# jMetalPy Documentation

***Release***

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# Contents:

**Warning:** Documentation is WIP!! Some information may be missing.

CHAPTER 1

# Contributing

Contributions to the jMetalPy project are welcome. Please, take into account the following guidelines (all developers should follow these guidelines):

## 1.1 Git WorkFlow

We have a set of branches on the remote Git server. Some branches are temporary, and others are constant throughout the life of the repository.

- **Branches always present in the repository:**
  - ***master*: You have the latest released to production, receive merges from the develop branch, or merge from a *hot***
    - Do I have to put a TAG when doing a merge from develop to master? yes
    - Do I have to put a TAG when doing a merge from a hotfix branch to master? yes
    - After merge from a hotfix to master, do I have to merge from master to develop? yes
  - *develop*: It is considered the "Next Release", receives merges from branches of each developer, either corrections (*fix*) or new features (*feature*).
- **Temporary branches:**
  - ***feature/<task-id>-<description>*: When we are doing a development, we create a local branch with the prefix "fea**
    - Where does this branch emerge? This branch always emerge from the develop branch
    - When I finish the development in my feature branch, which branch to merge into?: You always merge feature branch into develop branch
  - ***fix/<task-id>-<description>*: When we are making a correction, we create a local branch with the prefix "fix/", th**
    - Where does this branch emerge? This branch always emerge from the develop branch

        * When I finish the correction in my fix branch, which branch to merge into?: You always merge feature branch into develop branch

    - ***hotfix/<task-id>-<description>*: When we are correcting an emergency incidence in production, we create a local**

        * Where does this branch emerge?: This branch always emerge from the master branch
        * When I finish the correction in my hotfix branch, which branch to merge into?: This branch always emerge from the master and develop branch

- **Steps to follow when you are creating or going to work on a branch of any kind (feature / fix / hotfix):**
    1. After you create your branch (feature / fix / hotfix) locally, upload it to the remote Git server. The integration system will verify your code from the outset.
    2. Each time you commit, as much as possible, you send a push to the server. Each push will trigger the automated launch of the tests, etc.
    3. Once the development is finished, having done a push to the remote Git server, and that the test phase has passed without problem, you create an pull request.

**Note:** Do not forget to remove your branch (feature / fix / hotfix) once the merge has been made.

Some useful Git commands:

- git fetch –prune: Cleaning branches removed and bringing new branches

## 1.2 PEP8!

It is really important to follow some standards when a team develops an application. If all team members format the code in the same format, then it is much easier to read the code. PEP8 is Python's style guide. It's a set of rules for how to format your Python code.

Some style rules:

- Package and module names: Modules should have short, **all-lowercase** names. Underscores can be used in the module name if it improves readability. Python packages should also have short, **all-lowercase** names, although the use of underscores is discouraged. In Python, a module is a file with the suffix '.py'.
- Class names: Class names should normally use the **CapWords** convention.
- Method names and instance variables: **Lowercase with words separated by underscores** as necessary to improve readability.

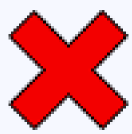
There are many more style standards in PEP8 so, please, refer to PEP8 documentation . The most appropriate is to use an IDE that has support for PEP8. For example, PyCharm.

## 1.3 Object-oriented programming

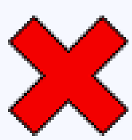
**Object-oriented programming should be the single programming paradigm used**. Avoiding as far as possible, imperative and functional programming.

```python
# Object-oriented programming

class Imprint(object):

    def world(self) -> str:
        return "World"

    def hello(self) -> str:
        return "Hello"

    def hello_world(self) -> None:
        print(self.hello(), self.world())


imprint = Imprint()
imprint.hello_world()
```

```python
# Functional programming

def world() -> str:
    return "World"


def hello() -> str:
    return "Hello"


def print_hello_world() -> None:
    print(hello(), world())


print_hello_world()
```



```python
# Imperative programming

world = "World"
hello = "Hello"
hello_world = hello + ' ' + world
print(hello_world)
```



In classes, we directly access the attributes, which are usually defined as public.

```python
class Circle(object):

    def __init__(self, radius: int):
        self.radius = radius
```

Only when we want to **implement additional logic in the accesses to the attributes** we define getter/setter methods, but **always by using the *property*** annotation or the ***property*** function:

```python
class Circle(object):

    def __init__(self):
        self.__radius = None

    @property
    def radius(self) -> int:
        print("Accessing the radius attribute by get")
        return self.__radius

    @radius.setter
    def radius(self, radius: int) -> None:
        print("Accessing the radius attribute by set")
        # Logic to validate
        if radius < 0:
            raise ValueError("The radius value must be a positive integer")
        self.__radius = radius
```

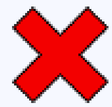
```python
class Circle(object):

    def __init__(self):
        self.__radius = None

    def __get_radius(self) -> int:
        print("Accessing the radius attribute by get")
        return self.__radius

    def __set_radius(self, radius: int) -> None:
        print("Accessing the radius attribute by set")
        # Logic to validate
        if radius < 0:
            raise ValueError("The radius value must be a positive integer")
        self.__radius = radius

    radius = property(fget=__get_radius, fset=__set_radius)
```

By using ***property***, we continue to access the attributes directly:

```python
circle = Circle()
circle.radius = 3
print(circle.radius)
```

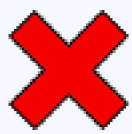
Do not use getter/setter methods without the *property* annotation or the *property* function:

```python
class Circle(object):

    def __init__(self):
        self.__radius = None

    def get_radius(self) -> int:
        return self.__radius

    def set_radius(self, radius: int) -> None:
        # Logic to validate
        if radius < 0:
            raise ValueError("The radius value must be a positive integer")
        self.__radius = radius
```



Since this way of accessing the attribute is not commonly used in Python:

```python
circle = Circle()
circle.set_radius(3)
print(circle.get_radius())
```



## 1.4 Structure

Python is not Java. In Java you cannot, by design, have more than one class in a file. In Python, you can do it.

In Python, **it is appropriate to group several classes into a single .py file. For that reason, the .py files are called modules.**

## 1.5 Python 3.6

We **always** define types in the parameters of the arguments and the return value:

```python
class Car(object):

    def __init__(self):
        self.fuel = 0
        self.battery = 0

    def refuel(self, new_fuel: int):
        self.fuel += new_fuel

    def recharge(self, new_energy: int):
        self.battery += new_energy

    def status(self) -> Tuple[int, int]:
        return self.fuel, self.battery
```

We can define abstract classes (ABCs) in Python:

```python
class AbstractClass(metaclass=ABCMeta):

    @abstractmethod
    def abstract_method(self) -> float:
        pass


class ImplementingClass(AbstractClass):

    def abstract_method(self) -> float:
        # implementation ...
```

In the case that we want to define an **interface** class, it is done in the same way. We just have to define all the methods of the class as abstract.

Example of use of generic types:

```
T = TypeVar('T')  # <- Can be anything
S = TypeVar('S', int, float)  # <- Must be int or float

class Car(object):

    def __init__(self, fuel: S, battery: S, model: T):
        self.fuel = fuel
        self.battery = battery
        self.model = model

    def refuel(self, new_fuel: S) -> None:
        self.fuel += new_fuel

    def recharge(self, new_energy: S) -> None:
        self.battery += new_energy

    def status(self) -> Tuple[S, S]:
        return self.fuel, self.battery
```

In the code below, the IDE displays a **warning**, since although the 2nd parameter is a float type, which is a type allowed in the definition of the generic type X, it is not of the same type as the first, since the first 2 parameters must be of the same generic type (S):

```
car1 = Car(3, 3.44, "FORD-F-150")
```

In the code below, the IDE displays a **warning**, since the 2nd parameter is a type not allowed in the definition of the generic type ( *TypeVar('S', int, float)* ):

```
car2 = Car(3, "hello", "FORD-F-150")
```

When the class inherits from *Generic[. . . ]*, the **class is defined as generic**. In this way we can indicate the types that will have the values of the generic types, when using the class as type. Look at the *add_car()* method of the *Parking* class.

**Note:** The generic classes inherit from abc.ABCMeta, so they are abstract classes and **abstract methods can be used**.

```python
T = TypeVar('T')  # <- Can be anything
S = TypeVar('S', int, float)  # <- Must be int or float


class CarGeneric(Generic[S, T]):

    def __init__(self, fuel: S, battery: S, model: T):
        self.fuel = fuel
        self.battery = battery
        self.model = model

    def refuel(self, new_fuel: S) -> None:
        self.fuel += new_fuel

    def recharge(self, new_energy: S) -> None:
        self.battery += new_energy

    def status(self) -> Tuple[S, S]:
        return self.fuel, self.battery
```

```python
class Parking(object):

    def __init__(self):
        self.car_list = list()

    def add_car(self, new_car: CarGeneric[int, str]) -> None:
        self.car_list.append(new_car)
```

In the code below, the IDE displays a **warning** in the call to the *add_car()* method when adding the car, since the 3rd parameter of the init must be a *str* type, as defined in the *add_car()* method of the *Parking* class.

```python
car3 = CarGeneric(3, 4, 777)
parking = Parking()
parking.add_car(car3)
```

When inheriting from generic classes, some type variables could be fixed:

```
T = TypeVar('T')


class MyClass(CarGeneric[str, T]):
    pass
```

Example of inheritance from non-generic class to generic class:

```
class A(object):
    pass


class B(A, Generic[S, T]):
    pass
```

Example of inheritance from generic class to another generic class:

```
class A(Generic[S, T]):
    pass


class B(A[S, T], Generic[S, T]):
    pass
```

## 1.6 Create automatic documentation files with Sphinx

First, you need to know how to correctly document your code. It is **important** to follow these simple rules in order to automatically create good documentation for the project.

When you create a new module file (testDoc.py in this example), you should mention it using this format:

```
"""
.. module:: testDoc
   :platform: Unix, Windows
   :synopsis: A useful module indeed.

.. moduleauthor:: Andrew Carter <andrew@invalid.com>
"""

class testDoc(object):
    """We use this as a public class example class.

    This class is ruled by the very trendy important method :func:`public_fn_with_
↪sphinxy_docstring`.
```

```
    .. note::
       An example of intersphinx is this: you **cannot** use :mod:`pickle` on this␣
↪class.
    """

    def __init__(self):
        pass
```

This code snippet generates the following documentation:

## jmetal.algorithm.singleobjective.testDoc module

*class* `jmetal.algorithm.singleobjective.testDoc.`**`testDoc`**(*foo: str*, *bar: str*)

Bases: **`object`**

We use this as a public class example class.

This class is ruled by the very trendy important method **`public_fn_with_sphinxy_docstring()`**.

**Note:** An example of intersphinx is this: you **cannot** use `pickle` on this class.

Now, you can document your methods using the following sintax:

```
def public_fn_with_sphinxy_docstring(self, name: str, state: bool = False) -> int:
    """This function does something.

    :param name: The name to use.
    :type name: str.
    :param state: Current state to be in.
    :type state: bool.
    :returns:  int -- the return code.
    :raises: AttributeError, KeyError
    """
    return 0

def public_fn_without_docstring(self):
    return True
```

And the produced output doc will be:

**`public_fn_with_sphinxy_docstring`**(*name: str*, *state: bool = False*) → int

This function does something.

| | |
|---|---|
| **Parameters:** | • **name** (*str.*) – The name to use.<br>• **state** (*bool.*) – Current state to be in. |
| **Returns:** | int – the return code. |
| **Raises:** | AttributeError, KeyError |

**`public_fn_without_docstring`**()

As you may notice, if you don’t use any docstring, the method documentation will be empty.

# CHAPTER 2

# jMetal

## 2.1 org.uma.jmetal.algorithm

### 2.1.1 Algorithm

public interface **Algorithm**<Result> extends Runnable, Serializable, *DescribedEntity*

Interface representing an algorithm

**Author** Antonio J. Nebro

**Parameters**

- **<Result>** – Result

#### Methods

#### getResult

Result **getResult**()

#### run

void **run**()

### 2.1.2 InteractiveAlgorithm

public interface **InteractiveAlgorithm**<S, R> extends *Algorithm*<R>

#### Methods

#### updatePointOfInterest

public void **updatePointOfInterest** (List<Double> *newReferencePoints*)

## 2.2 org.uma.jmetal.algorithm.impl

### 2.2.1 AbstractCoralReefsOptimization

public abstract class **AbstractCoralReefsOptimization**<S, R> implements *Algorithm*<R>

Abstract class representing a Coral Reefs Optimization Algorithm Reference: S. Salcedo-Sanz, J. Del Ser, S. Gil-López, I. Landa-Torres and J. A. Portilla-Figueras, "The coral reefs optimization algorithm: an efficient meta-heuristic for solving hard optimization problems," 15th Applied Stochastic Models and Data Analysis International Conference, Mataró, Spain, June, 2013.

**Author** Inacio Medeiros

#### Fields

#### comparator

protected Comparator<S> **comparator**

#### coordinates

protected List<*Coordinate*> **coordinates**

#### crossoverOperator

protected *CrossoverOperator*<S> **crossoverOperator**

#### mutationOperator

protected *MutationOperator*<S> **mutationOperator**

#### population

protected List<S> **population**

#### selectionOperator

protected *SelectionOperator*<List<S>, S> **selectionOperator**

### Constructors

#### AbstractCoralReefsOptimization

public **AbstractCoralReefsOptimization**(Comparator<S> *comparator*, SelectionOperator<List<S>, S> *selectionOperator*, CrossoverOperator<S> *crossoverOperator*, MutationOperator<S> *mutationOperator*, int *n*, int *m*, double *rho*, double *fbs*, double *fa*, double *pd*, int *attemptsToSettle*)

Constructor

**Parameters**

- **comparator** – Object for comparing two solutions
- **selectionOperator** – Selection Operator
- **crossoverOperator** – Crossover Operator
- **mutationOperator** – Mutation Operator
- **n** – width of Coral Reef Grid
- **m** – height of Coral Reef Grid
- **rho** – Percentage of occupied reef
- **fbs** – Percentage of broadcast spawners
- **fa** – Percentage of budders
- **pd** – Probability of depredation
- **attemptsToSettle** – number of attempts a larvae has to try to settle reef

### Methods

#### asexualReproduction

protected abstract List<S> **asexualReproduction**(List<S> *brooders*)

#### createInitialPopulation

protected abstract List<S> **createInitialPopulation**()

#### depredation

protected abstract List<S> **depredation**(List<S> *population*, List<Coordinate> *coordinates*)

#### evaluatePopulation

protected abstract List<S> **evaluatePopulation**(List<S> *population*)

### generateCoordinates

protected abstract List<*Coordinate*> **generateCoordinates**()

### getAttemptsToSettle

public int **getAttemptsToSettle**()

### getCoordinates

public List<*Coordinate*> **getCoordinates**()

### getFa

public double **getFa**()

### getFbr

public double **getFbr**()

### getFbs

public double **getFbs**()

### getFd

public double **getFd**()

### getM

public int **getM**()

### getN

public int **getN**()

### getPd

public double **getPd**()

### getPopulation

public List<S> **getPopulation**()

#### getPopulationSize

public int **getPopulationSize**()

#### getResult

public abstract R **getResult**()

#### getRho

public double **getRho**()

#### initProgress

protected abstract void **initProgress**()

#### isStoppingConditionReached

protected abstract boolean **isStoppingConditionReached**()

#### larvaeSettlementPhase

protected abstract List<S> **larvaeSettlementPhase**(List<S> *larvae*, List<S> *population*, List<*Coordinate*> *coordinates*)

#### run

public void **run**()

#### selectBroadcastSpawners

protected abstract List<S> **selectBroadcastSpawners**(List<S> *population*)

#### setCoordinates

public void **setCoordinates**(List<*Coordinate*> *coordinates*)

#### setPopulation

public void **setPopulation**(List<S> *population*)

#### sexualReproduction

protected abstract List<S> **sexualReproduction**(List<S> *broadcastSpawners*)

#### updateProgress

protected abstract void **updateProgress** ()

### 2.2.2 AbstractCoralReefsOptimization.Coordinate

public static class **Coordinate** implements Comparable<*Coordinate*>

Represents a Coordinate in Coral Reef Grid

**Author** inacio-medeiros

#### Constructors

#### Coordinate

public **Coordinate** (int *x*, int *y*)

Constructor

**Parameters**

- **x** – Coordinate's x-position
- **y** – Coordinate's y-position

#### Methods

#### compareTo

public int **compareTo** (*Coordinate arg0*)

#### equals

public boolean **equals** (Object *obj*)

#### getX

public int **getX** ()

Retrieves Coordinate's x-position

**Returns** Coordinate's x-position

#### getY

public int **getY** ()

Retrieves Coordinate's y-position

**Returns** Coordinate's y-position

#### setX

public void **setX** (int *x*)
Sets Coordinate's x-position to a new value

**Parameters**

- **x** – new value for Coordinate's x-position

#### setY

public void **setY** (int *y*)
Sets Coordinate's y-position to a new value

**Parameters**

- **x** – new value for Coordinate's y-position

### 2.2.3 AbstractDifferentialEvolution

public abstract class **AbstractDifferentialEvolution**<Result> extends *AbstractEvolutionaryAlgorithm*<*DoubleSolution*, Res
Abstract class representing differential evolution (DE) algorithms

**Author** Antonio J. Nebro

#### Fields

#### crossoverOperator

protected *DifferentialEvolutionCrossover* **crossoverOperator**

#### selectionOperator

protected *DifferentialEvolutionSelection* **selectionOperator**

### 2.2.4 AbstractEvolutionStrategy

public abstract class **AbstractEvolutionStrategy**<S, Result> extends *AbstractEvolutionaryAlgorithm*<S, Result>
Abstract class representing an evolution strategy algorithm

**Author** Antonio J. Nebro

#### Fields

#### mutationOperator

protected *MutationOperator*<S> **mutationOperator**

#### Constructors

#### AbstractEvolutionStrategy

public **AbstractEvolutionStrategy** (*Problem*<S> *problem*)
Constructor

**Parameters**

- **problem** – The problem to solve

#### Methods

#### getMutationOperator

public *MutationOperator*<S> **getMutationOperator** ()

### 2.2.5 AbstractEvolutionaryAlgorithm

public abstract class **AbstractEvolutionaryAlgorithm**<S, R> implements *Algorithm*<R>
Abstract class representing an evolutionary algorithm

**Author** Antonio J. Nebro

**Parameters**

- **<S>** – Solution
- **<R>** – Result

#### Fields

#### population

protected List<S> **population**

#### problem

protected *Problem*<S> **problem**

#### Methods

#### createInitialPopulation

protected abstract List<S> **createInitialPopulation** ()

#### evaluatePopulation

protected abstract List<S> **evaluatePopulation** (List<S> *population*)

#### getPopulation

public List<S> **getPopulation** ()

#### getProblem

public *Problem*<S> **getProblem** ()

#### getResult

public abstract R **getResult** ()

#### initProgress

protected abstract void **initProgress** ()

#### isStoppingConditionReached

protected abstract boolean **isStoppingConditionReached** ()

#### replacement

protected abstract List<S> **replacement** (List<S> *population*, List<S> *offspringPopulation*)

#### reproduction

protected abstract List<S> **reproduction** (List<S> *population*)

#### run

public void **run** ()

#### selection

protected abstract List<S> **selection** (List<S> *population*)

#### setPopulation

public void **setPopulation** (List<S> *population*)

#### setProblem

public void **setProblem** (*Problem*<S> *problem*)

#### updateProgress

protected abstract void **updateProgress** ()

### 2.2.6 AbstractGeneticAlgorithm

public abstract class **AbstractGeneticAlgorithm**<S, Result> extends *AbstractEvolutionaryAlgorithm*<S, Result>
Abstract class representing a genetic algorithm

**Author** Antonio J. Nebro

#### Fields

#### crossoverOperator

protected *CrossoverOperator*<S> **crossoverOperator**

#### maxPopulationSize

protected int **maxPopulationSize**

#### mutationOperator

protected *MutationOperator*<S> **mutationOperator**

#### selectionOperator

protected *SelectionOperator*<List<S>, S> **selectionOperator**

#### Constructors

#### AbstractGeneticAlgorithm

public **AbstractGeneticAlgorithm** (*Problem*<S> *problem*)
Constructor

**Parameters**

- **problem** – The problem to solve

#### Methods

#### checkNumberOfParents

protected void **checkNumberOfParents** (List<S> *population*, int *numberOfParentsForCrossover*)
A crossover operator is applied to a number of parents, and it assumed that the population contains a valid number of solutions. This method checks that.

**Parameters**

- **population** –
- **numberOfParentsForCrossover** –

### createInitialPopulation

protected List<S> **createInitialPopulation**()

This method implements a default scheme create the initial population of genetic algorithm

### getCrossoverOperator

public *CrossoverOperator*<S> **getCrossoverOperator**()

### getMaxPopulationSize

public int **getMaxPopulationSize**()

### getMutationOperator

public *MutationOperator*<S> **getMutationOperator**()

### getSelectionOperator

public *SelectionOperator*<List<S>, S> **getSelectionOperator**()

### reproduction

protected List<S> **reproduction**(List<S> *population*)

This methods iteratively applies a `CrossoverOperator` a `MutationOperator` to the population to create the offspring population. The population size must be divisible by the number of parents required by the `CrossoverOperator`; this way, the needed parents are taken sequentially from the population. No limits are imposed to the number of solutions returned by the `CrossoverOperator`.

**Parameters**

- **population** –

**Returns** The new created offspring population

### selection

protected List<S> **selection**(List<S> *population*)

This method iteratively applies a `SelectionOperator` to the population to fill the mating pool population.

**Parameters**

- **population** –

**Returns** The mating pool population

#### setMaxPopulationSize

public void **setMaxPopulationSize**(int *maxPopulationSize*)

### 2.2.7 AbstractParticleSwarmOptimization

public abstract class **AbstractParticleSwarmOptimization**<S, Result> implements *Algorithm*<Result>
Abstract class representing a PSO algorithm

**Author** Antonio J. Nebro

#### Methods

#### createInitialSwarm

protected abstract List<S> **createInitialSwarm**()

#### evaluateSwarm

protected abstract List<S> **evaluateSwarm**(List<S> *swarm*)

#### getResult

public abstract Result **getResult**()

#### getSwarm

public List<S> **getSwarm**()

#### initProgress

protected abstract void **initProgress**()

#### initializeLeader

protected abstract void **initializeLeader**(List<S> *swarm*)

#### initializeParticlesMemory

protected abstract void **initializeParticlesMemory**(List<S> *swarm*)

#### initializeVelocity

protected abstract void **initializeVelocity**(List<S> *swarm*)

#### isStoppingConditionReached

protected abstract boolean **isStoppingConditionReached**()

#### perturbation

protected abstract void **perturbation**(List<S> *swarm*)

#### run

public void **run**()

#### setSwarm

public void **setSwarm**(List<S> *swarm*)

#### updateLeaders

protected abstract void **updateLeaders**(List<S> *swarm*)

#### updateParticlesMemory

protected abstract void **updateParticlesMemory**(List<S> *swarm*)

#### updatePosition

protected abstract void **updatePosition**(List<S> *swarm*)

#### updateProgress

protected abstract void **updateProgress**()

#### updateVelocity

protected abstract void **updateVelocity**(List<S> *swarm*)

### 2.2.8 AbstractScatterSearch

public abstract class **AbstractScatterSearch**<S, R> implements *Algorithm*<R>

Abstract class representing a scatter search algorithm

**Author** Antonio J. Nebro

**Parameters**

- **<S>** – Solution

- **<R>** – Result

### Methods

#### diversificationGeneration

public abstract S **diversificationGeneration**()

#### getPopulation

public List<S> **getPopulation**()

#### getPopulationSize

public int **getPopulationSize**()

#### getResult

public abstract R **getResult**()

#### improvement

public abstract S **improvement**(S *solution*)

#### initializationPhase

public void **initializationPhase**()

Initialization phase of the scatter search: the population is filled with diverse solutions that have been improved.

**Returns** The population

#### isStoppingConditionReached

public abstract boolean **isStoppingConditionReached**()

#### referenceSetUpdate

public abstract void **referenceSetUpdate**()

#### referenceSetUpdate

public abstract void **referenceSetUpdate**(S *solution*)

#### restart

public abstract void **restart**()

#### restartConditionIsFulfilled

public abstract boolean **restartConditionIsFulfilled**(List<S> *solutionList*)

#### run

public void **run**()

#### setPopulation

public void **setPopulation**(List<S> *population*)

#### setPopulationSize

public void **setPopulationSize**(int *populationSize*)

#### solutionCombination

public abstract List<S> **solutionCombination**(List<List<S>> *population*)

#### subsetGeneration

public abstract List<List<S>> **subsetGeneration**()

## 2.3 org.uma.jmetal.algorithm.multiobjective.abyss

### 2.3.1 ABYSS

public class **ABYSS** extends *AbstractScatterSearch*<*DoubleSolution*, List<*DoubleSolution*>>

This class implements the AbYSS algorithm, a multiobjective scatter search metaheuristics, which is described in: A.J. Nebro, F. Luna, E. Alba, B. Dorronsoro, J.J. Durillo, A. Beham "AbYSS: Adapting Scatter Search to Multiobjective Optimization." IEEE Transactions on Evolutionary Computation. Vol. 12, No. 4 (August 2008), pp. 439-457

**Author** Antonio J. Nebro , Cristobal Barba

#### Fields

#### archive

protected *Archive*<*DoubleSolution*> **archive**

### archiveSize

protected final int **archiveSize**

### crossover

protected *CrossoverOperator*<*DoubleSolution*> **crossover**

### crowdingDistanceComparator

protected Comparator<*DoubleSolution*> **crowdingDistanceComparator**

### distanceToSolutionListAttribute

protected *DistanceToSolutionListAttribute* **distanceToSolutionListAttribute**

### dominanceComparator

protected Comparator<*DoubleSolution*> **dominanceComparator**

### equalComparator

protected Comparator<*DoubleSolution*> **equalComparator**

### evaluations

protected int **evaluations**

### fitnessComparator

protected Comparator<*DoubleSolution*> **fitnessComparator**

### frequency

protected int[][] **frequency**

### localSearch

protected *LocalSearchOperator*<*DoubleSolution*> **localSearch**

### marked

protected *MarkAttribute* **marked**

#### maxEvaluations

protected final int **maxEvaluations**

#### numberOfSubRanges

protected int **numberOfSubRanges**

These variables are used in the diversification method.

#### problem

protected final *Problem*<*DoubleSolution*> **problem**

#### randomGenerator

protected *JMetalRandom* **randomGenerator**

#### referenceSet1

protected List<*DoubleSolution*> **referenceSet1**

#### referenceSet1Size

protected final int **referenceSet1Size**

#### referenceSet2

protected List<*DoubleSolution*> **referenceSet2**

#### referenceSet2Size

protected final int **referenceSet2Size**

#### reverseFrequency

protected int[][] **reverseFrequency**

#### strengthRawFitness

protected *StrengthRawFitness*<*DoubleSolution*> **strengthRawFitness**

#### sumOfFrequencyValues

protected int[] **sumOfFrequencyValues**

#### sumOfReverseFrequencyValues

protected int[] **sumOfReverseFrequencyValues**

### Constructors

#### ABYSS

public **ABYSS** (*DoubleProblem problem*, int *maxEvaluations*, int *populationSize*, int *referenceSet1Size*, int *referenceSet2Size*, int *archiveSize*, *Archive*<*DoubleSolution*> *archive*, *LocalSearchOperator*<*DoubleSolution*> *localSearch*, *CrossoverOperator*<*DoubleSolution*> *crossoverOperator*, int *numberOfSubRanges*)

### Methods

#### buildNewReferenceSet1

public void **buildNewReferenceSet1** ()

Build the referenceSet1 by moving the best referenceSet1Size individuals, according to a fitness comparator, from the population to the referenceSet1

#### buildNewReferenceSet2

public void **buildNewReferenceSet2** ()

Build the referenceSet2 by moving to it the most diverse referenceSet2Size individuals from the population in respect to the referenceSet1. The size of the referenceSet2 can be lower than referenceSet2Size depending on the current size of the population

#### diversificationGeneration

public *DoubleSolution* **diversificationGeneration** ()

#### generatePairsFromSolutionList

public List<List<*DoubleSolution*>> **generatePairsFromSolutionList** (List<*DoubleSolution*> *solutionList*)

Generate all pair combinations of the referenceSet1

#### getDescription

public String **getDescription** ()

#### getName

public String **getName** ()

#### getResult

public List<*DoubleSolution*> **getResult**()

#### improvement

public *DoubleSolution* **improvement**(*DoubleSolution solution*)

#### isStoppingConditionReached

public boolean **isStoppingConditionReached**()

#### refSet1Test

public boolean **refSet1Test**(*DoubleSolution solution*)

Tries to update the reference set one with a solution

**Parameters**

- **solution** – The `Solution`

**Returns** true if the `Solution` has been inserted, false otherwise.

#### refSet2Test

public boolean **refSet2Test**(*DoubleSolution solution*)

Try to update the reference set 2 with a `Solution`

**Parameters**

- **solution** – The `Solution`

**Throws**

- **JMException** –

**Returns** true if the `Solution` has been inserted, false otherwise.

#### referenceSetUpdate

public void **referenceSetUpdate**()

Build the reference set after the initialization phase

#### referenceSetUpdate

public void **referenceSetUpdate**(*DoubleSolution solution*)

Update the reference set with a new solution

**Parameters**

- **solution** –

#### restart

public void **restart** ()

#### restartConditionIsFulfilled

public boolean **restartConditionIsFulfilled** (List<*DoubleSolution*> *combinedSolutions*)

#### solutionCombination

public List<*DoubleSolution*> **solutionCombination** (List<List<*DoubleSolution*>> *solutionList*)

#### subsetGeneration

public List<List<*DoubleSolution*>> **subsetGeneration** ()
Subset generation method

### 2.3.2 ABYSSBuilder

public class **ABYSSBuilder** implements *AlgorithmBuilder*<*ABYSS*>

**Author** Cristobal Barba

#### Fields

#### improvementOperator

protected *LocalSearchOperator*<*DoubleSolution*> **improvementOperator**

#### Constructors

#### ABYSSBuilder

public **ABYSSBuilder** (*DoubleProblem problem*, *Archive*<*DoubleSolution*> *archive*)

#### Methods

#### build

public *ABYSS* **build** ()

#### getArchiveSize

public int **getArchiveSize** ()

#### getCrossoverOperator

public *CrossoverOperator*<*DoubleSolution*> **getCrossoverOperator**()

#### getImprovementOperator

public *LocalSearchOperator*<*DoubleSolution*> **getImprovementOperator**()

#### getMaxEvaluations

public int **getMaxEvaluations**()

#### getMutationOperator

public *MutationOperator*<*DoubleSolution*> **getMutationOperator**()

#### getNumberOfSubranges

public int **getNumberOfSubranges**()

#### getPopulationSize

public int **getPopulationSize**()

#### getRefSet1Size

public int **getRefSet1Size**()

#### getRefSet2Size

public int **getRefSet2Size**()

#### setArchiveSize

public *ABYSSBuilder* **setArchiveSize**(int *archiveSize*)

#### setCrossoverOperator

public *ABYSSBuilder* **setCrossoverOperator**(*CrossoverOperator*<*DoubleSolution*> *crossoverOperator*)

#### setImprovementOperator

public *ABYSSBuilder* **setImprovementOperator** (*ArchiveMutationLocalSearch*<*DoubleSolution*> *improvementOperator*)

#### setMaxEvaluations

public *ABYSSBuilder* **setMaxEvaluations** (int *maxEvaluations*)

#### setMutationOperator

public *ABYSSBuilder* **setMutationOperator** (*MutationOperator*<*DoubleSolution*> *mutationOperator*)

#### setNumberOfSubranges

public *ABYSSBuilder* **setNumberOfSubranges** (int *numberOfSubranges*)

#### setPopulationSize

public *ABYSSBuilder* **setPopulationSize** (int *populationSize*)

#### setRefSet1Size

public *ABYSSBuilder* **setRefSet1Size** (int *refSet1Size*)

#### setRefSet2Size

public *ABYSSBuilder* **setRefSet2Size** (int *refSet2Size*)

### 2.3.3 ABYSSIT

public class **ABYSSIT**
Created by ajnebro on 11/6/15.

#### Fields

#### algorithm

*Algorithm*<List<*DoubleSolution*>> **algorithm**

#### archive

*Archive*<*DoubleSolution*> **archive**

#### crossover

*CrossoverOperator*<*DoubleSolution*> **crossover**

#### localSearchOperator

*LocalSearchOperator*<*DoubleSolution*> **localSearchOperator**

#### mutation

*MutationOperator*<*DoubleSolution*> **mutation**

#### problem

*DoubleProblem* **problem**

### Methods

#### setup

public void **setup**()

#### shouldTheAlgorithmReturnANumberOfSolutionsWhenSolvingASimpleProblem

public void **shouldTheAlgorithmReturnANumberOfSolutionsWhenSolvingASimpleProblem**()

#### shouldTheHypervolumeHaveAMininumValue

public void **shouldTheHypervolumeHaveAMininumValue**()

## 2.3.4 ABYSSTest

public class **ABYSSTest**
    Created by ajnebro on 11/6/15.

### Fields

#### archive

*Archive*<*DoubleSolution*> **archive**

#### localSearch

*LocalSearchOperator*<*DoubleSolution*> **localSearch**

#### mutation

*MutationOperator*<*DoubleSolution*> **mutation**

#### problem

*DoubleProblem* **problem**

#### Methods

#### setup

public void **setup**()

#### shouldInitializationPhaseLeadToAPopulationFilledWithEvaluatedSolutions

public void **shouldInitializationPhaseLeadToAPopulationFilledWithEvaluatedSolutions**()

#### shouldIsStoppingConditionReachedReturnFalseIfTheConditionDoesNotFulfill

public void **shouldIsStoppingConditionReachedReturnFalseIfTheConditionDoesNotFulfill**()

#### shouldIsStoppingConditionReachedReturnTrueIfTheConditionFulfills

public void **shouldIsStoppingConditionReachedReturnTrueIfTheConditionFulfills**()

#### shouldReferenceSetUpdateCreateAReducedSizeReferenceSet2IfThePopulationIsNotBigEnough

public void **shouldReferenceSetUpdateCreateAReducedSizeReferenceSet2IfThePopulationIsNotBigEnoug**

#### shouldReferenceSetUpdateCreateTheTwoRefSetsAfterBeingInvokedTheFirstTime

public void **shouldReferenceSetUpdateCreateTheTwoRefSetsAfterBeingInvokedTheFirstTime**()

#### shouldRestartCreateANewPopulationWithTheRefSet1Solutions

public void **shouldRestartCreateANewPopulationWithTheRefSet1Solutions**()

#### shouldSolutionCombinationProduceTheRightNumberOfSolutions

public void **shouldSolutionCombinationProduceTheRightNumberOfSolutions**()

#### shouldSubsetGenerationProduceAnEmptyListIfAllTheSolutionsAreMarked

public void **shouldSubsetGenerationProduceAnEmptyListIfAllTheSolutionsAreMarked**()

## 2.4 org.uma.jmetal.algorithm.multiobjective.abyss.util

### 2.4.1 MarkAttribute

public class **MarkAttribute** extends *GenericSolutionAttribute*<*Solution*<?>, Boolean>
Created by cbarba on 24/3/15.

## 2.5 org.uma.jmetal.algorithm.multiobjective.artificialdecisionmaker

### 2.5.1 ArtificiallDecisionMakerIT

public class **ArtificiallDecisionMakerIT**

#### Fields

#### algorithm

*Algorithm*<List<*DoubleSolution*>> **algorithm**

#### Methods

#### shouldTheAlgorithmReturnANumberOfSolutionsWhenSolvingASimpleProblem

public void **shouldTheAlgorithmReturnANumberOfSolutionsWhenSolvingASimpleProblem**()

## 2.6 org.uma.jmetal.algorithm.multiobjective.cdg

### 2.6.1 AbstractCDG

public abstract class **AbstractCDG**<S extends Solution<?>> implements *Algorithm*<List<S>>
Abstract class for implementing versions of the CDG algorithm.

**Author** Feng Zhang

#### Fields

#### badPopulation

protected List<S> **badPopulation**

### badSolution

protected int[] **badSolution**

### badSolutionNum

protected int **badSolutionNum**

### border

protected List<List<S>> **border**

### borderLength

protected int **borderLength**

### childGridNum

protected int **childGridNum_**

### childGrid

protected int **childGrid_**

### crossoverOperator

protected *CrossoverOperator*<S> **crossoverOperator**

### d

protected double[] **d_**

### evaluations

protected int **evaluations**

### gridDetalSum

protected double[][] **gridDetalSum_**

### gridDetal

protected int[] **gridDetal_**

### idealPoint

protected double[] **idealPoint**
Z vector in Zhang & Li paper

### k

protected int **k_**

### maxEvaluations

protected int **maxEvaluations**

### nadirPoint

protected double[] **nadirPoint**

### neighborhood

protected int[][] **neighborhood**

### neighborhoodNum

protected int[] **neighborhoodNum**

### neighborhoodSelectionProbability

protected double **neighborhoodSelectionProbability**
Delta in Zhang & Li paper

### population

protected List<S> **population**

### populationSize

protected int **populationSize**

### problem

protected *Problem*<S> **problem**

#### randomGenerator

protected *JMetalRandom* **randomGenerator**

#### resultPopulationSize

protected int **resultPopulationSize**

#### sigma

protected double **sigma_**

#### slimDetal

protected int **slimDetal_**

#### spPopulationOrder

protected List<Integer> **spPopulationOrder**

#### specialPopulation

protected List<S> **specialPopulation**

#### subP

protected int[][] **subP**

#### subPNum

protected int[] **subPNum**

#### subproblem

protected List<List<S>> **subproblem**

#### subproblemNum

protected int **subproblemNum_**

#### t

protected int **t_**

#### team

protected List<List<Integer>> **team**

#### tempBorder

protected List<List<S>> **tempBorder**

### Constructors

#### AbstractCDG

public **AbstractCDG** (*Problem*<S> *problem*, int *populationSize*, int *resultPopulationSize*, int *maxEvaluations*, *CrossoverOperator*<S> *crossoverOperator*, double *neighborhoodSelectionProbability*, double *sigma_*, int *k_*, int *t_*, int *subproblemNum_*, int *childGrid_*, int *childGridNum_*)

### Methods

#### allocateSolution

protected void **allocateSolution** ()

#### chooseNeighborType

protected *NeighborType* **chooseNeighborType** (int *i*)

#### chooseSolution

protected void **chooseSolution** ()

#### chooseSpecialPopulation

protected void **chooseSpecialPopulation** ()

#### excludeBadSolution

protected void **excludeBadSolution** ()

#### excludeBadSolution3

protected void **excludeBadSolution3** ()

### getBorder

protected void **getBorder** ()

### getG

protected int **getG** (S *individual*, int *index*)

### getGridPos

protected int **getGridPos** (int *j*, double *funValue*)

### getOrder

protected int **getOrder** (S *individual*)

### getPos

protected int **getPos** (int *i*, int *j*, int *k*)

### getRank

protected int **getRank** (S *individual*, int *index*)

### getResult

public List<S> **getResult** ()

### gridSystemSetup

protected void **gridSystemSetup** ()

### gridSystemSetup3

protected void **gridSystemSetup3** ()

### group2

protected void **group2** ()

### group3

protected void **group3** ()

### individualObjRankSort

protected void **individualObjRankSort** ()

### initialCDGAttributes

protected void **initialCDGAttributes** (S *individual*)

### initialGridDetal

protected void **initialGridDetal** ()

### initializeIdealPoint

protected void **initializeIdealPoint** ()

### initializeNadirPoint

protected void **initializeNadirPoint** ()

### initializeNeighborhood

protected void **initializeNeighborhood** ()
Initialize cdg neighborhoods

### initializeNeighborhoodGrid

protected void **initializeNeighborhoodGrid** ()

### initializeSubP2

protected void **initializeSubP2** ()

### initializeSubP3

protected void **initializeSubP3** ()

### isInner

protected boolean **isInner** (S *individual*)

### lexicographicSort

protected void **lexicographicSort** ()

#### matingSelection

protected List<Integer> **matingSelection**(int *subproblemId*, int *numberOfSolutionsToSelect*, *NeighborType* *neighbourType*)

**Parameters**

- **subproblemId** – the id of current subproblem
- **neighbourType** – neighbour type

#### parentSelection

protected List<S> **parentSelection**(int *subProblemId*, *NeighborType* *neighborType*)

#### paretoDom

protected boolean **paretoDom**(S *individual*, int *i*)

#### paretoFilter

protected void **paretoFilter**()

#### rankBasedSelection

protected void **rankBasedSelection**()

#### setG

protected void **setG**(S *individual*, int *index*, int *value*)

#### setIndividualObjRank

protected void **setIndividualObjRank**()

#### setOrder

protected void **setOrder**(S *individual*, int *value*)

#### setRank

protected void **setRank**(S *individual*, int *index*, int *value*)

#### setSpIndividualRank

protected void **setSpIndividualRank**()

#### subproblemSortl

protected void **subproblemSortl** ()

#### supplyBadSolution

protected void **supplyBadSolution** ()

#### updateBorder

protected void **updateBorder** ()

#### updateIdealPoint

protected void **updateIdealPoint** (S *individual*)

#### updateNadirPoint

void **updateNadirPoint** ()

#### updateNeighborhood

protected void **updateNeighborhood** ()

### 2.6.2 AbstractCDG.NeighborType

protected enum **NeighborType**

#### Enum Constants

#### NEIGHBOR

public static final *AbstractCDG.NeighborType* **NEIGHBOR**

#### POPULATION

public static final *AbstractCDG.NeighborType* **POPULATION**

### 2.6.3 CDG

public class **CDG** extends *AbstractCDG*<*DoubleSolution*>

Xinye Cai, Zhiwei Mei, Zhun Fan, Qingfu Zhang, A Constrained Decomposition Approach with Grids for Evolutionary Multiobjective Optimization, IEEE Transaction on Evolutionary Computation, press online, 2018, DOI: 10.1109/TEVC.2017.2744674 The paper and Matlab code can be download at http://xinyecai.github.io/

**Author** Feng Zhang

#### Constructors

#### CDG

public **CDG** (*Problem*<*DoubleSolution*> *problem*, int *populationSize*, int *resultPopulationSize*, int *maxEvaluations*, *CrossoverOperator*<*DoubleSolution*> *crossover*, double *neighborhoodSelectionProbability*, double *sigma_*, int *k_*, int *t_*, int *subproblemNum_*, int *childGrid_*, int *childGridNum_*)

#### Methods

#### getDescription

public String **getDescription** ()

#### getName

public String **getName** ()

#### initializePopulation

protected void **initializePopulation** ()

#### run

public void **run** ()

### 2.6.4 CDGBuilder

public class **CDGBuilder** implements *AlgorithmBuilder*<*AbstractCDG*<*DoubleSolution*>>
Builder class for algorithm CDG

**Author** Feng Zhang

#### Fields

#### childGridNum

protected int **childGridNum_**

#### childGrid

protected int **childGrid_**

#### crossover

protected *CrossoverOperator*<*DoubleSolution*> **crossover**

#### k

protected int **k_**

#### maxEvaluations

protected int **maxEvaluations**

#### neighborhoodSelectionProbability

protected double **neighborhoodSelectionProbability**
Delta in Zhang & Li paper

#### numberOfThreads

protected int **numberOfThreads**

#### populationSize

protected int **populationSize**

#### problem

protected *Problem*<*DoubleSolution*> **problem**

#### resultPopulationSize

protected int **resultPopulationSize**

#### sigma

protected double **sigma_**

#### subproblemNum

protected int **subproblemNum_**

#### t

protected int **t_**

### Constructors

#### CDGBuilder

public **CDGBuilder** (*Problem*<*DoubleSolution*> *problem*)
Constructor

### Methods

#### build

public *AbstractCDG*<*DoubleSolution*> **build** ()

#### getChildGrid

public int **getChildGrid** ()

#### getChildGridNum

public int **getChildGridNum** ()

#### getCrossover

public *CrossoverOperator*<*DoubleSolution*> **getCrossover** ()

#### getK

public int **getK** ()

#### getMaxEvaluations

public int **getMaxEvaluations** ()

#### getNeighborhoodSelectionProbability

public double **getNeighborhoodSelectionProbability** ()

#### getNumberOfThreads

public int **getNumberOfThreads** ()

#### getPopulationSize

public int **getPopulationSize** ()

#### getResultPopulationSize

public int **getResultPopulationSize**()

#### getT

public double **getT**()

#### setChildGrid

public *CDGBuilder* **setChildGrid**(int *childGrid*)

#### setChildGridNum

public *CDGBuilder* **setChildGridNum**(int *childGridNum*)

#### setCrossover

public *CDGBuilder* **setCrossover**(*CrossoverOperator*<*DoubleSolution*> *crossover*)

#### setK

public *CDGBuilder* **setK**(int *k*)

#### setMaxEvaluations

public *CDGBuilder* **setMaxEvaluations**(int *maxEvaluations*)

#### setNeighborhoodSelectionProbability

public *CDGBuilder* **setNeighborhoodSelectionProbability**(double *neighborhoodSelectionProbability*)

#### setNumberOfThreads

public *CDGBuilder* **setNumberOfThreads**(int *numberOfThreads*)

#### setPopulationSize

public *CDGBuilder* **setPopulationSize**(int *populationSize*)

#### setResultPopulationSize

public *CDGBuilder* **setResultPopulationSize**(int *resultPopulationSize*)

#### setT

public *CDGBuilder* **setT** (int *t*)

## 2.7 org.uma.jmetal.algorithm.multiobjective.cellde

### 2.7.1 CellDE

public class **CellDE**

**Author** Antonio J. Nebro

### 2.7.2 CellDE45

public class **CellDE45** implements *Algorithm*<List<*DoubleSolution*>>

**Author** Antonio J. Nebro

#### Fields

#### evaluations

protected int **evaluations**

#### maxEvaluations

protected int **maxEvaluations**

#### Constructors

#### CellDE45

public **CellDE45** (*Problem*<*DoubleSolution*> *problem*, int *maxEvaluations*, int *populationSize*, *BoundedArchive*<*DoubleSolution*> *archive*, *Neighborhood*<*DoubleSolution*> *neighborhood*, *SelectionOperator*<List<*DoubleSolution*>, *DoubleSolution*> *selection*, *DifferentialEvolutionCrossover* *crossover*, double *feedback*, *SolutionListEvaluator*<*DoubleSolution*> *evaluator*)

#### Methods

#### computeRanking

protected *Ranking*<*DoubleSolution*> **computeRanking** (List<*DoubleSolution*> *solutionList*)

#### createInitialPopulation

protected List<*DoubleSolution*> **createInitialPopulation** ()

#### evaluatePopulation

protected List<*DoubleSolution*> **evaluatePopulation**(List<*DoubleSolution*> *population*)

#### getDescription

public String **getDescription**()

#### getName

public String **getName**()

#### getResult

public List<*DoubleSolution*> **getResult**()

#### initProgress

protected void **initProgress**()

#### isStoppingConditionReached

protected boolean **isStoppingConditionReached**()

#### run

public void **run**()

#### updateProgress

protected void **updateProgress**()

## 2.8 org.uma.jmetal.algorithm.multiobjective.dmopso

### 2.8.1 DMOPSO

public class **DMOPSO** implements *Algorithm*<List<*DoubleSolution*>>

#### Fields

#### dataDirectory

String **dataDirectory**

#### functionType

*FunctionType* **functionType**

#### indArray

*DoubleSolution*[] **indArray**

#### iterations

protected int **iterations**

#### lambda

double[][] **lambda**

#### maxAge

protected int **maxAge**

#### maxIterations

protected int **maxIterations**

#### swarmSize

protected int **swarmSize**

#### z

double[] **z**

### Constructors

#### DMOPSO

public **DMOPSO** (*DoubleProblem problem*, int *swarmSize*, int *maxIterations*, double *r1Min*, double *r1Max*, double *r2Min*, double *r2Max*, double *c1Min*, double *c1Max*, double *c2Min*, double *c2Max*, double *weightMin*, double *weightMax*, double *changeVelocity1*, double *changeVelocity2*, *FunctionType functionType*, String *dataDirectory*, int *maxAge*)

### DMOPSO

public **DMOPSO** (*DoubleProblem problem*, int *swarmSize*, int *maxIterations*, double *r1Min*, double *r1Max*, double *r2Min*, double *r2Max*, double *c1Min*, double *c1Max*, double *c2Min*, double *c2Max*, double *weightMin*, double *weightMax*, double *changeVelocity1*, double *changeVelocity2*, *FunctionType functionType*, String *dataDirectory*, int *maxAge*, String *name*)

### Methods

#### createInitialSwarm

protected List<*DoubleSolution*> **createInitialSwarm** ()

#### evaluateSwarm

protected List<*DoubleSolution*> **evaluateSwarm** (List<*DoubleSolution*> *swarm*)

#### getDescription

public String **getDescription** ()

#### getName

public String **getName** ()

#### getResult

public List<*DoubleSolution*> **getResult** ()

#### getSwarm

public List<*DoubleSolution*> **getSwarm** ()

#### initProgress

protected void **initProgress** ()

#### initializeLeaders

protected void **initializeLeaders** (List<*DoubleSolution*> *swarm*)

#### initializeParticlesMemory

protected void **initializeParticlesMemory** (List<*DoubleSolution*> *swarm*)

#### initializeVelocity

protected void **initializeVelocity** (List<*DoubleSolution*> *swarm*)

#### isStoppingConditionReached

protected boolean **isStoppingConditionReached** ()

#### run

public void **run** ()

#### updateProgress

protected void **updateProgress** ()

#### updateVelocity

protected void **updateVelocity** (int *i*)

## 2.8.2 DMOPSO.FunctionType

public enum **FunctionType**

### Enum Constants

#### AGG

public static final *DMOPSO.FunctionType* **AGG**

#### PBI

public static final *DMOPSO.FunctionType* **PBI**

#### TCHE

public static final *DMOPSO.FunctionType* **TCHE**

## 2.8.3 DMOPSOBuilder

public class **DMOPSOBuilder** implements *AlgorithmBuilder*<*DMOPSO*>

**Author** Jorge Rodriguez

#### Constructors

##### DMOPSOBuilder

public **DMOPSOBuilder** (*DoubleProblem problem*)

#### Methods

##### build

public *DMOPSO* **build** ()

##### getC1Max

public double **getC1Max** ()

##### getC1Min

public double **getC1Min** ()

##### getC2Max

public double **getC2Max** ()

##### getC2Min

public double **getC2Min** ()

##### getChangeVelocity1

public double **getChangeVelocity1** ()

##### getChangeVelocity2

public double **getChangeVelocity2** ()

##### getDataDirectory

public String **getDataDirectory** ()

##### getEvaluator

public *SolutionListEvaluator*<*DoubleSolution*> **getEvaluator** ()

#### getFunctionType

public *DMOPSO.FunctionType* **getFunctionType**()

#### getMaxAge

public int **getMaxAge**()

#### getMaxIterations

public int **getMaxIterations**()

#### getName

public String **getName**()

#### getProblem

public *DoubleProblem* **getProblem**()

#### getR1Max

public double **getR1Max**()

#### getR1Min

public double **getR1Min**()

#### getR2Max

public double **getR2Max**()

#### getR2Min

public double **getR2Min**()

#### getSwarmSize

public int **getSwarmSize**()

#### getWeightMax

public double **getWeightMax**()

#### getWeightMin

public double **getWeightMin**()

#### setC1Max

public *DMOPSOBuilder* **setC1Max**(double *c1Max*)

#### setC1Min

public *DMOPSOBuilder* **setC1Min**(double *c1Min*)

#### setC2Max

public *DMOPSOBuilder* **setC2Max**(double *c2Max*)

#### setC2Min

public *DMOPSOBuilder* **setC2Min**(double *c2Min*)

#### setChangeVelocity1

public *DMOPSOBuilder* **setChangeVelocity1**(double *changeVelocity1*)

#### setChangeVelocity2

public *DMOPSOBuilder* **setChangeVelocity2**(double *changeVelocity2*)

#### setDataDirectory

public *DMOPSOBuilder* **setDataDirectory**(String *dataDirectory*)

#### setFunctionType

public *DMOPSOBuilder* **setFunctionType**(*DMOPSO.FunctionType* *functionType*)

#### setMaxAge

public *DMOPSOBuilder* **setMaxAge**(int *maxAge*)

#### setMaxIterations

public *DMOPSOBuilder* **setMaxIterations**(int *maxIterations*)

#### setName

public *DMOPSOBuilder* **setName** (String *name*)

#### setR1Max

public *DMOPSOBuilder* **setR1Max** (double *r1Max*)

#### setR1Min

public *DMOPSOBuilder* **setR1Min** (double *r1Min*)

#### setR2Max

public *DMOPSOBuilder* **setR2Max** (double *r2Max*)

#### setR2Min

public *DMOPSOBuilder* **setR2Min** (double *r2Min*)

#### setRandomGenerator

public *DMOPSOBuilder* **setRandomGenerator** (*PseudoRandomGenerator randomGenerator*)

#### setSolutionListEvaluator

public *DMOPSOBuilder* **setSolutionListEvaluator** (*SolutionListEvaluator*<*DoubleSolution*> *evaluator*)

#### setSwarmSize

public *DMOPSOBuilder* **setSwarmSize** (int *swarmSize*)

#### setVariant

public *DMOPSOBuilder* **setVariant** (*DMOPSOVariant variant*)

#### setWeightMax

public *DMOPSOBuilder* **setWeightMax** (double *weightMax*)

#### setWeightMin

public *DMOPSOBuilder* **setWeightMin** (double *weightMin*)

### 2.8.4 DMOPSOBuilder.DMOPSOVariant

public enum **DMOPSOVariant**

#### Enum Constants

#### DMOPSO

public static final *DMOPSOBuilder.DMOPSOVariant* **DMOPSO**

#### Measures

public static final *DMOPSOBuilder.DMOPSOVariant* **Measures**

### 2.8.5 DMOPSOIT

public class **DMOPSOIT**

Integration tests for algorithm DMOPSO

**Author** Antonio J. Nebro

#### Fields

#### algorithm

*Algorithm*<List<*DoubleSolution*>> **algorithm**

#### Methods

#### shouldTheAlgorithmReturnANumberOfSolutionsWhenSolvingASimpleProblem

public void **shouldTheAlgorithmReturnANumberOfSolutionsWhenSolvingASimpleProblem**()

#### shouldTheHypervolumeHaveAMininumValue

public void **shouldTheHypervolumeHaveAMininumValue**()

### 2.8.6 DMOPSOMeasures

public class **DMOPSOMeasures** extends *DMOPSO* implements *Measurable*

#### Fields

#### durationMeasure

protected *DurationMeasure* **durationMeasure**

#### epsilonValue

protected *BasicMeasure*<Double> **epsilonValue**

#### hypervolumeValue

protected *BasicMeasure*<Double> **hypervolumeValue**

#### iterations

protected *CountingMeasure* **iterations**

#### measureManager

protected *SimpleMeasureManager* **measureManager**

#### referenceFront

protected *Front* **referenceFront**

#### solutionListMeasure

protected *BasicMeasure*<List<*DoubleSolution*>> **solutionListMeasure**

### Constructors

#### DMOPSOMeasures

public **DMOPSOMeasures** (*DoubleProblem* *problem*, int *swarmSize*, int *maxIterations*, double *r1Min*, double *r1Max*, double *r2Min*, double *r2Max*, double *c1Min*, double *c1Max*, double *c2Min*, double *c2Max*, double *weightMin*, double *weightMax*, double *changeVelocity1*, double *changeVelocity2*, *FunctionType* *functionType*, String *dataDirectory*, int *maxAge*)

#### DMOPSOMeasures

public **DMOPSOMeasures** (*DoubleProblem* *problem*, int *swarmSize*, int *maxIterations*, double *r1Min*, double *r1Max*, double *r2Min*, double *r2Max*, double *c1Min*, double *c1Max*, double *c2Min*, double *c2Max*, double *weightMin*, double *weightMax*, double *changeVelocity1*, double *changeVelocity2*, *FunctionType* *functionType*, String *dataDirectory*, int *maxAge*, String *name*)

#### Methods

##### getDescription

public String **getDescription**()

##### getMeasureManager

public *MeasureManager* **getMeasureManager**()

##### initProgress

protected void **initProgress**()

##### isStoppingConditionReached

protected boolean **isStoppingConditionReached**()

##### run

public void **run**()

##### setReferenceFront

public void **setReferenceFront**(*Front referenceFront*)

##### updateProgress

protected void **updateProgress**()

## 2.9 org.uma.jmetal.algorithm.multiobjective.espea

### 2.9.1 ESPEA

public class **ESPEA**<S extends Solution<?>> extends *AbstractGeneticAlgorithm*<S, List<S>>

Implementation of the Electrostatic Potential Energy Evolutionary Algorithm (ESPEA) from the paper "Obtaining Optimal Pareto Front Approximations using Scalarized Preference Information" by M. Braun et al.

