()</code> .
<i><a href="#">Invalid_Argument_Exception</a></i>	Thrown if the constraint system contains any strict inequality or if the space dimension of the constraint system (resp., the objective function) is strictly greater than <code>dim</code> .

**10.35.3 Member Function Documentation****10.35.3.1 native void `parma_polyhedra_library.MIP_Problem.clear ( )`**

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

The space dimension is reset to 0.

**10.35.3.2 native void `parma_polyhedra_library.MIP_Problem.add_space_dimensions_and_embed ( long m )`**

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

**Parameters**

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

**Exceptions**

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

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

**10.35.3.3 native void `parma_polyhedra_library.MIP_Problem.add_to_integer_space_dimensions ( Variables_Set i_vars )`**

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

**Exceptions**

<i><a href="#">Invalid_Argument_Exception</a></i>	Thrown if some index in <code>i_vars</code> does not correspond to a space dimension in <code>this</code> .
---	---

**10.35.3.4 native void `parma_polyhedra_library.MIP_Problem.add_constraint ( Constraint c )`**

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



## Exceptions

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

## 10.35.3.5 native void parma\_polyhedra\_library.MIP\_Problem.add\_constraints ( Constraint\_System cs )

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

## Exceptions

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

## 10.35.3.6 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 <code>obj</code> is strictly greater than the space dimension of <code>this</code> .
------------------------------------	---

## 10.35.3.7 native boolean parma\_polyhedra\_library.MIP\_Problem.is\_satisfiable ( )

Checks satisfiability of `this`.

## Returns

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

## 10.35.3.8 native MIP\_Problem\_Status parma\_polyhedra\_library.MIP\_Problem.solve ( )

Optimizes the MIP problem.

## Returns

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

## 10.35.3.9 native void parma\_polyhedra\_library.MIP\_Problem.evaluate\_objective\_function ( Generator evaluating\_point, Coefficient num, Coefficient den )

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

## Parameters

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



**Exceptions**

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

**10.35.3.10 native Generator `parma_polyhedra_library.MIP_Problem.feasible_point ( )`**

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

**Exceptions**

<i><a href="#">Domain_Error_Exception</a></i>	Thrown if the MIP problem is not satisfiable.
---	---

**10.35.3.11 native Generator `parma_polyhedra_library.MIP_Problem.optimizing_point ( )`**

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

**Exceptions**

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

**10.35.3.12 native void `parma_polyhedra_library.MIP_Problem.optimal_value ( Coefficient num, Coefficient den )`**

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

**Exceptions**

<i><a href="#">Domain_Error_Exception</a></i>	Thrown if <code>this</code> 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.

### 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

#### 10.40.2.1 static native void parma\_polyhedra\_library.Parma\_Polyhedra\_Library.initialize\_library ( ) [static]

Initializes the Parma Polyhedra Library.

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

#### 10.40.2.2 static native void parma\_polyhedra\_library.Parma\_Polyhedra\_Library.finalize\_library ( ) [static]

Finalizes the Parma Polyhedra Library.

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

#### 10.40.2.3 static native String parma\_polyhedra\_library.Parma\_Polyhedra\_Library.banner ( ) [static]

Returns a string containing the PPL banner.

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

#### 10.40.2.4 static native void parma\_polyhedra\_library.Parma\_Polyhedra\_Library.set\_rounding\_for\_PPL ( ) [static]

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

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



#### 10.40.2.5 `static native void parma_polyhedra_library.Parma_Polyhedra_Library.restore_pre_PPL_rounding ( ) [static]`

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

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

#### 10.40.2.6 `static native void parma_polyhedra_library.Parma_Polyhedra_Library.set_irrational_precision ( int p ) [static]`

Sets the precision parameter used for irrational calculations.

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

#### 10.40.2.7 `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\(\)](#).

#### 10.40.2.8 `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 <i>unscaled_weight</i> ; it has to be non-negative.