The algorithm generates preference-biased Pareto front approximations that cover the entire front but focus more solutions in those regions that are interesting to the decision maker. Preferences are presented to the algorithm in the form of a scalarization function (value function) that maps the vector of objective to a real value. Smaller values are deemed to indicate higher desirability to comply with minimization.

If no scalarized preference is specified, uniform preferences are assumed and ESPEA generates a uniform approximation of the Pareto front.

**Author** Marlon Braun

#### Fields

##### archive

protected final *EnergyArchive*<S> **archive**

An archive of nondominated solutions that approximates the energy minimum state based on the chosen scalarization function.

##### evaluations

protected int **evaluations**

The number of function evaluations that have been executed so far.

##### evaluator

protected final *SolutionListEvaluator*<S> **evaluator**

Evaluates the solutions

##### fullArchiveCrossoverOperator

protected *CrossoverOperator*<S> **fullArchiveCrossoverOperator**

ESPEA uses two different crossover operators depending on the current archive size. If the archive is not full, it uses the crossover operator provided by `getCrossoverOperator()`. If the archive is full, `fullArchiveCrossoverOperator` is used.

##### maxEvaluations

protected int **maxEvaluations**

Maximum number of functions evaluations that are executed.

#### Constructors

##### ESPEA

public **ESPEA** (*Problem*<S> *problem*, int *maxEvaluations*, int *populationSize*, *CrossoverOperator*<S> *crossoverOperator*, *CrossoverOperator*<S> *fullArchiveCrossoverOperator*, *MutationOperator*<S> *mutationOperator*, *SelectionOperator*<List<S>, S> *selectionOperator*, *ScalarizationWrapper* *scalarizationWrapper*, *SolutionListEvaluator*<S> *evaluator*, boolean *normalizeObjectives*, *ReplacementStrategy* *replacementStrategy*)

Constructor for setting all parameters of ESPEA.

#### Methods

##### evaluatePopulation

protected List<S> **evaluatePopulation** (List<S> *population*)

#### getDescription

public String **getDescription** ()

#### getName

public String **getName** ()

#### getResult

public List<S> **getResult** ()

#### initProgress

protected void **initProgress** ()

#### isStoppingConditionReached

protected boolean **isStoppingConditionReached** ()

#### replacement

protected List<S> **replacement** (List<S> *population*, List<S> *offspringPopulation*)

#### reproduction

protected List<S> **reproduction** (List<S> *population*)

#### selection

protected List<S> **selection** (List<S> *population*)

#### updateProgress

protected void **updateProgress** ()

### 2.9.2 ESPEABuilder

public class **ESPEABuilder**<S extends Solution<?>> implements *AlgorithmBuilder*<*ESPEA*<S>>

### Constructors

#### ESPEABuilder

public **ESPEABuilder** (*Problem*<S> *problem*, *CrossoverOperator*<S> *crossoverOperator*, *MutationOperator*<S> *mutationOperator*)

### Methods

#### build

public *ESPEA*<S> **build** ()

#### getCrossoverOperator

public *CrossoverOperator*<S> **getCrossoverOperator** ()

**Returns** the crossoverOperator

#### getEvaluator

public *SolutionListEvaluator*<S> **getEvaluator** ()

**Returns** the evaluator

#### getFullArchiveCrossoverOperator

public *CrossoverOperator*<S> **getFullArchiveCrossoverOperator** ()

**Returns** the fullArchiveCrossoverOperator

#### getMaxEvaluations

public int **getMaxEvaluations** ()

**Returns** the maxEvaluations

#### getMutationOperator

public *MutationOperator*<S> **getMutationOperator** ()

**Returns** the mutationOperator

#### getOperationType

public *ReplacementStrategy* **getOperationType** ()

**Returns** the replacement strategy

### getPopulationSize

public int **getPopulationSize**()

**Returns** the populationSize

### getScalarization

public *ScalarizationWrapper* **getScalarization**()

**Returns** the scalarization

### getSelectionOperator

public *SelectionOperator*<List<S>, S> **getSelectionOperator**()

**Returns** the selectionOperator

### isNormalizeObjectives

public boolean **isNormalizeObjectives**()

**Returns** the normalizeObjectives

### setCrossoverOperator

public void **setCrossoverOperator**(*CrossoverOperator*<S> *crossoverOperator*)

**Parameters**

- **crossoverOperator** – the crossoverOperator to set

### setEvaluator

public void **setEvaluator**(*SolutionListEvaluator*<S> *evaluator*)

**Parameters**

- **evaluator** – the evaluator to set

### setFullArchiveCrossoverOperator

public void **setFullArchiveCrossoverOperator**(*CrossoverOperator*<S> *fullArchiveCrossoverOperator*)

**Parameters**

- **fullArchiveCrossoverOperator** – the fullArchiveCrossoverOperator to set

### setMaxEvaluations

public void **setMaxEvaluations** (int *maxEvaluations*)

**Parameters**

- **maxEvaluations** – the maxEvaluations to set

### setMutationOperator

public void **setMutationOperator** (*MutationOperator*<S> *mutationOperator*)

**Parameters**

- **mutationOperator** – the mutationOperator to set

### setNormalizeObjectives

public void **setNormalizeObjectives** (boolean *normalizeObjectives*)

**Parameters**

- **normalizeObjectives** – the normalizeObjectives to set

### setPopulationSize

public void **setPopulationSize** (int *populationSize*)

**Parameters**

- **populationSize** – the populationSize to set

### setReplacementStrategy

public void **setReplacementStrategy** (*ReplacementStrategy* *replacementStrategy*)

**Parameters**

- **replacementStrategy** – the replacement strategy to set

### setScalarization

public void **setScalarization** (*ScalarizationWrapper* *scalarization*)

**Parameters**

- **scalarization** – the scalarization to set

### setSelectionOperator

public void **setSelectionOperator** (*SelectionOperator*<List<S>, S> *selectionOperator*)

**Parameters**

- **selectionOperator** – the selectionOperator to set

## 2.10 org.uma.jmetal.algorithm.multiobjective.espea.util

### 2.10.1 AchievementScalarizationComparator

public class **AchievementScalarizationComparator**<S extends Solution<?>> implements Comparator<S>

Compares solutions based on their achievement scalarization value (ASV). The ASV is always defined for a specific objective k. A solution x dominates solution y w.r.t. to their ASV, if the maximum of all objectives without k is smaller for x compared to y. If both maxima are the same, solutions are compared w.r.t. to objective k. Achievement scalarization values can be used for identifying extreme points.

**Author** marlon.braun

**Parameters**

- **<S>** – The solution type.

#### Constructors

#### AchievementScalarizationComparator

public **AchievementScalarizationComparator** (int *objective*)

The achievement scalarization comparator requires an objective for which it is defined.

**Parameters**

- **objective** – The objective for which achievement scalarizationv alues are computed.

#### Methods

#### compare

public int **compare** (S *s1*, S *s2*)

### 2.10.2 EnergyArchive

public class **EnergyArchive**<S extends Solution<?>> extends *AbstractBoundedArchive*<S>

The archive that is used within the *ESPEA* algorithm. The archive is of variable size and bounded by the population size. A new solution can only replace an existing archive member if it leads to a reduction of the total energy of the archive.

**Author** marlon.braun

#### Constructors

#### EnergyArchive

public **EnergyArchive** (int *maxSize*)

Standard constructor that uses uniform preferences - all Pareto optimal solutions are equally desirable.

**Parameters**

- **maxSize** – Size of the final distribution of points generated by the archive.

#### EnergyArchive

public **EnergyArchive** (int *maxSize*, *ScalarizationWrapper scalWrapper*)
Constructor that requires archive size and scalarization method

**Parameters**

- **maxSize** – Size of the final distribution of points generated by the archive.
- **scalWrapper** – The scalarization method that is used for computing energy contributions.

#### EnergyArchive

public **EnergyArchive** (int *maxSize*, *ScalarizationWrapper scalWrapper*, boolean *normalizeObjectives*)
Constructor that requires archive size, scalarization method and whether objectives are normliazed.

**Parameters**

- **maxSize** – Size of the final distribution of points generated by the archive.
- **scalWrapper** – The scalarization method that is used for computing energy contributions.
- **normalizeObjectives** – Whether or not objective values are normlalized between distance computation.

#### EnergyArchive

public **EnergyArchive** (int *maxSize*, *ScalarizationWrapper scalWrapper*, boolean *normalizeObjectives*, *ReplacementStrategy replacementStrategy*)
Constructor that requires archive size, scalarization method, whether objectives are normalized and the replacement strategy.

**Parameters**

- **maxSize** – Size of the final distribution of points generated by the archive.
- **scalWrapper** – The scalarization method that is used for computing energy contributions.
- **normalizeObjectives** – Whether or not objective values are normlalized between distance computation.
- **replacementStrategy** – Replacement strategy for archive update.

### Methods

#### computeDensityEstimator

public void **computeDensityEstimator** ()

#### getComparator

public Comparator<S> **getComparator** ()

#### isFull

public boolean **isFull**()

A check for testing whether the archive is full.

**Returns** true if the archive possesses the maximum number of elements. False otherwise.

#### prune

public void **prune**()

#### sortByDensityEstimator

public void **sortByDensityEstimator**()

### 2.10.3 EnergyArchive.ReplacementStrategy

public static enum **ReplacementStrategy**

The replacement strategy defines the rule by which an existing archive member is replaced by a new solution. Computational studies have revealed that *BEST_FEASIBLE_POSITION* is inferior to *LARGEST_DIFFERENCE* and *WORST_IN_ARCHIVE*. No significant performance difference could be founnd between *LARGEST_DIFFERENCE* and *WORST_IN_ARCHIVE*. See "Obtaining Optimal Pareto Front Appx-oimations" by Braun et al. and "Scalarized Preferences in Multi-objective Optimizaiton" by Braun for details.

**Author** marlon.braun

#### Enum Constants

#### BEST_FEASIBLE_POSITION

public static final *EnergyArchive.ReplacementStrategy* **BEST_FEASIBLE_POSITION**

Inserts the new solution such that the energy it introduces into the archive is minimized.

#### LARGEST_DIFFERENCE

public static final *EnergyArchive.ReplacementStrategy* **LARGEST_DIFFERENCE**

Maximizes the energy differences before and after replacement.

#### WORST_IN_ARCHIVE

public static final *EnergyArchive.ReplacementStrategy* **WORST_IN_ARCHIVE**

Among all eligible archive members that can be replaced the one exhibiting the largest energy contribution is replaced.

### 2.10.4 ScalarizationUtils

public class **ScalarizationUtils**

A class that contains methods for computing the scalarization values of solutions. A scalarization value is an aggregation of the objective values that maps to the real numbers, e.g. the weighted sum.

Scalarization values are stored as *ScalarizationValue* in the solutions.

**Author** Marlon Braun

#### Methods

#### angleUtility

public static <S extends Solution<?>> void **angleUtility**(List<S> *solutionsList*)

Scalarization values based on angle utility (see Angle-based Preference Models in Multi-objective Optimization by Braun et al.). Extreme points are computed from the list of solutions.

**Parameters**

- **solutionsList** – A list of solutions.

#### angleUtility

public static <S extends Solution<?>> void **angleUtility**(List<S> *solutionsList*, double[][] *extremePoints*)

Scalarization values based on angle utility (see Angle-based Preference Models in Multi-objective Optimization by Braun et al.).

**Parameters**

- **solutionsList** – A list of solutions.
- **extremePoints** – used for angle computation.

#### chebyshev

public static <S extends Solution<?>> void **chebyshev**(List<S> *solutionsList*)

Scalarization values based on the Chebyshev function. The ideal point is computed from the list of solutions.

**Parameters**

- **solutionsList** – A list of solutions.

#### chebyshev

public static <S extends Solution<?>> void **chebyshev**(List<S> *solutionsList*, double[] *idealValues*)

Scalarization values based on the Chebyshev function.

**Parameters**

- **solutionsList** – A list of solutions.
- **idealValues** – The ideal point

### nash

public static <S extends Solution<?>> void **nash** (List<S> *solutionsList*)

Scalarization values based on the Nash bargaining solution. The disagreement point is computed based on the list of solutions.

**Parameters**

- **solutionsList** – A list of solutions.

### nash

public static <S extends Solution<?>> void **nash** (List<S> *solutionsList*, double[] *nadirValues*)

Scalarization values based on the Nash bargaining solution.

**Parameters**

- **solutionsList** – A list of solutions.
- **nadirValues** – The disagreement point.

### productOfObjectives

public static <S extends Solution<?>> void **productOfObjectives** (List<S> *solutionsList*)

Objective values are multiplied.

**Parameters**

- **solutionsList** – A list of solutions.

### sumOfObjectives

public static <S extends Solution<?>> void **sumOfObjectives** (List<S> *solutionsList*)

Scalarization values is computed by summing objective values.

**Parameters**

- **solutionsList** – A list of solutions.

### tradeoffUtility

public static <S extends Solution<?>> void **tradeoffUtility** (List<S> *solutionsList*)

Scalarization values based on tradeoff utility, also known as proper utility (see "Theory and Algorithm for Finding Knees" by Shukla et al.)

**Parameters**

- **solutionsList** – A list of solutions.

### uniform

public static <S extends Solution<?>> void **uniform** (List<S> *solutionsList*)

Uniform preferences. Each solution is assigned a scalarization value of 1.0.

**Parameters**

- **solutionsList** – A list of solutions.

#### weightedChebyshev

public static <S extends Solution<?>> void **weightedChebyshev** (List<S> *solutionsList*, double[] *weights*)

Chebyhsev function with weighted objectives.

**Parameters**

- **solutionsList** – A list of solutions.
- **weights** – Constants by which ideal values and objective values are multiplied.

#### weightedChebyshev

public static <S extends Solution<?>> void **weightedChebyshev** (List<S> *solutionsList*, double[] *idealValues*, double[] *weights*)

Scalarization values based on the weighted Chebyshev function.

**Parameters**

- **solutionsList** – A list of solutions.
- **idealValues** – The ideal point.
- **weights** – Constants by which ideal values and objective values are multiplied.

#### weightedProduct

public static <S extends Solution<?>> void **weightedProduct** (List<S> *solutionsList*, double[] *weights*)

Objectives are exponentiated by a positive weight and afterwards multiplied.

**Parameters**

- **solutionsList** – A list of solutions.
- **weights** – Weights by objectives are exponentiated

#### weightedSum

public static <S extends Solution<?>> void **weightedSum** (List<S> *solutionsList*, double[] *weights*)

Objective values are multiplied by weights and summed. Weights should always be positive.

**Parameters**

- **solutionsList** – A list of solutions.
- **weights** – Positive constants by which objectives are summed.

### 2.10.5 ScalarizationValue

public class **ScalarizationValue**<S extends Solution<?>> extends *GenericSolutionAttribute*<S, Double>

Scalarization attribute. A scalarization value is an aggregation of the objective values.

**Author** Marlon Braun

**Parameters**

- **<S>** – The solution type

### 2.10.6 ScalarizationWrapper

public class **ScalarizationWrapper**

A class for simplifying the access to *ScalarizationUtils*.

**Author** Marlon Braun

#### Constructors

##### ScalarizationWrapper

public **ScalarizationWrapper** (*ScalarizationType scalarizationType*)

Initialize from scalarization type

**Parameters**

- **scalarizationType** – Chosen scalarization function

##### ScalarizationWrapper

public **ScalarizationWrapper** (*Config config*)

Initialize from Config.

**Parameters**

- **config** – Configuration of the scalarization Wrapper.

#### Methods

##### execute

public <S extends Solution<?>> void **execute** (List<S> *solutionsList*)

Computes scalarization values and assigns them as *ScalarizationValue* attribute to the solutions.

**Parameters**

- **solutionsList** – Solutions for which scalarization values computed.

### 2.10.7 ScalarizationWrapper.Config

public static class **Config**

Configuration of the scalarization wrapper.

**Author** Marlon Braun

### 2.10.8 ScalarizationWrapper.ScalarizationType

public static enum **ScalarizationType**

The scalarization function that is used for computing values.

**Author** Marlon Braun

#### Enum Constants

##### ANGLE_UTILITY

public static final *ScalarizationWrapper.ScalarizationType* **ANGLE_UTILITY**

Scalarization values are based on maximum angles to extreme points (see "Angle based Preferences Models in Multi-objective Optimization" by Braun et al.)

##### CHEBYSHEV

public static final *ScalarizationWrapper.ScalarizationType* **CHEBYSHEV**

Chebyhsev scalarization function.

##### NASH

public static final *ScalarizationWrapper.ScalarizationType* **NASH**

The Nash bargaining solution

##### PRODUCT_OF_OBJECTIVES

public static final *ScalarizationWrapper.ScalarizationType* **PRODUCT_OF_OBJECTIVES**

Multiplication of all objectives.

##### SUM_OF_OBJECTIVES

public static final *ScalarizationWrapper.ScalarizationType* **SUM_OF_OBJECTIVES**

Summing up all objectives.

##### TRADEOFF_UTILITY

public static final *ScalarizationWrapper.ScalarizationType* **TRADEOFF_UTILITY**

Tradeoff utility also known as proper utility (see "Theory and Algorithms for Finding Knees" by Shukla et al.).

##### UNIFORM

public static final *ScalarizationWrapper.ScalarizationType* **UNIFORM**

All solutions are assigned a scalarization value of 1.

#### WEIGHTED_CHEBYSHEV

public static final *ScalarizationWrapper.ScalarizationType* **WEIGHTED_CHEBYSHEV**
Chebyhsev function with weights.

#### WEIGHTED_PRODUCT

public static final *ScalarizationWrapper.ScalarizationType* **WEIGHTED_PRODUCT**
Objectives are exponentiated by weights before being multiplied.

#### WEIGHTED_SUM

public static final *ScalarizationWrapper.ScalarizationType* **WEIGHTED_SUM**
Weighted sum.

## 2.11 org.uma.jmetal.algorithm.multiobjective.gde3

### 2.11.1 GDE3

public class **GDE3** extends *AbstractDifferentialEvolution*<List<*DoubleSolution*>>
This class implements the GDE3 algorithm

#### Fields

#### crowdingDistance

protected *DensityEstimator*<*DoubleSolution*> **crowdingDistance**

#### dominanceComparator

protected Comparator<*DoubleSolution*> **dominanceComparator**

#### evaluations

protected int **evaluations**

#### evaluator

protected *SolutionListEvaluator*<*DoubleSolution*> **evaluator**

#### maxEvaluations

protected int **maxEvaluations**

### ranking

protected *Ranking*<*DoubleSolution*> **ranking**

### Constructors

### GDE3

public **GDE3** (*DoubleProblem problem*, int *populationSize*, int *maxEvaluations*, *DifferentialEvolutionSelection selection*, *DifferentialEvolutionCrossover crossover*, *SolutionListEvaluator*<*DoubleSolution*> *evaluator*)

Constructor

### Methods

### addLastRankedSolutionsToPopulation

protected void **addLastRankedSolutionsToPopulation** (*Ranking*<*DoubleSolution*> *ranking*, int *rank*, List<*DoubleSolution*> *population*)

### addRankedSolutionsToPopulation

protected void **addRankedSolutionsToPopulation** (*Ranking*<*DoubleSolution*> *ranking*, int *rank*, List<*DoubleSolution*> *population*)

### computeRanking

protected *Ranking*<*DoubleSolution*> **computeRanking** (List<*DoubleSolution*> *solutionList*)

### createInitialPopulation

protected List<*DoubleSolution*> **createInitialPopulation** ()

### crowdingDistanceSelection

protected List<*DoubleSolution*> **crowdingDistanceSelection** (*Ranking*<*DoubleSolution*> *ranking*)

### evaluatePopulation

protected List<*DoubleSolution*> **evaluatePopulation** (List<*DoubleSolution*> *population*)

Evaluate population method

**Parameters**

- **population** – The list of solutions to be evaluated

**Returns** A list of evaluated solutions

### getDescription

public String **getDescription**()

### getMaxPopulationSize

public int **getMaxPopulationSize**()

### getName

public String **getName**()

### getNonDominatedSolutions

protected List<*DoubleSolution*> **getNonDominatedSolutions**(List<*DoubleSolution*> *solutionList*)

### getResult

public List<*DoubleSolution*> **getResult**()

### initProgress

protected void **initProgress**()

### isStoppingConditionReached

protected boolean **isStoppingConditionReached**()

### populationIsNotFull

protected boolean **populationIsNotFull**(List<*DoubleSolution*> *population*)

### replacement

protected List<*DoubleSolution*> **replacement**(List<*DoubleSolution*> *population*, List<*DoubleSolution*> *offspringPopulation*)

### reproduction

protected List<*DoubleSolution*> **reproduction**(List<*DoubleSolution*> *matingPopulation*)

### selection

protected List<*DoubleSolution*> **selection**(List<*DoubleSolution*> *population*)

#### setMaxPopulationSize

public void **setMaxPopulationSize** (int *maxPopulationSize*)

#### subfrontFillsIntoThePopulation

protected boolean **subfrontFillsIntoThePopulation** (*Ranking*<*DoubleSolution*> *ranking*, int *rank*, List<*DoubleSolution*> *population*)

#### updateProgress

protected void **updateProgress** ()

## 2.11.2 GDE3Builder

public class **GDE3Builder** implements *AlgorithmBuilder*<*GDE3*>
This class implements the GDE3 algorithm

### Fields

#### crossoverOperator

protected *DifferentialEvolutionCrossover* **crossoverOperator**

#### evaluator

protected *SolutionListEvaluator*<*DoubleSolution*> **evaluator**

#### maxEvaluations

protected int **maxEvaluations**

#### populationSize

protected int **populationSize**

#### selectionOperator

protected *DifferentialEvolutionSelection* **selectionOperator**

### Constructors

#### GDE3Builder

public **GDE3Builder** (*DoubleProblem problem*)
Constructor

### Methods

#### build

public *GDE3* **build** ()

#### getCrossoverOperator

public *CrossoverOperator*<*DoubleSolution*> **getCrossoverOperator** ()

#### getMaxEvaluations

public int **getMaxEvaluations** ()

#### getPopulationSize

public int **getPopulationSize** ()

#### getSelectionOperator

public *SelectionOperator*<List<*DoubleSolution*>, List<*DoubleSolution*>> **getSelectionOperator** ()

#### setCrossover

public *GDE3Builder* **setCrossover** (*DifferentialEvolutionCrossover crossover*)

#### setMaxEvaluations

public *GDE3Builder* **setMaxEvaluations** (int *maxEvaluations*)

#### setPopulationSize

public *GDE3Builder* **setPopulationSize** (int *populationSize*)

#### setSelection

public *GDE3Builder* **setSelection** (*DifferentialEvolutionSelection selection*)

#### setSolutionSetEvaluator

public *GDE3Builder* **setSolutionSetEvaluator**(*SolutionListEvaluator*<*DoubleSolution*> *evaluator*)

### 2.11.3 GDE3TestIT

public class **GDE3TestIT**
Created by ajnebro on 3/11/15.

#### Fields

#### algorithm

*Algorithm*<List<*DoubleSolution*>> **algorithm**

#### Methods

#### shouldTheAlgorithmReturnANumberOfSolutionsWhenSolvingASimpleProblem

public void **shouldTheAlgorithmReturnANumberOfSolutionsWhenSolvingASimpleProblem**()

#### shouldTheHypervolumeHaveAMininumValue

public void **shouldTheHypervolumeHaveAMininumValue**()

## 2.12 org.uma.jmetal.algorithm.multiobjective.gwasfga

### 2.12.1 GWASFGA

public class **GWASFGA**<S extends Solution<?>> extends *WASFGA*<S>
This class executes the GWASFGA algorithm described in: Saborido, R., Ruiz, A. B. and Luque, M. (2015). Global WASF-GA: An Evolutionary Algorithm in Multiobjective Optimization to Approximate the whole Pareto Optimal Front. Evolutionary Computation Accepted for publication.

**Author** Juanjo Durillo

#### Constructors

#### GWASFGA

public **GWASFGA**(*Problem*<S> *problem*, int *populationSize*, int *maxIterations*, *CrossoverOperator*<S> *crossoverOperator*, *MutationOperator*<S> *mutationOperator*, *SelectionOperator*<List<S>, S> *selectionOperator*, *SolutionListEvaluator*<S> *evaluator*, double *epsilon*, String *weightVectorsFileName*)

#### GWASFGA

public **GWASFGA** (*Problem*<S> *problem*, int *populationSize*, int *maxIterations*, *CrossoverOperator*<S> *crossoverOperator*, *MutationOperator*<S> *mutationOperator*, *SelectionOperator*<List<S>, S> *selectionOperator*, *SolutionListEvaluator*<S> *evaluator*, double *epsilon*)

#### Methods

#### computeRanking

protected *Ranking*<S> **computeRanking** (List<S> *solutionList*)

#### getDescription

public String **getDescription** ()

#### getName

public String **getName** ()

## 2.13 org.uma.jmetal.algorithm.multiobjective.gwasfga.util

### 2.13.1 GWASFGARanking

public class **GWASFGARanking**<S extends Solution<?>> extends *GenericSolutionAttribute*<S, Integer> implements *Ranking*<S>

**Author** Rubén Saborido Implementation of the ranking procedure for the algorithm GWASF-GA on jMetal5.0 It classifies solutions into different fronts. If the problem contains constraints, after feasible solutions it classifies the unfeasible solutions into fronts: - Each unfeasible solution goes into a different front. - Unfeasible solutions with lower number of violated constraints are preferred. - If two solutions have equal number of violated constraints it compares the overall constraint values. - If two solutions have equal overall constraint values it compares de values of the utility function.

#### Constructors

#### GWASFGARanking

public **GWASFGARanking** (*AbstractUtilityFunctionsSet*<S> *utilityFunctionsUtopia*, *AbstractUtilityFunctionsSet*<S> *utilityFunctionsNadir*)

#### Methods

#### computeRanking

public *Ranking*<S> **computeRanking** (List<S> *population*)

#### getNumberOfSubfronts

public int **getNumberOfSubfronts** ()

#### getSubfront

public List<S> **getSubfront** (int *rank*)

#### rankUnfeasibleSolutions

protected int[] **rankUnfeasibleSolutions** (List<S> *population*)
Obtain the rank of each solution in a list of unfeasible solutions

**Parameters**

- **population** – List of unfeasible solutions

**Returns** The rank of each unfeasible solutions

## 2.14 org.uma.jmetal.algorithm.multiobjective.ibea

### 2.14.1 IBEA

public class **IBEA**<S extends Solution<?>> implements *Algorithm*<List<S>>
This class implements the IBEA algorithm

#### Fields

#### TOURNAMENTS_ROUNDS

public static final int **TOURNAMENTS_ROUNDS**

#### archive

protected List<S> **archive**

#### archiveSize

protected int **archiveSize**

#### crossoverOperator

protected *CrossoverOperator*<S> **crossoverOperator**

#### indicatorValues

protected List<List<Double>> **indicatorValues**

#### maxEvaluations

protected int **maxEvaluations**

#### maxIndicatorValue

protected double **maxIndicatorValue**

#### mutationOperator

protected *MutationOperator*<S> **mutationOperator**

#### populationSize

protected int **populationSize**

#### problem

protected *Problem*<S> **problem**

#### selectionOperator

protected *SelectionOperator*<List<S>, S> **selectionOperator**

#### solutionFitness

protected *Fitness*<S> **solutionFitness**

### Constructors

#### IBEA

public **IBEA** (*Problem*<S> *problem*, int *populationSize*, int *archiveSize*, int *maxEvaluations*, *SelectionOperator*<List<S>, S> *selectionOperator*, *CrossoverOperator*<S> *crossoverOperator*, *MutationOperator*<S> *mutationOperator*)

Constructor

#### Methods

##### calculateFitness

public void **calculateFitness** (List<S> *solutionSet*)

Calculate the fitness for the entire population.

##### calculateHypervolumeIndicator

double **calculateHypervolumeIndicator** (Solution<?> *solutionA*, Solution<?> *solutionB*, int *d*, double[] *maximumValues*, double[] *minimumValues*)

Calculates the hypervolume of that portion of the objective space that is dominated by individual a but not by individual b

##### computeIndicatorValuesHD

public void **computeIndicatorValuesHD** (List<S> *solutionSet*, double[] *maximumValues*, double[] *minimumValues*)

This structure stores the indicator values of each pair of elements

##### fitness

public void **fitness** (List<S> *solutionSet*, int *pos*)

Calculate the fitness for the individual at position pos

##### getDescription

public String **getDescription** ()

##### getName

public String **getName** ()

##### getResult

public List<S> **getResult** ()

##### removeWorst

public void **removeWorst** (List<S> *solutionSet*)

Update the fitness before removing an individual

##### run

public void **run** ()

Execute() method

### 2.14.2 IBEABuilder

public class **IBEABuilder** implements *AlgorithmBuilder*<*IBEA*<*DoubleSolution*>>
This class implements the IBEA algorithm

#### Constructors

#### IBEABuilder

public **IBEABuilder**(*Problem*<*DoubleSolution*> *problem*)
Constructor

**Parameters**

- **problem** –

#### Methods

#### build

public *IBEA*<*DoubleSolution*> **build**()

#### getArchiveSize

public int **getArchiveSize**()

#### getCrossover

public *CrossoverOperator*<*DoubleSolution*> **getCrossover**()

#### getMaxEvaluations

public int **getMaxEvaluations**()

#### getMutation

public *MutationOperator*<*DoubleSolution*> **getMutation**()

#### getPopulationSize

public int **getPopulationSize**()

#### getSelection

public *SelectionOperator*<List<*DoubleSolution*>, *DoubleSolution*> **getSelection**()

#### setArchiveSize

public *IBEABuilder* **setArchiveSize**(int *archiveSize*)

#### setCrossover

public *IBEABuilder* **setCrossover**(*CrossoverOperator*<*DoubleSolution*> *crossover*)

#### setMaxEvaluations

public *IBEABuilder* **setMaxEvaluations**(int *maxEvaluations*)

#### setMutation

public *IBEABuilder* **setMutation**(*MutationOperator*<*DoubleSolution*> *mutation*)

#### setPopulationSize

public *IBEABuilder* **setPopulationSize**(int *populationSize*)

#### setSelection

public *IBEABuilder* **setSelection**(*SelectionOperator*<List<*DoubleSolution*>, *DoubleSolution*> *selection*)

## 2.15 org.uma.jmetal.algorithm.multiobjective.mocell

### 2.15.1 MOCell

public class **MOCell**<S extends Solution<?>> extends *AbstractGeneticAlgorithm*<S, List<S>>

**Author** JuanJo Durillo

**Parameters**

- **<S>** –

#### Fields

#### archive

protected *BoundedArchive*<S> **archive**

#### currentIndividual

protected int **currentIndividual**

#### currentNeighbors

protected List<S> **currentNeighbors**

#### dominanceComparator

protected Comparator<S> **dominanceComparator**

#### evaluations

protected int **evaluations**

#### evaluator

protected final *SolutionListEvaluator*<S> **evaluator**

#### location

protected *LocationAttribute*<S> **location**

#### maxEvaluations

protected int **maxEvaluations**

#### neighborhood

protected *Neighborhood*<S> **neighborhood**

### Constructors

#### MOCell

public **MOCell** (*Problem*<S> *problem*, int *maxEvaluations*, int *populationSize*, *BoundedArchive*<S> *archive*, *Neighborhood*<S> *neighborhood*, *CrossoverOperator*<S> *crossoverOperator*, *MutationOperator*<S> *mutationOperator*, *SelectionOperator*<List<S>, S> *selectionOperator*, *SolutionListEvaluator*<S> *evaluator*)

Constructor

**Parameters**

- **problem** –
- **maxEvaluations** –
- **populationSize** –
- **neighborhood** –
- **crossoverOperator** –

- **mutationOperator** –
- **selectionOperator** –
- **evaluator** –

### Methods

#### createInitialPopulation

protected List<S> **createInitialPopulation**()

#### evaluatePopulation

protected List<S> **evaluatePopulation**(List<S> *population*)

#### getDescription

public String **getDescription**()

#### getName

public String **getName**()

#### getResult

public List<S> **getResult**()

#### initProgress

protected void **initProgress**()

#### isStoppingConditionReached

protected boolean **isStoppingConditionReached**()

#### replacement

protected List<S> **replacement**(List<S> *population*, List<S> *offspringPopulation*)

#### reproduction

protected List<S> **reproduction**(List<S> *population*)

#### selection

protected List<S> **selection** (List<S> *population*)

#### updateProgress

protected void **updateProgress** ()

### 2.15.2 MOCellBuilder

public class **MOCellBuilder**<S extends Solution<?>> implements *AlgorithmBuilder*<*MOCell*<S>>
Created by juanjo

#### Fields

#### archive

protected *BoundedArchive*<S> **archive**

#### crossoverOperator

protected *CrossoverOperator*<S> **crossoverOperator**

#### evaluator

protected *SolutionListEvaluator*<S> **evaluator**

#### maxEvaluations

protected int **maxEvaluations**

#### mutationOperator

protected *MutationOperator*<S> **mutationOperator**

#### neighborhood

protected *Neighborhood*<S> **neighborhood**

#### populationSize

protected int **populationSize**

#### problem

protected final *Problem*<S> **problem**
MOCellBuilder class

#### selectionOperator

protected *SelectionOperator*<List<S>, S> **selectionOperator**

### Constructors

#### MOCellBuilder

public **MOCellBuilder** (*Problem*<S> *problem*, *CrossoverOperator*<S> *crossoverOperator*, *MutationOperator*<S> *mutationOperator*)
MOCellBuilder constructor

### Methods

#### build

public *MOCell*<S> **build** ()

#### getArchive

public *BoundedArchive*<S> **getArchive** ()

#### getCrossoverOperator

public *CrossoverOperator*<S> **getCrossoverOperator** ()

#### getMaxEvaluations

public int **getMaxEvaluations** ()

#### getMutationOperator

public *MutationOperator*<S> **getMutationOperator** ()

#### getPopulationSize

public int **getPopulationSize** ()

#### getProblem

public *Problem*<S> **getProblem**()

#### getSelectionOperator

public *SelectionOperator*<List<S>, S> **getSelectionOperator**()

#### getSolutionListEvaluator

public *SolutionListEvaluator*<S> **getSolutionListEvaluator**()

#### setArchive

public *MOCellBuilder*<S> **setArchive**(*BoundedArchive*<S> *archive*)

#### setMaxEvaluations

public *MOCellBuilder*<S> **setMaxEvaluations**(int *maxEvaluations*)

#### setNeighborhood

public *MOCellBuilder*<S> **setNeighborhood**(*Neighborhood*<S> *neighborhood*)

#### setPopulationSize

public *MOCellBuilder*<S> **setPopulationSize**(int *populationSize*)

#### setSelectionOperator

public *MOCellBuilder*<S> **setSelectionOperator**(*SelectionOperator*<List<S>, S> *selectionOperator*)

#### setSolutionListEvaluator

public *MOCellBuilder*<S> **setSolutionListEvaluator**(*SolutionListEvaluator*<S> *evaluator*)

### 2.15.3 MOCellBuilder.MOCellVariant

public enum **MOCellVariant**

#### Enum Constants

##### MOCell

public static final *MOCellBuilder.MOCellVariant* **MOCell**

##### Measures

public static final *MOCellBuilder.MOCellVariant* **Measures**

##### SteadyStateMOCell

public static final *MOCellBuilder.MOCellVariant* **SteadyStateMOCell**

### 2.15.4 MOCellIT

public class **MOCellIT**

#### Fields

##### algorithm

*Algorithm*<List<*DoubleSolution*>> **algorithm**

##### crossover

*CrossoverOperator*<*DoubleSolution*> **crossover**

##### mutation

*MutationOperator*<*DoubleSolution*> **mutation**

##### problem

*DoubleProblem* **problem**

#### Methods

##### setup

public void **setup**()

##### shouldTheAlgorithmReturnANumberOfSolutionsWhenSolvingASimpleProblem

public void **shouldTheAlgorithmReturnANumberOfSolutionsWhenSolvingASimpleProblem**()

#### shouldTheHypervolumeHaveAMininumValue

public void **shouldTheHypervolumeHaveAMininumValue**()

## 2.16 org.uma.jmetal.algorithm.multiobjective.mochc

### 2.16.1 MOCHC

public class **MOCHC** extends *AbstractEvolutionaryAlgorithm*<*BinarySolution*, List<*BinarySolution*>>
This class executes the MOCHC algorithm described in: A.J. Nebro, E. Alba, G. Molina, F. Chicano, F. Luna, J.J. Durillo "Optimal antenna placement using a new multi-objective chc algorithm". GECCO '07: Proceedings of the 9th annual conference on Genetic and evolutionary computation. London, England. July 2007.

#### Constructors

#### MOCHC

public **MOCHC**(*BinaryProblem* *problem*, int *populationSize*, int *maxEvaluations*, int *convergenceValue*, double *preservedPopulation*, double *initialConvergenceCount*, *CrossoverOperator*<*BinarySolution*> *crossoverOperator*, *MutationOperator*<*BinarySolution*> *cataclysmicMutation*, *SelectionOperator*<List<*BinarySolution*>, List<*BinarySolution*>> *newGenerationSelection*, *SelectionOperator*<List<*BinarySolution*>, *BinarySolution*> *parentSelection*, *SolutionListEvaluator*<*BinarySolution*> *evaluator*)
Constructor

#### Methods

#### createInitialPopulation

protected List<*BinarySolution*> **createInitialPopulation**()

#### evaluatePopulation

protected List<*BinarySolution*> **evaluatePopulation**(List<*BinarySolution*> *population*)

#### getDescription

public String **getDescription**()

#### getMaxPopulationSize

public int **getMaxPopulationSize**()

#### getName

public String **getName**()

#### getResult

public List<*BinarySolution*> **getResult**()

#### initProgress

protected void **initProgress**()

#### isStoppingConditionReached

protected boolean **isStoppingConditionReached**()

#### replacement

protected List<*BinarySolution*> **replacement**(List<*BinarySolution*> *population*, List<*BinarySolution*> *offspringPopulation*)

#### reproduction

protected List<*BinarySolution*> **reproduction**(List<*BinarySolution*> *matingPopulation*)

#### selection

protected List<*BinarySolution*> **selection**(List<*BinarySolution*> *population*)

#### setMaxPopulationSize

public void **setMaxPopulationSize**(int *maxPopulationSize*)

#### updateProgress

protected void **updateProgress**()

### 2.16.2 MOCHC45

public class **MOCHC45** implements *Algorithm*<List<*BinarySolution*>>

This class executes the MOCHC algorithm described in: A.J. Nebro, E. Alba, G. Molina, F. Chicano, F. Luna, J.J. Durillo "Optimal antenna placement using a new multi-objective chc algorithm". GECCO '07: Proceedings of the 9th annual conference on Genetic and evolutionary computation. London, England. July 2007. Implementation of MOCHC following the scheme used in jMetal4.5 and former versions, i.e, without implementing the `AbstractGeneticAlgorithm` interface.

#### Constructors

#### MOCHC45

public **MOCHC45**(*BinaryProblem problem*, int *populationSize*, int *maxEvaluations*, int *convergenceValue*, double *preservedPopulation*, double *initialConvergenceCount*, *CrossoverOperator*<*BinarySolution*> *crossoverOperator*, *MutationOperator*<*BinarySolution*> *cataclysmicMutation*, *SelectionOperator*<List<*BinarySolution*>, List<*BinarySolution*>> *newGenerationSelection*, *SelectionOperator*<List<*BinarySolution*>, *BinarySolution*> *parentSelection*, *SolutionListEvaluator*<*BinarySolution*> *evaluator*)
Constructor

#### Methods

#### getDescription

public String **getDescription**()

#### getName

public String **getName**()

#### getResult

public List<*BinarySolution*> **getResult**()

#### run

public void **run**()

### 2.16.3 MOCHCBuilder

public class **MOCHCBuilder** implements *AlgorithmBuilder*<*MOCHC*>
Builder class

#### Fields

#### cataclysmicMutation

*MutationOperator*<*BinarySolution*> **cataclysmicMutation**

#### convergenceValue

int **convergenceValue**

### crossoverOperator

*CrossoverOperator*<*BinarySolution*> **crossoverOperator**

### evaluator

*SolutionListEvaluator*<*BinarySolution*> **evaluator**

### initialConvergenceCount

double **initialConvergenceCount**

### maxEvaluations

int **maxEvaluations**

### newGenerationSelection

*SelectionOperator*<List<*BinarySolution*>, List<*BinarySolution*>> **newGenerationSelection**

### parentSelection

*SelectionOperator*<List<*BinarySolution*>, *BinarySolution*> **parentSelection**

### populationSize

int **populationSize**

### preservedPopulation

double **preservedPopulation**

### problem

*BinaryProblem* **problem**

### Constructors

### MOCHCBuilder

public **MOCHCBuilder** (*BinaryProblem problem*)

### Methods

#### build

public *MOCHC* **build**()

#### getCataclysmicMutation

public *MutationOperator*<*BinarySolution*> **getCataclysmicMutation**()

#### getConvergenceValue

public int **getConvergenceValue**()

#### getCrossover

public *CrossoverOperator*<*BinarySolution*> **getCrossover**()

#### getInitialConvergenceCount

public double **getInitialConvergenceCount**()

#### getMaxEvaluation

public int **getMaxEvaluation**()

#### getNewGenerationSelection

public *SelectionOperator*<List<*BinarySolution*>, List<*BinarySolution*>> **getNewGenerationSelection**()

#### getParentSelection

public *SelectionOperator*<List<*BinarySolution*>, *BinarySolution*> **getParentSelection**()

#### getPopulationSize

public int **getPopulationSize**()

#### getPreservedPopulation

public double **getPreservedPopulation**()

#### getProblem

public *BinaryProblem* **getProblem**()

#### setCataclysmicMutation

public *MOCHCBuilder* **setCataclysmicMutation**(*MutationOperator*<*BinarySolution*> *cataclysmicMutation*)

#### setConvergenceValue

public *MOCHCBuilder* **setConvergenceValue**(int *convergenceValue*)

#### setCrossover

public *MOCHCBuilder* **setCrossover**(*CrossoverOperator*<*BinarySolution*> *crossover*)

#### setEvaluator

public *MOCHCBuilder* **setEvaluator**(*SolutionListEvaluator*<*BinarySolution*> *evaluator*)

#### setInitialConvergenceCount

public *MOCHCBuilder* **setInitialConvergenceCount**(double *initialConvergenceCount*)

#### setMaxEvaluations

public *MOCHCBuilder* **setMaxEvaluations**(int *maxEvaluations*)

#### setNewGenerationSelection

public *MOCHCBuilder* **setNewGenerationSelection**(*SelectionOperator*<List<*BinarySolution*>, List<*BinarySolution*>> *newGenerationSelection*)

#### setParentSelection

public *MOCHCBuilder* **setParentSelection**(*SelectionOperator*<List<*BinarySolution*>, *BinarySolution*> *parentSelection*)

#### setPopulationSize

public *MOCHCBuilder* **setPopulationSize**(int *populationSize*)

#### setPreservedPopulation

public *MOCHCBuilder* **setPreservedPopulation**(double *preservedPopulation*)

## 2.17 org.uma.jmetal.algorithm.multiobjective.moead

### 2.17.1 AbstractMOEAD

public abstract class **AbstractMOEAD**<S extends Solution<?>> implements *Algorithm*<List<S>>
Abstract class for implementing versions of the MOEA/D algorithm.

**Author** Antonio J. Nebro

#### Fields

#### crossoverOperator

protected *CrossoverOperator*<S> **crossoverOperator**

#### dataDirectory

protected String **dataDirectory**

#### evaluations

protected int **evaluations**

#### functionType

protected *FunctionType* **functionType**

#### idealPoint

protected *IdealPoint* **idealPoint**
Z vector in Zhang & Li paper

#### indArray

protected *Solution*<?>[] **indArray**

#### jointPopulation

protected List<S> **jointPopulation**

### lambda

protected double[][] **lambda**
Lambda vectors

### maxEvaluations

protected int **maxEvaluations**

### maximumNumberOfReplacedSolutions

protected int **maximumNumberOfReplacedSolutions**
nr in Zhang & Li paper

### mutationOperator

protected *MutationOperator*<S> **mutationOperator**

### nadirPoint

protected *NadirPoint* **nadirPoint**

### neighborSize

protected int **neighborSize**
T in Zhang & Li paper

### neighborhood

protected int[][] **neighborhood**

### neighborhoodSelectionProbability

protected double **neighborhoodSelectionProbability**
Delta in Zhang & Li paper

### offspringPopulation

protected List<S> **offspringPopulation**

### population

protected List<S> **population**

#### populationSize

protected int **populationSize**

#### problem

protected *Problem*<S> **problem**

#### randomGenerator

protected *JMetalRandom* **randomGenerator**

#### resultPopulationSize

protected int **resultPopulationSize**

### Constructors

#### AbstractMOEAD

public **AbstractMOEAD**(*Problem*<S> *problem*, int *populationSize*, int *resultPopulationSize*, int *maxEvaluations*, *CrossoverOperator*<S> *crossoverOperator*, *MutationOperator*<S> *mutation*, *FunctionType* *functionType*, String *dataDirectory*, double *neighborhoodSelectionProbability*, int *maximumNumberOfReplacedSolutions*, int *neighborSize*)

### Methods

#### chooseNeighborType

protected *NeighborType* **chooseNeighborType**()

#### fitnessFunction

double **fitnessFunction**(S *individual*, double[] *lambda*)

#### getResult

public List<S> **getResult**()

#### initializeNeighborhood

protected void **initializeNeighborhood**()

Initialize neighborhoods

#### initializeUniformWeight

protected void **initializeUniformWeight**()
Initialize weight vectors

#### matingSelection

protected List<Integer> **matingSelection**(int *subproblemId*, int *numberOfSolutionsToSelect*, *NeighborType* *neighbourType*)

**Parameters**

- **subproblemId** – the id of current subproblem
- **neighbourType** – neighbour type

#### parentSelection

protected List<S> **parentSelection**(int *subProblemId*, *NeighborType* *neighborType*)

#### updateNeighborhood

protected void **updateNeighborhood**(S *individual*, int *subProblemId*, *NeighborType* *neighborType*)
Update neighborhood method

**Parameters**

- **individual** –
- **subProblemId** –
- **neighborType** –

**Throws**

- ***JMetalException*** –

### 2.17.2 AbstractMOEAD.FunctionType

public enum **FunctionType**

#### Enum Constants

#### AGG

public static final *AbstractMOEAD.FunctionType* **AGG**

#### PBI

public static final *AbstractMOEAD.FunctionType* **PBI**

#### TCHE

public static final *AbstractMOEAD.FunctionType* **TCHE**

### 2.17.3 AbstractMOEAD.NeighborType

protected enum **NeighborType**

#### Enum Constants

#### NEIGHBOR

public static final *AbstractMOEAD.NeighborType* **NEIGHBOR**

#### POPULATION

public static final *AbstractMOEAD.NeighborType* **POPULATION**

### 2.17.4 ConstraintMOEAD

public class **ConstraintMOEAD** extends *AbstractMOEAD*<*DoubleSolution*>

This class implements a constrained version of the MOEAD algorithm based on the one presented in the paper: "An adaptive constraint handling approach embedded MOEA/D". DOI: 10.1109/CEC.2012.6252868

**Author** Antonio J. Nebro, Juan J. Durillo

#### Constructors

#### ConstraintMOEAD

public **ConstraintMOEAD** (*Problem*<*DoubleSolution*> *problem*, int *populationSize*, int *resultPopulationSize*, int *maxEvaluations*, *MutationOperator*<*DoubleSolution*> *mutation*, *CrossoverOperator*<*DoubleSolution*> *crossover*, *FunctionType functionType*, String *dataDirectory*, double *neighborhoodSelectionProbability*, int *maximumNumberOfReplacedSolutions*, int *neighborSize*)

#### Methods

#### getDescription

public String **getDescription** ()

#### getName

public String **getName** ()

#### initializePopulation

public void **initializePopulation**()

#### run

public void **run**()

#### updateNeighborhood

protected void **updateNeighborhood**(*DoubleSolution* *individual*, int *subproblemId*, *NeighborType* *neighborType*)

### 2.17.5 MOEAD

public class **MOEAD** extends *AbstractMOEAD*<*DoubleSolution*>

Class implementing the MOEA/D-DE algorithm described in : Hui Li; Qingfu Zhang, "Multiobjective Optimization Problems With Complicated Pareto Sets, MOEA/D and NSGA-II," Evolutionary Computation, IEEE Transactions on , vol.13, no.2, pp.284,302, April 2009. doi: 10.1109/TEVC.2008.925798

**Author** Antonio J. Nebro

#### Fields

#### differentialEvolutionCrossover

protected *DifferentialEvolutionCrossover* **differentialEvolutionCrossover**

#### Constructors

#### MOEAD

public **MOEAD**(*Problem*<*DoubleSolution*> *problem*, int *populationSize*, int *resultPopulationSize*, int *maxEvaluations*, *MutationOperator*<*DoubleSolution*> *mutation*, *CrossoverOperator*<*DoubleSolution*> *crossover*, *FunctionType* *functionType*, String *dataDirectory*, double *neighborhoodSelectionProbability*, int *maximumNumberOfReplacedSolutions*, int *neighborSize*)

#### Methods

#### getDescription

public String **getDescription**()

#### getName

public String **getName**()

#### initializePopulation

protected void **initializePopulation**()

#### run

public void **run**()

### 2.17.6 MOEADBuilder

public class **MOEADBuilder** implements *AlgorithmBuilder*<*AbstractMOEAD*<*DoubleSolution*>>
Builder class for algorithm MOEA/D and variants

**Author** Antonio J. Nebro

#### Fields

#### crossover

protected *CrossoverOperator*<*DoubleSolution*> **crossover**

#### dataDirectory

protected String **dataDirectory**

#### functionType

protected *MOEAD*.FunctionType **functionType**

#### maxEvaluations

protected int **maxEvaluations**

#### maximumNumberOfReplacedSolutions

protected int **maximumNumberOfReplacedSolutions**
nr in Zhang & Li paper

#### moeadVariant

protected *Variant* **moeadVariant**

#### mutation

protected *MutationOperator*<*DoubleSolution*> **mutation**

#### neighborSize

protected int **neighborSize**
T in Zhang & Li paper

#### neighborhoodSelectionProbability

protected double **neighborhoodSelectionProbability**
Delta in Zhang & Li paper

#### numberOfThreads

protected int **numberOfThreads**

#### populationSize

protected int **populationSize**

#### problem

protected *Problem*<*DoubleSolution*> **problem**

#### resultPopulationSize

protected int **resultPopulationSize**

### Constructors

#### MOEADBuilder

public **MOEADBuilder**(*Problem*<*DoubleSolution*> *problem*, *Variant variant*)
Constructor

### Methods

#### build

public *AbstractMOEAD*<*DoubleSolution*> **build**()

#### getCrossover

public *CrossoverOperator*<*DoubleSolution*> **getCrossover**()

#### getDataDirectory

public String **getDataDirectory**()

#### getFunctionType

public *MOEAD*.FunctionType **getFunctionType**()

#### getMaxEvaluations

public int **getMaxEvaluations**()

#### getMaximumNumberOfReplacedSolutions

public int **getMaximumNumberOfReplacedSolutions**()

#### getMutation

public *MutationOperator*<*DoubleSolution*> **getMutation**()

#### getNeighborSize

public int **getNeighborSize**()

#### getNeighborhoodSelectionProbability

public double **getNeighborhoodSelectionProbability**()

#### getNumberOfThreads

public int **getNumberOfThreads**()

#### getPopulationSize

public int **getPopulationSize**()

#### getResultPopulationSize

public int **getResultPopulationSize**()

#### setCrossover

public *MOEADBuilder* **setCrossover**(*CrossoverOperator*<*DoubleSolution*> *crossover*)

#### setDataDirectory

public *MOEADBuilder* **setDataDirectory** (String *dataDirectory*)

#### setFunctionType

public *MOEADBuilder* **setFunctionType** (*MOEAD*.FunctionType *functionType*)

#### setMaxEvaluations

public *MOEADBuilder* **setMaxEvaluations** (int *maxEvaluations*)

#### setMaximumNumberOfReplacedSolutions

public *MOEADBuilder* **setMaximumNumberOfReplacedSolutions** (int *maximumNumberOfReplacedSolutions*)

#### setMutation

public *MOEADBuilder* **setMutation** (*MutationOperator*<*DoubleSolution*> *mutation*)

#### setNeighborSize

public *MOEADBuilder* **setNeighborSize** (int *neighborSize*)

#### setNeighborhoodSelectionProbability

public *MOEADBuilder* **setNeighborhoodSelectionProbability** (double *neighborhoodSelectionProbability*)

#### setNumberOfThreads

public *MOEADBuilder* **setNumberOfThreads** (int *numberOfThreads*)

#### setPopulationSize

public *MOEADBuilder* **setPopulationSize** (int *populationSize*)

#### setResultPopulationSize

public *MOEADBuilder* **setResultPopulationSize** (int *resultPopulationSize*)

### 2.17.7 MOEADBuilder.Variant

public enum **Variant**

#### Enum Constants

#### ConstraintMOEAD

public static final *MOEADBuilder.Variant* **ConstraintMOEAD**

#### MOEAD

public static final *MOEADBuilder.Variant* **MOEAD**

#### MOEADD

public static final *MOEADBuilder.Variant* **MOEADD**

#### MOEADDRA

public static final *MOEADBuilder.Variant* **MOEADDRA**

#### MOEADSTM

public static final *MOEADBuilder.Variant* **MOEADSTM**

### 2.17.8 MOEADD

public class **MOEADD**<S extends DoubleSolution> extends *AbstractMOEAD*<S>

#### Fields

#### numRanks

protected int **numRanks**

#### rankIdx

protected int[][] **rankIdx**

#### ranking

protected *Ranking* **ranking**

#### subregionDist

protected double[][] **subregionDist**

#### subregionIdx

protected int[][] **subregionIdx**

### Constructors

#### MOEADD

public **MOEADD** (*Problem*<S> *problem*, int *populationSize*, int *resultPopulationSize*, int *maxEvaluations*, *CrossoverOperator*<S> *crossoverOperator*, *MutationOperator*<S> *mutation*, *AbstractMOEAD.FunctionType* *functionType*, String *dataDirectory*, double *neighborhoodSelectionProbability*, int *maximumNumberOfReplacedSolutions*, int *neighborSize*)

### Methods

#### calculateDistance

public double **calculateDistance** (S *individual*, double[] *lambda*, double[] *z_*, double[] *nz_*)
Calculate the perpendicular distance between the solution and reference line

#### calculateDistance2

public double **calculateDistance2** (S *indiv*, double[] *lambda*, double[] *z_*, double[] *nz_*)

#### checkDominance

public int **checkDominance** (S *a*, S *b*)
check the dominance relationship between a and b: 1 -> a dominates b, -1 -> b dominates a 0 -> non-dominated with each other

#### computeRanking

protected *Ranking*<S> **computeRanking** (List<S> *solutionList*)

#### countOnes

public int **countOnes** (int *location*)
Count the number of 1s in the 'location'th subregion

### countRankOnes

public int **countRankOnes** (int *location*)
count the number of 1s in a row of rank matrix

### countTest

public int **countTest** ()

### deleteCrowdIndiv_diff

public void **deleteCrowdIndiv_diff** (int *crowdIdx*, int *curLocation*, int *nicheCount*, S *indiv*)
delete one solution from the most crowded subregion, which is different from indiv's subregion. just use indiv to replace the worst solution in that subregion

### deleteCrowdIndiv_same

public void **deleteCrowdIndiv_same** (int *crowdIdx*, int *nicheCount*, double *indivFitness*, S *indiv*)
delete one solution from the most crowded subregion, which is indiv's subregion. Compare indiv's fitness value and the worst one in this subregion

### deleteCrowdRegion1

public void **deleteCrowdRegion1** (S *indiv*, int *location*)
Delete a solution from the most crowded subregion (this function only happens when: it should delete 'indiv' based on traditional method. However, the subregion of 'indiv' only has one solution, so it should be kept)

### deleteCrowdRegion2

public void **deleteCrowdRegion2** (S *indiv*, int *location*)
delete a solution from the most crowded subregion (this function happens when: it should delete the solution in the 'parentLocation' subregion, but since this subregion only has one solution, it should be kept)

### deleteRankOne

public void **deleteRankOne** (S *indiv*, int *location*)
if there is only one non-domination level (i.e., all solutions are non-dominated with each other), we should delete a solution from the most crowded subregion

### findPosition

public int **findPosition** (S *indiv*)
find the index of the solution 'indiv' in the population

### findRegion

public int **findRegion** (int *idx*)
find the subregion of the 'idx'th solution in the population

### getDescription

public String **getDescription** ()

### getName

public String **getName** ()

### initPopulation

public void **initPopulation** ()
Initialize the population

### innerproduct

public double **innerproduct** (double[] *vec1*, double[] *vec2*)
Calculate the dot product of two vectors

### matingSelection

public List<S> **matingSelection** (int *cid*, int *type*)
Select two parents for reproduction

### nondominated_sorting_add

public int **nondominated_sorting_add** (S *indiv*)
update the non-domination level when adding a solution

### nondominated_sorting_delete

public void **nondominated_sorting_delete** (S *indiv*)
update the non-domination level structure after deleting a solution

### norm_vector

public double **norm_vector** (double[] *z*)
Calculate the norm of the vector

#### replace

public void **replace** (int *position*, S *solution*)

#### run

public void **run** ()

#### setLocation

public void **setLocation** (S *indiv*, double[] *z_*, double[] *nz_*)
Set the location of a solution based on the orthogonal distance

#### sumFitness

public double **sumFitness** (int *location*)
calculate the sum of fitnesses of solutions in the location subregion

#### updateArchive

public void **updateArchive** (S *indiv*)
update the parent population by using the ENLU method, instead of fast non-dominated sorting

### 2.17.9 MOEADDRA

public class **MOEADDRA** extends *AbstractMOEAD*<*DoubleSolution*>
Class implementing the MOEA/D-DRA algorithm described in : Q. Zhang, W. Liu, and H Li, The Performance of a New Version of MOEA/D on CEC09 Unconstrained MOP Test Instances, Working Report CES-491, School of CS & EE, University of Essex, 02/2009

**Author** Juan J. Durillo, Antonio J. Nebro

#### Fields

#### differentialEvolutionCrossover

protected *DifferentialEvolutionCrossover* **differentialEvolutionCrossover**

#### frequency

protected int[] **frequency**

#### randomGenerator

*JMetalRandom* **randomGenerator**

#### savedValues

protected *DoubleSolution*[] **savedValues**

#### utility

protected double[] **utility**

### Constructors

#### MOEADDRA

public **MOEADDRA** (*Problem*<*DoubleSolution*> *problem*, int *populationSize*, int *resultPopulationSize*, int *maxEvaluations*, *MutationOperator*<*DoubleSolution*> *mutation*, *CrossoverOperator*<*DoubleSolution*> *crossover*, *FunctionType* *functionType*, String *dataDirectory*, double *neighborhoodSelectionProbability*, int *maximumNumberOfReplacedSolutions*, int *neighborSize*)

### Methods

#### getDescription

public String **getDescription** ()

#### getName

public String **getName** ()

#### initializePopulation

protected void **initializePopulation** ()

#### run

public void **run** ()

#### tourSelection

public List<Integer> **tourSelection** (int *depth*)

#### utilityFunction

public void **utilityFunction** ()

### 2.17.10 MOEADDRAIT

public class **MOEADDRAIT**

#### Fields

##### algorithm

*Algorithm*<List<*DoubleSolution*>> **algorithm**

#### Methods

##### shouldTheAlgorithmReturnANumberOfSolutionsWhenSolvingASimpleProblem

public void **shouldTheAlgorithmReturnANumberOfSolutionsWhenSolvingASimpleProblem**()

##### shouldTheHypervolumeHaveAMininumValue

public void **shouldTheHypervolumeHaveAMininumValue**()

### 2.17.11 MOEADIT

public class **MOEADIT**

#### Fields

##### algorithm

*Algorithm*<List<*DoubleSolution*>> **algorithm**

#### Methods

##### shouldTheAlgorithmReturnANumberOfSolutionsWhenSolvingASimpleProblem

public void **shouldTheAlgorithmReturnANumberOfSolutionsWhenSolvingASimpleProblem**()

##### shouldTheHypervolumeHaveAMininumValue

public void **shouldTheHypervolumeHaveAMininumValue**()

### 2.17.12 MOEADSTM

public class **MOEADSTM** extends *AbstractMOEAD*<*DoubleSolution*>

Class implementing the MOEA/D-STM algorithm described in : K. Li, Q. Zhang, S. Kwong, M. Li and R. Wang, "Stable Matching-Based Selection in Evolutionary Multiobjective Optimization", IEEE Transactions on Evolutionary Computation, 18(6): 909-923, 2014. DOI: 10.1109/TEVC.2013.2293776

**Author** Ke Li

#### Fields

#### differentialEvolutionCrossover

protected *DifferentialEvolutionCrossover* **differentialEvolutionCrossover**

#### frequency

protected int[] **frequency**

#### randomGenerator

*JMetalRandom* **randomGenerator**

#### savedValues

protected *DoubleSolution*[] **savedValues**

#### utility

protected double[] **utility**

#### Constructors

#### MOEADSTM

public **MOEADSTM**(*Problem*<*DoubleSolution*> *problem*, int *populationSize*, int *resultPopulationSize*, int *maxEvaluations*, *MutationOperator*<*DoubleSolution*> *mutation*, *CrossoverOperator*<*DoubleSolution*> *crossover*, *FunctionType* *functionType*, String *dataDirectory*, double *neighborhoodSelectionProbability*, int *maximumNumberOfReplacedSolutions*, int *neighborSize*)

#### Methods

#### calculateDistance

public double **calculateDistance**(*DoubleSolution* *individual*, double[] *lambda*)

Calculate the perpendicular distance between the solution and reference line

#### calculateDistance2

public double **calculateDistance2** (*DoubleSolution individual*, double[] *lambda*)
Calculate the perpendicular distance between the solution and reference line

#### getDescription

public String **getDescription** ()

#### getName

public String **getName** ()

#### getResult

public List<*DoubleSolution*> **getResult** ()

#### initializePopulation

protected void **initializePopulation** ()

#### innerproduct

public double **innerproduct** (double[] *vec1*, double[] *vec2*)
Calculate the dot product of two vectors

#### norm_vector

public double **norm_vector** (double[] *z*)
Calculate the norm of the vector

#### prefers

public boolean **prefers** (int *x*, int *y*, int[] *womanPref*, int *size*)
Returns true in case that a given woman prefers x to y.

#### run

public void **run** ()

#### stableMatching

public int[] **stableMatching** (int[][] *manPref*, int[][] *womanPref*, int *menSize*, int *womenSize*)
Return the stable matching between 'subproblems' and 'solutions' ('subproblems' propose first). It is worth noting that the number of solutions is larger than that of the subproblems.

#### stmSelection

public void **stmSelection**()

Select the next parent population, based on the stable matching criteria

#### tourSelection

public List<Integer> **tourSelection**(int *depth*)

#### utilityFunction

public void **utilityFunction**()

## 2.18 org.uma.jmetal.algorithm.multiobjective.moead.util

### 2.18.1 MOEADUtils

public class **MOEADUtils**

Utilities methods to used by MOEA/D

#### Methods

#### distVector

public static double **distVector**(double[] *vector1*, double[] *vector2*)

#### getSubsetOfEvenlyDistributedSolutions

public static <S extends Solution<?>> List<S> **getSubsetOfEvenlyDistributedSolutions**(List<S> *solutionList*, int *newSolutionListSize*)

This methods select a subset of evenly spread solutions from a solution list. The implementation is based on the method described in the MOEA/D-DRA paper.

**Parameters**

- **solutionList** –
- **newSolutionListSize** –
- **<S>** –

#### minFastSort

public static void **minFastSort** (double[] *x*, int[] *idx*, int *n*, int *m*)

#### quickSort

public static void **quickSort** (double[] *array*, int[] *idx*, int *from*, int *to*)
Quick sort procedure (ascending order)

**Parameters**

- **array** –
- **idx** –
- **from** –
- **to** –

#### randomPermutation

public static void **randomPermutation** (int[] *perm*, int *size*)

## 2.19 org.uma.jmetal.algorithm.multiobjective.mombi

### 2.19.1 AbstractMOMBI

public abstract class **AbstractMOMBI**<S extends Solution<?>> extends *AbstractGeneticAlgorithm*<S, List<S>>
Abstract class representing variants of the MOMBI algorithm

**Author** Juan J. Durillo Modified by Antonio J. Nebro

**Parameters**

- **<S>** –

#### Fields

#### evaluator

protected final *SolutionListEvaluator*<S> **evaluator**

#### iterations

protected int **iterations**

#### maxIterations

protected final int **maxIterations**

#### nadirPoint

protected final List<Double> **nadirPoint**

#### referencePoint

protected final List<Double> **referencePoint**

### Constructors

#### AbstractMOMBI

public **AbstractMOMBI** (*Problem*<S> *problem*, int *maxIterations*, *CrossoverOperator*<S> *crossover*, *MutationOperator*<S> *mutation*, *SelectionOperator*<List<S>, S> *selection*, *SolutionListEvaluator*<S> *evaluator*)

Constructor

**Parameters**

- **problem** – Problem to be solved
- **maxIterations** – Maximum number of iterations the algorithm will perform
- **crossover** – Crossover operator
- **mutation** – Mutation operator
- **selection** – Selection operator
- **evaluator** – Evaluator object for evaluating solution lists

### Methods

#### evaluatePopulation

protected List<S> **evaluatePopulation** (List<S> *population*)

#### getNadirPoint

public List<Double> **getNadirPoint** ()

#### getReferencePoint

public List<Double> **getReferencePoint** ()

#### getResult

public List<S> **getResult** ()

#### initProgress

protected void **initProgress** ()

#### isStoppingConditionReached

protected boolean **isStoppingConditionReached** ()

#### populationIsNotFull

protected boolean **populationIsNotFull** (List<S> *population*)

#### reproduction

protected List<S> **reproduction** (List<S> *population*)

#### run

public void **run** ()

#### selection

protected List<S> **selection** (List<S> *population*)

#### setReferencePointValue

protected void **setReferencePointValue** (Double *value*, int *index*)

#### specificMOEAComputations

public abstract void **specificMOEAComputations** ()

#### updateNadirPoint

protected void **updateNadirPoint** (S *s*)

#### updateNadirPoint

public void **updateNadirPoint** (List<S> *population*)

#### updateProgress

protected void **updateProgress** ()

#### updateReferencePoint

protected void **updateReferencePoint** (S *s*)

#### updateReferencePoint

public void **updateReferencePoint** (List<S> *population*)

### 2.19.2 MOMBI

public class **MOMBI**<S extends Solution<?>> extends *AbstractMOMBI*<S>

#### Fields

#### utilityFunctions

protected final *AbstractUtilityFunctionsSet*<S> **utilityFunctions**

#### Constructors

#### MOMBI

public **MOMBI** (*Problem*<S> *problem*, int *maxIterations*, *CrossoverOperator*<S> *crossover*, *MutationOperator*<S> *mutation*, *SelectionOperator*<List<S>, S> *selection*, *SolutionListEvaluator*<S> *evaluator*, String *pathWeights*)

#### Methods

#### addLastRankedSolutionsToPopulation

protected void **addLastRankedSolutionsToPopulation** (*R2Ranking*<S> *ranking*, int *index*, List<S> *population*)

#### addRankedSolutionsToPopulation

protected void **addRankedSolutionsToPopulation** (*R2Ranking*<S> *ranking*, int *index*, List<S> *population*)

#### computeRanking

protected *R2Ranking*<S> **computeRanking** (List<S> *solutionList*)

#### createUtilityFunction

public *AbstractUtilityFunctionsSet*<S> **createUtilityFunction** (String *pathWeights*)

#### getDescription

public String **getDescription**()

#### getMaxPopulationSize

public int **getMaxPopulationSize**()

#### getName

public String **getName**()

#### getUtilityFunctions

protected *AbstractUtilityFunctionsSet*<S> **getUtilityFunctions**()

#### replacement

protected List<S> **replacement**(List<S> *population*, List<S> *offspringPopulation*)

#### selectBest

protected List<S> **selectBest**(*R2Ranking*<S> *ranking*)

#### specificMOEAComputations

public void **specificMOEAComputations**()

## 2.19.3 MOMBI2

public class **MOMBI2**<S extends Solution<?>> extends *MOMBI*<S>

**Author** Juan J. Durillo

### Fields

#### alpha

protected final Double **alpha**

#### epsilon

protected final Double **epsilon**

#### history

protected final *MOMBI2History*<S> **history**

#### maxs

protected List<Double> **maxs**

#### normalizer

protected *Normalizer* **normalizer**

### Constructors

#### MOMBI2

public **MOMBI2** (*Problem*<S> *problem*, int *maxIterations*, *CrossoverOperator*<S> *crossover*, *MutationOperator*<S> *mutation*, *SelectionOperator*<List<S>, S> *selection*, *SolutionListEvaluator*<S> *evaluator*, String *pathWeights*)

Creates a new instance of the MOMBI algorithm

**Parameters**

- **problem** –
- **maxIterations** –
- **crossover** –
- **mutation** –
- **selection** –
- **evaluator** –
- **pathWeights** –

### Methods

#### computeRanking

protected *R2Ranking*<S> **computeRanking** (List<S> *solutionList*)

#### createUtilityFunction

public *AbstractUtilityFunctionsSet*<S> **createUtilityFunction** (String *pathWeights*)

#### getDescription

public String **getDescription** ()

#### getMax

public Double **getMax** (List<Double> *list*)

#### getName

public String **getName** ()

#### initProgress

protected void **initProgress** ()

#### updateMax

protected void **updateMax** (List<S> *population*)

#### updateReferencePoint

public void **updateReferencePoint** (List<S> *population*)

## 2.20 org.uma.jmetal.algorithm.multiobjective.mombi.util

### 2.20.1 ASFUtilityFunctionSet

public class **ASFUtilityFunctionSet**<S extends Solution<?>> extends *AbstractUtilityFunctionsSet*<S>

**Author** Juan J. Durillo Modified by Antonio J. Nebro

**Parameters**

- **<S>** –

#### Constructors

#### ASFUtilityFunctionSet

public **ASFUtilityFunctionSet** (double[][] *weights*, List<Double> *referencePoint*)

#### ASFUtilityFunctionSet

public **ASFUtilityFunctionSet** (double[][] *weights*)

#### ASFUtilityFunctionSet

public **ASFUtilityFunctionSet** (String *file_path*, List<Double> *referencePoint*)

#### ASFUtilityFunctionSet

public **ASFUtilityFunctionSet** (String *file_path*)

#### Methods

#### evaluate

public Double **evaluate** (S *solution*, int *vector*)

#### setNormalizer

public void **setNormalizer** (*Normalizer* *normalizer*)

### 2.20.2 ASFWASFGA

public class **ASFWASFGA**<S extends Solution<?>> extends *AbstractUtilityFunctionsSet*<S>

**Author** Juan J. Durillo Modified by Antonio J. Nebro

**Parameters**

- **<S>** –

#### Constructors

#### ASFWASFGA

public **ASFWASFGA** (double[][] *weights*, List<Double> *interestPoint*)

#### ASFWASFGA

public **ASFWASFGA** (double[][] *weights*)

#### ASFWASFGA

public **ASFWASFGA** (String *file_path*, List<Double> *interestPoint*)

#### ASFWASFGA

public **ASFWASFGA** (String *file_path*)

#### Methods

#### evaluate

public Double **evaluate** (S *solution*, int *vector*)

#### setNadir

public void **setNadir** (List<Double> *nadir*)

#### setUtopia

public void **setUtopia** (List<Double> *utopia*)

#### updatePointOfInterest

public void **updatePointOfInterest** (List<Double> *newInterestPoint*)

### 2.20.3 AbstractUtilityFunctionsSet

public abstract class **AbstractUtilityFunctionsSet**<S extends Solution<?>> implements Serializable

**Author** Juan J. Durillo Modified by Antonio J. Nebro

**Parameters**

- **<S>** –

#### Constructors

#### AbstractUtilityFunctionsSet

public **AbstractUtilityFunctionsSet** (double[][] *weights*)

#### AbstractUtilityFunctionsSet

public **AbstractUtilityFunctionsSet** (String *file_path*)

#### Methods

#### evaluate

public List<Double> **evaluate** (S *solution*)

Evaluates a solution using all the utility functions stored in this set

**Parameters**

- **solution** –

#### evaluate

public abstract Double **evaluate** (S *solution*, int *vector*)

Evaluates a solution using the i-th utility function stored in this set

**Parameters**

- **solution** –
- **vector** –

#### getSize

public int **getSize**()
Returns the number of utility functions stored in this set

**Returns** The number of vectors

#### getVectorSize

public int **getVectorSize**()
Returns the number of components for all weight vectors

#### getWeightVector

public List<Double> **getWeightVector**(int *index*)
Returns a given weight vector

#### loadWeightsFromFile

public void **loadWeightsFromFile**(String *filePath*)
Reads a set of weight vectors from a file. The expected format for the file is as follows. The first line should start with at least the following three tokens # Any other token on this line will be ignored. indicates how many weight vectors are included in this file indicates how many component has each included vector Each of the following lines of the file represents a weight vector of at least components If more components are provided, they will be ignored by the program

**Parameters**

- **filePath** – The path in the file system of the file containing the weight vectors

### 2.20.4 MOMBI2History

public class **MOMBI2History**<T extends Solution<?>> implements Serializable
Created by ajnebro on 10/9/15.

#### Fields

#### MAX_LENGHT

public static final int **MAX_LENGHT**

### Constructors

#### MOMBI2History

public **MOMBI2History** (int *numberOfObjectives*)

### Methods

#### add

public void **add** (List<Double> *maxs*)
Adds a new vector of maxs values to the history. The method ensures that only the newest MAX_LENGTH vectors will be kept in the history

**Parameters**

- **maxs** –

#### decreaseMark

public void **decreaseMark** (int *index*)

#### getMaxObjective

public Double **getMaxObjective** (int *index*)

#### isUnMarked

public boolean **isUnMarked** (int *index*)

#### mark

public void **mark** (int *index*)

#### mean

public List<Double> **mean** ()
Returns the mean of the values contained in the history

#### std

public List<Double> **std** (List<Double> *mean*)
Return the std of the values contained in the history

#### variance

public List<Double> **variance** (List<Double> *mean*)
Returns the variance of the values contained in the history

### 2.20.5 Normalizer

public class **Normalizer**

#### Constructors

#### Normalizer

public **Normalizer** (List<Double> *min*, List<Double> *max*)

#### Methods

#### normalize

public Double **normalize** (Double *input*, int *index*)

### 2.20.6 R2Ranking

public class **R2Ranking**<S extends Solution<?>> extends *GenericSolutionAttribute*<S, *R2SolutionData*>

#### Constructors

#### R2Ranking

public **R2Ranking** (*AbstractUtilityFunctionsSet*<S> *utilityFunctions*)

#### Methods

#### computeRanking

public *R2Ranking*<S> **computeRanking** (List<S> *population*)

#### getAttribute

public *R2SolutionData* **getAttribute** (S *solution*)

#### getAttributeIdentifier

public Object **getAttributeIdentifier** ()

#### getNumberOfSubfronts

public int **getNumberOfSubfronts** ()

#### getSubfront

public List<S> **getSubfront** (int *rank*)

#### getUtilityFunctions

public *AbstractUtilityFunctionsSet*<S> **getUtilityFunctions** ()

#### setAttribute

public void **setAttribute** (S *solution*, *R2SolutionData* *value*)

## 2.20.7 R2RankingAttribute

public class **R2RankingAttribute**<T extends Solution<?>> extends *GenericSolutionAttribute*<T, *R2SolutionData*>
Created by ajnebro on 10/9/15.

## 2.20.8 R2RankingNormalized

public class **R2RankingNormalized**<S extends Solution<?>> extends *R2Ranking*<S>

### Constructors

#### R2RankingNormalized

public **R2RankingNormalized** (*AbstractUtilityFunctionsSet*<S> *utilityFunctions*, *Normalizer* *normalizer*)

### Methods

#### computeRanking

public *R2RankingNormalized*<S> **computeRanking** (List<S> *population*)

#### getNumberOfSubfronts

public int **getNumberOfSubfronts** ()

#### getSubfront

public List<S> **getSubfront** (int *rank*)

### 2.20.9 R2SolutionData

public class **R2SolutionData**

#### Fields

##### alpha

public double **alpha**

##### rank

public int **rank**

##### utility

public double **utility**

### 2.20.10 TchebycheffUtilityFunctionsSet

public class **TchebycheffUtilityFunctionsSet**<S extends Solution<?>> extends *AbstractUtilityFunctionsSet*<S>
This class implements a set of utility functions based on the Tchebycheff aggregation approach

**Author** Juan J. Durillo ToDo List: + check the size of nadir and reference points are the correct ones + check that the function that needs to be evaluated is the correct one

**Parameters**

- **<S>** –

#### Constructors

##### TchebycheffUtilityFunctionsSet

public **TchebycheffUtilityFunctionsSet** (String *file_path*, List<Double> *referencePoint*)

##### TchebycheffUtilityFunctionsSet

public **TchebycheffUtilityFunctionsSet** (String *file_path*)

#### Methods

##### evaluate

public Double **evaluate** (S *solution*, int *vector*)

# 2.21 org.uma.jmetal.algorithm.multiobjective.mombi2

## 2.21.1 MOMBI2IT

public class **MOMBI2IT**

### Fields

#### algorithm

*Algorithm*<List<*DoubleSolution*>> **algorithm**

### Methods

#### shouldTheAlgorithmReturnANumberOfSolutionsWhenSolvingASimpleProblem

public void **shouldTheAlgorithmReturnANumberOfSolutionsWhenSolvingASimpleProblem**()

#### shouldTheHypervolumeHaveAMininumValue

public void **shouldTheHypervolumeHaveAMininumValue**()

# 2.22 org.uma.jmetal.algorithm.multiobjective.nsgaii

## 2.22.1 NSGAII

public class **NSGAII**<S extends Solution<?>> extends *AbstractGeneticAlgorithm*<S, List<S>>

**Author** Antonio J. Nebro

### Fields

#### dominanceComparator

protected Comparator<S> **dominanceComparator**

#### evaluations

protected int **evaluations**

#### evaluator

protected final *SolutionListEvaluator*<S> **evaluator**

#### maxEvaluations

protected final int **maxEvaluations**

### Constructors

#### NSGAII

public **NSGAII** (*Problem*<S> *problem*, int *maxEvaluations*, int *populationSize*, *CrossoverOperator*<S> *crossoverOperator*, *MutationOperator*<S> *mutationOperator*, *SelectionOperator*<List<S>, S> *selectionOperator*, *SolutionListEvaluator*<S> *evaluator*)

Constructor

#### NSGAII

public **NSGAII** (*Problem*<S> *problem*, int *maxEvaluations*, int *populationSize*, *CrossoverOperator*<S> *crossoverOperator*, *MutationOperator*<S> *mutationOperator*, *SelectionOperator*<List<S>, S> *selectionOperator*, Comparator<S> *dominanceComparator*, *SolutionListEvaluator*<S> *evaluator*)

Constructor

### Methods

#### evaluatePopulation

protected List<S> **evaluatePopulation** (List<S> *population*)

#### getDescription

public String **getDescription** ()

#### getName

public String **getName** ()

#### getNonDominatedSolutions

protected List<S> **getNonDominatedSolutions** (List<S> *solutionList*)

#### getResult

public List<S> **getResult** ()

#### initProgress

protected void **initProgress** ()

#### isStoppingConditionReached

protected boolean **isStoppingConditionReached**()

#### replacement

protected List<S> **replacement**(List<S> *population*, List<S> *offspringPopulation*)

#### updateProgress

protected void **updateProgress**()

## 2.22.2 NSGAII45

public class **NSGAII45**<S extends Solution<?>> implements *Algorithm*<List<S>>
Implementation of NSGA-II following the scheme used in jMetal4.5 and former versions, i.e, without implementing the *AbstractGeneticAlgorithm* interface.

**Author** Antonio J. Nebro

### Fields

#### crossoverOperator

protected *CrossoverOperator*<S> **crossoverOperator**

#### evaluations

protected int **evaluations**

#### evaluator

protected final *SolutionListEvaluator*<S> **evaluator**

#### maxEvaluations

protected final int **maxEvaluations**

#### mutationOperator

protected *MutationOperator*<S> **mutationOperator**

#### population

protected List<S> **population**

#### populationSize

protected final int **populationSize**

#### problem

protected final *Problem*<S> **problem**

#### selectionOperator

protected *SelectionOperator*<List<S>, S> **selectionOperator**

### Constructors

#### NSGAII45

public **NSGAII45** (*Problem*<S> *problem*, int *maxEvaluations*, int *populationSize*, *CrossoverOperator*<S> *crossoverOperator*, *MutationOperator*<S> *mutationOperator*, *SelectionOperator*<List<S>, S> *selectionOperator*, *SolutionListEvaluator*<S> *evaluator*)

Constructor

### Methods

#### addLastRankedSolutionsToPopulation

protected void **addLastRankedSolutionsToPopulation** (*Ranking*<S> *ranking*, int *rank*, List<S> *population*)

#### addRankedSolutionsToPopulation

protected void **addRankedSolutionsToPopulation** (*Ranking*<S> *ranking*, int *rank*, List<S> *population*)

#### computeRanking

protected *Ranking*<S> **computeRanking** (List<S> *solutionList*)

#### createInitialPopulation

protected List<S> **createInitialPopulation** ()

#### crowdingDistanceSelection

protected List<S> **crowdingDistanceSelection** (*Ranking*<S> *ranking*)

#### evaluatePopulation

protected List<S> **evaluatePopulation** (List<S> *population*)

#### getDescription

public String **getDescription** ()

#### getName

public String **getName** ()

#### getNonDominatedSolutions

protected List<S> **getNonDominatedSolutions** (List<S> *solutionList*)

#### getResult

public List<S> **getResult** ()

#### populationIsNotFull

protected boolean **populationIsNotFull** (List<S> *population*)

#### run

public void **run** ()

Run method

#### subfrontFillsIntoThePopulation

protected boolean **subfrontFillsIntoThePopulation** (*Ranking*<S> *ranking*, int *rank*, List<S> *population*)

### 2.22.3 NSGAIIBuilder

public class **NSGAIIBuilder**<S extends Solution<?>> implements *AlgorithmBuilder*<*NSGAII*<S>>

**Author** Antonio J. Nebro

### Constructors

#### NSGAIIBuilder

public **NSGAIIBuilder** (*Problem*<S> *problem*, *CrossoverOperator*<S> *crossoverOperator*, *MutationOperator*<S> *mutationOperator*)
NSGAIIBuilder constructor

### Methods

#### build

public *NSGAII*<S> **build** ()

#### getCrossoverOperator

public *CrossoverOperator*<S> **getCrossoverOperator** ()

#### getMaxIterations

public int **getMaxIterations** ()

#### getMutationOperator

public *MutationOperator*<S> **getMutationOperator** ()

#### getPopulationSize

public int **getPopulationSize** ()

#### getProblem

public *Problem*<S> **getProblem** ()

#### getSelectionOperator

public *SelectionOperator*<List<S>, S> **getSelectionOperator** ()

#### getSolutionListEvaluator

public *SolutionListEvaluator*<S> **getSolutionListEvaluator** ()

#### setDominanceComparator

public *NSGAIIBuilder*<S> **setDominanceComparator** (Comparator<S> *dominanceComparator*)

#### setMaxEvaluations

public *NSGAIIBuilder*<S> **setMaxEvaluations** (int *maxEvaluations*)

#### setPopulationSize

public *NSGAIIBuilder*<S> **setPopulationSize** (int *populationSize*)

#### setSelectionOperator

public *NSGAIIBuilder*<S> **setSelectionOperator** (*SelectionOperator*<List<S>, S> *selectionOperator*)

#### setSolutionListEvaluator

public *NSGAIIBuilder*<S> **setSolutionListEvaluator** (*SolutionListEvaluator*<S> *evaluator*)

#### setVariant

public *NSGAIIBuilder*<S> **setVariant** (*NSGAIIVariant* *variant*)

## 2.22.4 NSGAIIBuilder.NSGAIIVariant

public enum **NSGAIIVariant**

### Enum Constants

#### Measures

public static final *NSGAIIBuilder.NSGAIIVariant* **Measures**

#### NSGAII

public static final *NSGAIIBuilder.NSGAIIVariant* **NSGAII**

#### NSGAII45

public static final *NSGAIIBuilder.NSGAIIVariant* **NSGAII45**

#### SteadyStateNSGAII

public static final *NSGAIIBuilder.NSGAIIVariant* **SteadyStateNSGAII**

### 2.22.5 NSGAIIBuilderTest

public class **NSGAIIBuilderTest**
Created by Antonio J. Nebro on 25/11/14.