##### Exceptions

<a href="#">Invalid_Argument_Exception</a>	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

#### 10.41.2.1 native boolean parma\_polyhedra\_library.Partial\_Function.has\_empty\_codomain ( )

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

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

#### 10.41.2.2 native long parma\_polyhedra\_library.Partial\_Function.maps ( long *i* )

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

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

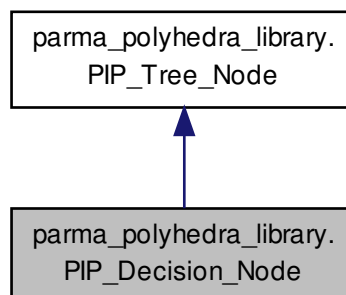
The documentation for this class was generated from the following file:

- `Partial_Function.java`

## 10.42 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.*

#### 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](#) ()  
*Returns the size in bytes of the memory occupied by the underlying C++ object.*
- native long [external\\_memory\\_in\\_bytes](#) ()  
*Returns the size in bytes of the memory managed by the underlying C++ object.*
- native boolean [OK](#) ()  
*Returns true if the pip problem is well formed, i.e., if it satisfies all its implementation invariants; returns 0 and perhaps makes some noise if broken. Useful for debugging purposes.*

### Functions that May Modify the PIP\_Problem

- native void [clear](#) ()  
*Resets this to be equal to the trivial PIP problem.*



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

### Computing the Solution of the PIP\_Problem

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

### Querying/Setting Control Parameters

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

### Protected Member Functions

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

#### 10.43.1 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

#### 10.43.2.1 parma\_polyhedra\_library.PIP\_Problem.PIP\_Problem ( long *dim* ) [inline]

Builds a trivial PIP problem.

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

#### Parameters

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



**Exceptions**

<i><a href="#">Length_Error_Exception</a></i>	Thrown if <code>dim</code> exceeds <code>max_space_dimension()</code> .
---	---

### 10.43.2.2 `parma.polyhedra.library.PIP_Problem.PIP_Problem ( long dim, Constraint_System cs, Variables_Set params ) [inline]`

Builds a PIP problem from a sequence of constraints.

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

**10.43.3 Member Function Documentation**

#### 10.43.3.1 `native void parma.polyhedra.library.PIP_Problem.clear ( )`

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

The space dimension is reset to 0.

#### 10.43.3.2 `native void parma.polyhedra.library.PIP_Problem.add_space_dimensions_and_embed ( long pip_vars, long pip_params )`

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

**Parameters**

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

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

#### 10.43.3.3 `native void parma.polyhedra.library.PIP_Problem.add_constraint ( Constraint c )`

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

**Exceptions**

<i><a href="#">Invalid_Argument_Exception</a></i>	Thrown if the constraint <code>c</code> is a strict inequality or if its space dimension is strictly greater than the space dimension of <code>this</code> .
---	--

#### 10.43.3.4 `native void parma.polyhedra.library.PIP_Problem.add_constraints ( Constraint_System cs )`

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

**Exceptions**

<i><a href="#">Invalid_Argument_Exception</a></i>	Thrown if the constraint system <code>cs</code> contains any strict inequality or if its space dimension is strictly greater than the space dimension of <code>this</code> .
---	--



#### 10.43.3.5 native boolean parma\_polyhedra\_library.PIP\_Problem.is\_satisfiable ( )

Checks satisfiability of `this`.

##### Returns

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

#### 10.43.3.6 native PIP\_Problem\_Status parma\_polyhedra\_library.PIP\_Problem.solve ( )

Optimizes the PIP problem.

Solves the PIP problem, returning an exit status.

##### Returns

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

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

- `PIP_Problem.java`

### 10.44 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:

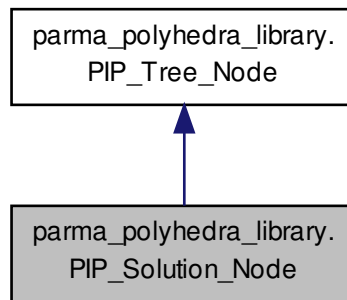
- `PIP_Problem_Status.java`

### 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*.

#### 10.47.1 Detailed Description

A leaf node of the PIP solution tree.