#### Methods

##### buildAlgorithm

public void **buildAlgorithm**()

##### cleanup

public void **cleanup**()

##### getProblem

public void **getProblem**()

##### setNegativeMaxNumberOfIterations

public void **setNegativeMaxNumberOfIterations**()

##### setNegativePopulationSize

public void **setNegativePopulationSize**()

##### setNewEvaluator

public void **setNewEvaluator**()

##### setNewSelectionOperator

public void **setNewSelectionOperator**()

##### setNullEvaluator

public void **setNullEvaluator**()

##### setNullSelectionOperator

public void **setNullSelectionOperator**()

#### setPositiveMaxNumberOfIterations

public void **setPositiveMaxNumberOfIterations**()

#### setValidPopulationSize

public void **setValidPopulationSize**()

#### startup

public void **startup**()

#### testDefaultConfiguration

public void **testDefaultConfiguration**()

### 2.22.6 NSGAIIIT

public class **NSGAIIIT**

#### Fields

#### algorithm

*Algorithm*<List<*DoubleSolution*>> **algorithm**

#### Methods

#### shouldTheAlgorithmReturnAGoodQualityFrontWhenSolvingAConstrainedProblem

public void **shouldTheAlgorithmReturnAGoodQualityFrontWhenSolvingAConstrainedProblem**()

#### shouldTheAlgorithmReturnANumberOfSolutionsWhenSolvingASimpleProblem

public void **shouldTheAlgorithmReturnANumberOfSolutionsWhenSolvingASimpleProblem**()

### 2.22.7 NSGAIIMeasures

public class **NSGAIIMeasures**<S extends Solution<?>> extends *NSGAII*<S> implements *Measurable*

**Author** Antonio J. Nebro

#### Fields

##### durationMeasure

protected *DurationMeasure* **durationMeasure**

##### evaluations

protected *CountingMeasure* **evaluations**

##### hypervolumeValue

protected *BasicMeasure*<Double> **hypervolumeValue**

##### measureManager

protected *SimpleMeasureManager* **measureManager**

##### numberOfNonDominatedSolutionsInPopulation

protected *BasicMeasure*<Integer> **numberOfNonDominatedSolutionsInPopulation**

##### referenceFront

protected *Front* **referenceFront**

##### solutionListMeasure

protected *BasicMeasure*<List<S>> **solutionListMeasure**

#### Constructors

##### NSGAIIMeasures

public **NSGAIIMeasures** (*Problem*<S> *problem*, int *maxIterations*, int *populationSize*, *CrossoverOperator*<S> *crossoverOperator*, *MutationOperator*<S> *mutationOperator*, *SelectionOperator*<List<S>, S> *selectionOperator*, Comparator<S> *dominanceComparator*, *SolutionListEvaluator*<S> *evaluator*)

Constructor

#### Methods

##### getDescription

public String **getDescription** ()

#### getEvaluations

public *CountingMeasure* **getEvaluations** ()

#### getMeasureManager

public *MeasureManager* **getMeasureManager** ()

#### getName

public String **getName** ()

#### initProgress

protected void **initProgress** ()

#### isStoppingConditionReached

protected boolean **isStoppingConditionReached** ()

#### replacement

protected List<S> **replacement** (List<S> *population*, List<S> *offspringPopulation*)

#### run

public void **run** ()

#### setReferenceFront

public void **setReferenceFront** (*Front* *referenceFront*)

#### updateProgress

protected void **updateProgress** ()

### 2.22.8 NSGAIIStoppingByTime

public class **NSGAIIStoppingByTime**<S extends Solution<?>> extends *NSGAII*<S>

This class shows a version of NSGA-II having a stopping condition depending on run-time

**Author** Antonio J. Nebro

#### Constructors

##### NSGAIIStoppingByTime

public **NSGAIIStoppingByTime**(*Problem*<S> *problem*, int *populationSize*, long *maxComputingTime*, *CrossoverOperator*<S> *crossoverOperator*, *MutationOperator*<S> *mutationOperator*, *SelectionOperator*<List<S>, S> *selectionOperator*, Comparator<S> *dominanceComparator*)

Constructor

#### Methods

##### evaluatePopulation

protected List<S> **evaluatePopulation**(List<S> *population*)

##### getDescription

public String **getDescription**()

##### getName

public String **getName**()

##### initProgress

protected void **initProgress**()

##### isStoppingConditionReached

protected boolean **isStoppingConditionReached**()

##### updateProgress

protected void **updateProgress**()

### 2.22.9 SteadyStateNSGAII

public class **SteadyStateNSGAII**<S extends Solution<?>> extends *NSGAII*<S>

**Author** Antonio J. Nebro

#### Constructors

#### SteadyStateNSGAII

public **SteadyStateNSGAII** (*Problem*<S> *problem*, int *maxEvaluations*, int *populationSize*, *CrossoverOperator*<S> *crossoverOperator*, *MutationOperator*<S> *mutationOperator*, *SelectionOperator*<List<S>, S> *selectionOperator*, Comparator<S> *dominanceComparator*, *SolutionListEvaluator*<S> *evaluator*)

Constructor

#### Methods

#### getDescription

public String **getDescription** ()

#### getName

public String **getName** ()

#### reproduction

protected List<S> **reproduction** (List<S> *population*)

#### selection

protected List<S> **selection** (List<S> *population*)

#### updateProgress

protected void **updateProgress** ()

## 2.23 org.uma.jmetal.algorithm.multiobjective.nsgaiii

### 2.23.1 NSGAIII

public class **NSGAIII**<S extends Solution<?>> extends *AbstractGeneticAlgorithm*<S, List<S>>

Created by ajnebro on 30/10/14. Modified by Juanjo on 13/11/14 This implementation is based on the code of Tsung-Che Chiang http://web.ntnu.edu.tw/~tcchiang/publications/nsga3cpp/nsga3cpp.htm

#### Fields

#### evaluator

protected *SolutionListEvaluator*<S> **evaluator**

#### iterations

protected int **iterations**

#### maxIterations

protected int **maxIterations**

#### numberOfDivisions

protected Vector<Integer> **numberOfDivisions**

#### referencePoints

protected List<*ReferencePoint*<S>> **referencePoints**

### Constructors

#### NSGAIII

public **NSGAIII** (*NSGAIIIBuilder*<S> *builder*)
Constructor

### Methods

#### addRankedSolutionsToPopulation

protected void **addRankedSolutionsToPopulation** (*Ranking*<S> *ranking*, int *rank*, List<S> *population*)

#### computeRanking

protected *Ranking*<S> **computeRanking** (List<S> *solutionList*)

#### evaluatePopulation

protected List<S> **evaluatePopulation** (List<S> *population*)

#### getDescription

public String **getDescription** ()

#### getName

public String **getName** ()

#### getNonDominatedSolutions

protected List<S> **getNonDominatedSolutions** (List<S> *solutionList*)

#### getResult

public List<S> **getResult** ()

#### initProgress

protected void **initProgress** ()

#### isStoppingConditionReached

protected boolean **isStoppingConditionReached** ()

#### replacement

protected List<S> **replacement** (List<S> *population*, List<S> *offspringPopulation*)

#### reproduction

protected List<S> **reproduction** (List<S> *population*)

#### selection

protected List<S> **selection** (List<S> *population*)

#### updateProgress

protected void **updateProgress** ()

### 2.23.2 NSGAIIIBuilder

public class **NSGAIIIBuilder**<S extends Solution<?>> implements *AlgorithmBuilder*<*NSGAIII*<S>>
Builder class

#### Constructors

#### NSGAIIIBuilder

public **NSGAIIIBuilder** (*Problem*<S> *problem*)
Builder constructor

### Methods

#### build

public *NSGAIII*<S> **build**()

#### getCrossoverOperator

public *CrossoverOperator*<S> **getCrossoverOperator**()

#### getEvaluator

public *SolutionListEvaluator*<S> **getEvaluator**()

#### getMaxIterations

public int **getMaxIterations**()

#### getMutationOperator

public *MutationOperator*<S> **getMutationOperator**()

#### getPopulationSize

public int **getPopulationSize**()

#### getProblem

public *Problem*<S> **getProblem**()

#### getSelectionOperator

public *SelectionOperator*<List<S>, S> **getSelectionOperator**()

#### setCrossoverOperator

public *NSGAIIIBuilder*<S> **setCrossoverOperator**(*CrossoverOperator*<S> *crossoverOperator*)

#### setMaxIterations

public *NSGAIIIBuilder*<S> **setMaxIterations**(int *maxIterations*)

#### setMutationOperator

public *NSGAIIIBuilder*<S> **setMutationOperator** (*MutationOperator*<S> *mutationOperator*)

#### setPopulationSize

public *NSGAIIIBuilder*<S> **setPopulationSize** (int *populationSize*)

#### setSelectionOperator

public *NSGAIIIBuilder*<S> **setSelectionOperator** (*SelectionOperator*<List<S>, S> *selectionOperator*)

#### setSolutionListEvaluator

public *NSGAIIIBuilder*<S> **setSolutionListEvaluator** (*SolutionListEvaluator*<S> *evaluator*)

## 2.24 org.uma.jmetal.algorithm.multiobjective.nsgaiii.util

### 2.24.1 EnvironmentalSelection

public class **EnvironmentalSelection**<S extends Solution<?>> implements *SelectionOperator*<List<S>, List<S>>, *SolutionAttr*

#### Constructors

#### EnvironmentalSelection

public **EnvironmentalSelection** (*Builder*<S> *builder*)

#### EnvironmentalSelection

public **EnvironmentalSelection** (List<List<S>> *fronts*, int *solutionsToSelect*, List<*ReferencePoint*<S>> *referencePoints*, int *numberOfObjectives*)

#### Methods

#### FindNicheReferencePoint

int **FindNicheReferencePoint** ()

#### SelectClusterMember

S **SelectClusterMember** (*ReferencePoint*<S> *rp*)

#### associate

public void **associate** (List<S> *population*)

#### constructHyperplane

public List<Double> **constructHyperplane** (List<S> *population*, List<S> *extreme_points*)

#### execute

public List<S> **execute** (List<S> *source*)

#### getAttribute

public List<Double> **getAttribute** (S *solution*)

#### getAttributeIdentifier

public Object **getAttributeIdentifier** ()

#### guassianElimination

public List<Double> **guassianElimination** (List<List<Double>> *A*, List<Double> *b*)

#### normalizeObjectives

public void **normalizeObjectives** (List<S> *population*, List<Double> *intercepts*, List<Double> *ideal_point*)

#### perpendicularDistance

public double **perpendicularDistance** (List<Double> *direction*, List<Double> *point*)

#### setAttribute

public void **setAttribute** (S *solution*, List<Double> *value*)

#### translateObjectives

public List<Double> **translateObjectives** (List<S> *population*)

### 2.24.2 EnvironmentalSelection.Builder

public static class **Builder**<S extends Solution<?>>

#### Methods

##### build

public *EnvironmentalSelection*<S> **build**()

##### getFronts

public List<List<S>> **getFronts**()

##### getNumberOfObjectives

public int **getNumberOfObjectives**()

##### getReferencePoints

public List<*ReferencePoint*<S>> **getReferencePoints**()

##### getSolutionsToSelet

public int **getSolutionsToSelet**()

##### setFronts

public *Builder*<S> **setFronts**(List<List<S>> *f*)

##### setNumberOfObjectives

public *Builder*<S> **setNumberOfObjectives**(int *n*)

##### setReferencePoints

public *Builder*<S> **setReferencePoints**(List<*ReferencePoint*<S>> *referencePoints*)

##### setSolutionsToSelect

public *Builder*<S> **setSolutionsToSelect**(int *solutions*)

### 2.24.3 ReferencePoint

public class **ReferencePoint**<S extends Solution<?>>

Created by ajnebro on 5/11/14. Modified by Juanjo on 13/11/14 This implementation is based on the code of Tsung-Che Chiang http://web.ntnu.edu.tw/~tcchiang/publications/nsga3cpp/nsga3cpp.htm

### Fields

#### position

public List<Double> **position**

### Constructors

#### ReferencePoint

public **ReferencePoint** ()

#### ReferencePoint

public **ReferencePoint** (int *size*)
Constructor

#### ReferencePoint

public **ReferencePoint** (*ReferencePoint*<S> *point*)

### Methods

#### AddMember

public void **AddMember** ()

#### AddPotentialMember

public void **AddPotentialMember** (S *member_ind*, double *distance*)

#### FindClosestMember

public S **FindClosestMember** ()

#### HasPotentialMember

public boolean **HasPotentialMember** ()

#### MemberSize

public int **MemberSize** ()

#### RandomMember

public S **RandomMember** ()

#### RemovePotentialMember

public void **RemovePotentialMember** (S *solution*)

#### clear

public void **clear** ()

#### generateReferencePoints

public void **generateReferencePoints** (List<*ReferencePoint*<S>> *referencePoints*, int *numberOfObjectives*, List<Integer> *numberOfDivisions*)

#### pos

public List<Double> **pos** ()

## 2.25 org.uma.jmetal.algorithm.multiobjective.omopso

### 2.25.1 OMOPSO

public class **OMOPSO** extends *AbstractParticleSwarmOptimization*<*DoubleSolution*, List<*DoubleSolution*>>
Class implementing the OMOPSO algorithm

#### Fields

#### evaluator

*SolutionListEvaluator*<*DoubleSolution*> **evaluator**

#### Constructors

#### OMOPSO

public **OMOPSO** (*DoubleProblem* *problem*, *SolutionListEvaluator*<*DoubleSolution*> *evaluator*, int *swarmSize*, int *maxIterations*, int *archiveSize*, *UniformMutation* *uniformMutation*, *NonUniformMutation* *nonUniformMutation*)
Constructor

#### Methods

##### createInitialSwarm

protected List<*DoubleSolution*> **createInitialSwarm**()

##### evaluateSwarm

protected List<*DoubleSolution*> **evaluateSwarm**(List<*DoubleSolution*> *swarm*)

##### getDescription

public String **getDescription**()

##### getName

public String **getName**()

##### getResult

public List<*DoubleSolution*> **getResult**()

##### initProgress

protected void **initProgress**()

##### initializeLeader

protected void **initializeLeader**(List<*DoubleSolution*> *swarm*)

##### initializeParticlesMemory

protected void **initializeParticlesMemory**(List<*DoubleSolution*> *swarm*)

##### initializeVelocity

protected void **initializeVelocity**(List<*DoubleSolution*> *swarm*)

##### isStoppingConditionReached

protected boolean **isStoppingConditionReached**()

#### perturbation

protected void **perturbation** (List<*DoubleSolution*> *swarm*)
Apply a mutation operator to all particles in the swarm (perturbation)

#### tearDown

protected void **tearDown** ()

#### updateLeaders

protected void **updateLeaders** (List<*DoubleSolution*> *swarm*)
Update leaders method

**Parameters**

- **swarm** – List of solutions (swarm)

#### updateParticlesMemory

protected void **updateParticlesMemory** (List<*DoubleSolution*> *swarm*)

#### updatePosition

protected void **updatePosition** (List<*DoubleSolution*> *swarm*)
Update the position of each particle

#### updateProgress

protected void **updateProgress** ()

#### updateVelocity

protected void **updateVelocity** (List<*DoubleSolution*> *swarm*)

### 2.25.2 OMOPSOBuilder

public class **OMOPSOBuilder** implements *AlgorithmBuilder*<*OMOPSO*>
Class implementing the OMOPSO algorithm

#### Fields

#### evaluator

protected *SolutionListEvaluator*<*DoubleSolution*> **evaluator**

#### problem

protected *DoubleProblem* **problem**

### Constructors

#### OMOPSOBuilder

public **OMOPSOBuilder**(*DoubleProblem problem*, *SolutionListEvaluator*<*DoubleSolution*> *evaluator*)

### Methods

#### build

public *OMOPSO* **build**()

#### getArchiveSize

public int **getArchiveSize**()

#### getMaxIterations

public int **getMaxIterations**()

#### getNonUniformMutation

public *NonUniformMutation* **getNonUniformMutation**()

#### getSwarmSize

public int **getSwarmSize**()

#### getUniformMutation

public *UniformMutation* **getUniformMutation**()

#### setArchiveSize

public *OMOPSOBuilder* **setArchiveSize**(int *archiveSize*)

#### setMaxIterations

public *OMOPSOBuilder* **setMaxIterations**(int *maxIterations*)

#### setNonUniformMutation

public *OMOPSOBuilder* **setNonUniformMutation**(*MutationOperator*<*DoubleSolution*> *nonUniformMutation*)

#### setSwarmSize

public *OMOPSOBuilder* **setSwarmSize**(int *swarmSize*)

#### setUniformMutation

public *OMOPSOBuilder* **setUniformMutation**(*MutationOperator*<*DoubleSolution*> *uniformMutation*)

### 2.25.3 OMOPSOIT

public class **OMOPSOIT**

Integration tests for algorithm OMOPSO

**Author** Antonio J. Nebro

#### Fields

#### algorithm

*Algorithm*<List<*DoubleSolution*>> **algorithm**

#### Methods

#### shouldTheAlgorithmReturnANumberOfSolutionsWhenSolvingASimpleProblem

public void **shouldTheAlgorithmReturnANumberOfSolutionsWhenSolvingASimpleProblem**()

#### shouldTheHypervolumeHaveAMininumValue

public void **shouldTheHypervolumeHaveAMininumValue**()

## 2.26 org.uma.jmetal.algorithm.multiobjective.paes

### 2.26.1 PAES

public class **PAES**<S extends Solution<?>> extends *AbstractEvolutionStrategy*<S, List<S>>

**Author** Antonio J. Nebro, Juan J. Durillo

#### Fields

##### archive

protected AdaptiveGridArchive<S> **archive**

##### archiveSize

protected int **archiveSize**

##### biSections

protected int **biSections**

##### comparator

protected Comparator<S> **comparator**

##### evaluations

protected int **evaluations**

##### maxEvaluations

protected int **maxEvaluations**

#### Constructors

##### PAES

public **PAES** (*Problem*<S> *problem*, int *archiveSize*, int *maxEvaluations*, int *biSections*, *MutationOperator*<S> *mutationOperator*)
Constructor

#### Methods

##### createInitialPopulation

protected List<S> **createInitialPopulation** ()

##### evaluatePopulation

protected List<S> **evaluatePopulation** (List<S> *population*)

#### getArchiveSize

public int **getArchiveSize**()

#### getBiSections

public int **getBiSections**()

#### getDescription

public String **getDescription**()

#### getMaxEvaluations

public int **getMaxEvaluations**()

#### getMutationOperator

public *MutationOperator*<S> **getMutationOperator**()

#### getName

public String **getName**()

#### getResult

public List<S> **getResult**()

#### initProgress

protected void **initProgress**()

#### isStoppingConditionReached

protected boolean **isStoppingConditionReached**()

#### replacement

protected List<S> **replacement**(List<S> *population*, List<S> *offspringPopulation*)

#### reproduction

protected List<S> **reproduction**(List<S> *population*)

#### selection

protected List<S> **selection** (List<S> *population*)

#### test

public S **test** (S *solution*, S *mutatedSolution*, *AdaptiveGridArchive*<S> *archive*)

Tests two solutions to determine which one becomes be the guide of PAES algorithm

**Parameters**

- **solution** – The actual guide of PAES
- **mutatedSolution** – A candidate guide

#### updateProgress

protected void **updateProgress** ()

### 2.26.2 PAESBuilder

public class **PAESBuilder**<S extends Solution<?>> implements *AlgorithmBuilder*<*PAES*<S>>

**Author** Antonio J. Nebro

#### Constructors

#### PAESBuilder

public **PAESBuilder** (*Problem*<S> *problem*)

#### Methods

#### build

public *PAES*<S> **build** ()

#### getArchiveSize

public int **getArchiveSize** ()

#### getBiSections

public int **getBiSections** ()

#### getMaxEvaluations

public int **getMaxEvaluations** ()

#### getMutationOperator

public *MutationOperator*<S> **getMutationOperator**()

#### getProblem

public *Problem*<S> **getProblem**()

#### setArchiveSize

public *PAESBuilder*<S> **setArchiveSize**(int *archiveSize*)

#### setBiSections

public *PAESBuilder*<S> **setBiSections**(int *biSections*)

#### setMaxEvaluations

public *PAESBuilder*<S> **setMaxEvaluations**(int *maxEvaluations*)

#### setMutationOperator

public *PAESBuilder*<S> **setMutationOperator**(*MutationOperator*<S> *mutation*)

## 2.27 org.uma.jmetal.algorithm.multiobjective.pesa2

### 2.27.1 PESA2

public class **PESA2**<S extends Solution<?>> extends *AbstractGeneticAlgorithm*<S, List<S>>

**Author** Antonio J. Nebro

#### Fields

#### evaluator

protected final *SolutionListEvaluator*<S> **evaluator**

#### selectionOperator

protected *SelectionOperator*<*AdaptiveGridArchive*<S>, S> **selectionOperator**

### Constructors

#### PESA2

public **PESA2** (*Problem*<S> *problem*, int *maxEvaluations*, int *populationSize*, int *archiveSize*, int *biSections*, *CrossoverOperator*<S> *crossoverOperator*, *MutationOperator*<S> *mutationOperator*, *SolutionListEvaluator*<S> *evaluator*)

### Methods

#### evaluatePopulation

protected List<S> **evaluatePopulation** (List<S> *population*)

#### getDescription

public String **getDescription** ()

#### getName

public String **getName** ()

#### getResult

public List<S> **getResult** ()

#### initProgress

protected void **initProgress** ()

#### isStoppingConditionReached

protected boolean **isStoppingConditionReached** ()

#### replacement

protected List<S> **replacement** (List<S> *population*, List<S> *offspringPopulation*)

#### reproduction

protected List<S> **reproduction** (List<S> *population*)

#### selection

protected List<S> **selection** (List<S> *population*)

#### updateProgress

protected void **updateProgress**()

### 2.27.2 PESA2Builder

public class **PESA2Builder**<S extends Solution<?>> implements *AlgorithmBuilder*<*PESA2*<S>>
Created by Antonio J. Nebro

#### Constructors

#### PESA2Builder

public **PESA2Builder**(*Problem*<S> *problem*, *CrossoverOperator*<S> *crossoverOperator*, *MutationOperator*<S> *mutationOperator*)
Constructor

#### Methods

#### build

public *PESA2*<S> **build**()

#### getArchiveSize

public int **getArchiveSize**()

#### getBiSections

public int **getBiSections**()

#### getCrossoverOperator

public *CrossoverOperator*<S> **getCrossoverOperator**()

#### getMaxEvaluations

public int **getMaxEvaluations**()

#### getMutationOperator

public *MutationOperator*<S> **getMutationOperator**()

#### getPopulationSize

public int **getPopulationSize**()

#### getProblem

public *Problem*<S> **getProblem**()

#### getSolutionListEvaluator

public *SolutionListEvaluator*<S> **getSolutionListEvaluator**()

#### setArchiveSize

public *PESA2Builder*<S> **setArchiveSize**(int *archiveSize*)

#### setBisections

public *PESA2Builder*<S> **setBisections**(int *biSections*)

#### setMaxEvaluations

public *PESA2Builder*<S> **setMaxEvaluations**(int *maxEvaluations*)

#### setPopulationSize

public *PESA2Builder*<S> **setPopulationSize**(int *populationSize*)

#### setSolutionListEvaluator

public *PESA2Builder*<S> **setSolutionListEvaluator**(*SolutionListEvaluator*<S> *evaluator*)

## 2.28 org.uma.jmetal.algorithm.multiobjective.pesa2.util

### 2.28.1 PESA2Selection

public class **PESA2Selection**<S extends Solution<?>> implements *SelectionOperator*<*AdaptiveGridArchive*<S>, S>
This class implements a selection operator as the used in the PESA-II algorithm

#### Constructors

#### PESA2Selection

public **PESA2Selection**()

#### Methods

##### execute

public S **execute** (*AdaptiveGridArchive*<S> *archive*)

## 2.29 org.uma.jmetal.algorithm.multiobjective.randomsearch

### 2.29.1 RandomSearch

public class **RandomSearch**<S extends Solution<?>> implements *Algorithm*<List<S>>

This class implements a simple random search algorithm.

**Author** Antonio J. Nebro

#### Fields

##### nonDominatedArchive

*NonDominatedSolutionListArchive*<S> **nonDominatedArchive**

#### Constructors

##### RandomSearch

public **RandomSearch** (*Problem*<S> *problem*, int *maxEvaluations*)

Constructor

#### Methods

##### getDescription

public String **getDescription** ()

##### getMaxEvaluations

public int **getMaxEvaluations** ()

##### getName

public String **getName** ()

##### getResult

public List<S> **getResult** ()

#### run

public void **run**()

### 2.29.2 RandomSearchBuilder

public class **RandomSearchBuilder**<S extends Solution<?>> implements *AlgorithmBuilder*<*RandomSearch*<S>>

This class implements a simple random search algorithm.

**Author** Antonio J. Nebro

#### Constructors

#### RandomSearchBuilder

public **RandomSearchBuilder**(*Problem*<S> *problem*)

#### Methods

#### build

public *RandomSearch*<S> **build**()

#### getMaxEvaluations

public int **getMaxEvaluations**()

#### setMaxEvaluations

public *RandomSearchBuilder*<S> **setMaxEvaluations**(int *maxEvaluations*)

## 2.30 org.uma.jmetal.algorithm.multiobjective.rnsgaii

### 2.30.1 RNSGAII

public class **RNSGAII**<S extends Solution<?>> extends *NSGAII*<S> implements *InteractiveAlgorithm*<S, List<S>>

**Author** Antonio J. Nebro

### Constructors

#### RNSGAII

public **RNSGAII** (*Problem*<S> *problem*, int *maxEvaluations*, int *populationSize*, *CrossoverOperator*<S> *crossoverOperator*, *MutationOperator*<S> *mutationOperator*, *SelectionOperator*<List<S>, S> *selectionOperator*, *SolutionListEvaluator*<S> *evaluator*, List<Double> *interestPoint*, double *epsilon*)

Constructor

### Methods

#### getDescription

public String **getDescription** ()

#### getName

public String **getName** ()

#### getResult

public List<S> **getResult** ()

#### initProgress

protected void **initProgress** ()

#### isStoppingConditionReached

protected boolean **isStoppingConditionReached** ()

#### replacement

protected List<S> **replacement** (List<S> *population*, List<S> *offspringPopulation*)

#### updatePointOfInterest

public void **updatePointOfInterest** (List<Double> *newReferencePoints*)

#### updateProgress

protected void **updateProgress** ()

### 2.30.2 RNSGAIIBuilder

public class **RNSGAIIBuilder**<S extends Solution<?>> implements *AlgorithmBuilder*<*RNSGAII*<S>>

**Author** Antonio J. Nebro

#### Constructors

#### RNSGAIIBuilder

public **RNSGAIIBuilder** (*Problem*<S> *problem*, *CrossoverOperator*<S> *crossoverOperator*, *MutationOperator*<S> *mutationOperator*, List<Double> *interestPoint*, double *epsilon*)
NSGAIIBuilder constructor

#### Methods

#### build

public *RNSGAII*<S> **build** ()

#### getCrossoverOperator

public *CrossoverOperator*<S> **getCrossoverOperator** ()

#### getMaxIterations

public int **getMaxIterations** ()

#### getMutationOperator

public *MutationOperator*<S> **getMutationOperator** ()

#### getPopulationSize

public int **getPopulationSize** ()

#### getProblem

public *Problem*<S> **getProblem** ()

#### getSelectionOperator

public *SelectionOperator*<List<S>, S> **getSelectionOperator** ()

#### getSolutionListEvaluator

public *SolutionListEvaluator*<S> **getSolutionListEvaluator** ()

#### setMaxEvaluations

public *RNSGAIIBuilder*<S> **setMaxEvaluations** (int *maxEvaluations*)

#### setPopulationSize

public *RNSGAIIBuilder*<S> **setPopulationSize** (int *populationSize*)

#### setSelectionOperator

public *RNSGAIIBuilder*<S> **setSelectionOperator** (*SelectionOperator*<List<S>, S> *selectionOperator*)

#### setSolutionListEvaluator

public *RNSGAIIBuilder*<S> **setSolutionListEvaluator** (*SolutionListEvaluator*<S> *evaluator*)

#### setVariant

public *RNSGAIIBuilder*<S> **setVariant** (*NSGAIIVariant variant*)

### 2.30.3 RNSGAIIBuilder.NSGAIIVariant

public enum **NSGAIIVariant**

#### Enum Constants

#### Measures

public static final *RNSGAIIBuilder.NSGAIIVariant* **Measures**

#### NSGAII

public static final *RNSGAIIBuilder.NSGAIIVariant* **NSGAII**

#### NSGAII45

public static final *RNSGAIIBuilder.NSGAIIVariant* **NSGAII45**

#### SteadyStateNSGAII

public static final *RNSGAIIBuilder.NSGAIIVariant* **SteadyStateNSGAII**

## 2.31 org.uma.jmetal.algorithm.multiobjective.rnsgaii.util

### 2.31.1 PreferenceNSGAII

public class **PreferenceNSGAII**<S extends Solution<?>>

#### Constructors

#### PreferenceNSGAII

public **PreferenceNSGAII** (List<Double> *weights*)

#### Methods

#### evaluate

public Double **evaluate** (S *solution*)

#### getSize

public int **getSize** ()

#### setLowerBounds

public void **setLowerBounds** (List<Double> *lowerBounds*)

#### setUpperBounds

public void **setUpperBounds** (List<Double> *upperBounds*)

#### updatePointOfInterest

public void **updatePointOfInterest** (List<Double> *newInterestPoint*)

### 2.31.2 RNSGAIIRanking

public class **RNSGAIIRanking**<S extends Solution<?>> extends *GenericSolutionAttribute*<S, Integer> implements *Ranking*<S>

#### Constructors

#### RNSGAIIRanking

public **RNSGAIIRanking** (*PreferenceNSGAII*<S> *utilityFunctions*, double *epsilon*, List<Double> *interestPoint*)

#### Methods

#### computeRanking

public *Ranking*<S> **computeRanking** (List<S> *population*)

#### getNumberOfSubfronts

public int **getNumberOfSubfronts** ()

#### getSubfront

public List<S> **getSubfront** (int *rank*)

## 2.32 org.uma.jmetal.algorithm.multiobjective.smpso

### 2.32.1 SMPSO

public class **SMPSO** extends *AbstractParticleSwarmOptimization*<*DoubleSolution*, List<*DoubleSolution*>>

This class implements the SMPSO algorithm described in: SMPSO: A new PSO-based metaheuristic for multi-objective optimization MCDM 2009. DOI: http://dx.doi.org/10.1109/MCDM.2009.4938830

**Author** Antonio J. Nebro

#### Constructors

#### SMPSO

public **SMPSO** (*DoubleProblem* *problem*, int *swarmSize*, *BoundedArchive*<*DoubleSolution*> *leaders*, *MutationOperator*<*DoubleSolution*> *mutationOperator*, int *maxIterations*, double *r1Min*, double *r1Max*, double *r2Min*, double *r2Max*, double *c1Min*, double *c1Max*, double *c2Min*, double *c2Max*, double *weightMin*, double *weightMax*, double *changeVelocity1*, double *changeVelocity2*, *SolutionListEvaluator*<*DoubleSolution*> *evaluator*)

Constructor

#### Methods

#### constrictionCoefficient

protected double **constrictionCoefficient** (double *c1*, double *c2*)

#### createInitialSwarm

protected List<*DoubleSolution*> **createInitialSwarm**()

#### evaluateSwarm

protected List<*DoubleSolution*> **evaluateSwarm**(List<*DoubleSolution*> *swarm*)

#### getDescription

public String **getDescription**()

#### getIterations

public int **getIterations**()

#### getMaxIterations

public int **getMaxIterations**()

#### getName

public String **getName**()

#### getResult

public List<*DoubleSolution*> **getResult**()

#### getSwarmSize

public int **getSwarmSize**()

#### initProgress

protected void **initProgress**()

#### initializeLeader

protected void **initializeLeader**(List<*DoubleSolution*> *swarm*)

#### initializeParticlesMemory

protected void **initializeParticlesMemory**(List<*DoubleSolution*> *swarm*)

### initializeVelocity

protected void **initializeVelocity** (List<*DoubleSolution*> *swarm*)

### isStoppingConditionReached

protected boolean **isStoppingConditionReached** ()

### perturbation

protected void **perturbation** (List<*DoubleSolution*> *swarm*)

### selectGlobalBest

protected *DoubleSolution* **selectGlobalBest** ()

### setIterations

public void **setIterations** (int *iterations*)

### updateLeaders

protected void **updateLeaders** (List<*DoubleSolution*> *swarm*)

### updateLeadersDensityEstimator

protected void **updateLeadersDensityEstimator** ()

### updateParticlesMemory

protected void **updateParticlesMemory** (List<*DoubleSolution*> *swarm*)

### updatePosition

protected void **updatePosition** (List<*DoubleSolution*> *swarm*)

### updateProgress

protected void **updateProgress** ()

### updateVelocity

protected void **updateVelocity** (List<*DoubleSolution*> *swarm*)

### 2.32.2 SMPSOBuilder

public class **SMPSOBuilder** implements *AlgorithmBuilder*<*SMPSO*>

**Author** Antonio J. Nebro

#### Fields

##### archiveSize

protected int **archiveSize**

##### evaluator

protected *SolutionListEvaluator*<*DoubleSolution*> **evaluator**

##### leaders

protected *BoundedArchive*<*DoubleSolution*> **leaders**

##### mutationOperator

protected *MutationOperator*<*DoubleSolution*> **mutationOperator**

##### variant

protected *SMPSOVariant* **variant**

#### Constructors

##### SMPSOBuilder

public **SMPSOBuilder**(*DoubleProblem problem*, *BoundedArchive*<*DoubleSolution*> *leaders*)

#### Methods

##### build

public *SMPSO* **build**()

##### getArchiveSize

public int **getArchiveSize**()

### getC1Max

public double **getC1Max**()

### getC1Min

public double **getC1Min**()

### getC2Max

public double **getC2Max**()

### getC2Min

public double **getC2Min**()

### getChangeVelocity1

public double **getChangeVelocity1**()

### getChangeVelocity2

public double **getChangeVelocity2**()

### getEvaluator

public *SolutionListEvaluator*<*DoubleSolution*> **getEvaluator**()

### getLeaders

public *BoundedArchive*<*DoubleSolution*> **getLeaders**()

### getMaxIterations

public int **getMaxIterations**()

### getMutation

public *MutationOperator*<*DoubleSolution*> **getMutation**()

### getMutationOperator

public *MutationOperator*<*DoubleSolution*> **getMutationOperator**()

#### getProblem

public *DoubleProblem* **getProblem**()

#### getR1Max

public double **getR1Max**()

#### getR1Min

public double **getR1Min**()

#### getR2Max

public double **getR2Max**()

#### getR2Min

public double **getR2Min**()

#### getSwarmSize

public int **getSwarmSize**()

#### getWeightMax

public double **getWeightMax**()

#### getWeightMin

public double **getWeightMin**()

#### setC1Max

public *SMPSOBuilder* **setC1Max**(double *c1Max*)

#### setC1Min

public *SMPSOBuilder* **setC1Min**(double *c1Min*)

#### setC2Max

public *SMPSOBuilder* **setC2Max**(double *c2Max*)

#### setC2Min

public *SMPSOBuilder* **setC2Min**(double *c2Min*)

#### setChangeVelocity1

public *SMPSOBuilder* **setChangeVelocity1**(double *changeVelocity1*)

#### setChangeVelocity2

public *SMPSOBuilder* **setChangeVelocity2**(double *changeVelocity2*)

#### setMaxIterations

public *SMPSOBuilder* **setMaxIterations**(int *maxIterations*)

#### setMutation

public *SMPSOBuilder* **setMutation**(*MutationOperator*<*DoubleSolution*> *mutation*)

#### setR1Max

public *SMPSOBuilder* **setR1Max**(double *r1Max*)

#### setR1Min

public *SMPSOBuilder* **setR1Min**(double *r1Min*)

#### setR2Max

public *SMPSOBuilder* **setR2Max**(double *r2Max*)

#### setR2Min

public *SMPSOBuilder* **setR2Min**(double *r2Min*)

#### setRandomGenerator

public *SMPSOBuilder* **setRandomGenerator**(*PseudoRandomGenerator* *randomGenerator*)

#### setSolutionListEvaluator

public *SMPSOBuilder* **setSolutionListEvaluator**(*SolutionListEvaluator*<*DoubleSolution*> *evaluator*)

#### setSwarmSize

public *SMPSOBuilder* **setSwarmSize**(int *swarmSize*)

#### setVariant

public *SMPSOBuilder* **setVariant**(*SMPSOVariant* *variant*)

#### setWeightMax

public *SMPSOBuilder* **setWeightMax**(double *weightMax*)

#### setWeightMin

public *SMPSOBuilder* **setWeightMin**(double *weightMin*)

## 2.32.3 SMPSOBuilder.SMPSOVariant

public enum **SMPSOVariant**

### Enum Constants

#### Measures

public static final *SMPSOBuilder.SMPSOVariant* **Measures**

#### SMPSO

public static final *SMPSOBuilder.SMPSOVariant* **SMPSO**

## 2.32.4 SMPSOIT

public class **SMPSOIT**

### Fields

#### algorithm

*Algorithm*<List<*DoubleSolution*>> **algorithm**

### Methods

#### shouldTheAlgorithmReturnAGoodQualityFrontWhenSolvingAConstrainedProblem

public void **shouldTheAlgorithmReturnAGoodQualityFrontWhenSolvingAConstrainedProblem**()

#### shouldTheAlgorithmReturnANumberOfSolutionsWhenSolvingASimpleProblem

public void **shouldTheAlgorithmReturnANumberOfSolutionsWhenSolvingASimpleProblem**()

#### shouldTheHypervolumeHaveAMininumValue

public void **shouldTheHypervolumeHaveAMininumValue**()

## 2.32.5 SMPSOMeasures

public class **SMPSOMeasures** extends *SMPSO* implements *Measurable*

This class implements a version of SMPSO using measures

**Author** Antonio J. Nebro

### Fields

#### durationMeasure

protected *DurationMeasure* **durationMeasure**

#### iterations

protected *CountingMeasure* **iterations**

#### measureManager

protected *SimpleMeasureManager* **measureManager**

#### solutionListMeasure

protected *BasicMeasure*<List<*DoubleSolution*>> **solutionListMeasure**

### Constructors

#### SMPSOMeasures

public **SMPSOMeasures**(*DoubleProblem* *problem*, int *swarmSize*, *BoundedArchive*<*DoubleSolution*> *leaders*, *MutationOperator*<*DoubleSolution*> *mutationOperator*, int *maxIterations*, double *r1Min*, double *r1Max*, double *r2Min*, double *r2Max*, double *c1Min*, double *c1Max*, double *c2Min*, double *c2Max*, double *weightMin*, double *weightMax*, double *changeVelocity1*, double *changeVelocity2*, *SolutionListEvaluator*<*DoubleSolution*> *evaluator*)

Constructor

**Parameters**

- **problem** –

- **swarmSize** –
- **leaders** –
- **mutationOperator** –
- **maxIterations** –
- **r1Min** –
- **r1Max** –
- **r2Min** –
- **r2Max** –
- **c1Min** –
- **c1Max** –
- **c2Min** –
- **c2Max** –
- **weightMin** –
- **weightMax** –
- **changeVelocity1** –
- **changeVelocity2** –
- **evaluator** –

### Methods

#### getDescription

public String **getDescription** ()

#### getMeasureManager

public *MeasureManager* **getMeasureManager** ()

#### getName

public String **getName** ()

#### initProgress

protected void **initProgress** ()

#### isStoppingConditionReached

protected boolean **isStoppingConditionReached** ()

#### run

public void **run**()

#### updateProgress

protected void **updateProgress**()

### 2.32.6 SMPSORP

public class **SMPSORP** extends *AbstractParticleSwarmOptimization*<*DoubleSolution*, List<*DoubleSolution*>> implements *Measurable*

This class implements the SMPSORP algorithm described in: "Extending the Speed-constrained Multi-Objective PSO (SMPSO) With Reference Point Based Preference Articulation. Antonio J. Nebro, Juan J. Durillo, José García-Nieto, Cristóbal Barba-González, Javier Del Ser, Carlos A. Coello Coello, Antonio Benítez-Hidalgo, José F. Aldana-Montes. Parallel Problem Solving from Nature – PPSN XV. Lecture Notes In Computer Science, Vol. 11101, pp. 298-310. 2018".

**Author** Antonio J. Nebro

#### Fields

#### currentIteration

protected *CountingMeasure* **currentIteration**

#### deltaMax

protected double **deltaMax**

#### deltaMin

protected double **deltaMin**

#### durationMeasure

protected *DurationMeasure* **durationMeasure**

#### evaluator

protected *SolutionListEvaluator*<*DoubleSolution*> **evaluator**

#### iterations

protected int **iterations**

#### leaders

public List<*ArchiveWithReferencePoint*<*DoubleSolution*>> **leaders**

#### maxIterations

protected int **maxIterations**

#### measureManager

protected *SimpleMeasureManager* **measureManager**

#### referencePoints

protected List<List<Double>> **referencePoints**

#### solutionListMeasure

protected *BasicMeasure*<List<*DoubleSolution*>> **solutionListMeasure**

#### swarmSize

protected int **swarmSize**

### Constructors

#### SMPSORP

public **SMPSORP** (*DoubleProblem problem*, int *swarmSize*, List<*ArchiveWithReferencePoint*<*DoubleSolution*>> *leaders*, List<List<Double>> *referencePoints*, *MutationOperator*<*DoubleSolution*> *mutationOperator*, int *maxIterations*, double *r1Min*, double *r1Max*, double *r2Min*, double *r2Max*, double *c1Min*, double *c1Max*, double *c2Min*, double *c2Max*, double *weightMin*, double *weightMax*, double *changeVelocity1*, double *changeVelocity2*, *SolutionListEvaluator*<*DoubleSolution*> *evaluator*)

Constructor

### Methods

#### changeReferencePoints

public synchronized void **changeReferencePoints** (List<List<Double>> *referencePoints*)

#### createInitialSwarm

protected List<*DoubleSolution*> **createInitialSwarm** ()

#### evaluateSwarm

protected List<*DoubleSolution*> **evaluateSwarm** (List<*DoubleSolution*> *swarm*)

#### getDescription

public String **getDescription** ()

#### getMeasureManager

public *MeasureManager* **getMeasureManager** ()

#### getName

public String **getName** ()

#### getResult

public List<*DoubleSolution*> **getResult** ()

#### initProgress

protected void **initProgress** ()

#### initializeLeader

protected void **initializeLeader** (List<*DoubleSolution*> *swarm*)

#### initializeParticlesMemory

protected void **initializeParticlesMemory** (List<*DoubleSolution*> *swarm*)

#### initializeVelocity

protected void **initializeVelocity** (List<*DoubleSolution*> *swarm*)

#### isStoppingConditionReached

protected boolean **isStoppingConditionReached** ()

#### perturbation

protected void **perturbation** (List<*DoubleSolution*> *swarm*)

#### removeDominatedSolutionsInArchives

public void **removeDominatedSolutionsInArchives** ()

#### selectGlobalBest

protected *DoubleSolution* **selectGlobalBest** ()

#### updateLeaders

protected void **updateLeaders** (List<*DoubleSolution*> *swarm*)

#### updateLeadersDensityEstimator

protected void **updateLeadersDensityEstimator** ()

#### updateParticlesMemory

protected void **updateParticlesMemory** (List<*DoubleSolution*> *swarm*)

#### updatePosition

protected void **updatePosition** (List<*DoubleSolution*> *swarm*)

#### updateProgress

protected void **updateProgress** ()

#### updateVelocity

protected void **updateVelocity** (List<*DoubleSolution*> *swarm*)

### 2.32.7 SMPSOhv2IT

public class **SMPSOhv2IT**

#### Methods

#### setup

public void **setup** ()

#### shouldTheAlgorithmReturnANumberOfSolutionsWhenSolvingASimpleProblem

public void **shouldTheAlgorithmReturnANumberOfSolutionsWhenSolvingASimpleProblem**()

#### shouldTheHypervolumeHaveAMininumValue

public void **shouldTheHypervolumeHaveAMininumValue**()

### 2.32.8 SMPSOhvIT

public class **SMPSOhvIT**

#### Methods

#### setup

public void **setup**()

#### shouldTheAlgorithmReturnANumberOfSolutionsWhenSolvingASimpleProblem

public void **shouldTheAlgorithmReturnANumberOfSolutionsWhenSolvingASimpleProblem**()

#### shouldTheHypervolumeHaveAMininumValue

public void **shouldTheHypervolumeHaveAMininumValue**()

## 2.33 org.uma.jmetal.algorithm.multiobjective.smsemoa

### 2.33.1 SMSEMOA

public class **SMSEMOA**<S extends Solution<?>> extends *AbstractGeneticAlgorithm*<S, List<S>>

**Author** Antonio J. Nebro

#### Fields

#### dominanceComparator

protected Comparator<S> **dominanceComparator**

#### evaluations

protected int **evaluations**

#### maxEvaluations

protected final int **maxEvaluations**

#### offset

protected final double **offset**

### Constructors

#### SMSEMOA

public **SMSEMOA** (*Problem*<S> *problem*, int *maxEvaluations*, int *populationSize*, double *offset*, *CrossoverOperator*<S> *crossoverOperator*, *MutationOperator*<S> *mutationOperator*, *SelectionOperator*<List<S>, S> *selectionOperator*, Comparator<S> *dominanceComparator*, *Hypervolume*<S> *hypervolumeImplementation*)

Constructor

### Methods

#### computeRanking

protected *Ranking*<S> **computeRanking** (List<S> *solutionList*)

#### evaluatePopulation

protected List<S> **evaluatePopulation** (List<S> *population*)

#### getDescription

public String **getDescription** ()

#### getName

public String **getName** ()

#### getResult

public List<S> **getResult** ()

#### initProgress

protected void **initProgress** ()

#### isStoppingConditionReached

protected boolean **isStoppingConditionReached**()

#### replacement

protected List<S> **replacement**(List<S> *population*, List<S> *offspringPopulation*)

#### reproduction

protected List<S> **reproduction**(List<S> *population*)

#### selection

protected List<S> **selection**(List<S> *population*)

#### updateProgress

protected void **updateProgress**()

## 2.33.2 SMSEMOABuilder

public class **SMSEMOABuilder**<S extends Solution<?>> implements *AlgorithmBuilder*<*SMSEMOA*<S>>

**Author** Antonio J. Nebro

### Fields

#### crossoverOperator

protected *CrossoverOperator*<S> **crossoverOperator**

#### dominanceComparator

protected Comparator<S> **dominanceComparator**

#### hypervolumeImplementation

protected *Hypervolume*<S> **hypervolumeImplementation**

#### maxEvaluations

protected int **maxEvaluations**

#### mutationOperator

protected *MutationOperator*<S> **mutationOperator**

#### offset

protected double **offset**

#### populationSize

protected int **populationSize**

#### problem

protected *Problem*<S> **problem**

#### selectionOperator

protected *SelectionOperator*<List<S>, S> **selectionOperator**

### Constructors

#### SMSEMOABuilder

public **SMSEMOABuilder**(*Problem*<S> *problem*, *CrossoverOperator*<S> *crossoverOperator*, *MutationOperator*<S> *mutationOperator*)

### Methods

#### build

public *SMSEMOA*<S> **build**()

#### getCrossoverOperator

public *CrossoverOperator*<S> **getCrossoverOperator**()

#### getMaxEvaluations

public int **getMaxEvaluations**()

#### getMutationOperator

public *MutationOperator*<S> **getMutationOperator**()

#### getOffset

public double **getOffset**()

#### getPopulationSize

public int **getPopulationSize**()

#### getProblem

public *Problem*<S> **getProblem**()

#### getSelectionOperator

public *SelectionOperator*<List<S>, S> **getSelectionOperator**()

#### setCrossoverOperator

public *SMSEMOABuilder*<S> **setCrossoverOperator**(*CrossoverOperator*<S> *crossover*)

#### setDominanceComparator

public *SMSEMOABuilder*<S> **setDominanceComparator**(Comparator<S> *dominanceComparator*)

#### setHypervolumeImplementation

public *SMSEMOABuilder*<S> **setHypervolumeImplementation**(*Hypervolume*<S> *hypervolumeImplementation*)

#### setMaxEvaluations

public *SMSEMOABuilder*<S> **setMaxEvaluations**(int *maxEvaluations*)

#### setMutationOperator

public *SMSEMOABuilder*<S> **setMutationOperator**(*MutationOperator*<S> *mutation*)

#### setOffset

public *SMSEMOABuilder*<S> **setOffset**(double *offset*)

#### setPopulationSize

public *SMSEMOABuilder*<S> **setPopulationSize**(int *populationSize*)

#### setSelectionOperator

public *SMSEMOABuilder*<S> **setSelectionOperator** (*SelectionOperator*<List<S>, S> *selection*)

### 2.33.3 SMSEMOAIT

public class **SMSEMOAIT**

#### Fields

#### algorithm

*Algorithm*<List<*DoubleSolution*>> **algorithm**

#### Methods

#### shouldTheAlgorithmReturnANumberOfSolutionsWhenSolvingASimpleProblem

public void **shouldTheAlgorithmReturnANumberOfSolutionsWhenSolvingASimpleProblem** ()

#### shouldTheHypervolumeHaveAMinimumValue

public void **shouldTheHypervolumeHaveAMinimumValue** ()

## 2.34 org.uma.jmetal.algorithm.multiobjective.spea2

### 2.34.1 SPEA2

public class **SPEA2**<S extends Solution<?>> extends *AbstractGeneticAlgorithm*<S, List<S>>

**Author** Juan J. Durillo

#### Fields

#### archive

protected List<S> **archive**

#### environmentalSelection

protected final *EnvironmentalSelection*<S> **environmentalSelection**

#### evaluator

protected final *SolutionListEvaluator*<S> **evaluator**

#### iterations

protected int **iterations**

#### maxIterations

protected final int **maxIterations**

#### strenghtRawFitness

protected final *StrengthRawFitness*<S> **strenghtRawFitness**

### Constructors

#### SPEA2

public **SPEA2** (*Problem*<S> *problem*, int *maxIterations*, int *populationSize*, *CrossoverOperator*<S> *crossoverOperator*, *MutationOperator*<S> *mutationOperator*, *SelectionOperator*<List<S>, S> *selectionOperator*, *SolutionListEvaluator*<S> *evaluator*)

### Methods

#### evaluatePopulation

protected List<S> **evaluatePopulation** (List<S> *population*)

#### getDescription

public String **getDescription** ()

#### getName

public String **getName** ()

#### getResult

public List<S> **getResult** ()

#### initProgress

protected void **initProgress** ()

#### isStoppingConditionReached

protected boolean **isStoppingConditionReached** ()

#### replacement

protected List<S> **replacement** (List<S> *population*, List<S> *offspringPopulation*)

#### reproduction

protected List<S> **reproduction** (List<S> *population*)

#### selection

protected List<S> **selection** (List<S> *population*)

#### updateProgress

protected void **updateProgress** ()

### 2.34.2 SPEA2Builder

public class **SPEA2Builder**<S extends Solution<?>> implements *AlgorithmBuilder*<*SPEA2*<S>>

**Author** Juan J. Durillo

#### Fields

#### crossoverOperator

protected *CrossoverOperator*<S> **crossoverOperator**

#### evaluator

protected *SolutionListEvaluator*<S> **evaluator**

#### maxIterations

protected int **maxIterations**

#### mutationOperator

protected *MutationOperator*<S> **mutationOperator**

#### populationSize

protected int **populationSize**

#### problem

protected final *Problem*<S> **problem**
SPEA2Builder class

#### selectionOperator

protected *SelectionOperator*<List<S>, S> **selectionOperator**

### Constructors

#### SPEA2Builder

public **SPEA2Builder** (*Problem*<S> *problem*, *CrossoverOperator*<S> *crossoverOperator*, *MutationOperator*<S> *mutationOperator*)
SPEA2Builder constructor

### Methods

#### build

public *SPEA2*<S> **build** ()

#### getCrossoverOperator

public *CrossoverOperator*<S> **getCrossoverOperator** ()

#### getMaxIterations

public int **getMaxIterations** ()

#### getMutationOperator

public *MutationOperator*<S> **getMutationOperator** ()

#### getPopulationSize

public int **getPopulationSize** ()

#### getProblem

public *Problem*<S> **getProblem** ()

#### getSelectionOperator

public *SelectionOperator*<List<S>, S> **getSelectionOperator**()

#### getSolutionListEvaluator

public *SolutionListEvaluator*<S> **getSolutionListEvaluator**()

#### setMaxIterations

public *SPEA2Builder*<S> **setMaxIterations**(int *maxIterations*)

#### setPopulationSize

public *SPEA2Builder*<S> **setPopulationSize**(int *populationSize*)

#### setSelectionOperator

public *SPEA2Builder*<S> **setSelectionOperator**(*SelectionOperator*<List<S>, S> *selectionOperator*)

#### setSolutionListEvaluator

public *SPEA2Builder*<S> **setSolutionListEvaluator**(*SolutionListEvaluator*<S> *evaluator*)

## 2.35 org.uma.jmetal.algorithm.multiobjective.spea2.util

### 2.35.1 EnvironmentalSelection

public class **EnvironmentalSelection**<S extends Solution<?>> implements *SelectionOperator*<List<S>, List<S>>

**Author** Juanjo Durillo

**Parameters**

- **<S>** –

#### Constructors

#### EnvironmentalSelection

public **EnvironmentalSelection**(int *solutionsToSelect*)

#### Methods

#### execute

public List<S> **execute** (List<S> *source2*)

## 2.36 org.uma.jmetal.algorithm.multiobjective.wasfga

### 2.36.1 WASFGA

public class **WASFGA**<S extends Solution<?>> extends *AbstractMOMBI*<S> implements *InteractiveAlgorithm*<S, List<S>>
Implementation of the preference based algorithm named WASF-GA on jMetal5.0

**Author** Juanjo Durillo This algorithm is described in the paper: A.B. Ruiz, R. Saborido, M. Luque "A Preference-based Evolutionary Algorithm for Multiobjective Optimization: The Weighting Achievement Scalarizing Function Genetic Algorithm". Journal of Global Optimization. May 2015, Volume 62, Issue 1, pp 101-129 DOI = {10.1007/s10898-014-0214-y}

#### Fields

#### epsilon

protected double **epsilon**

#### evaluations

protected int **evaluations**

#### maxEvaluations

protected int **maxEvaluations**

#### weights

protected double[][] **weights**

#### Constructors

#### WASFGA

public **WASFGA** (*Problem*<S> *problem*, int *populationSize*, int *maxIterations*, *CrossoverOperator*<S> *crossoverOperator*, *MutationOperator*<S> *mutationOperator*, *SelectionOperator*<List<S>, S> *selectionOperator*, *SolutionListEvaluator*<S> *evaluator*, double *epsilon*, List<Double> *referencePoint*, String *weightVectorsFileName*)
Constructor

**Parameters**

- **problem** – Problem to solve

### WASFGA

public **WASFGA** (*Problem*<S> *problem*, int *populationSize*, int *maxIterations*, *CrossoverOperator*<S> *crossoverOperator*, *MutationOperator*<S> *mutationOperator*, *SelectionOperator*<List<S>, S> *selectionOperator*, *SolutionListEvaluator*<S> *evaluator*, double *epsilon*, List<Double> *referencePoint*)

Constructor

**Parameters**

- **problem** – Problem to solve

### Methods

#### addLastRankedSolutionsToPopulation

protected void **addLastRankedSolutionsToPopulation** (*Ranking*<S> *ranking*, int *index*, List<S> *population*)

#### addRankedSolutionsToPopulation

protected void **addRankedSolutionsToPopulation** (*Ranking*<S> *ranking*, int *index*, List<S> *population*)

#### computeRanking

protected *Ranking*<S> **computeRanking** (List<S> *solutionList*)

#### createUtilityFunction

public *AbstractUtilityFunctionsSet*<S> **createUtilityFunction** ()

#### getDescription

public String **getDescription** ()

#### getName

public String **getName** ()

#### getNonDominatedSolutions

protected List<S> **getNonDominatedSolutions** (List<S> *solutionList*)

#### getPopulationSize

public int **getPopulationSize** ()

#### getResult

public List<S> **getResult** ()

#### replacement

protected List<S> **replacement** (List<S> *population*, List<S> *offspringPopulation*)

#### selectBest

protected List<S> **selectBest** (*Ranking*<S> *ranking*)

#### specificMOEAComputations

public void **specificMOEAComputations** ()

#### updatePointOfInterest

public void **updatePointOfInterest** (List<Double> *newPointOfInterest*)

## 2.36.2 WASFGAIT

public class **WASFGAIT**

### Methods

#### shouldTheAlgorithmReturnANumberOfSolutionsWhenSolvingASimpleProblem

public void **shouldTheAlgorithmReturnANumberOfSolutionsWhenSolvingASimpleProblem** ()

#### shouldTheAlgorithmReturnAnExceptionIfIndicatingANonExistingWeightVectorFile

public void **shouldTheAlgorithmReturnAnExceptionIfIndicatingANonExistingWeightVectorFile** ()

#### shouldTheHypervolumeHaveAMininumValue

public void **shouldTheHypervolumeHaveAMininumValue** ()

### 2.36.3 WASFGAMeasures

public class **WASFGAMeasures**<S extends Solution<?>> extends *WASFGA*<S> implements *Measurable*

Implementation of the preference based algorithm named WASF-GA on jMetal5.0

**Author** Jorge Rodriguez

#### Fields

#### durationMeasure

protected *DurationMeasure* **durationMeasure**

#### iterations

protected *CountingMeasure* **iterations**

#### measureManager

protected *SimpleMeasureManager* **measureManager**

#### solutionListMeasure

protected *BasicMeasure*<List<S>> **solutionListMeasure**

#### Constructors

#### WASFGAMeasures

public **WASFGAMeasures** (*Problem*<S> *problem*, int *populationSize*, int *maxIterations*, *CrossoverOperator*<S> *crossoverOperator*, *MutationOperator*<S> *mutationOperator*, *SelectionOperator*<List<S>, S> *selectionOperator*, *SolutionListEvaluator*<S> *evaluator*, double *epsilon*, List<Double> *referencePoint*, String *weightVectorsFileName*)

Constructor

**Parameters**

- **problem** – Problem to solve

#### WASFGAMeasures

public **WASFGAMeasures** (*Problem*<S> *problem*, int *populationSize*, int *maxIterations*, *CrossoverOperator*<S> *crossoverOperator*, *MutationOperator*<S> *mutationOperator*, *SelectionOperator*<List<S>, S> *selectionOperator*, *SolutionListEvaluator*<S> *evaluator*, double *epsilon*, List<Double> *referencePoint*)

Constructor

**Parameters**

- **problem** – Problem to solve

#### Methods

##### getDescription

public String **getDescription**()

##### getMeasureManager

public *MeasureManager* **getMeasureManager**()

##### getName

public String **getName**()

##### initProgress

protected void **initProgress**()

##### isStoppingConditionReached

protected boolean **isStoppingConditionReached**()

##### run

public void **run**()

##### updateProgress

protected void **updateProgress**()

## 2.37 org.uma.jmetal.algorithm.multiobjective.wasfga.util

### 2.37.1 WASFGARanking

public class **WASFGARanking**<S extends Solution<?>> extends *GenericSolutionAttribute*<S, Integer> implements *Ranking*<S>

**Author** Rubén Saborido Implementation of the ranking procedure for the preference based algorithm named WASF-GA on jMetal5.0 It classifies solutions into different fronts. If the problem contains constraints, after feasible solutions it classifies the unfeasible solutions into fronts: - Each unfeasible solutions goes into a different front. - Unfeasible solutions with lower number of violated constraints are preferred. - If two solutions have equal number of violated constraints it compares the overall constraint values. - If two solutions have equal overall constraint values it compares de values of the utility function.

#### Constructors

##### WASFGARanking

public **WASFGARanking** (*AbstractUtilityFunctionsSet*<S> *utilityFunctions*)

#### Methods

##### computeRanking

public *Ranking*<S> **computeRanking** (List<S> *population*)

##### getNumberOfSubfronts

public int **getNumberOfSubfronts** ()

##### getSubfront

public List<S> **getSubfront** (int *rank*)

##### getUtilityFunctions

public *AbstractUtilityFunctionsSet*<S> **getUtilityFunctions** ()

##### rankUnfeasibleSolutions

protected int[] **rankUnfeasibleSolutions** (List<S> *population*)

Obtain the rank of each solution in a list of unfeasible solutions

**Parameters**

- **population** – List of unfeasible solutions

**Returns** The rank of each unfeasible solutions

### 2.37.2 WeightVectors

public class **WeightVectors**

**Author** Rubén Saborido Infantes This class offers different methods to manipulate weight vectors.

#### Methods

##### initializeUniformlyInTwoDimensions

public static double[][] **initializeUniformlyInTwoDimensions** (double *epsilon*, int *numberOfWeights*)

Generate uniform weight vectors in two dimension

**Parameters**

- **epsilon** – Distance between each component of the weight vector
- **numberOfWeights** – Number of weight vectors to generate

**Returns** A set of weight vectors

#### invert

public static double[][] **invert** (double[][] *weights*, boolean *normalize*)

Calculate the inverse of a set of weight vectors

**Parameters**

- **weights** – A set of weight vectors
- **normalize** – True if the weights should be normalize by the sum of the components

**Returns** A set of weight vectors

#### readFromFile

public static double[][] **readFromFile** (String *filePath*)

Read a set of weight vector from a file

**Parameters**

- **filePath** – A file containing the weight vectors

**Returns** A set of weight vectors

#### readFromResourcesInJMetal

public static double[][] **readFromResourcesInJMetal** (String *filePath*)

Read a set of weight vector from a file in the resources folder in jMetal

**Parameters**

- **filePath** – The name of file in the resources folder of jMetal

**Returns** A set of weight vectors

#### validate

public static boolean **validate** (double[][] *weights*, int *numberOfComponents*)

Validate if the number of components of all weight vectors has the expected dimensionality.

**Parameters**

- **weights** – Weight vectors to validate
- **numberOfComponents** – Number of components each weight vector must have

**Returns** True if the weight vectors are correct, False if the weight vectors are incorrect

# 2.38 org.uma.jmetal.algorithm.singleobjective.coralreefsoptimization

## 2.38.1 CoralReefsOptimization

public class **CoralReefsOptimization**<S> extends *AbstractCoralReefsOptimization*<S, List<S>>

**Author** Inacio Medeiros

### Constructors

#### CoralReefsOptimization

public **CoralReefsOptimization** (*Problem*<S> *problem*, int *maxEvaluations*, Comparator<S> *comparator*, *SelectionOperator*<List<S>, S> *selectionOperator*, *CrossoverOperator*<S> *crossoverOperator*, *MutationOperator*<S> *mutationOperator*, int *n*, int *m*, double *rho*, double *fbs*, double *fa*, double *pd*, int *attemptsToSettle*)

### Methods

#### asexualReproduction

protected List<S> **asexualReproduction** (List<S> *brooders*)

#### createInitialPopulation

protected List<S> **createInitialPopulation** ()

#### depredation

protected List<S> **depredation** (List<S> *population*, List<*Coordinate*> *coordinates*)

#### evaluatePopulation

protected List<S> **evaluatePopulation** (List<S> *population*)

#### generateCoordinates

protected List<*Coordinate*> **generateCoordinates** ()

#### getDescription

public String **getDescription** ()

#### getName

public String **getName**()

#### getResult

public List<S> **getResult**()

#### initProgress

protected void **initProgress**()

#### isStoppingConditionReached

protected boolean **isStoppingConditionReached**()

#### larvaeSettlementPhase

protected List<S> **larvaeSettlementPhase**(List<S> *larvae*, List<S> *population*, List<*Coordinate*> *coordinates*)

#### selectBroadcastSpawners

protected List<S> **selectBroadcastSpawners**(List<S> *population*)

#### sexualReproduction

protected List<S> **sexualReproduction**(List<S> *broadcastSpawners*)

#### updateProgress

protected void **updateProgress**()

### 2.38.2 CoralReefsOptimizationBuilder

public class **CoralReefsOptimizationBuilder**<S extends Solution<?>> implements *AlgorithmBuilder*<*CoralReefsOptimizati*

**Author** Inacio Medeiros

### Constructors

#### CoralReefsOptimizationBuilder

public **CoralReefsOptimizationBuilder** (*Problem*<S> *problem*, *SelectionOperator*<List<S>, S> *selectionOperator*, *CrossoverOperator*<S> *crossoverOperator*, *MutationOperator*<S> *mutationOperator*)

CoralReefsOptimizationBuilder constructor

### Methods

#### build

public *CoralReefsOptimization*<S> **build** ()

#### getAttemptsToSettle

public int **getAttemptsToSettle** ()

#### getComparator

public Comparator<S> **getComparator** ()

#### getCrossoverOperator

public *CrossoverOperator*<S> **getCrossoverOperator** ()

#### getFa

public double **getFa** ()

#### getFbr

public double **getFbr** ()

#### getFbs

public double **getFbs** ()

#### getFd

public double **getFd** ()

### getM

public int **getM**()

### getMaxEvaluations

public int **getMaxEvaluations**()

### getMutationOperator

public *MutationOperator*<S> **getMutationOperator**()

### getN

public int **getN**()

### getPd

public double **getPd**()

### getProblem

public *Problem*<S> **getProblem**()

### getRho

public double **getRho**()

### getSelectionOperator

public *SelectionOperator*<List<S>, S> **getSelectionOperator**()

### setAttemptsToSettle

public *CoralReefsOptimizationBuilder*<S> **setAttemptsToSettle**(int *attemptsToSettle*)

### setComparator

public *CoralReefsOptimizationBuilder*<S> **setComparator**(Comparator<S> *comparator*)

### setFa

public *CoralReefsOptimizationBuilder*<S> **setFa**(double *fa*)

#### setFbr

public *CoralReefsOptimizationBuilder*<S> **setFbr**(double *fbr*)

#### setFbs

public *CoralReefsOptimizationBuilder*<S> **setFbs**(double *fbs*)

#### setFd

public *CoralReefsOptimizationBuilder*<S> **setFd**(double *fd*)

#### setM

public *CoralReefsOptimizationBuilder*<S> **setM**(int *m*)

#### setMaxEvaluations

public *CoralReefsOptimizationBuilder*<S> **setMaxEvaluations**(int *maxEvaluations*)

#### setN

public *CoralReefsOptimizationBuilder*<S> **setN**(int *n*)

#### setPd

public *CoralReefsOptimizationBuilder*<S> **setPd**(double *pd*)

#### setRho

public *CoralReefsOptimizationBuilder*<S> **setRho**(double *rho*)

## 2.39 org.uma.jmetal.algorithm.singleobjective.differentialevolution

### 2.39.1 DifferentialEvolution

public class **DifferentialEvolution** extends *AbstractDifferentialEvolution*<*DoubleSolution*>

This class implements a differential evolution algorithm.

**Author** Antonio J. Nebro

## Constructors

### DifferentialEvolution

public **DifferentialEvolution** (*DoubleProblem problem*, int *maxEvaluations*, int *populationSize*, *DifferentialEvolutionCrossover crossoverOperator*, *DifferentialEvolutionSelection selectionOperator*, *SolutionListEvaluator*<*DoubleSolution*> *evaluator*)

Constructor

**Parameters**

- **problem** – Problem to solve
- **maxEvaluations** – Maximum number of evaluations to perform
- **populationSize** –
- **crossoverOperator** –
- **selectionOperator** –
- **evaluator** –

## Methods

### createInitialPopulation

protected List<*DoubleSolution*> **createInitialPopulation** ()

### evaluatePopulation

protected List<*DoubleSolution*> **evaluatePopulation** (List<*DoubleSolution*> *population*)

### getDescription

public String **getDescription** ()

### getEvaluations

public int **getEvaluations** ()

### getName

public String **getName** ()

### getResult

public *DoubleSolution* **getResult** ()

Returns the best individual

#### initProgress

protected void **initProgress**()

#### isStoppingConditionReached

protected boolean **isStoppingConditionReached**()

#### replacement

protected List<*DoubleSolution*> **replacement**(List<*DoubleSolution*> *population*, List<*DoubleSolution*> *offspringPopulation*)

#### reproduction

protected List<*DoubleSolution*> **reproduction**(List<*DoubleSolution*> *matingPopulation*)

#### selection

protected List<*DoubleSolution*> **selection**(List<*DoubleSolution*> *population*)

#### setEvaluations

public void **setEvaluations**(int *evaluations*)

#### updateProgress

protected void **updateProgress**()

### 2.39.2 DifferentialEvolutionBuilder

public class **DifferentialEvolutionBuilder**
DifferentialEvolutionBuilder class

**Author** Antonio J. Nebro

#### Constructors

#### DifferentialEvolutionBuilder

public **DifferentialEvolutionBuilder**(*DoubleProblem* *problem*)

### Methods

#### build

public *DifferentialEvolution* **build**()

#### getCrossoverOperator

public *DifferentialEvolutionCrossover* **getCrossoverOperator**()

#### getMaxEvaluations

public int **getMaxEvaluations**()

#### getPopulationSize

public int **getPopulationSize**()

#### getProblem

public *DoubleProblem* **getProblem**()

#### getSelectionOperator

public *DifferentialEvolutionSelection* **getSelectionOperator**()

#### getSolutionListEvaluator

public *SolutionListEvaluator*<*DoubleSolution*> **getSolutionListEvaluator**()

#### setCrossover

public *DifferentialEvolutionBuilder* **setCrossover**(*DifferentialEvolutionCrossover crossover*)

#### setMaxEvaluations

public *DifferentialEvolutionBuilder* **setMaxEvaluations**(int *maxEvaluations*)

#### setPopulationSize

public *DifferentialEvolutionBuilder* **setPopulationSize**(int *populationSize*)

#### setSelection

public *DifferentialEvolutionBuilder* **setSelection**(*DifferentialEvolutionSelection selection*)

#### setSolutionListEvaluator

public *DifferentialEvolutionBuilder* **setSolutionListEvaluator**(*SolutionListEvaluator*<*DoubleSolution*> *evaluator*)

### 2.39.3 DifferentialEvolutionBuilderTest

public class **DifferentialEvolutionBuilderTest**

Created by ajnebro on 25/11/14.

#### Methods

#### buildAlgorithm

public void **buildAlgorithm**()

#### cleanup

public void **cleanup**()

#### getProblem

public void **getProblem**()

#### setNegativeMaxNumberOfEvaluations

public void **setNegativeMaxNumberOfEvaluations**()

#### setNegativePopulationSize

public void **setNegativePopulationSize**()

#### setNewCrossoverOperator

public void **setNewCrossoverOperator**()

#### setNewEvaluator

public void **setNewEvaluator**()

#### setNewSelectionOperator

public void **setNewSelectionOperator** ()

#### setPositiveMaxNumberOfEvaluations

public void **setPositiveMaxNumberOfEvaluations** ()

#### setValidPopulationSize

public void **setValidPopulationSize** ()

#### startup

public void **startup** ()

#### testDefaultConfiguration

public void **testDefaultConfiguration** ()

## 2.39.4 DifferentialEvolutionTestIT

public class **DifferentialEvolutionTestIT**
  Created by Antonio J. Nebro on 25/11/14.

### Methods

#### shouldCreateInitialPopulationWhenPopulationSizeIsBiggerThanZero

public void **shouldCreateInitialPopulationWhenPopulationSizeIsBiggerThanZero** ()

#### shouldCreateInitialPopulationWhenPopulationSizeIsZero

public void **shouldCreateInitialPopulationWhenPopulationSizeIsZero** ()

#### shouldEvaluatePopulation

public void **shouldEvaluatePopulation** ()

#### shouldGetEvaluations

public void **shouldGetEvaluations** ()

#### shouldGetResultReturnsThenReturnTheBestIndividual

public void **shouldGetResultReturnsThenReturnTheBestIndividual**()

#### shouldInitProgress

public void **shouldInitProgress**()

#### shouldIsStoppingConditionReachedWhenEvaluationsBiggerThenMaxEvaluations

public void **shouldIsStoppingConditionReachedWhenEvaluationsBiggerThenMaxEvaluations**()

#### shouldIsStoppingConditionReachedWhenEvaluationsEqualToMaxEvaluations

public void **shouldIsStoppingConditionReachedWhenEvaluationsEqualToMaxEvaluations**()

#### shouldIsStoppingConditionReachedWhenEvaluationsLesserThanMaxEvaluations

public void **shouldIsStoppingConditionReachedWhenEvaluationsLesserThanMaxEvaluations**()

#### shouldReplacemen2t

public void **shouldReplacemen2t**()

#### shouldReproduction

public void **shouldReproduction**()

#### shouldSelection

public void **shouldSelection**()

#### shouldSetEvaluations

public void **shouldSetEvaluations**()

#### shouldUpdateProgressWhenAnyIteration

public void **shouldUpdateProgressWhenAnyIteration**()

#### shouldUpdateProgressWhenFirstIteration

public void **shouldUpdateProgressWhenFirstIteration**()

#### startup

public void **startup** ()

## 2.40 org.uma.jmetal.algorithm.singleobjective.evolutionstrategy

### 2.40.1 CovarianceMatrixAdaptationEvolutionStrategy

public class **CovarianceMatrixAdaptationEvolutionStrategy** extends *AbstractEvolutionStrategy*<*DoubleSolution*, *Doub*

Class implementing the CMA-ES algorithm

#### Methods

#### createInitialPopulation

protected List<*DoubleSolution*> **createInitialPopulation** ()

#### evaluatePopulation

protected List<*DoubleSolution*> **evaluatePopulation** (List<*DoubleSolution*> *population*)

#### getDescription

public String **getDescription** ()

#### getLambda

public int **getLambda** ()

#### getMaxEvaluations

public int **getMaxEvaluations** ()

#### getName

public String **getName** ()

#### getResult

public *DoubleSolution* **getResult** ()

#### initProgress

protected void **initProgress** ()

#### isStoppingConditionReached

protected boolean **isStoppingConditionReached**()

#### replacement

protected List<*DoubleSolution*> **replacement**(List<*DoubleSolution*> *population*, List<*DoubleSolution*> *offspringPopulation*)

#### reproduction

protected List<*DoubleSolution*> **reproduction**(List<*DoubleSolution*> *population*)

#### selection

protected List<*DoubleSolution*> **selection**(List<*DoubleSolution*> *population*)

#### updateProgress

protected void **updateProgress**()

## 2.40.2 CovarianceMatrixAdaptationEvolutionStrategy.Builder

public static class **Builder**
Buider class

### Constructors

#### Builder

public **Builder**(*DoubleProblem* *problem*)

### Methods

#### build

public *CovarianceMatrixAdaptationEvolutionStrategy* **build**()

#### setLambda

public *Builder* **setLambda**(int *lambda*)

#### setMaxEvaluations

public *Builder* **setMaxEvaluations**(int *maxEvaluations*)

#### setSigma

public *Builder* **setSigma**(double *sigma*)

#### setTypicalX

public *Builder* **setTypicalX**(double[] *typicalX*)

### 2.40.3 ElitistEvolutionStrategy

public class **ElitistEvolutionStrategy**<S extends Solution<?>> extends *AbstractEvolutionStrategy*<S, S>
Class implementing a (mu + lambda) Evolution Strategy (lambda must be divisible by mu)

**Author** Antonio J. Nebro

#### Constructors

#### ElitistEvolutionStrategy

public **ElitistEvolutionStrategy**(*Problem*<S> *problem*, int *mu*, int *lambda*, int *maxEvaluations*, *MutationOperator*<S> *mutation*)
Constructor

#### Methods

#### createInitialPopulation

protected List<S> **createInitialPopulation**()

#### evaluatePopulation

protected List<S> **evaluatePopulation**(List<S> *population*)

#### getDescription

public String **getDescription**()

#### getName

public String **getName**()

#### getResult

public S **getResult**()

#### initProgress

protected void **initProgress**()

#### isStoppingConditionReached

protected boolean **isStoppingConditionReached**()

#### replacement

protected List<S> **replacement**(List<S> *population*, List<S> *offspringPopulation*)

#### reproduction

protected List<S> **reproduction**(List<S> *population*)

#### selection

protected List<S> **selection**(List<S> *population*)

#### updateProgress

protected void **updateProgress**()

### 2.40.4 EvolutionStrategyBuilder

public class **EvolutionStrategyBuilder**<S extends Solution<?>> implements *AlgorithmBuilder*<*Algorithm*<S>>
Class implementing a (mu , lambda) Evolution Strategy (lambda must be divisible by mu)

**Author** Antonio J. Nebro

#### Constructors

#### EvolutionStrategyBuilder

public **EvolutionStrategyBuilder**(*Problem*<S> *problem*, *MutationOperator*<S> *mutationOperator*, *EvolutionStrategyVariant* *variant*)

#### Methods

#### build

public *Algorithm*<S> **build**()

#### getLambda

public int **getLambda** ()

#### getMaxEvaluations

public int **getMaxEvaluations** ()

#### getMu

public int **getMu** ()

#### getMutation

public *MutationOperator*<S> **getMutation** ()

#### setLambda

public *EvolutionStrategyBuilder*<S> **setLambda** (int *lambda*)

#### setMaxEvaluations

public *EvolutionStrategyBuilder*<S> **setMaxEvaluations** (int *maxEvaluations*)

#### setMu

public *EvolutionStrategyBuilder*<S> **setMu** (int *mu*)

## 2.40.5 EvolutionStrategyBuilder.EvolutionStrategyVariant

public enum **EvolutionStrategyVariant**

### Enum Constants

#### ELITIST

public static final *EvolutionStrategyBuilder*.*EvolutionStrategyVariant* **ELITIST**

#### NON_ELITIST

public static final *EvolutionStrategyBuilder*.*EvolutionStrategyVariant* **NON_ELITIST**

### 2.40.6 NonElitistEvolutionStrategy

public class **NonElitistEvolutionStrategy**<S extends Solution<?>> extends *AbstractEvolutionStrategy*<S, S>
Class implementing a (mu + lambda) Evolution Strategy (lambda must be divisible by mu)

**Author** Antonio J. Nebro

#### Constructors

#### NonElitistEvolutionStrategy

public **NonElitistEvolutionStrategy** (*Problem*<S> *problem*, int *mu*, int *lambda*, int *maxEvaluations*, *MutationOperator*<S> *mutation*)
Constructor

#### Methods

#### createInitialPopulation

protected List<S> **createInitialPopulation** ()

#### evaluatePopulation

protected List<S> **evaluatePopulation** (List<S> *population*)

#### getDescription

public String **getDescription** ()

#### getName

public String **getName** ()

#### getResult

public S **getResult** ()

#### initProgress

protected void **initProgress** ()

#### isStoppingConditionReached

protected boolean **isStoppingConditionReached** ()

#### replacement

protected List<S> **replacement** (List<S> *population*, List<S> *offspringPopulation*)

#### reproduction

protected List<S> **reproduction** (List<S> *population*)

#### selection

protected List<S> **selection** (List<S> *population*)

#### updateProgress

protected void **updateProgress** ()

## 2.41 org.uma.jmetal.algorithm.singleobjective.evolutionstrategy.util

### 2.41.1 CMAESUtils

public class **CMAESUtils**

#### Methods

#### checkEigenSystem

public static int **checkEigenSystem** (int *n*, double[][] *c*, double[] *diag*, double[][] *q*)

#### norm

public static double **norm** (double[] *vector*)

#### tql2

public static void **tql2** (int *n*, double[] *d*, double[] *e*, double[][] *v*)

#### tred2

public static void **tred2** (int *n*, double[][] *v*, double[] *d*, double[] *e*)

## 2.42 org.uma.jmetal.algorithm.singleobjective.geneticalgorithm

### 2.42.1 GenerationalGeneticAlgorithm

public class **GenerationalGeneticAlgorithm**<S extends Solution<?>> extends *AbstractGeneticAlgorithm*<S, S>

**Author** Antonio J. Nebro

#### Constructors

#### GenerationalGeneticAlgorithm

public **GenerationalGeneticAlgorithm**(*Problem*<S> *problem*, int *maxEvaluations*, int *populationSize*, *CrossoverOperator*<S> *crossoverOperator*, *MutationOperator*<S> *mutationOperator*, *SelectionOperator*<List<S>, S> *selectionOperator*, *SolutionListEvaluator*<S> *evaluator*)

Constructor

#### Methods

#### evaluatePopulation

protected List<S> **evaluatePopulation**(List<S> *population*)

#### getDescription

public String **getDescription**()

#### getName

public String **getName**()

#### getResult

public S **getResult**()

#### initProgress

public void **initProgress**()

#### isStoppingConditionReached

protected boolean **isStoppingConditionReached**()

#### replacement

protected List<S> **replacement** (List<S> *population*, List<S> *offspringPopulation*)

#### updateProgress

public void **updateProgress** ()

### 2.42.2 GenerationalGeneticAlgorithmTestIT

public class **GenerationalGeneticAlgorithmTestIT**
Created by ajnebro on 27/10/15.

#### Methods

#### shouldTheAlgorithmReturnTheCorrectSolutionWhenSolvingProblemOneMax

public void **shouldTheAlgorithmReturnTheCorrectSolutionWhenSolvingProblemOneMax** ()

### 2.42.3 GeneticAlgorithmBuilder

public class **GeneticAlgorithmBuilder**<S extends Solution<?>>
Created by ajnebro on 10/12/14.

#### Constructors

#### GeneticAlgorithmBuilder

public **GeneticAlgorithmBuilder** (*Problem*<S> *problem*, *CrossoverOperator*<S> *crossoverOperator*, *MutationOperator*<S> *mutationOperator*)
Builder constructor

#### Methods

#### build

public *Algorithm*<S> **build** ()

#### getCrossoverOperator

public *CrossoverOperator*<S> **getCrossoverOperator** ()

#### getEvaluator

public *SolutionListEvaluator*<S> **getEvaluator** ()

#### getMaxEvaluations

public int **getMaxEvaluations** ()

#### getMutationOperator

public *MutationOperator*<S> **getMutationOperator** ()

#### getPopulationSize

public int **getPopulationSize** ()

#### getProblem

public *Problem*<S> **getProblem** ()

#### getSelectionOperator

public *SelectionOperator*<List<S>, S> **getSelectionOperator** ()

#### getVariant

public *GeneticAlgorithmVariant* **getVariant** ()

#### setMaxEvaluations

public *GeneticAlgorithmBuilder*<S> **setMaxEvaluations** (int *maxEvaluations*)

#### setPopulationSize

public *GeneticAlgorithmBuilder*<S> **setPopulationSize** (int *populationSize*)

#### setSelectionOperator

public *GeneticAlgorithmBuilder*<S> **setSelectionOperator** (*SelectionOperator*<List<S>, S> *selectionOperator*)

#### setSolutionListEvaluator

public *GeneticAlgorithmBuilder*<S> **setSolutionListEvaluator** (*SolutionListEvaluator*<S> *evaluator*)

#### setVariant

public *GeneticAlgorithmBuilder*<S> **setVariant** (*GeneticAlgorithmVariant variant*)

### 2.42.4 GeneticAlgorithmBuilder.GeneticAlgorithmVariant

public enum **GeneticAlgorithmVariant**

#### Enum Constants

#### GENERATIONAL

public static final *GeneticAlgorithmBuilder*.*GeneticAlgorithmVariant* **GENERATIONAL**

#### STEADY_STATE

public static final *GeneticAlgorithmBuilder*.*GeneticAlgorithmVariant* **STEADY_STATE**

### 2.42.5 SteadyStateGeneticAlgorithm

public class **SteadyStateGeneticAlgorithm**<S extends Solution<?>> extends *AbstractGeneticAlgorithm*<S, S>

**Author** Antonio J. Nebro

#### Constructors

#### SteadyStateGeneticAlgorithm

public **SteadyStateGeneticAlgorithm** (*Problem*<S> *problem*, int *maxEvaluations*, int *populationSize*, *CrossoverOperator*<S> *crossoverOperator*, *MutationOperator*<S> *mutationOperator*, *SelectionOperator*<List<S>, S> *selectionOperator*)

Constructor

#### Methods

#### evaluatePopulation

protected List<S> **evaluatePopulation** (List<S> *population*)

#### getDescription

public String **getDescription** ()

#### getName

public String **getName** ()

#### getResult

public S **getResult**()

#### initProgress

public void **initProgress**()

#### isStoppingConditionReached

protected boolean **isStoppingConditionReached**()

#### replacement

protected List<S> **replacement**(List<S> *population*, List<S> *offspringPopulation*)

#### reproduction

protected List<S> **reproduction**(List<S> *matingPopulation*)

#### selection

protected List<S> **selection**(List<S> *population*)

#### updateProgress

public void **updateProgress**()

## 2.42.6 SteadyStateGeneticAlgorithmTestIT

public class **SteadyStateGeneticAlgorithmTestIT**
Created by ajnebro on 27/10/15.

### Methods

#### shouldTheAlgorithmReturnTheCorrectSolutionWhenSolvingProblemOneMax

public void **shouldTheAlgorithmReturnTheCorrectSolutionWhenSolvingProblemOneMax**()

# 2.43 org.uma.jmetal.algorithm.singleobjective.particleswarmoptimization

## 2.43.1 StandardPSO2007

public class **StandardPSO2007** extends *AbstractParticleSwarmOptimization*<*DoubleSolution*, *DoubleSolution*>
Class implementing a Standard PSO 2007 algorithm.

**Author** Antonio J. Nebro

### Constructors

#### StandardPSO2007

public **StandardPSO2007**(*DoubleProblem* *problem*, int *objectiveId*, int *swarmSize*, int *maxIterations*, int *numberOfParticlesToInform*, *SolutionListEvaluator*<*DoubleSolution*> *evaluator*)
Constructor

**Parameters**

- **problem** –
- **objectiveId** – This field indicates which objective, in the case of a multi-objective problem, is selected to be optimized.
- **swarmSize** –
- **maxIterations** –
- **numberOfParticlesToInform** –
- **evaluator** –

#### StandardPSO2007

public **StandardPSO2007**(*DoubleProblem* *problem*, int *swarmSize*, int *maxIterations*, int *numberOfParticlesToInform*, *SolutionListEvaluator*<*DoubleSolution*> *evaluator*)
Constructor

**Parameters**

- **problem** –
- **swarmSize** –
- **maxIterations** –
- **numberOfParticlesToInform** –
- **evaluator** –

### Methods

#### createInitialSwarm

public List<*DoubleSolution*> **createInitialSwarm**()

#### evaluateSwarm

public List<*DoubleSolution*> **evaluateSwarm**(List<*DoubleSolution*> *swarm*)

#### getDescription

public String **getDescription**()

#### getLocalBest

public *DoubleSolution*[] **getLocalBest**()

#### getName

public String **getName**()

#### getResult

public *DoubleSolution* **getResult**()

#### getSwarmSpeedMatrix

public double[][] **getSwarmSpeedMatrix**()

#### initProgress

public void **initProgress**()

#### initializeLeader

public void **initializeLeader**(List<*DoubleSolution*> *swarm*)

#### initializeParticlesMemory

public void **initializeParticlesMemory**(List<*DoubleSolution*> *swarm*)

#### initializeVelocity

public void **initializeVelocity**(List<*DoubleSolution*> *swarm*)

#### isStoppingConditionReached

public boolean **isStoppingConditionReached**()

#### perturbation

public void **perturbation** (List<*DoubleSolution*> *swarm*)

#### updateLeaders

public void **updateLeaders** (List<*DoubleSolution*> *swarm*)

#### updateParticlesMemory

public void **updateParticlesMemory** (List<*DoubleSolution*> *swarm*)

#### updatePosition

public void **updatePosition** (List<*DoubleSolution*> *swarm*)

#### updateProgress

public void **updateProgress** ()

#### updateVelocity

public void **updateVelocity** (List<*DoubleSolution*> *swarm*)

### 2.43.2 StandardPSO2011

public class **StandardPSO2011** extends *AbstractParticleSwarmOptimization*<*DoubleSolution*, *DoubleSolution*>
Class implementing a Standard PSO 2011 algorithm.

**Author** Antonio J. Nebro

#### Constructors

#### StandardPSO2011

public **StandardPSO2011** (*DoubleProblem problem*, int *objectiveId*, int *swarmSize*, int *maxIterations*, int *numberOfParticlesToInform*, *SolutionListEvaluator*<*DoubleSolution*> *evaluator*)
Constructor

**Parameters**

- **problem** –
- **objectiveId** – This field indicates which objective, in the case of a multi-objective problem, is selected to be optimized.
- **swarmSize** –
- **maxIterations** –

- **numberOfParticlesToInform** –
- **evaluator** –

### StandardPSO2011

public **StandardPSO2011** (*DoubleProblem problem*, int *swarmSize*, int *maxIterations*, int *numberOfParticlesToInform*, *SolutionListEvaluator*<*DoubleSolution*> *evaluator*)

Constructor

**Parameters**

- **problem** –
- **swarmSize** –
- **maxIterations** –
- **numberOfParticlesToInform** –
- **evaluator** –

### Methods

### createInitialSwarm

public List<*DoubleSolution*> **createInitialSwarm** ()

### evaluateSwarm

public List<*DoubleSolution*> **evaluateSwarm** (List<*DoubleSolution*> *swarm*)

### getDescription

public String **getDescription** ()

### getLocalBest

public *DoubleSolution*[] **getLocalBest** ()

### getName

public String **getName** ()

### getResult

public *DoubleSolution* **getResult** ()

#### getSwarmSpeedMatrix

public double[][] **getSwarmSpeedMatrix**()

#### initProgress

public void **initProgress**()

#### initializeLeader

public void **initializeLeader**(List<*DoubleSolution*> *swarm*)

#### initializeParticlesMemory

public void **initializeParticlesMemory**(List<*DoubleSolution*> *swarm*)

#### initializeVelocity

public void **initializeVelocity**(List<*DoubleSolution*> *swarm*)

#### isStoppingConditionReached

public boolean **isStoppingConditionReached**()

#### perturbation

public void **perturbation**(List<*DoubleSolution*> *swarm*)

#### updateLeaders

public void **updateLeaders**(List<*DoubleSolution*> *swarm*)

#### updateParticlesMemory

public void **updateParticlesMemory**(List<*DoubleSolution*> *swarm*)

#### updatePosition

public void **updatePosition**(List<*DoubleSolution*> *swarm*)

#### updateProgress

public void **updateProgress**()

#### updateVelocity

public void **updateVelocity**(List<*DoubleSolution*> *swarm*)

## 2.44 org.uma.jmetal.experiment

### 2.44.1 BinaryProblemsStudy

public class **BinaryProblemsStudy**

Example of experimental study based on solving two binary problems with four algorithms: NSGAII, SPEA2, MOCell, and MOCHC This experiment assumes that the reference Pareto front are not known, so the must be produced. Six quality indicators are used for performance assessment. The steps to carry out the experiment are: 1. Configure the experiment 2. Execute the algorithms 3. Generate the reference Pareto fronts 4. Compute que quality indicators 5. Generate Latex tables reporting means and medians 6. Generate Latex tables with the result of applying the Wilcoxon Rank Sum Test 7. Generate Latex tables with the ranking obtained by applying the Friedman test 8. Generate R scripts to obtain boxplots

**Author** Antonio J. Nebro

#### Methods

#### configureAlgorithmList

static List<*ExperimentAlgorithm*<*BinarySolution*, List<*BinarySolution*>>> **configureAlgorithmList**(List<*ExperimentProblem* *problemList*)

The algorithm list is composed of pairs `Algorithm` + `Problem` which form part of a `ExperimentAlgorithm`, which is a decorator for class `Algorithm`.

#### main

public static void **main**(String[] *args*)

### 2.44.2 ConstraintProblemsStudy

public class **ConstraintProblemsStudy**

Example of experimental study based on solving the unconstrained problems included in jMetal. This experiment assumes that the reference Pareto front are known and that, given a problem named P, there is a corresponding file called P.pf containing its corresponding Pareto front. If this is not the case, please refer to class `DTLZStudy` to see an example of how to explicitly indicate the name of those files. Six quality indicators are used for performance assessment. The steps to carry out the experiment are: 1. Configure the experiment 2. Execute the algorithms 3. Generate the reference Pareto fronts 4. Compute the quality indicators 5. Generate Latex tables reporting means and medians 6. Generate Latex tables with the result of applying the Wilcoxon Rank Sum Test 7. Generate Latex tables with the ranking obtained by applying the Friedman test 8. Generate R scripts to obtain boxplots

**Author** Antonio J. Nebro

#### Methods

##### configureAlgorithmList

static List<*ExperimentAlgorithm*<*DoubleSolution*, List<*DoubleSolution*>>> **configureAlgorithmList** (List<*ExperimentProble*
*prob-
lem-
List*)

The algorithm list is composed of pairs *Algorithm* + *Problem* which form part of a *ExperimentAlgorithm*, which is a decorator for class *Algorithm*. The *ExperimentAlgorithm* has an optional tag component, that can be set as it is shown in this example, where four variants of a same algorithm are defined.

##### main

public static void **main** (String[] *args*)

### 2.44.3 DTLZStudy

public class **DTLZStudy**

Example of experimental study based on solving the problems (configured with 3 objectives) with the algorithms NSGAII, SPEA2, and SMPSO This experiment assumes that the reference Pareto front are known and stored in files whose names are different from the default name expected for every problem. While the default would be "problem_name.pf" (e.g. DTLZ1.pf), the references are stored in files following the nomenclature "problem_name.3D.pf" (e.g. DTLZ1.3D.pf). This is indicated when creating the ExperimentProblem instance of each of the evaluated poblems by using the method changeReferenceFrontTo() Six quality indicators are used for performance assessment. The steps to carry out the experiment are: 1. Configure the experiment 2. Execute the algorithms 3. Compute que quality indicators 4. Generate Latex tables reporting means and medians 5. Generate R scripts to produce latex tables with the result of applying the Wilcoxon Rank Sum Test 6. Generate Latex tables with the ranking obtained by applying the Friedman test 7. Generate R scripts to obtain boxplots

#### Methods

##### configureAlgorithmList

static List<*ExperimentAlgorithm*<*DoubleSolution*, List<*DoubleSolution*>>> **configureAlgorithmList** (List<*ExperimentProble*
*prob-
lem-
List*)

The algorithm list is composed of pairs *Algorithm* + *Problem* which form part of a *ExperimentAlgorithm*, which is a decorator for class *Algorithm*.

##### main

public static void **main** (String[] *args*)

### 2.44.4 NSGAIIStudy

public class **NSGAIIStudy**

Example of experimental study based on solving the ZDT problems with four versions of NSGA-II, each of them applying a different crossover probability (from 0.7 to 1.0). This experiment assumes that the reference Pareto front are known and that, given a problem named P, there is a corresponding file called P.pf containing its corresponding Pareto front. If this is not the case, please refer to class `DTLZStudy` to see an example of how to explicitly indicate the name of those files. Six quality indicators are used for performance assessment. The steps to carry out the experiment are: 1. Configure the experiment 2. Execute the algorithms 3. Compute the quality indicators 4. Generate Latex tables reporting means and medians 5. Generate Latex tables with the result of applying the Wilcoxon Rank Sum Test 6. Generate Latex tables with the ranking obtained by applying the Friedman test 7. Generate R scripts to obtain boxplots

**Author** Antonio J. Nebro

#### Methods

##### configureAlgorithmList

static List<*ExperimentAlgorithm*<*DoubleSolution*, List<*DoubleSolution*>>> **configureAlgorithmList**(List<*ExperimentProblem*<*DoubleSolution*>> *problemList*)

The algorithm list is composed of pairs `Algorithm` + `Problem` which form part of a `ExperimentAlgorithm`, which is a decorator for class `Algorithm`. The `ExperimentAlgorithm` has an optional tag component, that can be set as it is shown in this example, where four variants of a same algorithm are defined.

##### main

public static void **main**(String[] *args*)

### 2.44.5 NSGAIIStudy2

public class **NSGAIIStudy2**

Example of experimental study based on solving the ZDT problems with four versions of NSGA-II, each of them applying a different crossover probability (from 0.7 to 1.0). This experiment assumes that the reference Pareto front are not known, so the names of files containing them and the directory where they are located must be specified. Six quality indicators are used for performance assessment. The steps to carry out the experiment are: 1. Configure the experiment 2. Execute the algorithms 3. Generate the reference Pareto fronts 4. Compute the quality indicators 5. Generate Latex tables reporting means and medians 6. Generate Latex tables with the result of applying the Wilcoxon Rank Sum Test 7. Generate Latex tables with the ranking obtained by applying the Friedman test 8. Generate R scripts to obtain boxplots

**Author** Antonio J. Nebro

#### Methods

##### configureAlgorithmList

static List<*ExperimentAlgorithm*<*DoubleSolution*, List<*DoubleSolution*>>> **configureAlgorithmList**(List<*ExperimentProblem*<*DoubleSolution*>> *problemList*)

The algorithm list is composed of pairs `Algorithm` + `Problem` which form part of a `ExperimentAlgorithm`, which is a decorator for class `Algorithm`. The `ExperimentAlgorithm` has an optional tag component, that can be set as it is shown in this example, where four variants of a same algorithm are defined.

#### main

public static void **main** (String[] *args*)

### 2.44.6 ZDTScalabilityIStudy

public class **ZDTScalabilityIStudy**

Example of experimental study based on solving the ZDT1 problem but using five different number of variables. This can be interesting to study the behaviour of the algorithms when solving an scalable problem (in the number of variables). The used algorithms are NSGA-II, SPEA2 and SMPSO. This experiment assumes that the reference Pareto front is of problem ZDT1 is known and that there is a file called ZDT1.pf containing it. Six quality indicators are used for performance assessment. The steps to carry out the experiment are: 1. Configure the experiment 2. Execute the algorithms 3. Generate the reference Pareto fronts 4. Compute the quality indicators 5. Generate Latex tables reporting means and medians 6. Generate Latex tables with the result of applying the Wilcoxon Rank Sum Test 7. Generate Latex tables with the ranking obtained by applying the Friedman test 8. Generate R scripts to obtain boxplots

**Author** Antonio J. Nebro

#### Methods

#### configureAlgorithmList

static List<*ExperimentAlgorithm*<*DoubleSolution*, List<*DoubleSolution*>>> **configureAlgorithmList** (List<*ExperimentProblem* *problemList*)

The algorithm list is composed of pairs `Algorithm` + `Problem` which form part of a `ExperimentAlgorithm`, which is a decorator for class `Algorithm`. The `ExperimentAlgorithm` has an optional tag component, that can be set as it is shown in this example, where four variants of a same algorithm are defined.

#### main

public static void **main** (String[] *args*)

### 2.44.7 ZDTScalabilityIStudy2

public class **ZDTScalabilityIStudy2**

Example of experimental study based on solving the ZDT1 problem but using five different number of variables. This can be interesting to study the behaviour of the algorithms when solving an scalable problem (in the number of variables). The used algorithms are NSGA-II, SPEA2 and SMPSO. This experiment assumes that the reference Pareto front is of problem ZDT1 is not known, so a reference front must be obtained. Six quality indicators are used for performance assessment. The steps to carry out the experiment are: 1. Configure the experiment 2. Execute the algorithms 3. Generate the reference Pareto sets and Pareto fronts 4. Compute the quality indicators 5. Generate Latex tables reporting means and medians 6. Generate Latex tables with the result of applying the Wilcoxon Rank Sum Test 7. Generate Latex tables with the ranking obtained by applying the Friedman test 8. Generate R scripts to obtain boxplots

**Author** Antonio J. Nebro

### Methods

#### configureAlgorithmList

static List<*ExperimentAlgorithm*<*DoubleSolution*, List<*DoubleSolution*>>> **configureAlgorithmList** (List<*ExperimentProblem* *problemList*)

The algorithm list is composed of pairs `Algorithm` + `Problem` which form part of a `ExperimentAlgorithm`, which is a decorator for class `Algorithm`. The `ExperimentAlgorithm` has an optional tag component, that can be set as it is shown in this example, where four variants of a same algorithm are defined.

#### main

public static void **main** (String[] *args*)

## 2.44.8 ZDTStudy

public class **ZDTStudy**

Example of experimental study based on solving the ZDT problems with the algorithms NSGAII, MOEA/D, and SMPSO This experiment assumes that the reference Pareto front are known and that, given a problem named P, there is a corresponding file called P.pf containing its corresponding Pareto front. If this is not the case, please refer to class `DTLZStudy` to see an example of how to explicitly indicate the name of those files. Six quality indicators are used for performance assessment. The steps to carry out the experiment are: 1. Configure the experiment 2. Execute the algorithms 3. Compute que quality indicators 4. Generate Latex tables reporting means and medians 5. Generate R scripts to produce latex tables with the result of applying the Wilcoxon Rank Sum Test 6. Generate Latex tables with the ranking obtained by applying the Friedman test 7. Generate R scripts to obtain boxplots

**Author** Antonio J. Nebro

### Methods

#### configureAlgorithmList

static List<*ExperimentAlgorithm*<*DoubleSolution*, List<*DoubleSolution*>>> **configureAlgorithmList** (List<*ExperimentProblem* *problemList*)

The algorithm list is composed of pairs `Algorithm` + `Problem` which form part of a `ExperimentAlgorithm`, which is a decorator for class `Algorithm`.

#### main

public static void **main** (String[] *args*)

### 2.44.9 ZDTStudy2

public class **ZDTStudy2**

Example of experimental study based on solving the ZDT problems with algorithms NSGAII, MOEA/D, and SMPSO This experiment assumes that the reference Pareto front are not known, so the names of files containing them and the directory where they are located must be specified. Six quality indicators are used for performance assessment. The steps to carry out the experiment are: 1. Configure the experiment 2. Execute the algorithms 3. Generate the reference Pareto fronts 4. Compute que quality indicators 5. Generate Latex tables reporting means and medians 6. Generate Latex tables with the result of applying the Wilcoxon Rank Sum Test 7. Generate R scripts to obtain boxplots

**Author** Antonio J. Nebro

#### Methods

#### configureAlgorithmList

static List<*ExperimentAlgorithm*<*DoubleSolution*, List<*DoubleSolution*>>> **configureAlgorithmList**(List<*ExperimentProble *prob-lem-List*)

The algorithm list is composed of pairs `Algorithm` + `Problem` which form part of a `ExperimentAlgorithm`, which is a decorator for class `Algorithm`.

#### main

public static void **main**(String[] *args*)

## 2.45 org.uma.jmetal.measure

### 2.45.1 Measurable

public interface **Measurable**

A `Measurable` entity is an entity which provides one or several `Measure`s. To keep it simple, these `Measure`s are provided through a `MeasureManager`.

**Author** Created by Antonio J. Nebro on 21/10/14 based on the ideas of Matthieu Vergne

#### Methods

#### getMeasureManager

public *MeasureManager* **getMeasureManager**()

**Returns** the `MeasureManager` which stores all the `Measure`s supported by this `Measurable` entity

### 2.45.2 Measure

public interface **Measure**<Value> extends *DescribedEntity*, Serializable

A `Measure` aims at providing the `Value` of a specific property, typically of an `Algorithm`. In order to facilitate external uses, it implements the methods of `DescribedEntity`.

**Author** Created by Antonio J. Nebro on 21/10/14 based on the ideas of Matthieu Vergne

**Parameters**

- **<Value>** – the type of value the `Measure` can provide

### 2.45.3 MeasureListener

public interface **MeasureListener**<Value>

A `MeasureListener` allows to register a given behavior to `PushMeasure.register(MeasureListener)`. When the `PushMeasure` generate a `Value`, it is provided to `MeasureListener.measureGenerated(Object)` in order to execute the specified behavior.

**Author** Created by Antonio J. Nebro on 21/10/14 based on the ideas of Matthieu Vergne

**Parameters**

- **<Value>** –

#### Methods

#### measureGenerated

public void **measureGenerated**(Value *value*)

**Parameters**

- **value** – the `Value` generated by the `PushMeasure`

### 2.45.4 MeasureManager

public interface **MeasureManager**

A `MeasureManager` aims at managing a set of `Measure`s. Typically, a `Measurable` entity would create a single `MeasureManager` to store all the `Measure`s it would like to support, each of them being identified by a key. Because a `Measure` can be whether a `PullMeasure` or a `PushMeasure`, the two methods `getPullMeasure(Object)` and `getPushMeasure(Object)` are provided. It could be that a single `Measure` is also available through both (via a single instance implementing both interfaces or two different instances implementing each interface), leading to have both methods returning a non-`null` value for the same key.

**Author** Created by Antonio J. Nebro on 21/10/14 based on the ideas of Matthieu Vergne

#### Methods

#### getMeasureKeys

public Collection<Object> **getMeasureKeys**()

This method should return all the keys identifying the `Measure`s managed by this `MeasureManager`. More precisely, if `getPullMeasure(Object)` or `getPushMeasure(Object)` returns a non-`null` value for a given key, then this key should be returned by *getMeasureKeys()*. However, it is not because a key is returned by *getMeasureKeys()* that it necessarily has a *PullMeasure* or a *PushMeasure* returned by this *MeasureManager*.

**Returns** the set of keys identifying the managed *Measure*s

#### getPullMeasure

public <T> *PullMeasure*<T> **getPullMeasure**(Object *key*)

**Parameters**

- **key** – the key of the *Measure*

**Returns** the *PullMeasure* identified by this key

#### getPushMeasure

public <T> *PushMeasure*<T> **getPushMeasure**(Object *key*)

**Parameters**

- **key** – the key of the *Measure*

**Returns** the *PushMeasure* identified by this key

### 2.45.5 PullMeasure

public interface **PullMeasure**<Value> extends *Measure*<Value>

A *PullMeasure* is a *Measure* from which the `Value` can be accessed on demand through the *get()* method. As such, a *PullMeasure* should ensure that its current `Value` is always available or generated before to be returned by *get()*.

**Author** Created by Antonio J. Nebro on 21/10/14 based on the ideas of Matthieu Vergne

**Parameters**

- **<Value>** – the type of value the *PullMeasure* can provide

#### Methods

#### get

public Value **get**()

**Returns** the current `Value` of the *Measure*

### 2.45.6 PushMeasure

public interface **PushMeasure**<Value> extends *Measure*<Value>

A *PushMeasure* is a *Measure* which provides its `Value` through notifications. As such, any observer on a *PushMeasure* should register a *MeasureListener* through *register(MeasureListener)* to specify what to do with the `Value` once it is received.