#### 10.47.2 Member Function Documentation

##### 10.47.2.1 native [Linear\\_Expression](#) parma\_polyhedra\_library.PIP\_Solution\_Node.parametric\_values ([Variable](#) *var* )

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

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

### Parameters

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

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

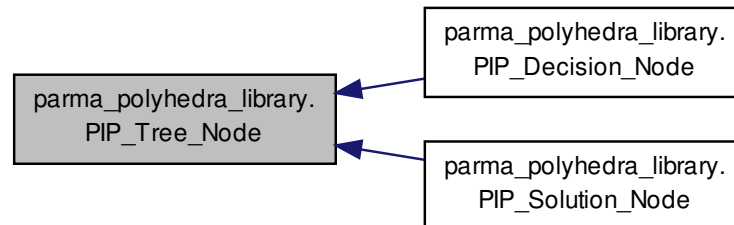
- PIP\_Solution\_Node.java

## 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

### 10.48.2.1 native Constraint\_System parma\_polyhedra\_library.PIP\_Tree\_Node.constraints ( )

Returns the system of parameter constraints controlling the [PIP\\_Tree\\_Node](#).

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

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

- PIP\_Tree\_Node.java

## 10.49 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

#### 10.49.2.1 native long `parma_polyhedra_library.Pointset_Powerset_C_Polyhedron.size ( )`

Returns the number of disjuncts.

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

The documentation for this class was generated from the following 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

#### 10.50.2.1 native C\_Polyhedron parma\_polyhedra\_library.Pointset\_Powerset\_C\_Polyhedron\_Iterator.get\_disjunct ( )

Returns the disjunct referenced by `this`.

#### Warning

On exit, the [C\\_Polyhedron](#) disjunct is still owned by the powerset object: any function call on the owning powerset object may invalidate it. Moreover, the disjunct is meant to be immutable and should not be modified in any way (its resources will be released when deleting the owning powerset). If really needed, the disjunct may be copied into a new object, which will be under control of the user.

The documentation for this class was generated from the following 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:

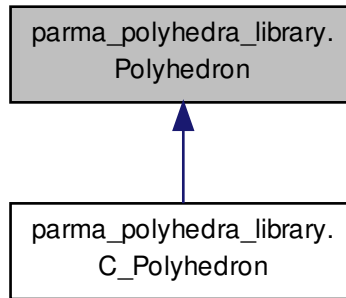
- Poly\_Gen\_Relation.java

## 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  $\text{lhs}' \bowtie \text{rhs}$ , where  $\bowtie$  is the relation symbol encoded by *relsym*.

- native void **unconstrain\_space\_dimension** (Variable var)  
Computes the cylindrification of *this* with respect to space dimension *var*, assigning the result to *this*.
- native void **unconstrain\_space\_dimensions** (Variables\_Set vars)  
Computes the cylindrification of *this* with respect to the set of space dimensions *vars*, assigning the result to *this*.
- native void **widening\_assign** (Polyhedron y, By\_Reference< Integer > tp)  
Assigns to *this* the result of computing the H79-widening between *this* and *y*.

### Member Functions that May Modify the Dimension of the Vector Space

- native void **swap** (Polyhedron y)  
Swaps *this* with polyhedron *y*. (*this* and *y* can be dimension-incompatible.)
- native void **add\_space\_dimensions\_and\_embed** (long m)  
Adds *m* new space dimensions and embeds the old polyhedron in the new vector space.
- native void **add\_space\_dimensions\_and\_project** (long m)  
Adds *m* new space dimensions to the polyhedron and does not embed it in the new vector space.
- native void **concatenate\_assign** (Polyhedron y)  
Assigns to *this* the concatenation of *this* and *y*, taken in this order.
- native void **remove\_space\_dimensions** (Variables\_Set vars)  
Removes all the specified dimensions from the vector space.
- native void **remove\_higher\_space\_dimensions** (long new\_dimension)  
Removes the higher dimensions of the vector space so that the resulting space will have dimension *new\_dimension*.
- native void **expand\_space\_dimension** (Variable var, long m)  
Creates *m* copies of the space dimension corresponding to *var*.
- native void **fold\_space\_dimensions** (Variables\_Set vars, Variable dest)  
Folds the space dimensions in *vars* into *dest*.
- native void **map\_space\_dimensions** (Partial\_Function pfunc)  
Remaps the dimensions of the vector space according to a partial function.

### Ad Hoc Functions for (C or NNC) Polyhedra

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

- native **Generator\_System generators** ()  
Returns the system of generators.
- native **Generator\_System minimized\_generators** ()  
Returns the system of generators, with no redundant generator.
- native void **add\_generator** (Generator g)  
Adds a copy of generator *g* to the system of generators of *this* (without minimizing the result).
- native void **add\_generators** (Generator\_System gs)  
Adds a copy of the generators in *gs* to the system of generators of *this* (without minimizing the result).
- native void **poly\_hull\_assign** (Polyhedron y)  
Same as *upper\_bound\_assign*.
- native void **poly\_difference\_assign** (Polyhedron y)  
Same as *difference\_assign*.
- native void **BHRZ03\_widening\_assign** (Polyhedron y, By\_Reference< Integer > tp)  
Assigns to *this* the result of computing the BHRZ03-widening between *this* and *y*.
- native void **H79\_widening\_assign** (Polyhedron y, By\_Reference< Integer > tp)  
Assigns to *this* the result of computing the H79-widening between *this* and *y*.



- native void [limited\\_BHRZ03\\_extrapolation\\_assign](#) ([Polyhedron](#) y, [Constraint\\_System](#) cs, [By\\_Reference](#)< Integer > tp)  
*Improves the result of the BHRZ03-widening computation by also enforcing those constraints in cs that are satisfied by all the points of this.*
- native void [limited\\_H79\\_extrapolation\\_assign](#) ([Polyhedron](#) y, [Constraint\\_System](#) cs, [By\\_Reference](#)< Integer > tp)  
*Improves the result of the H79-widening computation by also enforcing those constraints in cs that are satisfied by all the points of this.*
- native void [bounded\\_BHRZ03\\_extrapolation\\_assign](#) ([Polyhedron](#) y, [Constraint\\_System](#) cs, [By\\_Reference](#)< Integer > tp)  
*Improves the result of the BHRZ03-widening computation by also enforcing those constraints in cs that are satisfied by all the points of this, plus all the constraints of the form  $\pm x \leq r$  and  $\pm x < r$ , with  $r \in \mathbb{Q}$ , that are satisfied by all the points of this.*
- native void [bounded\\_H79\\_extrapolation\\_assign](#) ([Polyhedron](#) y, [Constraint\\_System](#) cs, [By\\_Reference](#)< Integer > tp)  
*Improves the result of the H79-widening computation by also enforcing those constraints in cs that are satisfied by all the points of this, plus all the constraints of the form  $\pm x \leq r$  and  $\pm x < r$ , with  $r \in \mathbb{Q}$ , that are satisfied by all the points of this.*

## 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

#### 10.53.2.1 native boolean parma\_polyhedra\_library.Polyhedron.constrains ( Variable var )

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

#### Exceptions

<a href="#">Invalid_Argument_Exception</a>	Thrown if <code>var</code> is not a space dimension of <code>this</code> .
--	--

#### 10.53.2.2 native boolean parma\_polyhedra\_library.Polyhedron.bounds\_from\_above ( Linear\_Expression expr )

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

#### Exceptions

<a href="#">Invalid_Argument_Exception</a>	Thrown if <code>expr</code> and <code>this</code> are dimension-incompatible.
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### 10.53.2.3 native boolean `parma_polyhedra_library.Polyhedron.bounds_from_below ( Linear_Expression expr )`

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

#### Exceptions

<i><a href="#">Invalid_Argument_Exception</a></i>	Thrown if <code>expr</code> and <code>this</code> are dimension-incompatible.
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### 10.53.2.4 native boolean `parma_polyhedra_library.Polyhedron.maximize ( Linear_Expression expr, Coefficient sup_n, Coefficient sup_d, By_Reference< Boolean > maximum )`

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

#### Parameters

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

#### Exceptions

<i><a href="#">Invalid_Argument_Exception</a></i>	Thrown if <code>expr</code> and <code>this</code> are dimension-incompatible.
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If `this` is empty or `expr` is not bounded from above, `false` is returned and `sup_n`, `sup_d` and `maximum` are left untouched.

### 10.53.2.5 native boolean `parma_polyhedra_library.Polyhedron.minimize ( Linear_Expression expr, Coefficient inf_n, Coefficient inf_d, By_Reference< Boolean > minimum )`

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

#### Parameters

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

#### Exceptions

<i><a href="#">Invalid_Argument_Exception</a></i>	Thrown if <code>expr</code> and <code>this</code> are dimension-incompatible.
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If `this` is empty or `expr` is not bounded from below, `false` is returned and `inf_n`, `inf_d` and `minimum` are left untouched.