**Author** Created by Antonio J. Nebro on 21/10/14 based on the ideas of Matthieu Vergne

**Parameters**

- **<Value>** – the type of value the *PushMeasure* can provide

### Methods

#### register

public void **register** (*MeasureListener*<Value> *listener*)

Register a *MeasureListener* to use the Values of the *PushMeasure* when they are generated.

**Parameters**

- **listener** – the *MeasureListener* to register

#### unregister

public void **unregister** (*MeasureListener*<Value> *listener*)

Unregister a *MeasureListener* registered with *register(MeasureListener)* to stop receiving the notifications of the *PushMeasure*.

**Parameters**

- **listener** – the *MeasureListener* to unregister

# 2.46 org.uma.jmetal.measure.impl

## 2.46.1 BasicMeasure

public class **BasicMeasure**<T> extends *SimplePushMeasure*<T> implements *PullMeasure*<T>, *PushMeasure*<T>

A *BasicMeasure* provides a simple way to define a measure that merely stores a single value

**Author** Antonio J. Nebro

### Constructors

#### BasicMeasure

public **BasicMeasure** ()

Create a *BasicMeasure*

### Methods

#### get

public synchronized T **get** ()

**Returns** the current value

#### push

public void **push** (T *value*)

#### set

public synchronized void **set** (T *value*)

**Parameters**

- **value** – The value to be stored

### 2.46.2 CountingMeasure

public class **CountingMeasure** extends *SimplePushMeasure*<Long> implements *PullMeasure*<Long>, *PushMeasure*<Long>

A `CountingMeasure` provides a simple way to evaluate a number of occurrences. For instance, it can be used to count how many solutions have been generated within an algorithm, how many evaluations have been computed, how many rounds have been run, etc. If these occurrences are provided by some `PushMeasure`s, you can use `link(PushMeasure)` to register the `CountingMeasure` to these `PushMeasure`s. Otherwise, use `increment()` when the `CountingMeasure` need to count one more occurrence. In order to get the count, one can access it immediately through `get()` or when it is updated by registering a listener with `register(MeasureListener)`.

**Author** Matthieu Vergne

#### Fields

#### count

long **count**

The current amount of occurrences counted.

#### Constructors

#### CountingMeasure

public **CountingMeasure** (String *name*, String *description*, long *initialCount*)

Create a `CountingMeasure` which starts at a given value. The next value to be pushed to the registered observers will be this value + 1.

**Parameters**

- **name** – the name of the measure
- **description** – the description of the measure
- **initialCount** – the value to start from

#### CountingMeasure

public **CountingMeasure**(String *name*, String *description*)

Create a *CountingMeasure* starting from zero. The registered observers will receive their first notification when it will increment to 1.

**Parameters**

- **name** – the name of the measure
- **description** – the description of the measure

#### CountingMeasure

public **CountingMeasure**(long *initialCount*)

Create a *CountingMeasure* which starts at a given value. The next value to be pushed to the registered observers will be this value + 1. A default name and description are used.

**Parameters**

- **initialCount** – the value to start from

#### CountingMeasure

public **CountingMeasure**()

Create a *CountingMeasure* starting from zero. The registered observers will receive their first notification when it will increment to 1. A default name and description are used.

### Methods

#### finalize

protected void **finalize**()

#### get

public synchronized Long **get**()

**Returns** the current amount of occurrences counted

#### increment

public synchronized void **increment**()

Add 1 to the current count and push its value to all the registered observers.

#### increment

public synchronized void **increment**(long *amount*)

Increment the current count in a given amount. If the amount is zero, no change occurs, thus no notification is sent.

**Parameters**

- **amount** – the amount to add

#### link

public <T> void **link** (*PushMeasure*<T> *measure*)

If this *CountingMeasure* is used to count the number of time a *PushMeasure* notifies its observers, you can use this method to link them. The *CountingMeasure* will automatically register a *MeasureListener* on the *PushMeasure* such that, every time the *PushMeasure* send a notification, *CountingMeasure.increment()* is called. You can link several *PushMeasure*s at the same time, but each of their notifications will increment the counter, leading to summing their notifications. When a *PushMeasure* should not be considered anymore, use *unlink(PushMeasure)* to remove the link.

**Parameters**

- **measure** – the *PushMeasure* to link

#### reset

public synchronized void **reset** ()

Restart the counter to zero. Generate a notification if the value was not zero.

#### reset

public synchronized void **reset** (long *value*)

Restart the counter to a given value. Generate a notification if the value was different.

**Parameters**

- **value** – the value to restart from

#### unlink

public <T> void **unlink** (*PushMeasure*<T> *measure*)

If you have linked a *PushMeasure* through *link(PushMeasure)*, you can discard the link by using this method.

**Parameters**

- **measure** – the *PushMeasure* to unlink

## 2.46.3 CountingMeasureTest

public class **CountingMeasureTest**

### Methods

#### testGetAlignedWithNotifications

public void **testGetAlignedWithNotifications** ()

#### testIncrementAddOne

public void **testIncrementAddOne**()

#### testIncrementNotificationsOccur

public void **testIncrementNotificationsOccur**()

#### testIncrementNotificationsOccurIfNonZero

public void **testIncrementNotificationsOccurIfNonZero**()

#### testLinkedMeasureCorrectlyCounted

public void **testLinkedMeasureCorrectlyCounted**()

#### testMultipleLinkedMeasuresCorrectlyCounted

public void **testMultipleLinkedMeasuresCorrectlyCounted**()

#### testMultipleLinksOnTheSameMeasureCountedOnce

public void **testMultipleLinksOnTheSameMeasureCountedOnce**()

#### testReset

public void **testReset**()

#### testResetNotificationsOccur

public void **testResetNotificationsOccur**()

#### testResetToAGivenValue

public void **testResetToAGivenValue**()

#### testUnlinkCorrectlyIgnored

public void **testUnlinkCorrectlyIgnored**()

### 2.46.4 DurationMeasure

public class **DurationMeasure** extends *SimplePullMeasure*<Long>

This measure allows to have a simple way to compute the time spent in doing something. For instance, an algorithm can compute the time spent to run. In such a case, the algorithm would call `start()` at the beginning of the running and `stop()` at the end. Additional calls to these two methods can also be made during the running to exclude specific parts from the counting. At any time during (and after) the running, the `get()` method can be used to know how much time have been spent so far. If the algorithm is rerun, it will restart and the additional time will sum up to the time already spent before, but it can be avoided by resetting the measure with `reset()`.

**Author** Matthieu Vergne

#### Constructors

##### DurationMeasure

public **DurationMeasure**()

#### Methods

##### get

public Long **get**()

**Returns** the total time spent so far

##### reset

public void **reset**()

Reset the total time to zero. If a round is currently running, it is restarted.

##### start

public void **start**()

Start a round. If the round is already started, it has no effect.

##### stop

public void **stop**()

Stop a round. If the round is already stopped, it has no effect.

### 2.46.5 DurationMeasureTest

public class **DurationMeasureTest**

#### Methods

##### testDoNotEvolveBetweenStopAndRestart

public void **testDoNotEvolveBetweenStopAndRestart** ()

##### testIncreasesBetweenStartAndStop

public void **testIncreasesBetweenStartAndStop** ()

##### testNoRunningRemainsAtZero

public void **testNoRunningRemainsAtZero** ()

##### testResetGoBackToZeroWhenStopped

public void **testResetGoBackToZeroWhenStopped** ()

##### testResetRestartFromZeroWhenRunning

public void **testResetRestartFromZeroWhenRunning** ()

### 2.46.6 LastEvaluationMeasure

public class **LastEvaluationMeasure**<Solution, Value> extends *SimplePushMeasure*<*Evaluation*<*Solution*, Value>>

`LastEvaluationMeasure` is a `PushMeasure` providing the last evaluation made in an algorithm. It extends `SimplePushMeasure` and add the method `push(Object, Object)` for simplicity.

**Author** Matthieu Vergne

**Parameters**

- **<Solution>** – the solution evaluated
- **<Value>** – the type of value used to evaluate the solution (Double, BigDecimal, enum, …)

#### Constructors

##### LastEvaluationMeasure

public **LastEvaluationMeasure** ()

#### Methods

##### push

public void **push** (*Solution solution*, Value *value*)

This method is equivalent to `push(Object)` excepted that it automatically create the `Evaluation` instance.

**Parameters**

- **solution** – the solution evaluated
- **value** – the value of this solution

## 2.46.7 LastEvaluationMeasure.Evaluation

public static class **Evaluation**<Solution, Value>

This structure represent an atomic evaluation of a given solution.

**Author** Matthieu Vergne

### Fields

#### solution

*Solution* **solution**

The solution evaluated.

#### value

Value **value**

The evaluation of the solution.

## 2.46.8 LastEvaluationMeasureTest

public class **LastEvaluationMeasureTest**

### Methods

#### testSpecializedPushActLikeParentPush

public void **testSpecializedPushActLikeParentPush**()

## 2.46.9 ListenerTimeMeasure

public class **ListenerTimeMeasure** extends *SimplePullMeasure*<Long> implements *PullMeasure*<Long>

This measure is a facility to evaluate the time spent in `MeasureListener`s registered in `PushMeasure`s. In order to measure the time spent in a `MeasureListener`, you should wrap it by calling `wrapListener(MeasureListener)`. The wrapper returned should be used instead of the original `MeasureListener` to allow the `ListenerTimeMeasure` to account for its execution time. If you want to wrap automatically all the `MeasureListener`s registered to a given `PushMeasure`, you can wrap the `PushMeasure` through `wrapMeasure(PushMeasure)`: all the `MeasureListener`s registered to the wrapper will be wrapped too. You can restart the evaluation by calling `reset()`. Notice that the time accounted is not the physical time but the processing time: if several listeners run in parallel, their execution time is summed as if they were running sequentially, thus you can have a measured time which is superior to the physical time spent. If you want to measure the physical time spent in the execution of parallel runs, you should use another way.

**Author** Matthieu Vergne

## Methods

### get

public Long **get**()

**Returns** the time spent in the wrapped `MeasureListener`s

### reset

public void **reset**()

This method reset the time measured to zero. Notice that `MeasureListener`s which are still running will be affected consequently: their execution time will be measured from the reset time, not from their own starting time.

### wrapListener

public <Value> *MeasureListener*<Value> **wrapListener**(*MeasureListener*<Value> *wrapped*)

This method wrap a `MeasureListener` (the wrapped) into another one (the wrapper). Any notification made via the wrapper will allow to measure how much time has been spent by the wrapped to treat this notification. The wrapped listener is not changed, thus it can be reused in other `PushMeasure`s that we don't want to consider. If a wrapper has already been made for the given wrapped, it will be returned and no new one will be instantiated (weak references are used to not keep in memory the unused wrappers).

**Parameters**

- **wrapped** – the `MeasureListener` to wrap

**Returns** the `MeasureListener` wrapper

### wrapManager

public <Value> *MeasureManager* **wrapManager**(*MeasureManager* *wrapped*, Object *measureKey*)

This method wrap a `MeasureManager` (the wrapped) into another one (the wrapper) which provides the same measures, excepted that any `PushMeasure` returned by the wrapper will be automatically wrapped via `wrapMeasure(PushMeasure)`. This allows to ensure that any `MeasureListener` registered to the `PushMeasure`s provided by the wrapper will be considered, independently of who registers it or when it is registered. You can also provide an additional key to add this `ListenerTimeMeasure` to the wrapper. The wrapped manager is not changed, thus it can be reused to register `MeasureListener`s that we don't want to consider.

**Parameters**

- **wrapped** – the `MeasureManager` to wrap
- **measureKey** – the key that the wrapper should use for this `ListenerTimeMeasure`, `null` if it should not use it

**Returns** the `MeasureManager` wrapper

#### wrapMeasure

public <Value> *PushMeasure*<Value> **wrapMeasure** (*PushMeasure*<Value> *wrapped*)

This method wrap a `PushMeasure` (the wrapped) into another one (the wrapper). Any `MeasureListener` registered to the wrapper will be automatically wrapped via `wrapListener(MeasureListener)`. This allows to ensure that any `MeasureListener` registered will be considered, independently of who registers it or when it is registered. The wrapped measure is not changed, thus it can be reused to register `MeasureListener`s that we don't want to consider. If a wrapper has already been made for the given wrapped, it will be returned and no new one will be instantiated (weak references are used to not keep in memory the unused wrappers).

**Parameters**

- **wrapped** – the `PushMeasure` to wrap

**Returns** the `PushMeasure` wrapper

## 2.46.10 ListenerTimeMeasureTest

public class **ListenerTimeMeasureTest**

### Methods

#### testAdditionalKeyForWrappedManagerRejectAlreadyUsedKeys

public void **testAdditionalKeyForWrappedManagerRejectAlreadyUsedKeys** ()

#### testAdditionalKeyForWrappedManagerReturnCurrentMeasure

public void **testAdditionalKeyForWrappedManagerReturnCurrentMeasure** ()

#### testAdditionalKeyProvidedByManager

public void **testAdditionalKeyProvidedByManager** ()

#### testCountTimeInListeners

public void **testCountTimeInListeners** ()

#### testCountTimeInManager

public void **testCountTimeInManager** ()

#### testCountTimeInMeasures

public void **testCountTimeInMeasures** ()

#### testExceptionOnNullListener

public void **testExceptionOnNullListener**()

#### testExceptionOnNullManager

public void **testExceptionOnNullManager**()

#### testExceptionOnNullMeasure

public void **testExceptionOnNullMeasure**()

#### testFakeListener

public void **testFakeListener**()

#### testForgetListenerWrapperIfNotUsedAnymore

public void **testForgetListenerWrapperIfNotUsedAnymore**()

#### testForgetMeasureWrapperIfNotUsedAnymore

public void **testForgetMeasureWrapperIfNotUsedAnymore**()

#### testResetToCurrentTimeWhenListenerIsRunning

public void **testResetToCurrentTimeWhenListenerIsRunning**()

#### testResetToZeroWhenNoListenerIsRunning

public void **testResetToZeroWhenNoListenerIsRunning**()

#### testReturnSameWrapperForSameListener

public void **testReturnSameWrapperForSameListener**()

#### testReturnSameWrapperForSameMeasure

public void **testReturnSameWrapperForSameMeasure**()

#### testSameNameAndDescriptionThanOriginalMeasure

public void **testSameNameAndDescriptionThanOriginalMeasure**()

### 2.46.11 MeasureFactory

public class **MeasureFactory**

The *MeasureFactory* provides some useful methods to build specific *Measure*s.

**Author** Matthieu Vergne

#### Methods

##### createPullFromPush

public <Value> *PullMeasure*<Value> **createPullFromPush**(*PushMeasure*<Value> *push*, Value *initialValue*)

Create a *PullMeasure* to backup the last `Value` of a *PushMeasure*. When the *PushMeasure* send a notification with a given `Value`, this `Value` is stored into a variable so that it can be retrieved at any time through the method *PullMeasure.get()*.

**Parameters**

- **push** – a *PushMeasure* to backup
- **initialValue** – the `Value` to return before the next notification of the *PushMeasure* is sent

**Returns** a *PullMeasure* allowing to retrieve the last value sent by the *PushMeasure*, or the initial value if it did not send any

##### createPullsFromFields

public Map<String, *PullMeasure*<?>> **createPullsFromFields**(Object *object*)

Create *PullMeasure*s based on the fields available from an instance, whatever it is. The `Class` of the instance is analyzed to retrieve its public fields and a *PullMeasure* is built for each of them. The name of the field is further exploited to identify the measure, such that the map returned use the name of the field as a key which maps to the *PullMeasure* built from this field. The *PullMeasure* itself is named by using the name of the field.

**Parameters**

- **object** – the `Object` to cover

**Returns** the `Map` which contains the names of the getter methods and the corresponding *PullMeasure* built from them

##### createPullsFromGetters

public Map<String, *PullMeasure*<?>> **createPullsFromGetters**(Object *object*)

Create *PullMeasure*s based on the getters available from an instance, whatever it is. The `Class` of the instance is analyzed to retrieve its public methods and a *PullMeasure* is built for each method which use a getter-like signature. The name of the method is further exploited to identify the measure, such that the map returned use the name of the method (without "get") as a key which maps to the *PullMeasure* built from this method. The *PullMeasure* itself is named by using the name of the method.

**Parameters**

- **object** – the `Object` to cover

**Returns** the Map which contains the names of the getter methods and the corresponding *PullMeasure* built from them

#### createPushFromPull

public <Value> *PushMeasure*<Value> **createPushFromPull**(*PullMeasure*<Value> *pull*, long *period*)

Create a *PushMeasure* which checks at regular intervals the value of a *PullMeasure*. If the value have changed since the last check (or since the creation of the *PushMeasure*), a notification will be generated by the *PushMeasure* with the new `Value`. Notice that if the period is two small, the checking process could have a significant impact on performances, because a Thread is run in parallel to check regularly the `Value` modifications. If the period is too big, you could miss relevant notifications, especially if the *PullMeasure* change to a new `Value` and change back to its previous `Value` between two consecutive checks. In such a case, no notification will be sent because the `Value` during the two checks is equal.

**Parameters**

- **pull** – the *PullMeasure* to cover
- **period** – the number of milliseconds between each check

**Returns** a *PushMeasure* which will notify any change occurred on the *PullMeasure* at the given frequency

### 2.46.12 MeasureFactoryTest

public class **MeasureFactoryTest**

#### Methods

#### testCreatePullFromPush

public void **testCreatePullFromPush**()

#### testCreatePullsFromFieldsRetrieveAllInheritedPublicFields

public void **testCreatePullsFromFieldsRetrieveAllInheritedPublicFields**()

#### testCreatePullsFromFieldsRetrieveAllInstantiatedPublicFields

public void **testCreatePullsFromFieldsRetrieveAllInstantiatedPublicFields**()

#### testCreatePullsFromFieldsRetrieveNoInheritedProtectedNorPrivateField

public void **testCreatePullsFromFieldsRetrieveNoInheritedProtectedNorPrivateField**()

#### testCreatePullsFromFieldsRetrieveNoInstantiatedProtectedNorPrivateField

public void **testCreatePullsFromFieldsRetrieveNoInstantiatedProtectedNorPrivateField**()

#### testCreatePullsFromFieldsRetrieveNothingFromEmptyObject

public void **testCreatePullsFromFieldsRetrieveNothingFromEmptyObject**()

#### testCreatePullsFromGettersRetrieveAllInheritedPublicGetters

public void **testCreatePullsFromGettersRetrieveAllInheritedPublicGetters**()

#### testCreatePullsFromGettersRetrieveAllInstantiatedPublicGetters

public void **testCreatePullsFromGettersRetrieveAllInstantiatedPublicGetters**()

#### testCreatePullsFromGettersRetrieveNoInheritedProtectedNorPrivateGetter

public void **testCreatePullsFromGettersRetrieveNoInheritedProtectedNorPrivateGetter**()

#### testCreatePullsFromGettersRetrieveNoInstantiatedProtectedNorPrivateGetter

public void **testCreatePullsFromGettersRetrieveNoInstantiatedProtectedNorPrivateGetter**()

#### testCreatePullsFromGettersRetrieveNothingFromEmptyObject

public void **testCreatePullsFromGettersRetrieveNothingFromEmptyObject**()

#### testCreatePushFromPullNotifiesOnlyWhenValueChanged

public void **testCreatePushFromPullNotifiesOnlyWhenValueChanged**()

#### testCreatePushFromPullNotifiesWithTheCorrectFrequency

public void **testCreatePushFromPullNotifiesWithTheCorrectFrequency**()

#### testCreatePushFromPullStopNotificationsWhenPullDestroyed

public void **testCreatePushFromPullStopNotificationsWhenPullDestroyed**()

#### testCreatePushFromPullStopNotificationsWhenPushDestroyed

public void **testCreatePushFromPullStopNotificationsWhenPushDestroyed**()

### 2.46.13 PullPushMeasure

public class **PullPushMeasure**<Value> implements *PullMeasure*<Value>, *PushMeasure*<Value>

A `PullPushMeasure` aims at providing both the `PushMeasure` and `PullMeasure` abilities into a single `Measure`. One could simply build a brand new `Measure` by calling `PullPushMeasure(String, String)`, but in the case where some existing measures are available, he can wrap them into a `PullPushMeasure` by calling `PullPushMeasure(PushMeasure,Object)` or other constructors taking a `Measure` as argument.

**Author** Matthieu Vergne

**Parameters**

- **<Value>** –

#### Constructors

#### PullPushMeasure

public **PullPushMeasure**(*PullMeasure*<Value> *pull*, *PushMeasure*<Value> *push*, *DescribedEntity reference*)

Create a `PullPushMeasure` which wraps both a `PullMeasure` and a `PushMeasure`. The assumption is that both `Measure`s already represent the same `Measure` (i.e. the same `Value`) but were implemented separately. Instantiating a `PullPushMeasure` this way allows to merge them easily without creating a completely new measure. Don't use this constructor to merge two different `Measure`s. The last parameter is generally used to specify which of the two `Measure`s should be used for `getName()` and `getDescription()`, but you can also provide a completely new instance to change them.

**Parameters**

- **pull** – the `PullMeasure` to wrap
- **push** – the `PushMeasure` to wrap
- **reference** – the reference to use for the name and the description of this `PullPushMeasure`

#### PullPushMeasure

public **PullPushMeasure**(*PullMeasure*<Value> *pull*, *PushMeasure*<Value> *push*, String *name*, String *description*)

Equivalent to `PullPushMeasure(PullMeasure,PushMeasure,DescribedEntity)` but the reference parameter is replaced by the specific name and description that you want to provide. This is a shortcut to the creation of the `DescribedEntity` instance followed by the call of the reference-based method.

**Parameters**

- **pull** – the `PullMeasure` to wrap
- **push** – the `PushMeasure` to wrap
- **name** – the name of the `PullPushMeasure`
- **description** – the description of the `PullPushMeasure`

#### PullPushMeasure

public **PullPushMeasure** (*PushMeasure*<Value> *push*, Value *initialValue*)

Create a `PullPushMeasure` which wraps a `PushMeasure`. The `PullMeasure` ability corresponds the storage of the `Value` pushed by the `PushMeasure` in order to retrieve it on demand through `PullMeasure.get()`. The name and the description of the `PullPushMeasure` are the ones provided by the wrapped `PushMeasure`.

**Parameters**

- **push** – the `PushMeasure` to wraps
- **initialValue** – the `Value` to return before the next notification of the `PushMeasure`

#### PullPushMeasure

public **PullPushMeasure** (String *name*, String *description*)

Create a `PullPushMeasure` from scratch.

**Parameters**

- **name** – the name of the `PullPushMeasure`
- **description** – the description of the `PullPushMeasure`

### Methods

#### get

public Value **get** ()

#### getDescription

public String **getDescription** ()

#### getName

public String **getName** ()

#### register

public void **register** (*MeasureListener*<Value> *listener*)

#### unregister

public void **unregister** (*MeasureListener*<Value> *listener*)

### 2.46.14 SimpleMeasure

public class **SimpleMeasure**<Value> extends *SimpleDescribedEntity* implements *Measure*<Value>

*SimpleMeasure* is a basic implementation of *Measure*. It provides a basic support for the most generic properties required by this interface.

**Author** Matthieu Vergne

**Parameters**

- **<Value>** –

#### Constructors

##### SimpleMeasure

public **SimpleMeasure**(String *name*, String *description*)

Create a *SimpleMeasure* with a given name and a given description.

**Parameters**

- **name** – the name of the *Measure*
- **description** – the description of the *Measure*

##### SimpleMeasure

public **SimpleMeasure**(String *name*)

Create a *SimpleMeasure* with a given name and a `null` description.

**Parameters**

- **name** – the name of the *Measure*

##### SimpleMeasure

public **SimpleMeasure**()

Create a *SimpleMeasure* with the class name as its name and a `null` description.

### 2.46.15 SimpleMeasureManager

public class **SimpleMeasureManager** implements *MeasureManager*

This *SimpleMeasureManager* provides a basic implementation to manage a collection of *Measure*s. One can use the setXxxMeasure() methods to configure the *MeasureManager* with the finest granularity, or exploit the centralized *setMeasure(Object,Measure)* to register a *Measure* depending on the interfaces it implements, or even use the massive *setAllMeasures(Map)* to register a set of *Measure*s at once. The corresponding removeXxx methods are also available for each case. However, the only way to access a *Measure* is through the finest granularity with *getPullMeasure(Object)* and *getPushMeasure(Object)*.

**Author** Matthieu Vergne

### Methods

#### getMeasureKeys

public Collection<Object> **getMeasureKeys**()
Provides the keys of all the *Measure*s which are supported by this *SimpleMeasureManager*. If a key is provided, then at least one version is available through *getPullMeasure(Object)* or *getPushMeasure(Object)*.

#### getPullMeasure

public <T> *PullMeasure*<T> **getPullMeasure**(Object *key*)

#### getPushMeasure

public <T> *PushMeasure*<T> **getPushMeasure**(Object *key*)

#### removeAllMeasures

public void **removeAllMeasures**(Iterable<? extends Object> *keys*)
Massive equivalent to *removeMeasure(Object)*.

**Parameters**

- **keys** – the keys of the *Measure*s to remove

#### removeMeasure

public void **removeMeasure**(Object *key*)
This method removes an entire *Measure*, meaning that if both a *PullMeasure* and a *PushMeasure* are registered for this key, then both are removed.

**Parameters**

- **key** – the key of the *Measure* to remove

#### removePullMeasure

public void **removePullMeasure**(Object *key*)

**Parameters**

- **key** – the key of the *PullMeasure* to remove

#### removePushMeasure

public void **removePushMeasure**(Object *key*)

**Parameters**

- **key** – the key of the *PushMeasure* to remove

#### setAllMeasures

public void **setAllMeasures**(Map<? extends Object, ? extends *Measure*<?>> *measures*)

Massive equivalent of `setMeasure(Object,Measure)`.

**Parameters**

- **measures** – the `Measure`s to register with their corresponding keys

#### setMeasure

public void **setMeasure**(Object *key*, *Measure*<?> *measure*)

This method call `setPullMeasure(Object,PullMeasure)` or `setPushMeasure(Object, PushMeasure)` depending on the interfaces implemented by the `Measure` given in argument. If both interfaces are implemented, both methods are called, allowing to register all the aspects of the `Measure` in one call.

**Parameters**

- **key** – the key of the `Measure`
- **measure** – the `Measure` to register

#### setPullMeasure

public void **setPullMeasure**(Object *key*, *PullMeasure*<?> *measure*)

**Parameters**

- **key** – the key of the `Measure`
- **measure** – the `PullMeasure` to register

#### setPushMeasure

public void **setPushMeasure**(Object *key*, *PushMeasure*<?> *measure*)

**Parameters**

- **key** – the key of the `Measure`
- **measure** – the `PushMeasure` to register

### 2.46.16 SimpleMeasureManagerTest

public class **SimpleMeasureManagerTest**

#### Methods

#### testAddMeasureAddKey

public void **testAddMeasureAddKey**()

#### testAddMultipleMeasures

public void **testAddMultipleMeasures**()

#### testRemoveBothAtOnce

public void **testRemoveBothAtOnce**()

#### testRemoveBothMeasuresRemoveKey

public void **testRemoveBothMeasuresRemoveKey**()

#### testRemoveMultipleMeasures

public void **testRemoveMultipleMeasures**()

#### testSetGetPullMeasure

public void **testSetGetPullMeasure**()

#### testSetGetPushMeasure

public void **testSetGetPushMeasure**()

#### testSetMeasureGetBoth

public void **testSetMeasureGetBoth**()

#### testStartEmpty

public void **testStartEmpty**()

### 2.46.17 SimplePullMeasure

public abstract class **SimplePullMeasure**<Value> extends *SimpleMeasure*<Value> implements *PullMeasure*<Value>

`SimplePullMeasure` is a basic implementation of `PullMeasure`. As a `PullMeasure`, it is intended to be used by external entities through its `get()` method. This method must be implemented by the algorithm to specify how the value can be retrieved.

**Author** Matthieu Vergne

**Parameters**

- **<Value>** –

#### Constructors

##### SimplePullMeasure

public **SimplePullMeasure** (String *name*, String *description*)
Create a *SimplePullMeasure* with a given name and a given description.

**Parameters**

- **name** – the name of the *Measure*
- **description** – the description of the *Measure*

##### SimplePullMeasure

public **SimplePullMeasure** (String *name*)
Create a *SimplePullMeasure* with a given name and a `null` description.

**Parameters**

- **name** – the name of the *Measure*

##### SimplePullMeasure

public **SimplePullMeasure** ()
Create a *SimplePullMeasure* with the class name as its name and a `null` description.

### 2.46.18 SimplePushMeasure

public class **SimplePushMeasure**<Value> extends *SimpleMeasure*<Value> implements *PushMeasure*<Value>
*SimplePushMeasure* is a basic implementation of *PushMeasure*. As a *PushMeasure*, it is intended to be fed by the algorithm while external entities should use *register(MeasureListener)* to be notified in real time. For the algorithm to feed it, it should provide a solution and its value to *push(Object,Object)*, leading to the notification of the registered observers.

**Author** Matthieu Vergne

**Parameters**

- **<Value>** –

#### Constructors

##### SimplePushMeasure

public **SimplePushMeasure** (String *name*, String *description*)
Create a *SimplePushMeasure* with a given name and a given description.

**Parameters**

- **name** – the name of the *Measure*
- **description** – the description of the *Measure*

#### SimplePushMeasure

public **SimplePushMeasure**(String *name*)

Create a *SimplePushMeasure* with a given name and a `null` description.

**Parameters**

- **name** – the name of the *Measure*

#### SimplePushMeasure

public **SimplePushMeasure**()

Create a *SimplePushMeasure* with the class name as its name and a `null` description.

### Methods

#### push

public void **push**(Value *value*)

Notify the observers which has registered a *MeasureListener* through *register(MeasureListener)* about a value.

**Parameters**

- **value** – the value to send to the observers

#### register

public void **register**(*MeasureListener*<Value> *listener*)

#### unregister

public void **unregister**(*MeasureListener*<Value> *listener*)

## 2.46.19 SimplePushMeasureTest

public class **SimplePushMeasureTest**

### Methods

#### testNotNotifiedWhenUnregistered

public void **testNotNotifiedWhenUnregistered**()

#### testNotifiedWhenRegistered

public void **testNotifiedWhenRegistered**()

# 2.47 org.uma.jmetal.operator

## 2.47.1 CrossoverOperator

public interface **CrossoverOperator**<Source> extends *Operator*<List<Source>, List<Source>>

Interface representing crossover operators. They will receive a list of solutions and return another list of solutions

**Author** Antonio J. Nebro

**Parameters**

- **<Source>** – The class of the solutions

### Methods

#### getNumberOfGeneratedChildren

int **getNumberOfGeneratedChildren**()

#### getNumberOfRequiredParents

int **getNumberOfRequiredParents**()

## 2.47.2 LocalSearchOperator

public interface **LocalSearchOperator**<Source> extends *Operator*<Source, Source>

Interface representing a local search operator Created by cbarba on 5/3/15.

### Methods

#### getEvaluations

int **getEvaluations**()

#### getNumberOfImprovements

int **getNumberOfImprovements**()

#### getNumberOfNonComparableSolutions

int **getNumberOfNonComparableSolutions**()

## 2.47.3 MutationOperator

public interface **MutationOperator**<Source> extends *Operator*<Source, Source>

Interface representing mutation operators

**Author** Antonio J. Nebro

**Parameters**

- **<Source>** – The solution class of the solution to be mutated

### 2.47.4 Operator

public interface **Operator**<Source, Result> extends Serializable

Interface representing an operator

**Author** Antonio J. Nebro

**Parameters**

- **<Source>** – Source Class of the object to be operated with
- **<Result>** – Result Class of the result obtained after applying the operator

#### Methods

#### execute

Result **execute** (Source *source*)

**Parameters**

- **source** – The data to process

### 2.47.5 SelectionOperator

public interface **SelectionOperator**<Source, Result> extends *Operator*<Source, Result>

Interface representing selection operators

**Author** Antonio J. Nebro

**Parameters**

- **<Source>** – Class of the source object (typically, a list of solutions)
- **<Result>** – Class of the result of applying the operator

## 2.48 org.uma.jmetal.operator.impl.crossover

### 2.48.1 BLXAlphaCrossover

public class **BLXAlphaCrossover** implements *CrossoverOperator*<*DoubleSolution*>

This class allows to apply a BLX-alpha crossover operator to two parent solutions.

**Author** Antonio J. Nebro

## Constructors

### BLXAlphaCrossover

public **BLXAlphaCrossover**(double *crossoverProbability*)
Constructor

### BLXAlphaCrossover

public **BLXAlphaCrossover**(double *crossoverProbability*, double *alpha*)
Constructor

### BLXAlphaCrossover

public **BLXAlphaCrossover**(double *crossoverProbability*, double *alpha*, *RepairDoubleSolution* *solutionRepair*)
Constructor

### BLXAlphaCrossover

public **BLXAlphaCrossover**(double *crossoverProbability*, double *alpha*, *RepairDoubleSolution* *solutionRepair*, *RandomGenerator*<Double> *randomGenerator*)
Constructor

## Methods

### doCrossover

public List<*DoubleSolution*> **doCrossover**(double *probability*, *DoubleSolution* *parent1*, *DoubleSolution* *parent2*)
doCrossover method

### execute

public List<*DoubleSolution*> **execute**(List<*DoubleSolution*> *solutions*)
Execute() method

### getAlpha

public double **getAlpha**()

### getCrossoverProbability

public double **getCrossoverProbability**()

#### getNumberOfGeneratedChildren

public int **getNumberOfGeneratedChildren**()

#### getNumberOfRequiredParents

public int **getNumberOfRequiredParents**()

#### setAlpha

public void **setAlpha**(double *alpha*)

#### setCrossoverProbability

public void **setCrossoverProbability**(double *crossoverProbability*)

## 2.48.2 BLXAlphaCrossoverTest

public class **BLXAlphaCrossoverTest**

Note: this class does check that the BLX-aplha crossover operator does not return invalid values, but not that it works properly (@see BLXAlphaCrossoverWorkingTest)

**Author** Antonio J. Nebro

### Methods

#### shouldConstructorAssignTheCorrectDistributionIndex

public void **shouldConstructorAssignTheCorrectDistributionIndex**()

#### shouldConstructorAssignTheCorrectProbabilityValue

public void **shouldConstructorAssignTheCorrectProbabilityValue**()

#### shouldConstructorFailWhenPassedANegativeAlphaValue

public void **shouldConstructorFailWhenPassedANegativeAlphaValue**()

#### shouldConstructorFailWhenPassedANegativeProbabilityValue

public void **shouldConstructorFailWhenPassedANegativeProbabilityValue**()

#### shouldCrossingTwoDoubleVariableSolutionsReturnValidSolutions

public void **shouldCrossingTwoDoubleVariableSolutionsReturnValidSolutions**()

#### shouldCrossingTwoSingleVariableSolutionsReturnTheSameSolutionsIfNotCrossoverIsApplied

public void **shouldCrossingTwoSingleVariableSolutionsReturnTheSameSolutionsIfNotCrossoverIsAppli**

#### shouldCrossingTwoSingleVariableSolutionsReturnTheSameSolutionsIfProbabilityIsZero

public void **shouldCrossingTwoSingleVariableSolutionsReturnTheSameSolutionsIfProbabilityIsZero**()

#### shouldCrossingTwoSingleVariableSolutionsReturnValidSolutions

public void **shouldCrossingTwoSingleVariableSolutionsReturnValidSolutions**()

#### shouldCrossingTwoSingleVariableSolutionsWithSimilarValueReturnTheSameVariables

public void **shouldCrossingTwoSingleVariableSolutionsWithSimilarValueReturnTheSameVariables**()

#### shouldExecuteWithInvalidSolutionListSizeThrowAnException

public void **shouldExecuteWithInvalidSolutionListSizeThrowAnException**()

#### shouldExecuteWithNullParameterThrowAnException

public void **shouldExecuteWithNullParameterThrowAnException**()

#### shouldGetAlphaReturnTheRightValue

public void **shouldGetAlphaReturnTheRightValue**()

#### shouldGetProbabilityReturnTheRightValue

public void **shouldGetProbabilityReturnTheRightValue**()

#### shouldJMetalRandomGeneratorNotBeUsedWhenCustomRandomGeneratorProvided

public void **shouldJMetalRandomGeneratorNotBeUsedWhenCustomRandomGeneratorProvided**()

### 2.48.3 DifferentialEvolutionCrossover

public class **DifferentialEvolutionCrossover** implements *CrossoverOperator*<*DoubleSolution*>
Differential evolution crossover operator

**Author** Antonio J. Nebro Comments: - The operator receives two parameters: the current individual and an array of three parent individuals - The best and rand variants depends on the third parent, according whether it represents the current of the "best" individual or a random one. The implementation of both variants are the same, due to that the parent selection is external to the crossover operator. - Implemented variants: - rand/1/bin (best/1/bin) - rand/1/exp (best/1/exp) - current-to-rand/1 (current-to-best/1) - current-to-rand/1/bin (current-to-best/1/bin) - current-to-rand/1/exp (current-to-best/1/exp)

### Constructors

#### DifferentialEvolutionCrossover

public **DifferentialEvolutionCrossover**()
Constructor

#### DifferentialEvolutionCrossover

public **DifferentialEvolutionCrossover**(double *cr*, double *f*, String *variant*)
Constructor

**Parameters**

- **cr** –
- **f** –
- **variant** –

#### DifferentialEvolutionCrossover

public **DifferentialEvolutionCrossover**(double *cr*, double *f*, String *variant*, *RandomGenerator*<Double> *randomGenerator*)
Constructor

**Parameters**

- **cr** –
- **f** –
- **variant** –
- **jRandomGenerator** –
- **crRandomGenerator** –

#### DifferentialEvolutionCrossover

public **DifferentialEvolutionCrossover**(double *cr*, double *f*, String *variant*, *BoundedRandomGenerator*<Integer> *jRandomGenerator*, *BoundedRandomGenerator*<Double> *crRandomGenerator*)
Constructor

**Parameters**

- **cr** –
- **f** –
- **variant** –
- **jRandomGenerator** –

- **crRandomGenerator** –

### DifferentialEvolutionCrossover

public **DifferentialEvolutionCrossover** (double *cr*, double *f*, double *k*, String *variant*)
Constructor

## Methods

### execute

public List<*DoubleSolution*> **execute** (List<*DoubleSolution*> *parentSolutions*)
Execute() method

### getCr

public double **getCr** ()

### getF

public double **getF** ()

### getK

public double **getK** ()

### getNumberOfGeneratedChildren

public int **getNumberOfGeneratedChildren** ()

### getNumberOfRequiredParents

public int **getNumberOfRequiredParents** ()

### getVariant

public String **getVariant** ()

### setCr

public void **setCr** (double *cr*)

#### setCurrentSolution

public void **setCurrentSolution** (*DoubleSolution current*)

#### setF

public void **setF** (double *f*)

#### setK

public void **setK** (double *k*)

### 2.48.4 DifferentialEvolutionCrossoverTest

public class **DifferentialEvolutionCrossoverTest**

#### Methods

#### shouldJMetalRandomGeneratorNotBeUsedWhenCustomRandomGeneratorProvided

public void **shouldJMetalRandomGeneratorNotBeUsedWhenCustomRandomGeneratorProvided** ()

### 2.48.5 HUXCrossover

public class **HUXCrossover** implements *CrossoverOperator*<*BinarySolution*>

This class allows to apply a HUX crossover operator using two parent solutions. NOTE: the operator is applied to the first encoding.variable of the solutions, and the type of the solutions must be Binary

**Author** Antonio J. Nebro, Juan J. Durillo

#### Constructors

#### HUXCrossover

public **HUXCrossover** (double *crossoverProbability*)

Constructor

#### HUXCrossover

public **HUXCrossover** (double *crossoverProbability*, *RandomGenerator*<Double> *randomGenerator*)

Constructor

#### Methods

##### doCrossover

public List<*BinarySolution*> **doCrossover** (double *probability*, *BinarySolution parent1*, *BinarySolution parent2*)

Perform the crossover operation

**Parameters**

- **probability** – Crossover setProbability
- **parent1** – The first parent
- **parent2** – The second parent

**Throws**

- *org.uma.jmetal.util.JMetalException* –

**Returns** An array containing the two offspring

##### execute

public List<*BinarySolution*> **execute** (List<*BinarySolution*> *parents*)

Execute() method

##### getCrossoverProbability

public double **getCrossoverProbability** ()

##### getNumberOfGeneratedChildren

public int **getNumberOfGeneratedChildren** ()

##### getNumberOfRequiredParents

public int **getNumberOfRequiredParents** ()

##### setCrossoverProbability

public void **setCrossoverProbability** (double *crossoverProbability*)

### 2.48.6 HUXCrossoverTest

public class **HUXCrossoverTest**

#### Methods

##### testJMetalRandomGeneratorNotUsedWhenCustomRandomGeneratorProvided

public void **testJMetalRandomGeneratorNotUsedWhenCustomRandomGeneratorProvided**()

### 2.48.7 IntegerSBXCrossover

public class **IntegerSBXCrossover** implements *CrossoverOperator*<*IntegerSolution*>
This class allows to apply a SBX crossover operator using two parent solutions (Integer encoding)

**Author** Antonio J. Nebro

#### Constructors

##### IntegerSBXCrossover

public **IntegerSBXCrossover**(double *crossoverProbability*, double *distributionIndex*)
Constructor

##### IntegerSBXCrossover

public **IntegerSBXCrossover**(double *crossoverProbability*, double *distributionIndex*, *RandomGenerator*<Double> *randomGenerator*)
Constructor

#### Methods

##### doCrossover

public List<*IntegerSolution*> **doCrossover**(double *probability*, *IntegerSolution* *parent1*, *IntegerSolution* *parent2*)
doCrossover method

##### execute

public List<*IntegerSolution*> **execute**(List<*IntegerSolution*> *solutions*)
Execute() method

##### getCrossoverProbability

public double **getCrossoverProbability**()

##### getDistributionIndex

public double **getDistributionIndex**()

#### getNumberOfGeneratedChildren

public int **getNumberOfGeneratedChildren** ()

#### getNumberOfRequiredParents

public int **getNumberOfRequiredParents** ()

#### setCrossoverProbability

public void **setCrossoverProbability** (double *crossoverProbability*)

#### setDistributionIndex

public void **setDistributionIndex** (double *distributionIndex*)

## 2.48.8 IntegerSBXCrossoverTest

public class **IntegerSBXCrossoverTest**

### Methods

#### testJMetalRandomGeneratorNotUsedWhenCustomRandomGeneratorProvided

public void **testJMetalRandomGeneratorNotUsedWhenCustomRandomGeneratorProvided** ()

## 2.48.9 NPointCrossover

public class **NPointCrossover**<T> implements *CrossoverOperator*<*Solution*<T>>
Created by FlapKap on 23-03-2017.

### Constructors

#### NPointCrossover

public **NPointCrossover** (double *probability*, int *crossovers*)

#### NPointCrossover

public **NPointCrossover** (int *crossovers*)

#### Methods

##### execute

public List<*Solution*<T>> **execute** (List<*Solution*<T>> *s*)

##### getCrossoverProbability

public double **getCrossoverProbability** ()

##### getNumberOfGeneratedChildren

public int **getNumberOfGeneratedChildren** ()

##### getNumberOfRequiredParents

public int **getNumberOfRequiredParents** ()

### 2.48.10 NullCrossover

public class **NullCrossover**<S extends Solution<?>> implements *CrossoverOperator*<S>

This class defines a null crossover operator: the parent solutions are returned without any change. It can be useful when configuring a genetic algorithm and we want to use only mutation.

**Author** Antonio J. Nebro

#### Methods

##### execute

public List<S> **execute** (List<S> *source*)

Execute() method

##### getNumberOfGeneratedChildren

public int **getNumberOfGeneratedChildren** ()

##### getNumberOfRequiredParents

public int **getNumberOfRequiredParents** ()

### 2.48.11 NullCrossoverTest

public class **NullCrossoverTest**

Created by ajnebro on 10/6/15.

#### Methods

##### shouldExecuteReturnTwoDifferentObjectsWhichAreEquals

public void **shouldExecuteReturnTwoDifferentObjectsWhichAreEquals**()

### 2.48.12 PMXCrossover

public class **PMXCrossover** implements *CrossoverOperator*<*PermutationSolution*<Integer>>
This class allows to apply a PMX crossover operator using two parent solutions.

**Author** Antonio J. Nebro , Juan J. Durillo

#### Constructors

##### PMXCrossover

public **PMXCrossover**(double *crossoverProbability*)
Constructor

##### PMXCrossover

public **PMXCrossover**(double *crossoverProbability*, *RandomGenerator*<Double> *randomGenerator*)
Constructor

##### PMXCrossover

public **PMXCrossover**(double *crossoverProbability*, *RandomGenerator*<Double> *crossoverRandomGenerator*, *BoundedRandomGenerator*<Integer> *cuttingPointRandomGenerator*)
Constructor

#### Methods

##### doCrossover

public List<*PermutationSolution*<Integer>> **doCrossover**(double *probability*, List<*PermutationSolution*<Integer>> *parents*)
Perform the crossover operation

**Parameters**

- **probability** – Crossover probability
- **parents** – Parents

**Returns** An array containing the two offspring

#### execute

public List<*PermutationSolution*<Integer>> **execute**(List<*PermutationSolution*<Integer>> *parents*)
Executes the operation

**Parameters**

- **parents** – An object containing an array of two solutions

#### getCrossoverProbability

public double **getCrossoverProbability**()

#### getNumberOfGeneratedChildren

public int **getNumberOfGeneratedChildren**()

#### getNumberOfRequiredParents

public int **getNumberOfRequiredParents**()

#### setCrossoverProbability

public void **setCrossoverProbability**(double *crossoverProbability*)

### 2.48.13 PMXCrossoverTest

public class **PMXCrossoverTest**

#### Methods

#### shouldJMetalRandomGeneratorNotBeUsedWhenCustomRandomGeneratorProvided

public void **shouldJMetalRandomGeneratorNotBeUsedWhenCustomRandomGeneratorProvided**()

### 2.48.14 SBXCrossover

public class **SBXCrossover** implements *CrossoverOperator*<*DoubleSolution*>
This class allows to apply a SBX crossover operator using two parent solutions (Double encoding). A `RepairDoubleSolution` object is used to decide the strategy to apply when a value is out of range. The implementation is based on the NSGA-II code available in http://www.iitk.ac.in/kangal/codes.shtml

**Author** Antonio J. Nebro , Juan J. Durillo

## Constructors

### SBXCrossover

public **SBXCrossover** (double *crossoverProbability*, double *distributionIndex*)
Constructor

### SBXCrossover

public **SBXCrossover** (double *crossoverProbability*, double *distributionIndex*, *RandomGenerator*<Double> *randomGenerator*)
Constructor

### SBXCrossover

public **SBXCrossover** (double *crossoverProbability*, double *distributionIndex*, *RepairDoubleSolution* *solutionRepair*)
Constructor

### SBXCrossover

public **SBXCrossover** (double *crossoverProbability*, double *distributionIndex*, *RepairDoubleSolution* *solutionRepair*, *RandomGenerator*<Double> *randomGenerator*)
Constructor

## Methods

### doCrossover

public List<*DoubleSolution*> **doCrossover** (double *probability*, *DoubleSolution* *parent1*, *DoubleSolution* *parent2*)
doCrossover method

### execute

public List<*DoubleSolution*> **execute** (List<*DoubleSolution*> *solutions*)
Execute() method

### getCrossoverProbability

public double **getCrossoverProbability** ()

### getDistributionIndex

public double **getDistributionIndex** ()

#### getNumberOfGeneratedChildren

public int **getNumberOfGeneratedChildren**()

#### getNumberOfRequiredParents

public int **getNumberOfRequiredParents**()

#### setCrossoverProbability

public void **setCrossoverProbability**(double *probability*)

#### setDistributionIndex

public void **setDistributionIndex**(double *distributionIndex*)

### 2.48.15 SBXCrossoverTest

public class **SBXCrossoverTest**

Note: this class does check that the SBX crossover operator does not return invalid values, but not that it works properly (@see SBXCrossoverWorkingTest)

**Author** Antonio J. Nebro

#### Methods

#### shouldConstructorAssignTheCorrectDistributionIndex

public void **shouldConstructorAssignTheCorrectDistributionIndex**()

#### shouldConstructorAssignTheCorrectProbabilityValue

public void **shouldConstructorAssignTheCorrectProbabilityValue**()

#### shouldConstructorFailWhenPassedANegativeDistributionIndex

public void **shouldConstructorFailWhenPassedANegativeDistributionIndex**()

#### shouldConstructorFailWhenPassedANegativeProbabilityValue

public void **shouldConstructorFailWhenPassedANegativeProbabilityValue**()

#### shouldCrossingTheSecondVariableReturnTheOtherVariablesUnchangedInTheOffspringSolutions

public void **shouldCrossingTheSecondVariableReturnTheOtherVariablesUnchangedInTheOffspringSoluti**

#### shouldCrossingTwoDoubleVariableSolutionsReturnValidSolutions

public void **shouldCrossingTwoDoubleVariableSolutionsReturnValidSolutions**()

#### shouldCrossingTwoSingleVariableSolutionsReturnTheSameSolutionsIfNotCrossoverIsApplied

public void **shouldCrossingTwoSingleVariableSolutionsReturnTheSameSolutionsIfNotCrossoverIsAppli**

#### shouldCrossingTwoSingleVariableSolutionsReturnTheSameSolutionsIfProbabilityIsZero

public void **shouldCrossingTwoSingleVariableSolutionsReturnTheSameSolutionsIfProbabilityIsZero**(

#### shouldCrossingTwoSingleVariableSolutionsReturnValidSolutions

public void **shouldCrossingTwoSingleVariableSolutionsReturnValidSolutions**()

#### shouldCrossingTwoSingleVariableSolutionsWithSimilarValueReturnTheSameVariables

public void **shouldCrossingTwoSingleVariableSolutionsWithSimilarValueReturnTheSameVariables**()

#### shouldExecuteWithInvalidSolutionListSizeThrowAnException

public void **shouldExecuteWithInvalidSolutionListSizeThrowAnException**()

#### shouldExecuteWithNullParameterThrowAnException

public void **shouldExecuteWithNullParameterThrowAnException**()

#### shouldGetDistributionIndexReturnTheRightValue

public void **shouldGetDistributionIndexReturnTheRightValue**()

#### shouldGetProbabilityReturnTheRightValue

public void **shouldGetProbabilityReturnTheRightValue**()

#### shouldJMetalRandomGeneratorNotBeUsedWhenCustomRandomGeneratorProvided

public void **shouldJMetalRandomGeneratorNotBeUsedWhenCustomRandomGeneratorProvided**()

### 2.48.16 SinglePointCrossover

public class **SinglePointCrossover** implements *CrossoverOperator*<*BinarySolution*>

This class implements a single point crossover operator.