### 10.53.2.6 native boolean parma\_polyhedra\_library.Polyhedron.maximize ( Linear\_Expression *expr*, Coefficient *sup\_n*, Coefficient *sup\_d*, By\_Reference< Boolean > *maximum*, Generator *g* )

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

#### Parameters

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

#### Exceptions

<i>Invalid_Argument_-Exception</i>	Thrown if <code>expr</code> and <code>this</code> are dimension-incompatible.
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If `this` is empty or `expr` is not bounded from above, `false` is returned and `sup_n`, `sup_d`, `maximum` and `g` are left untouched.

### 10.53.2.7 native boolean parma\_polyhedra\_library.Polyhedron.minimize ( Linear\_Expression *expr*, Coefficient *inf\_n*, Coefficient *inf\_d*, By\_Reference< Boolean > *minimum*, Generator *g* )

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

#### Parameters

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

#### Exceptions

<i>Invalid_Argument_-Exception</i>	Thrown if <code>expr</code> and <code>this</code> are dimension-incompatible.
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If `this` is empty or `expr` is not bounded from below, `false` is returned and `inf_n`, `inf_d`, `minimum` and `g` are left untouched.

### 10.53.2.8 native Poly\_Con\_Relation parma\_polyhedra\_library.Polyhedron.relation\_with ( Constraint *c* )

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

#### Exceptions

<i>Invalid_Argument_-Exception</i>	Thrown if <code>this</code> and constraint <code>c</code> are dimension-incompatible.
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### 10.53.2.9 native Poly\_Gen\_Relation parma\_polyhedra\_library.Polyhedron.relation\_with ( Generator *c* )

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

#### Exceptions

<i>Invalid_Argument_-Exception</i>	Thrown if <code>this</code> and generator <code>g</code> are dimension-incompatible.
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### 10.53.2.10 native Poly\_Con\_Relation parma\_polyhedra\_library.Polyhedron.relation\_with ( Congruence *c* )

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

#### Exceptions

<i>Invalid_Argument_-Exception</i>	Thrown if <code>this</code> and congruence <code>c</code> are dimension-incompatible.
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### 10.53.2.11 native boolean parma\_polyhedra\_library.Polyhedron.contains ( Polyhedron *y* )

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

#### Exceptions

<i>Invalid_Argument_-Exception</i>	Thrown if <code>this</code> and <code>y</code> are topology-incompatible or dimension-incompatible.
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### 10.53.2.12 native boolean parma\_polyhedra\_library.Polyhedron.strictly\_contains ( Polyhedron *y* )

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

#### Exceptions

<i>Invalid_Argument_-Exception</i>	Thrown if <code>this</code> and <code>y</code> are topology-incompatible or dimension-incompatible.
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### 10.53.2.13 native boolean parma\_polyhedra\_library.Polyhedron.is\_disjoint\_from ( Polyhedron *y* )

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

#### Exceptions

<i>Invalid_Argument_-Exception</i>	Thrown if <code>x</code> and <code>y</code> are topology-incompatible or dimension-incompatible.
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### 10.53.2.14 native int parma\_polyhedra\_library.Polyhedron.hashCode ( )

Returns a hash code for `this`.

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



**10.53.2.15 native String parma\_polyhedra\_library.Polyhedron.ascii\_dump ( )**

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

Useful for debugging purposes.

**10.53.2.16 native void parma\_polyhedra\_library.Polyhedron.add\_constraint ( Constraint *c* )**

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

**Parameters**

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

<i>Invalid_Argument_-Exception</i>	Thrown if <code>this</code> and constraint <code>c</code> are topology-incompatible or dimension-incompatible.
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**10.53.2.17 native void parma\_polyhedra\_library.Polyhedron.add\_congruence ( Congruence *cg* )**

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

**Exceptions**

<i>Invalid_Argument_-Exception</i>	Thrown if <code>this</code> and congruence <code>cg</code> are dimension-incompatible, or if <code>cg</code> is a proper congruence which is neither a tautology, nor a contradiction.
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**10.53.2.18 native void parma\_polyhedra\_library.Polyhedron.add\_constraints ( Constraint\_System *cs* )**