**Author** Antonio J. Nebro

#### Constructors

#### SinglePointCrossover

public **SinglePointCrossover**(double *crossoverProbability*)

Constructor

#### SinglePointCrossover

public **SinglePointCrossover**(double *crossoverProbability*, *RandomGenerator*<Double> *randomGenerator*)

Constructor

#### SinglePointCrossover

public **SinglePointCrossover**(double *crossoverProbability*, *RandomGenerator*<Double> *crossoverRandomGenerator*, *BoundedRandomGenerator*<Integer> *pointRandomGenerator*)

Constructor

#### Methods

#### doCrossover

public List<*BinarySolution*> **doCrossover**(double *probability*, *BinarySolution* *parent1*, *BinarySolution* *parent2*)

Perform the crossover operation.

**Parameters**

- **probability** – Crossover setProbability
- **parent1** – The first parent
- **parent2** – The second parent

**Returns** An array containing the two offspring

#### execute

public List<*BinarySolution*> **execute**(List<*BinarySolution*> *solutions*)

#### getCrossoverProbability

public double **getCrossoverProbability**()

#### getNumberOfGeneratedChildren

public int **getNumberOfGeneratedChildren**()

#### getNumberOfRequiredParents

public int **getNumberOfRequiredParents**()

#### setCrossoverProbability

public void **setCrossoverProbability**(double *crossoverProbability*)

## 2.48.17 SinglePointCrossoverTest

public class **SinglePointCrossoverTest**

### Methods

#### shouldConstructorAssignTheCorrectProbabilityValue

public void **shouldConstructorAssignTheCorrectProbabilityValue**()

#### shouldConstructorFailWhenPassedANegativeProbabilityValue

public void **shouldConstructorFailWhenPassedANegativeProbabilityValue**()

#### shouldCrossingTheBitInTheMiddleOfSecondVariableReturnTheCorrectCrossedSolutions

public void **shouldCrossingTheBitInTheMiddleOfSecondVariableReturnTheCorrectCrossedSolutions**()

#### shouldCrossingTheBitInTheMiddleOfTwoSingleVariableSolutionsReturnTheCorrectCrossedSolutions

public void **shouldCrossingTheBitInTheMiddleOfTwoSingleVariableSolutionsReturnTheCorrectCrossedS**

#### shouldCrossingTheFistBitOfSecondVariableReturnTheCorrectCrossedSolutions

public void **shouldCrossingTheFistBitOfSecondVariableReturnTheCorrectCrossedSolutions**()

#### shouldCrossingTheFistBitOfTwoSingleVariableSolutionsReturnTheCorrectCrossedSolutions

public void **shouldCrossingTheFistBitOfTwoSingleVariableSolutionsReturnTheCorrectCrossedSolutio**

#### shouldCrossingTheLastBitOfTwoSingleVariableSolutionsReturnTheCorrectCrossedSolutions

public void **shouldCrossingTheLastBitOfTwoSingleVariableSolutionsReturnTheCorrectCrossedSolutio**

#### shouldCrossingTwoVariableSolutionsReturnTheSameSolutionsIfNoBitsAreMutated

public void **shouldCrossingTwoVariableSolutionsReturnTheSameSolutionsIfNoBitsAreMutated**()

#### shouldExecuteFailIfTheListContainsMoreThanTwoSolutions

public void **shouldExecuteFailIfTheListContainsMoreThanTwoSolutions**()

#### shouldExecuteFailIfTheListContainsOnlyOneSolution

public void **shouldExecuteFailIfTheListContainsOnlyOneSolution**()

#### shouldExecuteWithNullParameterThrowAnException

public void **shouldExecuteWithNullParameterThrowAnException**()

#### shouldGetMutationProbabilityReturnTheRightValue

public void **shouldGetMutationProbabilityReturnTheRightValue**()

#### shouldJMetalRandomGeneratorNotBeUsedWhenCustomRandomGeneratorProvided

public void **shouldJMetalRandomGeneratorNotBeUsedWhenCustomRandomGeneratorProvided**()

## 2.48.18 TwoPointCrossover

public class **TwoPointCrossover**<T> implements *CrossoverOperator*<*Solution*<T>>
Created by FlapKap on 27-05-2017.

### Fields

#### operator

*NPointCrossover*<T> **operator**

### Constructors

#### TwoPointCrossover

public **TwoPointCrossover**(double *probability*)

#### Methods

##### execute

public List<*Solution*<T>> **execute** (List<*Solution*<T>> *solutions*)

##### getCrossoverProbability

public double **getCrossoverProbability** ()

##### getNumberOfGeneratedChildren

public int **getNumberOfGeneratedChildren** ()

##### getNumberOfRequiredParents

public int **getNumberOfRequiredParents** ()

## 2.49 org.uma.jmetal.operator.impl.localsearch

### 2.49.1 ArchiveMutationLocalSearch

public class **ArchiveMutationLocalSearch**<S extends Solution<?>> implements *LocalSearchOperator*<S>

This class implements a local search operator based in the use of a mutation operator. An archive is used to store the non-dominated solutions found during the search.

**Author** Antonio J. Nebro

#### Constructors

##### ArchiveMutationLocalSearch

public **ArchiveMutationLocalSearch** (int *improvementRounds*, *MutationOperator*<S> *mutationOperator*, *Archive*<S> *archive*, *Problem*<S> *problem*)

Constructor. Creates a new local search object.

**Parameters**

- **improvementRounds** – number of iterations
- **mutationOperator** – mutation operator
- **archive** – archive to store non-dominated solution
- **problem** – problem to resolve

#### Methods

##### execute

public S **execute** (S *solution*)

Executes the local search.

**Parameters**

- **solution** – The solution to improve

**Returns** The improved solution

##### getEvaluations

public int **getEvaluations** ()

Returns the number of evaluations

##### getNumberOfImprovements

public int **getNumberOfImprovements** ()

##### getNumberOfNonComparableSolutions

public int **getNumberOfNonComparableSolutions** ()

### 2.49.2 BasicLocalSearch

public class **BasicLocalSearch**<S extends Solution<?>> implements *LocalSearchOperator*<S>

This class implements a basic local search operator based in the use of a mutation operator.

**Author** Antonio J. Nebro

#### Constructors

##### BasicLocalSearch

public **BasicLocalSearch** (int *improvementRounds*, *MutationOperator*<S> *mutationOperator*, Comparator<S> *comparator*, *Problem*<S> *problem*)

Constructor. Creates a new local search object.

**Parameters**

- **improvementRounds** – number of iterations
- **mutationOperator** – mutation operator
- **comparator** – comparator to determine which solution is the best
- **problem** – problem to resolve

#### BasicLocalSearch

public **BasicLocalSearch** (int *improvementRounds*, *MutationOperator*<S> *mutationOperator*, Comparator<S> *comparator*, *Problem*<S> *problem*, *RandomGenerator*<Double> *randomGenerator*)

Constructor. Creates a new local search object.

**Parameters**

- **improvementRounds** – number of iterations
- **mutationOperator** – mutation operator
- **comparator** – comparator to determine which solution is the best
- **problem** – problem to resolve
- **randomGenerator** – the *RandomGenerator* to use when we must choose between equivalent solutions

#### Methods

#### execute

public S **execute** (S *solution*)

Executes the local search.

**Parameters**

- **solution** – The solution to improve

**Returns** An improved solution

#### getEvaluations

public int **getEvaluations** ()

Returns the number of evaluations

#### getNumberOfImprovements

public int **getNumberOfImprovements** ()

#### getNumberOfNonComparableSolutions

public int **getNumberOfNonComparableSolutions** ()

### 2.49.3 BasicLocalSearchTest

public class **BasicLocalSearchTest**

#### Methods

##### testJMetalRandomGeneratorNotUsedWhenCustomRandomGeneratorProvided

public void **testJMetalRandomGeneratorNotUsedWhenCustomRandomGeneratorProvided**()

## 2.50 org.uma.jmetal.operator.impl.mutation

### 2.50.1 BitFlipMutation

public class **BitFlipMutation** implements *MutationOperator*<*BinarySolution*>

**Author** Antonio J. Nebro

#### Constructors

##### BitFlipMutation

public **BitFlipMutation**(double *mutationProbability*)
Constructor

##### BitFlipMutation

public **BitFlipMutation**(double *mutationProbability*, *RandomGenerator*<Double> *randomGenerator*)
Constructor

#### Methods

##### doMutation

public void **doMutation**(double *probability*, *BinarySolution* *solution*)
Perform the mutation operation

**Parameters**

- **probability** – Mutation setProbability
- **solution** – The solution to mutate

##### execute

public *BinarySolution* **execute**(*BinarySolution* *solution*)
Execute() method

##### getMutationProbability

public double **getMutationProbability**()

#### setMutationProbability

public void **setMutationProbability** (double *mutationProbability*)

### 2.50.2 BitFlipMutationTest

public class **BitFlipMutationTest**

#### Methods

#### shouldConstructorAssignTheCorrectProbabilityValue

public void **shouldConstructorAssignTheCorrectProbabilityValue** ()

#### shouldConstructorFailWhenPassedANegativeProbabilityValue

public void **shouldConstructorFailWhenPassedANegativeProbabilityValue** ()

#### shouldExecuteWithNullParameterThrowAnException

public void **shouldExecuteWithNullParameterThrowAnException** ()

#### shouldGetMutationProbabilityReturnTheRightValue

public void **shouldGetMutationProbabilityReturnTheRightValue** ()

#### shouldJMetalRandomGeneratorNotBeUsedWhenCustomRandomGeneratorProvided

public void **shouldJMetalRandomGeneratorNotBeUsedWhenCustomRandomGeneratorProvided** ()

#### shouldMutateASingleVariableSolutionReturnTheSameSolutionIfNoBitsAreMutated

public void **shouldMutateASingleVariableSolutionReturnTheSameSolutionIfNoBitsAreMutated** ()

#### shouldMutateASingleVariableSolutionWhenASingleBitIsMutated

public void **shouldMutateASingleVariableSolutionWhenASingleBitIsMutated** ()

#### shouldMutateATwoVariableSolutionReturnTheSameSolutionIfNoBitsAreMutated

public void **shouldMutateATwoVariableSolutionReturnTheSameSolutionIfNoBitsAreMutated** ()

#### shouldMutateATwoVariableSolutionWhenTwoBitsAreMutated

public void **shouldMutateATwoVariableSolutionWhenTwoBitsAreMutated**()

### 2.50.3 CDGMutation

public class **CDGMutation** implements *MutationOperator*<*DoubleSolution*>

This class implements a polynomial mutation operator The implementation is based on the NSGA-II code available in http://www.iitk.ac.in/kangal/codes.shtml If the lower and upper bounds of a variable are the same, no mutation is carried out and the bound value is returned.

**Author** Feng Zhang

#### Constructors

#### CDGMutation

public **CDGMutation**()

Constructor

#### CDGMutation

public **CDGMutation**(*DoubleProblem* *problem*, double *delta*)

Constructor

#### CDGMutation

public **CDGMutation**(double *mutationProbability*, double *delta*)

Constructor

#### CDGMutation

public **CDGMutation**(double *mutationProbability*, double *delta*, *RepairDoubleSolution* *solutionRepair*)

Constructor

#### Methods

#### execute

public *DoubleSolution* **execute**(*DoubleSolution* *solution*)

Execute() method

#### getDelta

public double **getDelta**()

#### getMutationProbability

public double **getMutationProbability**()

#### setDelta

public void **setDelta**(double *delta*)

#### setMutationProbability

public void **setMutationProbability**(double *probability*)

### 2.50.4 IntegerPolynomialMutation

public class **IntegerPolynomialMutation** implements *MutationOperator*<*IntegerSolution*>

This class implements a polynomial mutation operator to be applied to Integer solutions If the lower and upper bounds of a variable are the same, no mutation is carried out and the bound value is returned. A *RepairDoubleSolution* object is used to decide the strategy to apply when a value is out of range.

**Author** Antonio J. Nebro

#### Constructors

#### IntegerPolynomialMutation

public **IntegerPolynomialMutation**()

Constructor

#### IntegerPolynomialMutation

public **IntegerPolynomialMutation**(*IntegerProblem* *problem*, double *distributionIndex*)

Constructor

#### IntegerPolynomialMutation

public **IntegerPolynomialMutation**(double *mutationProbability*, double *distributionIndex*)

Constructor

#### IntegerPolynomialMutation

public **IntegerPolynomialMutation**(double *mutationProbability*, double *distributionIndex*, *RepairDoubleSolution* *solutionRepair*)

Constructor

#### IntegerPolynomialMutation

public **IntegerPolynomialMutation** (double *mutationProbability*, double *distributionIndex*, *RepairDoubleSolution* *solutionRepair*, *RandomGenerator*<Double> *randomGenerator*)

Constructor

#### Methods

#### execute

public *IntegerSolution* **execute** (*IntegerSolution* *solution*)

Execute() method

#### getDistributionIndex

public double **getDistributionIndex** ()

#### getMutationProbability

public double **getMutationProbability** ()

#### setDistributionIndex

public void **setDistributionIndex** (double *distributionIndex*)

#### setMutationProbability

public void **setMutationProbability** (double *mutationProbability*)

### 2.50.5 IntegerPolynomialMutationTest

public class **IntegerPolynomialMutationTest**

#### Methods

#### shouldConstructorAssignTheCorrectDistributionIndex

public void **shouldConstructorAssignTheCorrectDistributionIndex** ()

#### shouldConstructorAssignTheCorrectProbabilityValue

public void **shouldConstructorAssignTheCorrectProbabilityValue** ()

### shouldConstructorFailWhenPassedANegativeDistributionIndex

public void **shouldConstructorFailWhenPassedANegativeDistributionIndex**()

### shouldConstructorFailWhenPassedANegativeProbabilityValue

public void **shouldConstructorFailWhenPassedANegativeProbabilityValue**()

### shouldConstructorWithProblemAndDistributionIndexParametersAssignTheCorrectValues

public void **shouldConstructorWithProblemAndDistributionIndexParametersAssignTheCorrectValues**()

### shouldConstructorWithoutParameterAssignTheDefaultValues

public void **shouldConstructorWithoutParameterAssignTheDefaultValues**()

### shouldExecuteWithNullParameterThrowAnException

public void **shouldExecuteWithNullParameterThrowAnException**()

### shouldGetDistributionIndexReturnTheRightValue

public void **shouldGetDistributionIndexReturnTheRightValue**()

### shouldGetMutationProbabilityReturnTheRightValue

public void **shouldGetMutationProbabilityReturnTheRightValue**()

### shouldJMetalRandomGeneratorNotBeUsedWhenCustomRandomGeneratorProvided

public void **shouldJMetalRandomGeneratorNotBeUsedWhenCustomRandomGeneratorProvided**()

### shouldMutateASingleVariableSolutionReturnAValidSolution

public void **shouldMutateASingleVariableSolutionReturnAValidSolution**()

### shouldMutateASingleVariableSolutionReturnAnotherValidSolution

public void **shouldMutateASingleVariableSolutionReturnAnotherValidSolution**()

### shouldMutateASingleVariableSolutionReturnTheSameSolutionIfItIsNotMutated

public void **shouldMutateASingleVariableSolutionReturnTheSameSolutionIfItIsNotMutated**()

#### shouldMutateASingleVariableSolutionReturnTheSameSolutionIfProbabilityIsZero

public void **shouldMutateASingleVariableSolutionReturnTheSameSolutionIfProbabilityIsZero**()

#### shouldMutateASingleVariableSolutionWithSameLowerAndUpperBoundsReturnTheBoundValue

public void **shouldMutateASingleVariableSolutionWithSameLowerAndUpperBoundsReturnTheBoundValue**()

### 2.50.6 NonUniformMutation

public class **NonUniformMutation** implements *MutationOperator*<*DoubleSolution*>

This class implements a non-uniform mutation operator.

**Author** Antonio J. Nebro , Juan J. Durillo

#### Constructors

#### NonUniformMutation

public **NonUniformMutation**(double *mutationProbability*, double *perturbation*, int *maxIterations*)

Constructor

#### NonUniformMutation

public **NonUniformMutation**(double *mutationProbability*, double *perturbation*, int *maxIterations*, *RandomGenerator*<Double> *randomGenenerator*)

Constructor

#### Methods

#### doMutation

public void **doMutation**(double *probability*, *DoubleSolution* *solution*)

Perform the mutation operation

**Parameters**

- **probability** – Mutation setProbability
- **solution** – The solution to mutate

#### execute

public *DoubleSolution* **execute**(*DoubleSolution* *solution*)

Execute() method

#### getCurrentIteration

public int **getCurrentIteration**()

#### getMaxIterations

public int **getMaxIterations** ()

#### getMutationProbability

public double **getMutationProbability** ()

#### getPerturbation

public double **getPerturbation** ()

#### setCurrentIteration

public void **setCurrentIteration** (int *currentIteration*)

#### setMaxIterations

public void **setMaxIterations** (int *maxIterations*)

#### setMutationProbability

public void **setMutationProbability** (double *mutationProbability*)

#### setPerturbation

public void **setPerturbation** (double *perturbation*)

## 2.50.7 NonUniformMutationTest

public class **NonUniformMutationTest**

### Methods

#### testJMetalRandomGeneratorNotUsedWhenCustomRandomGeneratorProvided

public void **testJMetalRandomGeneratorNotUsedWhenCustomRandomGeneratorProvided** ()

## 2.50.8 NullMutation

public class **NullMutation**<S> implements *MutationOperator*<S>

This class is intended to perform no mutation. It can be useful when configuring a genetic algorithm and we want to use only crossover.

**Author** Antonio J. Nebro

#### Methods

##### execute

public S **execute** (S *source*)
Execute() method

### 2.50.9 PermutationSwapMutation

public class **PermutationSwapMutation**<T> implements *MutationOperator*<*PermutationSolution*<T>>
This class implements a swap mutation. The solution type of the solution must be Permutation.

**Author** Antonio J. Nebro , Juan J. Durillo

#### Constructors

##### PermutationSwapMutation

public **PermutationSwapMutation** (double *mutationProbability*)
Constructor

##### PermutationSwapMutation

public **PermutationSwapMutation** (double *mutationProbability*, *RandomGenerator*<Double> *randomGenerator*)
Constructor

##### PermutationSwapMutation

public **PermutationSwapMutation** (double *mutationProbability*, *RandomGenerator*<Double> *mutationRandomGenerator*, *BoundedRandomGenerator*<Integer> *positionRandomGenerator*)
Constructor

#### Methods

##### doMutation

public void **doMutation** (*PermutationSolution*<T> *solution*)
Performs the operation

##### execute

public *PermutationSolution*<T> **execute** (*PermutationSolution*<T> *solution*)

##### getMutationProbability

public double **getMutationProbability** ()

#### setMutationProbability

public void **setMutationProbability** (double *mutationProbability*)

### 2.50.10 PermutationSwapMutationTest

public class **PermutationSwapMutationTest**

#### Methods

#### shouldJMetalRandomGeneratorNotBeUsedWhenCustomRandomGeneratorProvided

public void **shouldJMetalRandomGeneratorNotBeUsedWhenCustomRandomGeneratorProvided** ()

### 2.50.11 PolynomialMutation

public class **PolynomialMutation** implements *MutationOperator*<*DoubleSolution*>

This class implements a polynomial mutation operator The implementation is based on the NSGA-II code available in http://www.iitk.ac.in/kangal/codes.shtml If the lower and upper bounds of a variable are the same, no mutation is carried out and the bound value is returned.

**Author** Antonio J. Nebro , Juan J. Durillo

#### Constructors

#### PolynomialMutation

public **PolynomialMutation** ()

Constructor

#### PolynomialMutation

public **PolynomialMutation** (*DoubleProblem problem*, double *distributionIndex*)

Constructor

#### PolynomialMutation

public **PolynomialMutation** (*DoubleProblem problem*, double *distributionIndex*, *RandomGenerator*<Double> *randomGenerator*)

Constructor

#### PolynomialMutation

public **PolynomialMutation** (double *mutationProbability*, double *distributionIndex*)

Constructor

#### PolynomialMutation

public **PolynomialMutation**(double *mutationProbability*, double *distributionIndex*, *RandomGenerator*<Double> *randomGenerator*)
Constructor

#### PolynomialMutation

public **PolynomialMutation**(double *mutationProbability*, double *distributionIndex*, *RepairDoubleSolution* *solutionRepair*)
Constructor

#### PolynomialMutation

public **PolynomialMutation**(double *mutationProbability*, double *distributionIndex*, *RepairDoubleSolution* *solutionRepair*, *RandomGenerator*<Double> *randomGenerator*)
Constructor

#### Methods

#### execute

public *DoubleSolution* **execute**(*DoubleSolution* *solution*)
Execute() method

#### getDistributionIndex

public double **getDistributionIndex**()

#### getMutationProbability

public double **getMutationProbability**()

#### setDistributionIndex

public void **setDistributionIndex**(double *distributionIndex*)

#### setMutationProbability

public void **setMutationProbability**(double *probability*)

### 2.50.12 PolynomialMutationTest

public class **PolynomialMutationTest**
Note: this class does check that the polynomial mutation operator does not return invalid values, but not that it works properly (@see PolynomialMutationWorkingTest)

**Author** Antonio J. Nebro

## Methods

### shouldConstructorAssignTheCorrectDistributionIndex

public void **shouldConstructorAssignTheCorrectDistributionIndex**()

### shouldConstructorAssignTheCorrectProbabilityValue

public void **shouldConstructorAssignTheCorrectProbabilityValue**()

### shouldConstructorFailWhenPassedANegativeDistributionIndex

public void **shouldConstructorFailWhenPassedANegativeDistributionIndex**()

### shouldConstructorFailWhenPassedANegativeProbabilityValue

public void **shouldConstructorFailWhenPassedANegativeProbabilityValue**()

### shouldConstructorWithProblemAndDistributionIndexParametersAssignTheCorrectValues

public void **shouldConstructorWithProblemAndDistributionIndexParametersAssignTheCorrectValues**()

### shouldConstructorWithoutParameterAssignTheDefaultValues

public void **shouldConstructorWithoutParameterAssignTheDefaultValues**()

### shouldExecuteWithNullParameterThrowAnException

public void **shouldExecuteWithNullParameterThrowAnException**()

### shouldGetDistributionIndexReturnTheRightValue

public void **shouldGetDistributionIndexReturnTheRightValue**()

### shouldGetMutationProbabilityReturnTheRightValue

public void **shouldGetMutationProbabilityReturnTheRightValue**()

### shouldJMetalRandomGeneratorNotBeUsedWhenCustomRandomGeneratorProvided

public void **shouldJMetalRandomGeneratorNotBeUsedWhenCustomRandomGeneratorProvided**()

#### shouldMutateASingleVariableSolutionReturnAValidSolution

public void **shouldMutateASingleVariableSolutionReturnAValidSolution**()

#### shouldMutateASingleVariableSolutionReturnAnotherValidSolution

public void **shouldMutateASingleVariableSolutionReturnAnotherValidSolution**()

#### shouldMutateASingleVariableSolutionReturnTheSameSolutionIfItIsNotMutated

public void **shouldMutateASingleVariableSolutionReturnTheSameSolutionIfItIsNotMutated**()

#### shouldMutateASingleVariableSolutionReturnTheSameSolutionIfProbabilityIsZero

public void **shouldMutateASingleVariableSolutionReturnTheSameSolutionIfProbabilityIsZero**()

#### shouldMutateASingleVariableSolutionWithSameLowerAndUpperBoundsReturnTheBoundValue

public void **shouldMutateASingleVariableSolutionWithSameLowerAndUpperBoundsReturnTheBoundValue**()

## 2.50.13 SimpleRandomMutation

public class **SimpleRandomMutation** implements *MutationOperator*<*DoubleSolution*>

This class implements a random mutation operator for double solutions

**Author** Antonio J. Nebro

### Constructors

#### SimpleRandomMutation

public **SimpleRandomMutation**(double *probability*)

Constructor

#### SimpleRandomMutation

public **SimpleRandomMutation**(double *probability*, *RandomGenerator*<Double> *randomGenerator*)

Constructor

### Methods

#### execute

public *DoubleSolution* **execute**(*DoubleSolution* *solution*)

Execute() method

#### getMutationProbability

public double **getMutationProbability**()

#### setMutationProbability

public void **setMutationProbability**(double *mutationProbability*)

### 2.50.14 SimpleRandomMutationTest

public class **SimpleRandomMutationTest**

#### Methods

#### testJMetalRandomGeneratorNotUsedWhenCustomRandomGeneratorProvided

public void **testJMetalRandomGeneratorNotUsedWhenCustomRandomGeneratorProvided**()

### 2.50.15 UniformMutation

public class **UniformMutation** implements *MutationOperator*<*DoubleSolution*>

This class implements a uniform mutation operator.

**Author** Antonio J. Nebro , Juan J. Durillo

#### Constructors

#### UniformMutation

public **UniformMutation**(double *mutationProbability*, double *perturbation*)

Constructor

#### UniformMutation

public **UniformMutation**(double *mutationProbability*, double *perturbation*, *RandomGenerator*<Double> *randomGenenerator*)

Constructor

#### Methods

#### doMutation

public void **doMutation**(double *probability*, *DoubleSolution* *solution*)

Perform the operation

**Parameters**

- **probability** – Mutation setProbability

- **solution** – The solution to mutate

#### execute

public *DoubleSolution* **execute**(*DoubleSolution solution*)
Execute() method

#### getMutationProbability

public Double **getMutationProbability**()

#### getPerturbation

public double **getPerturbation**()

#### setMutationProbability

public void **setMutationProbability**(Double *mutationProbability*)

#### setPerturbation

public void **setPerturbation**(Double *perturbation*)

### 2.50.16 UniformMutationTest

public class **UniformMutationTest**

#### Methods

#### testJMetalRandomGeneratorNotUsedWhenCustomRandomGeneratorProvided

public void **testJMetalRandomGeneratorNotUsedWhenCustomRandomGeneratorProvided**()

## 2.51 org.uma.jmetal.operator.impl.selection

### 2.51.1 BestSolutionSelection

public class **BestSolutionSelection**<S> implements *SelectionOperator*<List<S>, S>
This class implements a selection operator used for selecting the best solution in a list according to a given comparator.

**Author** Antonio J. Nebro

#### Constructors

##### BestSolutionSelection

public **BestSolutionSelection** (Comparator<S> *comparator*)

#### Methods

##### execute

public S **execute** (List<S> *solutionList*)
Execute() method

### 2.51.2 BinaryTournamentSelection

public class **BinaryTournamentSelection**<S extends Solution<?>> extends *TournamentSelection*<S>
Applies a binary tournament selection to return the best solution between two that have been chosen at random from a solution list. Modified by Juanjo in 13.03.2015. A binary tournament is now a TournamenteSelection with 2 tournaments

**Author** Antonio J. Nebro, Juan J. Durillo

#### Constructors

##### BinaryTournamentSelection

public **BinaryTournamentSelection** ()
Constructor

##### BinaryTournamentSelection

public **BinaryTournamentSelection** (Comparator<S> *comparator*)
Constructor

### 2.51.3 BinaryTournamentSelectionTest

public class **BinaryTournamentSelectionTest**

**Author** Antonio J. Nebro

#### Methods

##### shouldExecuteRaiseAnExceptionIfTheListOfSolutionsIsEmpty

public void **shouldExecuteRaiseAnExceptionIfTheListOfSolutionsIsEmpty** ()

#### shouldExecuteRaiseAnExceptionIfTheListOfSolutionsIsNull

public void **shouldExecuteRaiseAnExceptionIfTheListOfSolutionsIsNull**()

#### shouldExecuteReturnAValidSolutionIsWithCorrectParameters

public void **shouldExecuteReturnAValidSolutionIsWithCorrectParameters**()

#### shouldExecuteReturnTheSameSolutionIfTheListContainsOneSolution

public void **shouldExecuteReturnTheSameSolutionIfTheListContainsOneSolution**()

#### shouldExecuteReturnTwoSolutionsIfTheListContainsTwoSolutions

public void **shouldExecuteReturnTwoSolutionsIfTheListContainsTwoSolutions**()

#### shouldExecuteWorkProperlyIfTheTwoSolutionsInTheListAreNondominated

public void **shouldExecuteWorkProperlyIfTheTwoSolutionsInTheListAreNondominated**()

#### tearDown

public void **tearDown**()

## 2.51.4 DifferentialEvolutionSelection

public class **DifferentialEvolutionSelection** implements *SelectionOperator*<List<*DoubleSolution*>, List<*DoubleSolution*>

Class implementing the selection operator used in DE: three different solutions are returned from a population. The three solutions must be also different from the one indicated by an index (its position in the list). As a consequence, the operator requires a solution list with at least for elements.

**Author** Antonio J. Nebro , Juan J. Durillo

### Constructors

#### DifferentialEvolutionSelection

public **DifferentialEvolutionSelection**()

Constructor

#### DifferentialEvolutionSelection

public **DifferentialEvolutionSelection**(*BoundedRandomGenerator*<Integer> *randomGenerator*)

Constructor

#### Methods

##### execute

public List<*DoubleSolution*> **execute** (List<*DoubleSolution*> *solutionSet*)
Execute() method

##### setIndex

public void **setIndex** (int *index*)

### 2.51.5 DifferentialEvolutionSelectionTest

public class **DifferentialEvolutionSelectionTest**
Created by ajnebro on 3/5/15.

#### Fields

##### exception

public ExpectedException **exception**

#### Methods

##### shouldExecuteRaiseAnExceptionIfTheIndexIsHigherThanTheSolutionListLength

public void **shouldExecuteRaiseAnExceptionIfTheIndexIsHigherThanTheSolutionListLength** ()

##### shouldExecuteRaiseAnExceptionIfTheIndexIsNegative

public void **shouldExecuteRaiseAnExceptionIfTheIndexIsNegative** ()

##### shouldExecuteRaiseAnExceptionIfTheIndexIsNotIndicated

public void **shouldExecuteRaiseAnExceptionIfTheIndexIsNotIndicated** ()

##### shouldExecuteRaiseAnExceptionIfTheListOfSolutionsHasOneSolution

public void **shouldExecuteRaiseAnExceptionIfTheListOfSolutionsHasOneSolution** ()

##### shouldExecuteRaiseAnExceptionIfTheListOfSolutionsIsEmpty

public void **shouldExecuteRaiseAnExceptionIfTheListOfSolutionsIsEmpty** ()

#### shouldExecuteRaiseAnExceptionIfTheListOfSolutionsIsNull

public void **shouldExecuteRaiseAnExceptionIfTheListOfSolutionsIsNull**()

#### shouldExecuteReturnThreeDifferentSolutionsIfTheListHasFourElements

public void **shouldExecuteReturnThreeDifferentSolutionsIfTheListHasFourElements**()

#### shouldJMetalRandomGeneratorNotBeUsedWhenCustomRandomGeneratorProvided

public void **shouldJMetalRandomGeneratorNotBeUsedWhenCustomRandomGeneratorProvided**()

## 2.51.6 NaryRandomSelection

public class **NaryRandomSelection**<S> implements *SelectionOperator*<List<S>, List<S>>
This class implements a random selection operator used for selecting a N number of solutions from a list

**Author** Antonio J. Nebro

### Constructors

#### NaryRandomSelection

public **NaryRandomSelection**()
Constructor

#### NaryRandomSelection

public **NaryRandomSelection**(int *numberOfSolutionsToBeReturned*)
Constructor

### Methods

#### execute

public List<S> **execute**(List<S> *solutionList*)
Execute() method

## 2.51.7 NaryRandomSelectionTest

public class **NaryRandomSelectionTest**

**Author** Antonio J. Nebro

#### Fields

##### exception

public ExpectedException **exception**

#### Methods

##### shouldDefaultConstructorReturnASingleSolution

public void **shouldDefaultConstructorReturnASingleSolution**()

##### shouldExecuteRaiseAnExceptionIfTheListSizeIsOneAndTwoSolutionsAreRequested

public void **shouldExecuteRaiseAnExceptionIfTheListSizeIsOneAndTwoSolutionsAreRequested**()

##### shouldExecuteRaiseAnExceptionIfTheListSizeIsTwoAndFourSolutionsAreRequested

public void **shouldExecuteRaiseAnExceptionIfTheListSizeIsTwoAndFourSolutionsAreRequested**()

##### shouldExecuteRaiseAnExceptionIfTheSolutionListIsEmpty

public void **shouldExecuteRaiseAnExceptionIfTheSolutionListIsEmpty**()

##### shouldExecuteRaiseAnExceptionIfTheSolutionListIsNull

public void **shouldExecuteRaiseAnExceptionIfTheSolutionListIsNull**()

##### shouldExecuteReturnTheCorrectNumberOfSolutions

public void **shouldExecuteReturnTheCorrectNumberOfSolutions**()

##### shouldExecuteReturnTheSolutionInTheListIfTheListContainsASolution

public void **shouldExecuteReturnTheSolutionInTheListIfTheListContainsASolution**()

##### shouldExecuteReturnTheSolutionSInTheListIfTheListContainsTwoSolutions

public void **shouldExecuteReturnTheSolutionSInTheListIfTheListContainsTwoSolutions**()

##### shouldNonDefaultConstructorReturnTheCorrectNumberOfSolutions

public void **shouldNonDefaultConstructorReturnTheCorrectNumberOfSolutions**()

#### shouldSelectNRandomDifferentSolutionsReturnTheCorrectListOfSolutions

public void **shouldSelectNRandomDifferentSolutionsReturnTheCorrectListOfSolutions**()
If the list contains 4 solutions, the result list must return all of them

### 2.51.8 NaryTournamentSelection

public class **NaryTournamentSelection**<S extends Solution<?>> implements *SelectionOperator*<List<S>, S>
Applies a N-ary tournament selection to return the best solution between N that have been chosen at random from a solution list.

**Author** Antonio J. Nebro

#### Constructors

#### NaryTournamentSelection

public **NaryTournamentSelection**()
Constructor

#### NaryTournamentSelection

public **NaryTournamentSelection**(int *numberOfSolutionsToBeReturned*, Comparator<S> *comparator*)
Constructor

#### Methods

#### execute

public S **execute**(List<S> *solutionList*)

### 2.51.9 NaryTournamentSelectionTest

public class **NaryTournamentSelectionTest**

**Author** Antonio J. Nebro

#### Fields

#### exception

public ExpectedException **exception**

#### Methods

#### shouldDefaultConstructorSetTheNumberOfSolutionsToBeReturnedEqualsToTwo

public void **shouldDefaultConstructorSetTheNumberOfSolutionsToBeReturnedEqualsToTwo**()

#### shouldExecuteRaiseAnExceptionIfTheListOfSolutionsIsEmpty

public void **shouldExecuteRaiseAnExceptionIfTheListOfSolutionsIsEmpty**()

#### shouldExecuteRaiseAnExceptionIfTheListOfSolutionsIsNull

public void **shouldExecuteRaiseAnExceptionIfTheListOfSolutionsIsNull**()

#### shouldExecuteRaiseAnExceptionIfTheListSizeIsOneAndTwoSolutionsAreRequested

public void **shouldExecuteRaiseAnExceptionIfTheListSizeIsOneAndTwoSolutionsAreRequested**()

#### shouldExecuteReturnAValidSolutionIsWithCorrectParameters

public void **shouldExecuteReturnAValidSolutionIsWithCorrectParameters**()

#### shouldExecuteReturnTheSameSolutionIfTheListContainsOneSolution

public void **shouldExecuteReturnTheSameSolutionIfTheListContainsOneSolution**()

#### shouldExecuteReturnTwoSolutionsIfTheListContainsTwoSolutions

public void **shouldExecuteReturnTwoSolutionsIfTheListContainsTwoSolutions**()

## 2.51.10 RandomSelection

public class **RandomSelection**<S> implements *SelectionOperator*<List<S>, S>

This class implements a random selection operator used for selecting a N number of solutions from a list

**Author** Antonio J. Nebro

### Methods

#### execute

public S **execute**(List<S> *solutionList*)

Execute() method

## 2.51.11 RandomSelectionTest

public class **RandomSelectionTest**

Created by ajnebro on 4/5/15.

### 2.51.12 RankingAndCrowdingSelection

public class **RankingAndCrowdingSelection**<S extends Solution<?>> implements *SelectionOperator*<List<S>, List<S>>

This class implements a selection for selecting a number of solutions from a solution list. The solutions are taken by mean of its ranking and crowding distance values.

**Author** Antonio J. Nebro, Juan J. Durillo

#### Constructors

##### RankingAndCrowdingSelection

public **RankingAndCrowdingSelection**(int *solutionsToSelect*, Comparator<S> *dominanceComparator*)

Constructor

##### RankingAndCrowdingSelection

public **RankingAndCrowdingSelection**(int *solutionsToSelect*)

Constructor

#### Methods

##### addLastRankedSolutionsToPopulation

protected void **addLastRankedSolutionsToPopulation**(*Ranking*<S> *ranking*, int *rank*, List<S> *population*)

##### addRankedSolutionsToPopulation

protected void **addRankedSolutionsToPopulation**(*Ranking*<S> *ranking*, int *rank*, List<S> *population*)

##### crowdingDistanceSelection

protected List<S> **crowdingDistanceSelection**(*Ranking*<S> *ranking*)

##### execute

public List<S> **execute**(List<S> *solutionList*)

Execute() method

##### getNumberOfSolutionsToSelect

public int **getNumberOfSolutionsToSelect**()

#### subfrontFillsIntoThePopulation

protected boolean **subfrontFillsIntoThePopulation** (*Ranking*<S> *ranking*, int *rank*, List<S> *population*)

### 2.51.13 RankingAndCrowdingSelectionTest

public class **RankingAndCrowdingSelectionTest**

**Author** Antonio J. Nebro

#### Fields

#### exception

public ExpectedException **exception**

#### Methods

#### shouldDefaultConstructorReturnASingleSolution

public void **shouldDefaultConstructorReturnASingleSolution** ()

#### shouldExecuteRaiseAnExceptionIfTheSolutionListIsEmpty

public void **shouldExecuteRaiseAnExceptionIfTheSolutionListIsEmpty** ()

#### shouldExecuteRaiseAnExceptionIfTheSolutionListIsNull

public void **shouldExecuteRaiseAnExceptionIfTheSolutionListIsNull** ()

#### shouldNonDefaultConstructorReturnTheCorrectNumberOfSolutions

public void **shouldNonDefaultConstructorReturnTheCorrectNumberOfSolutions** ()

### 2.51.14 RankingAndPreferenceSelection

public class **RankingAndPreferenceSelection**<S extends Solution<?>> implements *SelectionOperator*<List<S>, List<S>>

#### Constructors

#### RankingAndPreferenceSelection

public **RankingAndPreferenceSelection** (int *solutionsToSelect*, List<Double> *interestPoint*, double *epsilon*)

Constructor

### Methods

#### addLastRankedSolutionsToPopulation

protected void **addLastRankedSolutionsToPopulation** (*Ranking*<S> *ranking*, int *rank*, List<S> *population*)

#### addRankedSolutionsToPopulation

protected void **addRankedSolutionsToPopulation** (*Ranking*<S> *ranking*, int *rank*, List<S> *population*)

#### execute

public List<S> **execute** (List<S> *solutionList*)

#### getNumberOfSolutionsToSelect

public int **getNumberOfSolutionsToSelect** ()

#### preferenceDistanceSelection

protected List<S> **preferenceDistanceSelection** (*Ranking*<S> *ranking*, int *numberOfObjectives*)

#### subfrontFillsIntoThePopulation

protected boolean **subfrontFillsIntoThePopulation** (*Ranking*<S> *ranking*, int *rank*, List<S> *population*)

## 2.51.15 TournamentSelection

public class **TournamentSelection**<S extends Solution<?>> implements *SelectionOperator*<List<S>, S>

**Author** Juanjo

### Constructors

#### TournamentSelection

public **TournamentSelection** (int *numberOfTournaments*)
Constructor

#### TournamentSelection

public **TournamentSelection** (Comparator<S> *comparator*, int *numberOfTournaments*)
Constructor

#### Methods

##### execute

public S **execute** (List<S> *solutionList*)

### 2.51.16 TournamentSelectionTest

public class **TournamentSelectionTest**
Created by ajnebro on 3/5/15.

#### Fields

##### exception

public ExpectedException **exception**

#### Methods

##### shouldConstructorAssignTheCorrectValueSToTheNumberOfTournamentsAndTheComparator

public void **shouldConstructorAssignTheCorrectValueSToTheNumberOfTournamentsAndTheComparator** ()

##### shouldConstructorAssignTheCorrectValueToTheNumberOfTournaments

public void **shouldConstructorAssignTheCorrectValueToTheNumberOfTournaments** ()

##### shouldExecuteRaiseAnExceptionIfTheSolutionListIsEmpty

public void **shouldExecuteRaiseAnExceptionIfTheSolutionListIsEmpty** ()

##### shouldExecuteRaiseAnExceptionIfTheSolutionListIsNull

public void **shouldExecuteRaiseAnExceptionIfTheSolutionListIsNull** ()

##### shouldExecuteReturnAnElementIfTheListHasOneElement

public void **shouldExecuteReturnAnElementIfTheListHasOneElement** ()

## 2.52 org.uma.jmetal.problem

### 2.52.1 BinaryProblem

public interface **BinaryProblem** extends *Problem*<*BinarySolution*>
Interface representing binary problems

**Author** Antonio J. Nebro

#### Methods

#### getNumberOfBits

public int **getNumberOfBits** (int *index*)

#### getTotalNumberOfBits

public int **getTotalNumberOfBits** ()

### 2.52.2 ConstrainedProblem

public interface **ConstrainedProblem**<S> extends *Problem*<S>
Interface representing problems having constraints

**Author** Antonio J. Nebro

#### Methods

#### evaluateConstraints

public void **evaluateConstraints** (S *solution*)

#### getNumberOfConstraints

public int **getNumberOfConstraints** ()

### 2.52.3 DoubleBinaryProblem

public interface **DoubleBinaryProblem**<S> extends *Problem*<S>
Interface representing problems having integer and double variables

**Author** Antonio J. Nebro

#### Methods

#### getLowerBound

public Number **getLowerBound** (int *index*)

#### getNumberOfBits

public int **getNumberOfBits** ()

#### getNumberOfDoubleVariables

public int **getNumberOfDoubleVariables**()

#### getUpperBound

public Number **getUpperBound**(int *index*)

### 2.52.4 DoubleProblem

public interface **DoubleProblem** extends *Problem*<*DoubleSolution*>
Interface representing continuous problems

**Author** Antonio J. Nebro

#### Methods

#### getLowerBound

Double **getLowerBound**(int *index*)

#### getUpperBound

Double **getUpperBound**(int *index*)

### 2.52.5 IntegerDoubleProblem

public interface **IntegerDoubleProblem**<S> extends *Problem*<S>
Interface representing problems having integer and double variables

**Author** Antonio J. Nebro

#### Methods

#### getLowerBound

public Number **getLowerBound**(int *index*)

#### getNumberOfDoubleVariables

public int **getNumberOfDoubleVariables**()

#### getNumberOfIntegerVariables

public int **getNumberOfIntegerVariables**()

#### getUpperBound

public Number **getUpperBound**(int *index*)

### 2.52.6 IntegerProblem

public interface **IntegerProblem** extends *Problem*<*IntegerSolution*>
Interface representing integer problems

**Author** Antonio J. Nebro

#### Methods

#### getLowerBound

public Integer **getLowerBound**(int *index*)

#### getUpperBound

public Integer **getUpperBound**(int *index*)

### 2.52.7 PermutationProblem

public interface **PermutationProblem**<S extends PermutationSolution<?>> extends *Problem*<S>
Interface representing permutation problems

**Author** Antonio J. Nebro

#### Methods

#### getPermutationLength

public int **getPermutationLength**()

### 2.52.8 Problem

public interface **Problem**<S> extends Serializable
Interface representing a multi-objective optimization problem

**Author** Antonio J. Nebro

**Parameters**

- **<S>** – Encoding

#### Methods

#### createSolution

S **createSolution**()

#### evaluate

void **evaluate** (S *solution*)

#### getName

String **getName** ()

#### getNumberOfConstraints

int **getNumberOfConstraints** ()

#### getNumberOfObjectives

int **getNumberOfObjectives** ()

#### getNumberOfVariables

int **getNumberOfVariables** ()

## 2.53 org.uma.jmetal.problem.impl

### 2.53.1 AbstractBinaryProblem

public abstract class **AbstractBinaryProblem** extends *AbstractGenericProblem*<*BinarySolution*> implements *BinaryProblem*

#### Methods

#### createSolution

public *BinarySolution* **createSolution** ()

#### getBitsPerVariable

protected abstract int **getBitsPerVariable** (int *index*)

#### getNumberOfBits

public int **getNumberOfBits** (int *index*)

#### getTotalNumberOfBits

public int **getTotalNumberOfBits** ()

### 2.53.2 AbstractDoubleProblem

public abstract class **AbstractDoubleProblem** extends *AbstractGenericProblem*<*DoubleSolution*> implements *DoubleProblem*

#### Methods

##### createSolution

public *DoubleSolution* **createSolution**()

##### getLowerBound

public Double **getLowerBound**(int *index*)

##### getUpperBound

public Double **getUpperBound**(int *index*)

##### setLowerLimit

protected void **setLowerLimit**(List<Double> *lowerLimit*)

##### setUpperLimit

protected void **setUpperLimit**(List<Double> *upperLimit*)

### 2.53.3 AbstractGenericProblem

public abstract class **AbstractGenericProblem**<S> implements *Problem*<S>

#### Methods

##### getName

public String **getName**()

##### getNumberOfConstraints

public int **getNumberOfConstraints**()

##### getNumberOfObjectives

public int **getNumberOfObjectives**()

#### getNumberOfVariables

public int **getNumberOfVariables** ()

#### setName

protected void **setName** (String *name*)

#### setNumberOfConstraints

protected void **setNumberOfConstraints** (int *numberOfConstraints*)

#### setNumberOfObjectives

protected void **setNumberOfObjectives** (int *numberOfObjectives*)

#### setNumberOfVariables

protected void **setNumberOfVariables** (int *numberOfVariables*)

## 2.53.4 AbstractIntegerDoubleProblem

public abstract class **AbstractIntegerDoubleProblem**<S> extends *AbstractGenericProblem*<S> implements *IntegerDoublePro*

### Methods

#### getLowerBound

public Number **getLowerBound** (int *index*)

#### getNumberOfDoubleVariables

public int **getNumberOfDoubleVariables** ()

#### getNumberOfIntegerVariables

public int **getNumberOfIntegerVariables** ()

#### getUpperBound

public Number **getUpperBound** (int *index*)

#### setLowerLimit

protected void **setLowerLimit** (List<Number> *lowerLimit*)

#### setNumberOfDoubleVariables

protected void **setNumberOfDoubleVariables** (int *numberOfDoubleVariables*)

#### setNumberOfIntegerVariables

protected void **setNumberOfIntegerVariables** (int *numberOfIntegerVariables*)

#### setUpperLimit

protected void **setUpperLimit** (List<Number> *upperLimit*)

### 2.53.5 AbstractIntegerPermutationProblem

public abstract class **AbstractIntegerPermutationProblem** extends *AbstractGenericProblem*<*PermutationSolution*<Integer>

#### Methods

#### createSolution

public *PermutationSolution*<Integer> **createSolution** ()

### 2.53.6 AbstractIntegerProblem

public abstract class **AbstractIntegerProblem** extends *AbstractGenericProblem*<*IntegerSolution*> implements *IntegerProblem*

#### Methods

#### createSolution

public *IntegerSolution* **createSolution** ()

#### getLowerBound

public Integer **getLowerBound** (int *index*)

#### getUpperBound

public Integer **getUpperBound** (int *index*)

#### setLowerLimit

protected void **setLowerLimit** (List<Integer> *lowerLimit*)

#### setUpperLimit

protected void **setUpperLimit** (List<Integer> *upperLimit*)

## 2.54 org.uma.jmetal.problem.multiobjective

### 2.54.1 Binh2

public class **Binh2** extends *AbstractDoubleProblem* implements *ConstrainedProblem*<*DoubleSolution*>
Class representing problem Binh2

#### Fields

#### numberOfViolatedConstraints

public *NumberOfViolatedConstraints*<*DoubleSolution*> **numberOfViolatedConstraints**

#### overallConstraintViolationDegree

public *OverallConstraintViolation*<*DoubleSolution*> **overallConstraintViolationDegree**

#### Constructors

#### Binh2

public **Binh2** ()
Constructor Creates a default instance of the Binh2 problem

#### Methods

#### evaluate

public void **evaluate** (*DoubleSolution* *solution*)
Evaluate() method

#### evaluateConstraints

public void **evaluateConstraints** (*DoubleSolution* *solution*)
EvaluateConstraints() method

### 2.54.2 ConstrEx

public class **ConstrEx** extends *AbstractDoubleProblem* implements *ConstrainedProblem*<*DoubleSolution*>
Class representing problem ConstrEx

#### Fields

##### numberOfViolatedConstraints

public *NumberOfViolatedConstraints*<*DoubleSolution*> **numberOfViolatedConstraints**

##### overallConstraintViolationDegree

public *OverallConstraintViolation*<*DoubleSolution*> **overallConstraintViolationDegree**

#### Constructors

##### ConstrEx

public **ConstrEx**()
Constructor Creates a default instance of the ConstrEx problem

#### Methods

##### evaluate

public void **evaluate**(*DoubleSolution solution*)
Evaluate() method

##### evaluateConstraints

public void **evaluateConstraints**(*DoubleSolution solution*)
EvaluateConstraints() method

### 2.54.3 Fonseca

public class **Fonseca** extends *AbstractDoubleProblem*
Class representing problem Fonseca

#### Constructors

##### Fonseca

public **Fonseca**()
Constructor

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluate() method

### 2.54.4 FourBarTruss

public class **FourBarTruss** extends *AbstractDoubleProblem*
Class representing problem FourBarTruss Measures: f = 10kN e = 200000 kN/cm2 l = 200 cm sigma = 10kN/cm2

#### Constructors

##### FourBarTruss

public **FourBarTruss** ()
Constructor Creates a default instance of the FourBarTruss problem

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluate() method

### 2.54.5 Golinski

public class **Golinski** extends *AbstractDoubleProblem* implements *ConstrainedProblem*<*DoubleSolution*>
Class representing problem Golinski.