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

**Parameters**

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

<i>Invalid_Argument_-Exception</i>	Thrown if <code>this</code> and <code>cs</code> are topology-incompatible or dimension-incompatible.
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**10.53.2.19 native void parma\_polyhedra\_library.Polyhedron.add\_congruences ( Congruence\_System *cgs* )**

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

**Parameters**

<code>cgs</code>	The congruences to be added.
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**Exceptions**

<i>Invalid_Argument_-Exception</i>	Thrown if <code>this</code> and <code>cgs</code> are dimension-incompatible, of if there exists in <code>cgs</code> a proper congruence which is neither a tautology, nor a contradiction.
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**10.53.2.20 native void parma\_polyhedra\_library.Polyhedron.refine\_with\_constraint ( Constraint *c* )**

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

**Exceptions**

<i>Invalid_Argument_-Exception</i>	Thrown if <code>this</code> and constraint <code>c</code> are dimension-incompatible.
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**10.53.2.21 native void parma\_polyhedra\_library.Polyhedron.refine\_with\_congruence ( Congruence *cg* )**

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

**Exceptions**

<i>Invalid_Argument_-Exception</i>	Thrown if <code>this</code> and congruence <code>cg</code> are dimension-incompatible.
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**10.53.2.22 native void parma\_polyhedra\_library.Polyhedron.refine\_with\_constraints ( Constraint\_System *cs* )**

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

**Parameters**

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

<i>Invalid_Argument_-Exception</i>	Thrown if <code>this</code> and <code>cs</code> are dimension-incompatible.
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**10.53.2.23 native void parma\_polyhedra\_library.Polyhedron.refine\_with\_congruences ( Congruence\_System *cgs* )**

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

**Parameters**

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

<i>Invalid_Argument_-Exception</i>	Thrown if <code>this</code> and <code>cgs</code> are dimension-incompatible.
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**10.53.2.24 native void parma\_polyhedra\_library.Polyhedron.intersection\_assign ( Polyhedron y )**

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

**Exceptions**

<i>Invalid_Argument_-Exception</i>	Thrown if <code>this</code> and <code>y</code> are topology-incompatible or dimension-incompatible.
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**10.53.2.25 native void parma\_polyhedra\_library.Polyhedron.upper\_bound\_assign ( Polyhedron y )**

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

**Exceptions**

<i>Invalid_Argument_-Exception</i>	Thrown if <code>this</code> and <code>y</code> are topology-incompatible or dimension-incompatible.
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**10.53.2.26 native void parma\_polyhedra\_library.Polyhedron.difference\_assign ( Polyhedron y )**

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

**Exceptions**

<i>Invalid_Argument_-Exception</i>	Thrown if <code>this</code> and <code>y</code> are topology-incompatible or dimension-incompatible.
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**10.53.2.27 native void parma\_polyhedra\_library.Polyhedron.time\_elapse\_assign ( Polyhedron y )**

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

**Exceptions**

<i>Invalid_Argument_-Exception</i>	Thrown if <code>this</code> and <code>y</code> are topology-incompatible or dimension-incompatible.
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**10.53.2.28 native boolean parma\_polyhedra\_library.Polyhedron.simplify\_using\_context\_assign ( Polyhedron y )**

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

**Exceptions**

<i>Invalid_Argument_-Exception</i>	Thrown if <code>this</code> and <code>y</code> are topology-incompatible or dimension-incompatible.
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**10.53.2.29 native void parma\_polyhedra\_library.Polyhedron.affine\_image ( Variable var, Linear\_Expression expr, Coefficient denominator )**

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



**Parameters**

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

**Exceptions**

<i>Invalid_Argument_Exception</i>	Thrown if <i>denominator</i> is zero or if <i>expr</i> and <i>this</i> are dimension-incompatible or if <i>var</i> is not a space dimension of <i>this</i> .
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### 10.53.2.30 native void parma\_polyhedra\_library.Polyhedron.affine\_preimage ( Variable *var*, Linear\_Expression *expr*, Coefficient *denominator* )

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

**Parameters**

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

**Exceptions**

<i>Invalid_Argument_Exception</i>	Thrown if <i>denominator</i> is zero or if <i>expr</i> and <i>this</i> are dimension-incompatible or if <i>var</i> is not a space dimension of <i>this</i> .
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### 10.53.2.31 native void parma\_polyhedra\_library.Polyhedron.bounded\_affine\_image ( Variable *var*, Linear\_Expression *lb\_expr*, Linear\_Expression *ub\_expr*, Coefficient *denominator* )

Assigns to *this* the image of *this* with respect to the *bounded affine relation*  $\frac{lb\_expr}{denominator} \leq var' \leq \frac{ub\_expr}{denominator}$ .

**Parameters**

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

**Exceptions**

<i>Invalid_Argument_Exception</i>	Thrown if <i>denominator</i> is zero or if <i>lb_expr</i> (resp., <i>ub_expr</i> ) and <i>this</i> are dimension-incompatible or if <i>var</i> is not a space dimension of <i>this</i> .
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### 10.53.2.32 native void parma\_polyhedra\_library.Polyhedron.bounded\_affine\_preimage ( Variable *var*, Linear\_Expression *lb\_expr*, Linear\_Expression *ub\_expr*, Coefficient *denominator* )

Assigns to *this* the preimage of *this* with respect to the *bounded affine relation*  $\frac{lb\_expr}{denominator} \leq var' \leq \frac{ub\_expr}{denominator}$ .



## Parameters

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

## Exceptions

<i>Invalid_Argument_Exception</i>	Thrown if <i>denominator</i> is zero or if <i>lb_expr</i> (resp., <i>ub_expr</i> ) and <i>this</i> are dimension-incompatible or if <i>var</i> is not a space dimension of <i>this</i> .
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### 10.53.2.33 native void parma\_polyhedra\_library.Polyhedron.generalized\_affine\_image ( Variable *var*, Relation\_Symbol *relsym*, Linear\_Expression *expr*, Coefficient *denominator* )

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

## Parameters

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

## Exceptions

<i>Invalid_Argument_Exception</i>	Thrown if <i>denominator</i> is zero or if <i>expr</i> and <i>this</i> are dimension-incompatible or if <i>var</i> is not a space dimension of <i>this</i> or if <i>this</i> is a <a href="#">C_Polyhedron</a> and <i>relsym</i> is a strict relation symbol.
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### 10.53.2.34 native void parma\_polyhedra\_library.Polyhedron.generalized\_affine\_preimage ( Variable *var*, Relation\_Symbol *relsym*, Linear\_Expression *expr*, Coefficient *denominator* )

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

## Parameters

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

## Exceptions

<i>Invalid_Argument_Exception</i>	Thrown if <i>denominator</i> is zero or if <i>expr</i> and <i>this</i> are dimension-incompatible or if <i>var</i> is not a space dimension of <i>this</i> or if <i>this</i> is a <a href="#">C_Polyhedron</a> and <i>relsym</i> is a strict relation symbol.
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### 10.53.2.35 native void parma\_polyhedra\_library.Polyhedron.generalized\_affine\_image ( Linear\_Expression *lhs*, Relation\_Symbol *relysym*, 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 `relysym`.

#### Parameters

<i>lhs</i>	The left hand side affine expression;
<i>relysym</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>relysym</code> is a strict relation symbol.
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### 10.53.2.36 native void parma\_polyhedra\_library.Polyhedron.generalized\_affine\_preimage ( Linear\_Expression *lhs*, Relation\_Symbol *relysym*, 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 `relysym`.

#### Parameters

<i>lhs</i>	The left hand side affine expression;
<i>relysym</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>relysym</code> is a strict relation symbol.
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### 10.53.2.37 native void parma\_polyhedra\_library.Polyhedron.unconstrain\_space\_dimension ( Variable *var* )

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

#### Parameters

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

#### Exceptions

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

### 10.53.2.38 native void parma\_polyhedra\_library.Polyhedron.unconstrain\_space\_dimensions ( Variables\_Set *vars* )

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





## Parameters

<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 <a href="#">Variable</a> objects contained in <code>vars</code> .
-----------------------------------	---

### 10.53.2.39 native void parma\_polyhedra\_library.Polyhedron.widening\_assign ( Polyhedron y, By\_Reference< Integer > tp )

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

## Parameters

<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.
-----------------------------------	---

### 10.53.2.40 native void parma\_polyhedra\_library.Polyhedron.swap ( Polyhedron y )

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

## Exceptions

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

### 10.53.2.41 native void parma\_polyhedra\_library.Polyhedron.add\_space\_dimensions\_and\_embed ( long m )

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

## Parameters

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

## Exceptions

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

### 10.53.2.42 native void parma\_polyhedra\_library.Polyhedron.add\_space\_dimensions\_and\_project ( long m )

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



**Parameters**

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

**Exceptions**

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

**10.53.2.43 native void `parma_polyhedra_library.Polyhedron.concatenate_assign ( Polyhedron y )`**

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

**Exceptions**

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

**10.53.2.44 native void `parma_polyhedra_library.Polyhedron.remove_space_dimensions ( Variables_Set vars )`**

Removes all the specified dimensions from the vector space.

**Parameters**

<i>vars</i>	The set of <a href="#">Variable</a> objects corresponding to the space dimensions to be removed.
-------------	--

**Exceptions**

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

**10.53.2.45 native void `parma_polyhedra_library.Polyhedron.remove_higher_space_dimensions ( long new_dimension )`**

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

**Exceptions**

<i><a href="#">Invalid_Argument_Exception</a></i>	Thrown if <code>new_dimensions</code> is greater than the space dimension of <code>this</code> .
---	--

**10.53.2.46 native void `parma_polyhedra_library.Polyhedron.expand_space_dimension ( Variable var, long m )`**

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



## Parameters

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

## Exceptions

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

### 10.53.2.47 native void parma\_polyhedra\_library.Polyhedron.fold\_space\_dimensions ( Variables\_Set vars, Variable dest )

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

## Parameters

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

## Exceptions

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

### 10.53.2.48 native void parma\_polyhedra\_library.Polyhedron.map\_space\_dimensions ( Partial\_Function pfunc )

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

## Parameters

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

### 10.53.2.49 native void parma\_polyhedra\_library.Polyhedron.add\_generator ( Generator g )

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

## Exceptions

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

### 10.53.2.50 native void parma\_polyhedra\_library.Polyhedron.add\_generators ( Generator\_System gs )

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



**Parameters**

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

**Exceptions**

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

### 10.53.2.51 native void parma\_polyhedra\_library.Polyhedron.BHRZ03\_widening\_assign ( Polyhedron y, By\_Reference< Integer > tp )

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

**Parameters**

<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.
------------------------------------	---

### 10.53.2.52 native void parma\_polyhedra\_library.Polyhedron.H79\_widening\_assign ( Polyhedron y, By\_Reference< Integer > tp )

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

**Parameters**

<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.
------------------------------------	---

### 10.53.2.53 native void parma\_polyhedra\_library.Polyhedron.limited\_BHRZ03\_extrapolation\_assign ( Polyhedron y, Constraint\_System cs, By\_Reference< Integer > tp )

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

**Parameters**

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



## Exceptions

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

#### 10.53.2.54 native void parma\_polyhedra\_library.Polyhedron.limited\_H79\_extrapolation\_assign ( Polyhedron y, Constraint\_System cs, By\_Reference< Integer > tp )

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

## Parameters

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

## Exceptions

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

#### 10.53.2.55 native void parma\_polyhedra\_library.Polyhedron.bounded\_BHRZ03\_extrapolation\_assign ( Polyhedron y, Constraint\_System cs, By\_Reference< Integer > tp )

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

## Parameters

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

## Exceptions

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

#### 10.53.2.56 native void parma\_polyhedra\_library.Polyhedron.bounded\_H79\_extrapolation\_assign ( Polyhedron y, Constraint\_System cs, By\_Reference< Integer > tp )

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

## Parameters

<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;



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

The documentation for this class was generated from the following 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.*

### 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.

### 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.

### Public Member Functions

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

### 10.56.1 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

#### 10.56.2.1 parma\_polyhedra\_library.Variable.Variable ( int *i* ) [inline]

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

### Exceptions

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

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

- Variable.java

## 10.57 parma\_polyhedra\_library.Variables\_Set Class Reference

A java.util.TreeSet of variables' indexes.



### Public Member Functions

- [Variables\\_Set \(\)](#)

*Builds the empty set of variable indexes.*

#### 10.57.1 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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