#### Fields

##### numberOfViolatedConstraints

public *NumberOfViolatedConstraints*<*DoubleSolution*> **numberOfViolatedConstraints**

##### overallConstraintViolationDegree

public *OverallConstraintViolation*<*DoubleSolution*> **overallConstraintViolationDegree**

#### Constructors

##### Golinski

public **Golinski**()
Constructor. Creates a default instance of the Golinski problem.

#### Methods

##### evaluate

public void **evaluate**(*DoubleSolution solution*)
Evaluate() method

##### evaluateConstraints

public void **evaluateConstraints**(*DoubleSolution solution*)
EvaluateConstraints() method

### 2.54.6 Kursawe

public class **Kursawe** extends *AbstractDoubleProblem*
Class representing problem Kursawe

#### Constructors

##### Kursawe

public **Kursawe**()
Constructor. Creates a default instance (3 variables) of the Kursawe problem

##### Kursawe

public **Kursawe**(Integer *numberOfVariables*)
Constructor. Creates a new instance of the Kursawe problem.

**Parameters**

- **numberOfVariables** – Number of variables of the problem

#### Methods

##### evaluate

public void **evaluate**(*DoubleSolution solution*)
Evaluate() method

## 2.54.7 MultiobjectiveTSP

public class **MultiobjectiveTSP** extends *AbstractIntegerPermutationProblem*

Class representing a bi-objective TSP (Traveling Salesman Problem) problem. It accepts data files from TSPLIB: http://www.iwr.uni-heidelberg.de/groups/comopt/software/TSPLIB95/tsp/

### Fields

#### costMatrix

protected double[][] **costMatrix**

#### distanceMatrix

protected double[][] **distanceMatrix**

#### numberOfCities

protected int **numberOfCities**

### Constructors

#### MultiobjectiveTSP

public **MultiobjectiveTSP** (String *distanceFile*, String *costFile*)

Creates a new MultiobjectiveTSP problem instance

### Methods

#### evaluate

public void **evaluate** (*PermutationSolution*<Integer> *solution*)

Evaluate() method

#### getPermutationLength

public int **getPermutationLength** ()

## 2.54.8 NMMin

public class **NMMin** extends *AbstractIntegerProblem*

Created by Antonio J. Nebro on 03/07/14. Bi-objective problem for testing integer encoding. Objective 1: minimizing the distance to value N Objective 2: minimizing the distance to value M

#### Constructors

##### NMMin

public **NMMin** ()

##### NMMin

public **NMMin** (int *numberOfVariables*, int *n*, int *m*, int *lowerBound*, int *upperBound*)
Constructor

#### Methods

##### evaluate

public void **evaluate** (*IntegerSolution* *solution*)
Evaluate() method

### 2.54.9 NMMin2

public class **NMMin2** extends *AbstractIntegerDoubleProblem*<*IntegerDoubleSolution*>
Created by Antonio J. Nebro on 18/09/14. Bi-objective problem for testing integer/double encoding. Objective 1: minimizing the distance to value N Objective 2: minimizing the distance to value M

#### Constructors

##### NMMin2

public **NMMin2** ()

##### NMMin2

public **NMMin2** (int *numberOfIntegerVariables*, int *numberOfDoubleVariables*, int *n*, int *m*, int *lowerBound*, int *upperBound*)
Constructor

#### Methods

##### createSolution

public *IntegerDoubleSolution* **createSolution** ()

##### evaluate

public void **evaluate** (*IntegerDoubleSolution* *solution*)
Evaluate() method

### 2.54.10 NMMinTest

public class **NMMinTest**
Created by Antonio J. Nebro on 17/09/14.

#### Fields

##### problem

*Problem*<*IntegerSolution*> **problem**

#### Methods

##### evaluateSimpleSolutions

public void **evaluateSimpleSolutions**()

### 2.54.11 OneZeroMax

public class **OneZeroMax** extends *AbstractBinaryProblem*
Class representing problem OneZeroMax. The problem consist of maximizing the number of '1's and '0's in a binary string.

#### Constructors

##### OneZeroMax

public **OneZeroMax**()
Constructor

##### OneZeroMax

public **OneZeroMax**(Integer *numberOfBits*)
Constructor

#### Methods

##### createSolution

public *BinarySolution* **createSolution**()

##### evaluate

public void **evaluate**(*BinarySolution* *solution*)
Evaluate() method

#### getBitsPerVariable

protected int **getBitsPerVariable** (int *index*)

### 2.54.12 Osyczka2

public class **Osyczka2** extends *AbstractDoubleProblem* implements *ConstrainedProblem*<*DoubleSolution*>
Class representing problem Oyczka2

#### Fields

#### numberOfViolatedConstraints

public *NumberOfViolatedConstraints*<*DoubleSolution*> **numberOfViolatedConstraints**

#### overallConstraintViolationDegree

public *OverallConstraintViolation*<*DoubleSolution*> **overallConstraintViolationDegree**

#### Constructors

#### Osyczka2

public **Osyczka2** ()
Constructor. Creates a default instance of the Osyczka2 problem.

#### Methods

#### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluate() method

#### evaluateConstraints

public void **evaluateConstraints** (*DoubleSolution solution*)
EvaluateConstraints() method

### 2.54.13 Schaffer

public class **Schaffer** extends *AbstractDoubleProblem*
Class representing problem Schaffer

#### Constructors

##### Schaffer

public **Schaffer**()
Constructor. Creates a default instance of problem Schaffer

#### Methods

##### evaluate

public void **evaluate**(*DoubleSolution solution*)
Evaluate() method

### 2.54.14 Srinivas

public class **Srinivas** extends *AbstractDoubleProblem* implements *ConstrainedProblem*<*DoubleSolution*>
Class representing problem Srinivas

#### Fields

##### numberOfViolatedConstraints

public *NumberOfViolatedConstraints*<*DoubleSolution*> **numberOfViolatedConstraints**

##### overallConstraintViolationDegree

public *OverallConstraintViolation*<*DoubleSolution*> **overallConstraintViolationDegree**

#### Constructors

##### Srinivas

public **Srinivas**()
Constructor

#### Methods

##### evaluate

public void **evaluate**(*DoubleSolution solution*)
Evaluate() method

##### evaluateConstraints

public void **evaluateConstraints**(*DoubleSolution solution*)
EvaluateConstraints() method

### 2.54.15 Tanaka

public class **Tanaka** extends *AbstractDoubleProblem* implements *ConstrainedProblem*<*DoubleSolution*>
Class representing problem Tanaka

#### Fields

##### numberOfViolatedConstraints

public *NumberOfViolatedConstraints*<*DoubleSolution*> **numberOfViolatedConstraints**

##### overallConstraintViolationDegree

public *OverallConstraintViolation*<*DoubleSolution*> **overallConstraintViolationDegree**

#### Constructors

##### Tanaka

public **Tanaka**()
Constructor. Creates a default instance of the problem Tanaka

#### Methods

##### evaluate

public void **evaluate**(*DoubleSolution solution*)

##### evaluateConstraints

public void **evaluateConstraints**(*DoubleSolution solution*)
EvaluateConstraints() method

### 2.54.16 Viennet2

public class **Viennet2** extends *AbstractDoubleProblem*
Class representing problem Viennet2

#### Constructors

##### Viennet2

public **Viennet2**()
Constructor. Creates a default instance of the Viennet2 problem

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluate() method

### 2.54.17 Viennet3

public class **Viennet3** extends *AbstractDoubleProblem*
Class representing problem Viennet3

#### Constructors

##### Viennet3

public **Viennet3** ()
Constructor. Creates a default instance of the Viennet3 problem.

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluate() method

### 2.54.18 Viennet4

public class **Viennet4** extends *AbstractDoubleProblem* implements *ConstrainedProblem*<*DoubleSolution*>
Class representing problem Viennet4

#### Fields

##### numberOfViolatedConstraints

public *NumberOfViolatedConstraints*<*DoubleSolution*> **numberOfViolatedConstraints**

##### overallConstraintViolationDegree

public *OverallConstraintViolation*<*DoubleSolution*> **overallConstraintViolationDegree**

#### Constructors

##### Viennet4

public **Viennet4** ()
Constructor. Creates a default instance of the Viennet4 problem.

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluate() method

##### evaluateConstraints

public void **evaluateConstraints** (*DoubleSolution solution*)
EvaluateConstraints() method

### 2.54.19 Water

public class **Water** extends *AbstractDoubleProblem* implements *ConstrainedProblem*<*DoubleSolution*>
Class representing problem Water

#### Fields

##### LOWERLIMIT

public static final Double[] **LOWERLIMIT**

##### UPPERLIMIT

public static final Double[] **UPPERLIMIT**

##### numberOfViolatedConstraints

public *NumberOfViolatedConstraints*<*DoubleSolution*> **numberOfViolatedConstraints**

##### overallConstraintViolationDegree

public *OverallConstraintViolation*<*DoubleSolution*> **overallConstraintViolationDegree**

#### Constructors

##### Water

public **Water** ()
Constructor. Creates a default instance of the Water problem.

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluate() method

##### evaluateConstraints

public void **evaluateConstraints** (*DoubleSolution solution*)
EvaluateConstraints() method

## 2.55 org.uma.jmetal.problem.multiobjective.UF

### 2.55.1 UF1

public class **UF1** extends *AbstractDoubleProblem*
Class representing problem CEC2009_UF1

#### Constructors

##### UF1

public **UF1** ()
Constructor. Creates a default instance of problem CEC2009_UF1 (30 decision variables)

##### UF1

public **UF1** (int *numberOfVariables*)
Creates a new instance of problem CEC2009_UF1.

**Parameters**

- **numberOfVariables** – Number of variables.

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluate() method

### 2.55.2 UF10

public class **UF10** extends *AbstractDoubleProblem*
Class representing problem CEC2009_UF10

#### Constructors

##### UF10

public **UF10** ()
Constructor. Creates a default instance of problem CEC2009_UF10 (30 decision variables)

##### UF10

public **UF10** (int *numberOfVariables*)
Creates a new instance of problem CEC2009_UF10.

**Parameters**

- **numberOfVariables** – Number of variables.

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluate() method

### 2.55.3 UF2

public class **UF2** extends *AbstractDoubleProblem*
Class representing problem CEC2009_UF2

#### Constructors

##### UF2

public **UF2** ()
Constructor. Creates a default instance of problem CEC2009_UF2 (30 decision variables)

##### UF2

public **UF2** (int *numberOfVariables*)
Creates a new instance of problem CEC2009_UF2.

**Parameters**

- **numberOfVariables** – Number of variables.

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluate() method

### 2.55.4 UF3

public class **UF3** extends *AbstractDoubleProblem*
Class representing problem CEC2009_UF3

#### Constructors

##### UF3

public **UF3** ()
Constructor. Creates a default instance of problem CEC2009_UF3 (30 decision variables)

##### UF3

public **UF3** (int *numberOfVariables*)
Creates a new instance of problem CEC2009_UF3.

**Parameters**

- **numberOfVariables** – Number of variables.

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluate() method

### 2.55.5 UF4

public class **UF4** extends *AbstractDoubleProblem*
Class representing problem CEC2009_UF4

#### Constructors

##### UF4

public **UF4** ()
Constructor. Creates a default instance of problem CEC2009_UF4 (30 decision variables)

##### UF4

public **UF4** (Integer *numberOfVariables*)
Creates a new instance of problem CEC2009_UF4.

**Parameters**

- **numberOfVariables** – Number of variables.

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluate() method

### 2.55.6 UF5

public class **UF5** extends *AbstractDoubleProblem*
Class representing problem CEC2009_UF5

#### Fields

##### epsilon

double **epsilon**

##### n

int **n**

#### Constructors

##### UF5

public **UF5** ()
Constructor. Creates a default instance of problem CEC2009_UF5 (30 decision variables)

##### UF5

public **UF5** (int *numberOfVariables*, int *N*, double *epsilon*)
Creates a new instance of problem CEC2009_UF5.

**Parameters**

- **numberOfVariables** – Number of variables.

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluate() method

### 2.55.7 UF6

public class **UF6** extends *AbstractDoubleProblem*
Class representing problem CEC2009_UF5

#### Fields

##### epsilon

double **epsilon**

##### n

int **n**

#### Constructors

##### UF6

public **UF6**()
Constructor. Creates a default instance of problem CEC2009_UF6 (30 decision variables, N =10, epsilon = 0.1)

##### UF6

public **UF6**(Integer *numberOfVariables*, int *N*, double *epsilon*)
Creates a new instance of problem CEC2009_UF6.

**Parameters**

- **numberOfVariables** – Number of variables.

#### Methods

##### evaluate

public void **evaluate**(*DoubleSolution solution*)
Evaluate() method

### 2.55.8 UF7

public class **UF7** extends *AbstractDoubleProblem*
Class representing problem CEC2009_UF7

#### Constructors

##### UF7

public **UF7** ()
Constructor. Creates a default instance of problem CEC2009_UF7 (30 decision variables)

##### UF7

public **UF7** (int *numberOfVariables*)
Creates a new instance of problem CEC2009_UF7.

**Parameters**

- **numberOfVariables** – Number of variables.

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluate() method

### 2.55.9 UF8

public class **UF8** extends *AbstractDoubleProblem*
Class representing problem CEC2009_UF8

#### Constructors

##### UF8

public **UF8** ()
Constructor. Creates a default instance of problem CEC2009_UF8 (30 decision variables)

##### UF8

public **UF8** (int *numberOfVariables*)
Creates a new instance of problem CEC2009_UF8.

**Parameters**

- **numberOfVariables** – Number of variables.

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluate() method

### 2.55.10 UF9

public class **UF9** extends *AbstractDoubleProblem*
Class representing problem CEC2009_UF9

#### Fields

##### epsilon

double **epsilon**

#### Constructors

##### UF9

public **UF9**()
Constructor. Creates a default instance of problem CEC2009_UF9 (30 decision variables, epsilon = 0.1)

##### UF9

public **UF9**(int *numberOfVariables*, double *epsilon*)
Creates a new instance of problem CEC2009_UF9.

**Parameters**

- **numberOfVariables** – Number of variables.

#### Methods

##### evaluate

public void **evaluate**(*DoubleSolution solution*)
Evaluate() method

## 2.56 org.uma.jmetal.problem.multiobjective.cdtlz

### 2.56.1 C1_DTLZ1

public class **C1_DTLZ1** extends *DTLZ1* implements *ConstrainedProblem*<*DoubleSolution*>
Problem C1-DTLZ1, defined in: Jain, H. and K. Deb. "An Evolutionary Many-Objective Optimization Algorithm Using Reference-Point-Based Nondominated Sorting Approach, Part II: Handling Constraints and Extending to an Adaptive Approach." EEE Transactions on Evolutionary Computation, 18(4):602-622, 2014.

**Author** Antonio J. Nebro

#### Fields

##### numberOfViolatedConstraints

public *NumberOfViolatedConstraints*<*DoubleSolution*> **numberOfViolatedConstraints**

##### overallConstraintViolationDegree

public *OverallConstraintViolation*<*DoubleSolution*> **overallConstraintViolationDegree**

#### Constructors

##### C1_DTLZ1

public **C1_DTLZ1** (int *numberOfVariables*, int *numberOfObjectives*)
Constructor

**Parameters**

- **numberOfVariables** –
- **numberOfObjectives** –

#### Methods

##### evaluateConstraints

public void **evaluateConstraints** (*DoubleSolution* *solution*)

### 2.56.2 C1_DTLZ3

public class **C1_DTLZ3** extends *DTLZ3* implements *ConstrainedProblem*<*DoubleSolution*>
Problem C1-DTLZ3, defined in: Jain, H. and K. Deb. "An Evolutionary Many-Objective Optimization Algorithm Using Reference-Point-Based Nondominated Sorting Approach, Part II: Handling Constraints and Extending to an Adaptive Approach." EEE Transactions on Evolutionary Computation, 18(4):602-622, 2014.

**Author** Antonio J. Nebro

#### Fields

##### numberOfViolatedConstraints

public *NumberOfViolatedConstraints*<*DoubleSolution*> **numberOfViolatedConstraints**

##### overallConstraintViolationDegree

public *OverallConstraintViolation*<*DoubleSolution*> **overallConstraintViolationDegree**

#### Constructors

##### C1_DTLZ3

public **C1_DTLZ3** (int *numberOfVariables*, int *numberOfObjectives*)
Constructor

**Parameters**

- **numberOfVariables** –
- **numberOfObjectives** –

#### Methods

##### evaluateConstraints

public void **evaluateConstraints** (*DoubleSolution* *solution*)

### 2.56.3 C2_DTLZ2

public class **C2_DTLZ2** extends *DTLZ2* implements *ConstrainedProblem*<*DoubleSolution*>
Problem C2-DTLZ2, defined in: Jain, H. and K. Deb. "An Evolutionary Many-Objective Optimization Algorithm Using Reference-Point-Based Nondominated Sorting Approach, Part II: Handling Constraints and Extending to an Adaptive Approach." EEE Transactions on Evolutionary Computation, 18(4):602-622, 2014.

**Author** Antonio J. Nebro

#### Fields

##### numberOfViolatedConstraints

public *NumberOfViolatedConstraints*<*DoubleSolution*> **numberOfViolatedConstraints**

##### overallConstraintViolationDegree

public *OverallConstraintViolation*<*DoubleSolution*> **overallConstraintViolationDegree**

#### Constructors

##### C2_DTLZ2

public **C2_DTLZ2** (int *numberOfVariables*, int *numberOfObjectives*)
Constructor

**Parameters**

- **numberOfVariables** –
- **numberOfObjectives** –

#### Methods

##### evaluateConstraints

public void **evaluateConstraints** (*DoubleSolution solution*)

### 2.56.4 C3_DTLZ1

public class **C3_DTLZ1** extends *DTLZ1* implements *ConstrainedProblem*<*DoubleSolution*>

Problem C3-DTLZ1, defined in: Jain, H. and K. Deb. "An Evolutionary Many-Objective Optimization Algorithm Using Reference-Point-Based Nondominated Sorting Approach, Part II: Handling Constraints and Extending to an Adaptive Approach." EEE Transactions on Evolutionary Computation, 18(4):602-622, 2014.

**Author** Antonio J. Nebro

#### Fields

##### numberOfViolatedConstraints

public *NumberOfViolatedConstraints*<*DoubleSolution*> **numberOfViolatedConstraints**

##### overallConstraintViolationDegree

public *OverallConstraintViolation*<*DoubleSolution*> **overallConstraintViolationDegree**

#### Constructors

##### C3_DTLZ1

public **C3_DTLZ1** (int *numberOfVariables*, int *numberOfObjectives*, int *numberOfConstraints*)

Constructor

**Parameters**

- **numberOfVariables** –
- **numberOfObjectives** –

#### Methods

##### evaluateConstraints

public void **evaluateConstraints** (*DoubleSolution solution*)

### 2.56.5 C3_DTLZ4

public class **C3_DTLZ4** extends *DTLZ4* implements *ConstrainedProblem*<*DoubleSolution*>

Problem C3-DTLZ4, defined in: Jain, H. and K. Deb. "An Evolutionary Many-Objective Optimization Algorithm Using Reference-Point-Based Nondominated Sorting Approach, Part II: Handling Constraints and Extending to an Adaptive Approach." EEE Transactions on Evolutionary Computation, 18(4):602-622, 2014.

**Author** Antonio J. Nebro

### Fields

#### numberOfViolatedConstraints

public *NumberOfViolatedConstraints*<*DoubleSolution*> **numberOfViolatedConstraints**

#### overallConstraintViolationDegree

public *OverallConstraintViolation*<*DoubleSolution*> **overallConstraintViolationDegree**

### Constructors

#### C3_DTLZ4

public **C3_DTLZ4** (int *numberOfVariables*, int *numberOfObjectives*, int *numberOfConstraints*)
Constructor

**Parameters**

- **numberOfVariables** –
- **numberOfObjectives** –

### Methods

#### evaluateConstraints

public void **evaluateConstraints** (*DoubleSolution solution*)

## 2.56.6 ConvexC2_DTLZ2

public class **ConvexC2_DTLZ2** extends *DTLZ2* implements *ConstrainedProblem*<*DoubleSolution*>
Problem ConvexC2-DTLZ2, defined in: Jain, H. and K. Deb. "An Evolutionary Many-Objective Optimization Algorithm Using Reference-Point-Based Nondominated Sorting Approach, Part II: Handling Constraints and Extending to an Adaptive Approach." EEE Transactions on Evolutionary Computation, 18(4):602-622, 2014.

**Author** Antonio J. Nebro

### Fields

#### numberOfViolatedConstraints

public *NumberOfViolatedConstraints*<*DoubleSolution*> **numberOfViolatedConstraints**

#### overallConstraintViolationDegree

public *OverallConstraintViolation*<*DoubleSolution*> **overallConstraintViolationDegree**

#### Constructors

#### ConvexC2_DTLZ2

public **ConvexC2_DTLZ2** (int *numberOfVariables*, int *numberOfObjectives*)
Constructor

**Parameters**

- **numberOfVariables** –
- **numberOfObjectives** –

#### Methods

#### evaluateConstraints

public void **evaluateConstraints** (*DoubleSolution solution*)

## 2.57 org.uma.jmetal.problem.multiobjective.cec2015OptBigDataCompetition

### 2.57.1 BigOpt2015

public class **BigOpt2015** extends *AbstractDoubleProblem*
Created by ajnebro on 14/1/15.

#### Fields

#### dTypeG

int **dTypeG**

#### f1max

double **f1max**

#### f1min

double **f1min**

#### f2max

double **f2max**

#### f2min

double **f2min**

#### scaling

boolean **scaling**

### Constructors

#### BigOpt2015

public **BigOpt2015** (String *instanceName*)
  Constructor

### Methods

#### correlation

List<List<Double>> **correlation** (List<List<Double>> *list1*, List<List<Double>> *list2*)

#### diagonal1

double **diagonal1** (List<List<Double>> *list*)

#### diagonal2

double **diagonal2** (List<List<Double>> *list*)

#### evaluate

public void **evaluate** (*DoubleSolution solution*)
  Evaluate() method

#### multiplyWithOutAMP

List<List<Double>> **multiplyWithOutAMP** (List<List<Double>> *list1*, List<List<Double>> *list2*)

#### newMeanStandardDeviation

List<Double> **newMeanStandardDeviation** (List<Double> *list*)

#### vectorCorrelation

double **vectorCorrelation** (List<Double> *list1*, List<Double> *list2*)

## 2.58 org.uma.jmetal.problem.multiobjective.dtlz

### 2.58.1 DTLZ1

public class **DTLZ1** extends *AbstractDoubleProblem*
Class representing problem DTLZ1

#### Constructors

#### DTLZ1

public **DTLZ1** ()
Creates a default DTLZ1 problem (7 variables and 3 objectives)

#### DTLZ1

public **DTLZ1** (Integer *numberOfVariables*, Integer *numberOfObjectives*)
Creates a DTLZ1 problem instance

**Parameters**

- **numberOfVariables** – Number of variables
- **numberOfObjectives** – Number of objective functions

#### Methods

#### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluate() method

### 2.58.2 DTLZ2

public class **DTLZ2** extends *AbstractDoubleProblem*
Class representing problem DTLZ1

#### Constructors

#### DTLZ2

public **DTLZ2** ()
Creates a default DTLZ2 problem (12 variables and 3 objectives)

#### DTLZ2

public **DTLZ2** (Integer *numberOfVariables*, Integer *numberOfObjectives*)
Creates a DTLZ2 problem instance

**Parameters**

- **numberOfVariables** – Number of variables
- **numberOfObjectives** – Number of objective functions

### Methods

#### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluate() method

## 2.58.3 DTLZ3

public class **DTLZ3** extends *AbstractDoubleProblem*
Class representing problem DTLZ3

### Constructors

#### DTLZ3

public **DTLZ3** ()
Creates a default DTLZ3 problem (12 variables and 3 objectives)

#### DTLZ3

public **DTLZ3** (Integer *numberOfVariables*, Integer *numberOfObjectives*)
Creates a DTLZ3 problem instance

**Parameters**

- **numberOfVariables** – Number of variables
- **numberOfObjectives** – Number of objective functions

### Methods

#### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluate() method

## 2.58.4 DTLZ4

public class **DTLZ4** extends *AbstractDoubleProblem*
Class representing problem DTLZ4

### Constructors

#### DTLZ4

public **DTLZ4** ()
Creates a default DTLZ4 problem (12 variables and 3 objectives)

#### DTLZ4

public **DTLZ4** (Integer *numberOfVariables*, Integer *numberOfObjectives*)
Creates a DTLZ4 problem instance

**Parameters**

- **numberOfVariables** – Number of variables
- **numberOfObjectives** – Number of objective functions

### Methods

#### evaluate

public void **evaluate** (*DoubleSolution* *solution*)
Evaluate() method

## 2.58.5 DTLZ5

public class **DTLZ5** extends *AbstractDoubleProblem*
Class representing problem DTLZ5

### Constructors

#### DTLZ5

public **DTLZ5** ()
Creates a default DTLZ5 problem (12 variables and 3 objectives)

#### DTLZ5

public **DTLZ5** (Integer *numberOfVariables*, Integer *numberOfObjectives*)
Creates a DTLZ5 problem instance

**Parameters**

- **numberOfVariables** – Number of variables

- **numberOfObjectives** – Number of objective functions

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluate() method

### 2.58.6 DTLZ6

public class **DTLZ6** extends *AbstractDoubleProblem*
Class representing problem DTLZ6

#### Constructors

##### DTLZ6

public **DTLZ6** ()
Creates a default DTLZ6 problem (12 variables and 3 objectives)

##### DTLZ6

public **DTLZ6** (Integer *numberOfVariables*, Integer *numberOfObjectives*)
Creates a DTLZ6 problem instance

**Parameters**

- **numberOfVariables** – Number of variables
- **numberOfObjectives** – Number of objective functions

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluate() method

### 2.58.7 DTLZ7

public class **DTLZ7** extends *AbstractDoubleProblem*
Class representing problem DTLZ7

#### Constructors

#### DTLZ7

public **DTLZ7** ()
Creates a default DTLZ7 problem (22 variables and 3 objectives)

#### DTLZ7

public **DTLZ7** (Integer *numberOfVariables*, Integer *numberOfObjectives*)
Creates a DTLZ7 problem instance

**Parameters**

- **numberOfVariables** – Number of variables
- **numberOfObjectives** – Number of objective functions

#### Methods

#### evaluate

public void **evaluate** (*DoubleSolution* *solution*)
Evaluate() method

## 2.59 org.uma.jmetal.problem.multiobjective.ebes

### 2.59.1 Ebes

public class **Ebes** extends *AbstractDoubleProblem* implements *ConstrainedProblem*<*DoubleSolution*>
Class representing problem Ebes Spatial Bars Structure (Estructuras de Barras Espaciales)

#### Fields

#### AREA

int **AREA**

#### ART_ART

int **ART_ART**

#### ART_RIG

int **ART_RIG**

#### AxialForcei_

protected double[] **AxialForcei_**
Stores the Axial force in node i

#### AxialForcej_

protected double[] **AxialForcej_**
Stores the Axial force in node j

#### Ay_

int **Ay_**

#### Az_

int **Az_**

#### BETA

int **BETA**

#### BLijY

int **BLijY_**

#### BLijZ

int **BLijZ_**

#### CARGA_MOMENTO_DISTRIBUIDO

int **CARGA_MOMENTO_DISTRIBUIDO**

#### CARGA_MOMENTO_PUNTUAL

int **CARGA_MOMENTO_PUNTUAL**

#### CARGA_PARABOLICA

int **CARGA_PARABOLICA**

### CARGA_PUNTUAL

int **CARGA_PUNTUAL**

### CARGA_TEMPERATURA

int **CARGA_TEMPERATURA**

### CARGA_TRIANGULAR_I

int **CARGA_TRIANGULAR_I**

### CARGA_UNIFORME_PARCIAL

int **CARGA_UNIFORME_PARCIAL**

### CARGA_UNIFORME_TOTAL

int **CARGA_UNIFORME_TOTAL**

### CARGA__TRIANGULAR_J

int **CARGA__TRIANGULAR_J**

### CIRCLE

public static final int **CIRCLE**

### COMPRESSION

int **COMPRESSION**

### CONSTRAINT

int **CONSTRAINT**

### DESCRIPTION

int **DESCRIPTION**

### DisplacementNodes_

protected double[][] **DisplacementNodes_**
Stores the k displacement

### ELONGATION_NEG

int **ELONGATION_NEG**

### ELONGATION_POS

int **ELONGATION_POS**

### E

int **E_**

### Efforti_

protected double[][][] **Efforti_**
Stores the Effort in node i

### Effortj_

protected double[][][] **Effortj_**
Stores the Effort in node j

### Ei

int **Ei_**

### Ej

int **Ej_**

### Element

protected double[][] **Element_**
Stores the Element

### Fyz

int **Fyz_**

### GROUP

int **GROUP_**

### G_

int **G_**

### GravitationalAxis

String **GravitationalAxis_**

### Groups

protected double[][] **Groups_**
Stores the Groups

### HOLE_CIRCLE

public static final int **HOLE_CIRCLE**

### HOLE_RECTANGLE

public static final int **HOLE_RECTANGLE**

### H_DOUBLE

public static final int **H_DOUBLE**

### H_SINGLE

public static final int **H_SINGLE**

### INDEX

int **INDEX_**

### I_DOUBLE

public static final int **I_DOUBLE**

### I_SINGLE

public static final int **I_SINGLE**

### It

int **It_**

### Iw

int `Iw_`

### Iy

int `Iy_`

### Iz

int `Iz_`

### KGii

double[][] `KGii`

### KGij

double[][] `KGij`

### KGji

double[][] `KGji`

### KGjj

double[][] `KGjj`

### Kii

double[][] `Kii`

### KiiSOG

double[][] `KiiSOG`

### Kij

double[][] `Kij`

### KijSOG

double[][] `KijSOG`

### Kji

double[][] **Kji**

### KjiSOG

double[][] **KjiSOG**

### Kjj

double[][] **Kjj**

### KjjSOG

double[][] **KjjSOG**

### L

int **L_**

### L_DOUBLE

public static final int **L_DOUBLE**

### L_SINGLE

public static final int **L_SINGLE**

### Li

int **Li_**

### Lj

int **Lj_**

### MAX_COLUMN

int **MAX_COLUMN**

### MatrixStiffness_

protected double[] **MatrixStiffness_**
Stores the k

#### MxyMax

protected double[][] **MxyMax_**
Stores the max Mxy for groups

#### MxyMin

protected double[][] **MxyMin_**
Stores the min Mxy for groups

#### MxzMax

protected double[][] **MxzMax_**
Stores the max Mxz for groups

#### MxzMin

protected double[][] **MxzMin_**
Stores the max Mxz for groups

#### NodeRestrict

protected double[][] **NodeRestrict_**
Stores the NodeRestrict

#### Node

protected double[][] **Node_**
Stores the Node

#### NxxMax

protected double[][] **NxxMax_**
Stores the max Nxx for groups

#### NxxMin

protected double[][] **NxxMin_**
Stores the min Nxx for groups

#### OF

String[] **OF_**

### OldStrainMax

protected double[][] **OldStrainMax_**
Stores the max Strain for elements

### OldStrainMin

protected double[][] **OldStrainMin_**

### OverloadInElement

protected double[][] **OverloadInElement_**
Stores the OverLoad on Elements

### PQ

double[][] **PQ**

### QAx

int **QAx_**

### QAy

int **QAy_**

### QAz

int **QAz_**

### QE

int **QE_**

### QH

int **QH_**

### QT

int **QT_**

### Qa

int **Qa_**

### Qb

int **Qb_**

### Qi

double[] **Qi**

### Qj

double[] **Qj**

### RATIO_YZ

int **RATIO_YZ**

### RECTANGLE

public static final int **RECTANGLE**

### RIG_ART

int **RIG_ART**

### RIG_RIG

int **RIG_RIG**

### RTij

double[][] **RTij**

### RTji

double[][] **RTji**

### Reaction

double **Reaction_**

### Rij

double[][] **Rij**

### Rji

double[][] **Rji**

### RpTij

double[][] **RpTij**

### RpTji

double[][] **RpTji**

### Rpij

double[][] **Rpij**

### Rpji

double[][] **Rpji**

### SHAPE

int **SHAPE**

### SPECIFIC_WEIGHT

int **SPECIFIC_WEIGHT**

### STRAIN_COMPRESS

int **STRAIN_COMPRESS**

### STRAIN_CUT

int **STRAIN_CUT**

### STRAIN_TRACTION

int **STRAIN_TRACTION**

### STRESS

int **STRESS**

### STRESS_CUT

int **STRESS_CUT**

### StrainCutMax

protected double[][] **StrainCutMax_**
Stores the max Strain for elements

### StrainMax

protected double[][] **StrainMax_**
Stores the max Strain for elements

### StrainMin

protected double[][] **StrainMin_**

### StrainMxyMax

protected double[][] **StrainMxyMax_**
Stores the max Mxz Strain for groups

### StrainMxyMin

protected double[][] **StrainMxyMin_**
Stores the max Mxz Strain for groups

### StrainMxzMax

protected double[][] **StrainMxzMax_**
Stores the max Mxz Strain for groups

### StrainMxzMin

protected double[][] **StrainMxzMin_**
Stores the max Mxz Strain for groups

#### StrainNxxMax

protected double[][] **StrainNxxMax_**
Stores the max Nxx Strain for groups

#### StrainNxxMin

protected double[][] **StrainNxxMin_**

#### StrainResidualCut

protected double[] **StrainResidualCut_**
Stores the Cut Strain Residual for elements

#### StrainResidualMax

protected double[] **StrainResidualMax_**
Stores the max Strain for elements

#### StrainResidualMin

protected double[] **StrainResidualMin_**
Stores the min Strain for elements

#### Straini_

protected double[][][] **Straini_**
Stores the Strain in node i

#### Strainj

protected double[][][] **Strainj_**
Stores the Strain in node j

#### T_DOUBLE

public static final int **T_DOUBLE**

#### T_SINGLE

public static final int **T_SINGLE**

#### TypeMaterial

int **TypeMaterial_**

### VARIABLES

int **VARIABLES**

### VAR_POSITION

int **VAR_POSITION**

### VAR_Y_LOWER_LIMIT

int **VAR_Y_LOWER_LIMIT**

### VAR_Y_UPPER_LIMIT

int **VAR_Y_UPPER_LIMIT**

### VAR_Z_LOWER_LIMIT

int **VAR_Z_LOWER_LIMIT**

### VAR_Z_UPPER_LIMIT

int **VAR_Z_UPPER_LIMIT**

### VAR_eY_LOWER_LIMIT

int **VAR_eY_LOWER_LIMIT**

### VAR_eY_UPPER_LIMIT

int **VAR_eY_UPPER_LIMIT**

### VAR_eZ_LOWER_LIMIT

int **VAR_eZ_LOWER_LIMIT**

### VAR_eZ_UPPER_LIMIT

int **VAR_eZ_UPPER_LIMIT**

### Vij

int **Vij_**

#### WeightElement

protected double[][] **WeightElement_**
Stores the Load on Elements Itself

#### WeightNode

protected double[][] **WeightNode_**
Stores the Load on Nodes

#### Y

int **Y_**

#### Z

int **Z_**

#### aX

int **aX_**

#### aY_

int **aY_**

#### aZ_

int **aZ_**

#### cbi

double[][][] **cbi**

#### cbj

double[][][] **cbj**

#### dY

int **dY_**

#### eY

int **eY_**

#### eZ

int **eZ_**

#### elementsBetweenDiffGreat

protected int **elementsBetweenDiffGreat_**
Stores the Elements Between Difference Greatest

#### gX

int **gX_**

#### gY

int **gY_**

#### gZ

int **gZ_**

#### g_

double **g_**

#### geometryCheck_

protected int[][] **geometryCheck_**

#### i

int **i_**

#### j

int **j_**

#### lBuckling

public boolean **lBuckling**

### lLoadsOwnWeight

public boolean **lLoadsOwnWeight**

### lSecondOrderGeometric

public boolean **lSecondOrderGeometric**

### lZ

int **lZ_**

### matrixWidthBand

protected int **matrixWidthBand_**
Stores the number a wide the diagonal matrix

### nodeCheck_

protected double[][] **nodeCheck_**
Stores the number of Nodes of the problem

### numberOfConstraintsGeometric

public int **numberOfConstraintsGeometric_**

### numberOfConstraintsNodes

protected int **numberOfConstraintsNodes_**

### numberOfElements

protected int **numberOfElements_**
Stores the number of Bar of the problem

### numberOfEval

protected int **numberOfEval_**
Stores the number of Bar Groups

### numberOfGroupElements

protected int **numberOfGroupElements_**
Stores the number of Bar Groups

### numberOfGroupsToCheckGeometry

protected int **numberOfGroupsToCheckGeometry_**

### numberOfLibertyDegree

protected int **numberOfLibertyDegree_**
Stores the number of Nodes of the problem

### numberOfNodes

protected int **numberOfNodes**

### numberOfNodesRestricts_

protected int **numberOfNodesRestricts_**

### numberOfWeigthHypothesis

protected int **numberOfWeigthHypothesis_**

### numberOfWeigthsElements

protected int **numberOfWeigthsElements_**
Stores the number of Load in ElementsNodes of the problem

### numberOfWeigthsNodes

protected int **numberOfWeigthsNodes_**
Stores the number of Load in Nodes of the problem

### omegaMax

protected double[][] **omegaMax_**
Stores the max omega for groups

### overallConstraintViolationDegree

public *OverallConstraintViolation*<*DoubleSolution*> **overallConstraintViolationDegree**

### pi

double[] **pi**

### pj

double[] **pj**

### rZ

int **rZ_**

### selectedOF

int **selectedOF**

### strainAdmissibleCut

protected int **strainAdmissibleCut_**

### uY

int **uY_**

## Constructors

### Ebes

public **Ebes** ()

### Ebes

public **Ebes** (String *ebesFileName*, String[] *objectiveList*)
Constructor

**Throws**

- **FileNotFoundException** –

## Methods

### AxialForcei_

public double **AxialForcei_** (int *element*)

### AxialForcej_

public double **AxialForcej_** (int *element*)

### BucklingOmega

public double **BucklingOmega** (double *Nxx*, double[] *G*, double[] *B*)

### DisplacementNodes

public double **DisplacementNodes** (int *node*, int *hi*)

### EBEsAssignAxialForces

public void **EBEsAssignAxialForces** (int *hi*)

### EBEsCalculus

public void **EBEsCalculus** ()

### EBEsEcuationSolution

public void **EBEsEcuationSolution** (int *hi*)

### EBEsEffortsElements3D

public void **EBEsEffortsElements3D** (int *hi*, int *countIter*, double[][] *Slip*)

### EBEsEffortsTotal3D

public void **EBEsEffortsTotal3D** (int *hi*)

### EBEsElementsTopology

public void **EBEsElementsTopology** (*DoubleSolution* *solution*)

### EBEsInitialize

public void **EBEsInitialize** (String *file*)

### EBEsMat3DG

public void **EBEsMat3DG** (int *e*)

### EBEsMat3DGij

public void **EBEsMat3DGij** ()

### EBEsMat3DL_SOG

public void **EBEsMat3DL_SOG** (int *e*)

### EBEsMat3DL_iArt_jArt

public void **EBEsMat3DL_iArt_jArt** (int *e*)

### EBEsMat3DL_iArt_jRig

public void **EBEsMat3DL_iArt_jRig** (int *e*)

### EBEsMat3DL_iRig_jArt

public void **EBEsMat3DL_iRig_jArt** (int *e*)

### EBEsMat3DL_iRig_jRig

public void **EBEsMat3DL_iRig_jRig** (int *e*)

### EBEsMatRot3DLaG

public void **EBEsMatRot3DLaG** (int *e*)

### EBEsMatRot3DLpSaL

public void **EBEsMatRot3DLpSaL** (int *e*)

### EBEsMatrixAdd

public double[][] **EBEsMatrixAdd** (double[][] *s*, double[][] *t*)

### EBEsMatrixGlobalFactory

public void **EBEsMatrixGlobalFactory** (int *countIter*)

### EBEsMatrixGlobalPenalization

public void **EBEsMatrixGlobalPenalization** ()

### EBEsMatrixSubtractions

public double[][] **EBEsMatrixSubtractions** (double[][] *s*, double[][] *t*)

#### EBEsMatrixWeight

public void **EBEsMatrixWeight** (int *hi*)

#### EBEsMatrizMultiplicar

public double[][] **EBEsMatrizMultiplicar** (double[][] *s*, double[][] *t*)

#### EBEsMatrizTraspuesta

public double[][] **EBEsMatrizTraspuesta** (double[][] *m*)

#### EBEsMatrizVectorMultiplicar

public double[] **EBEsMatrizVectorMultiplicar** (double[][] *s*, double[] *t*)

#### EBEsNodesEquilibrium3D

public void **EBEsNodesEquilibrium3D** (int *hi*)

#### EBEsOverloadWeightElement

public void **EBEsOverloadWeightElement** ()

#### EBEsPrintArchTxtDesp

public void **EBEsPrintArchTxtDesp** (int *hi*)

#### EBEsPrintArchTxtEfforts

public void **EBEsPrintArchTxtEfforts** (int *hi*)

#### EBEsPrintArchTxtElements

public void **EBEsPrintArchTxtElements** ()

#### EBEsPrintArchTxtMKG

public void **EBEsPrintArchTxtMKG** (String *s*, int *hi*)

#### EBEsPrintArchTxtMKLB

public void **EBEsPrintArchTxtMKLB** (int *e*)

### EBEsPrintArchTxtReaction

public void **EBEsPrintArchTxtReaction** (int *hi*)

### EBEsPrintArchTxtStrain

public void **EBEsPrintArchTxtStrain** ()

### EBEsReactions3D

public void **EBEsReactions3D** (int *hi*)

### EBEsReadDataFile

public final void **EBEsReadDataFile** (String *fileName*)

### EBEsReadProblems

public String **EBEsReadProblems** ()

### EBEsSteelingResults

public void **EBEsSteelingResults** (int *hi*)

### EBEsStrainMaxWhitElement

public void **EBEsStrainMaxWhitElement** ()

### EBEsStrainMaxWhitGroup

public void **EBEsStrainMaxWhitGroup** ()

### EBEsStrainMinWhitElement

public void **EBEsStrainMinWhitElement** ()

### EBEsStrainMinWhitGroup

public void **EBEsStrainMinWhitGroup** ()

### EBEsStrainNode

public double[][][] **EBEsStrainNode** (double[][][] *E*)

#### EBEsStrainResidualVerication

public void **EBEsStrainResidualVerication**()

#### EBEsTransversalSectionCircular

public void **EBEsTransversalSectionCircular**(int *gr*, double *d*)

#### EBEsTransversalSectionHoleCircular

public void **EBEsTransversalSectionHoleCircular**(int *gr*, double *D*, double *e*)

#### EBEsTransversalSectionHoleRectangle

public void **EBEsTransversalSectionHoleRectangle**(int *gr*, double *y*, double *z*, double *ey*, double *ez*)

#### EBEsTransversalSectionRectangle

public void **EBEsTransversalSectionRectangle**(int *gr*, double *y*, double *z*)

#### EBEsTransversalSection_H_Double

public void **EBEsTransversalSection_H_Double**(int *gr*, double *y*, double *z*, double *ey*, double *ez*)

#### EBEsTransversalSection_H_Single

public void **EBEsTransversalSection_H_Single**(int *gr*, double *y*, double *z*, double *ey*, double *ez*)

#### EBEsTransversalSection_I_Double

public void **EBEsTransversalSection_I_Double**(int *gr*, double *y*, double *z*, double *ey*, double *ez*)

#### EBEsTransversalSection_I_Single

public void **EBEsTransversalSection_I_Single**(int *gr*, double *y*, double *z*, double *ey*, double *ez*)

#### EBEsTransversalSection_L_Double

public void **EBEsTransversalSection_L_Double**(int *gr*, double *y*, double *z*, double *ey*, double *ez*)

#### EBEsTransversalSection_L_Single

public void **EBEsTransversalSection_L_Single**(int *gr*, double *y*, double *z*, double *ey*, double *ez*)

#### EBEsTransversalSection_T_Double

public void **EBEsTransversalSection_T_Double** (int *ba*, double *y*, double *z*, double *ey*, double *ez*)

#### EBEsTransversalSection_T_Single

public void **EBEsTransversalSection_T_Single** (int *ba*, double *y*, double *z*, double *ey*, double *ez*)

#### EBEsWeightDistributedUniformly

public void **EBEsWeightDistributedUniformly** (int *el*, double[] *LoadInElement_*)

#### EBEsWeightNodes

public void **EBEsWeightNodes** ()

#### EBEsWeigthElement

public void **EBEsWeigthElement** ()

#### Efforti

public double **Efforti** (int *i*, int *element*, int *hypothesis*)

#### Effortj

public double **Effortj** (int *i*, int *element*, int *hypothesis*)

#### FunctionENS

public double **FunctionENS** (int *hi*)

#### FunctionsMahalanobis_Distance_With_Variance

public double **FunctionsMahalanobis_Distance_With_Variance** (int *hi*)

#### Interpolation_I_Single_Y_func_Area

public double **Interpolation_I_Single_Y_func_Area_** (double *A*)

#### Interpolation_I_Single_Y_func_Wxy

public double **Interpolation_I_Single_Y_func_Wxy_** (double *Wxy*)

### Interpolation_I_Single_Y_func_Wxz

public double **Interpolation_I_Single_Y_func_Wxz_** (double *Wxz*)

### Interpolation_I_Single_Z_func_Y

public double **Interpolation_I_Single_Z_func_Y_** (double *Y*)

### Interpolation_I_Single_ey_func_Y

public double **Interpolation_I_Single_ey_func_Y_** (double *Y*)

### Interpolation_I_Single_ez_func_Y

public double **Interpolation_I_Single_ez_func_Y_** (double *Y*)

### MatrixStiffness

public double **MatrixStiffness** (int *i*)

### Straini

public double **Straini** (int *i*, int *element*, int *hypothesis*)

### Variable_Position

public int **Variable_Position** ()

### createSolution

public *DoubleSolution* **createSolution** ()

### evaluate

public void **evaluate** (*DoubleSolution solution*)

Evaluates a solution

**Parameters**

- **solution** – The solution to evaluate

### evaluateConstraints

public void **evaluateConstraints** (*DoubleSolution solution*)

Evaluates the constraint overhead of a solution

**Parameters**

- **solution** – The solution

**Throws**

- ***JMetalException*** –

### geometryCheck

public int **geometryCheck** (int *i*, int *j*)

### getElement

public double **getElement** (int *i*, int *j*)

### getElementsBetweenDiffGreat

public int **getElementsBetweenDiffGreat** ()

### getGroupShape

public int **getGroupShape** (int *groupId*)

### getGroups

public double **getGroups** (int *i*)

### getMatrixWidthBand

public int **getMatrixWidthBand** ()

### getMxyMax

public double **getMxyMax** (int *group*, int *hypothesis*)

### getMxyMin

public double **getMxyMin** (int *group*, int *hypothesis*)

#### getMxzMax

public double **getMxzMax** (int *group*, int *hypothesis*)

#### getMxzMin

public double **getMxzMin** (int *group*, int *hypothesis*)

#### getNode

public double **getNode** (int *i*, int *j*)

#### getNodeRestrict

public double **getNodeRestrict** (int *i*, int *j*)

#### getNumberOfConstraintsNodes

public int **getNumberOfConstraintsNodes** ()

#### getNumberOfElements

public int **getNumberOfElements** ()

#### getNumberOfNodes

public int **getNumberOfNodes** ()

#### getNumberOfNodesRestricts

public int **getNumberOfNodesRestricts** ()

#### getNumberOfWeigthHypothesis

public int **getNumberOfWeigthHypothesis** ()

#### getNumberOfWeigthsElements

public int **getNumberOfWeigthsElements** ()

#### getNumberOfWeigthsNodes

public int **getNumberOfWeigthsNodes** ()

### getNxxMax

public double **getNxxMax** (int *group*, int *hypothesis*)

### getNxxMin

public double **getNxxMin** (int *group*, int *hypothesis*)

### getOldStrainMax

public double **getOldStrainMax** (int *group*, int *hypothesis*)

### getOldStrainMin

public double **getOldStrainMin** (int *group*, int *hypothesis*)

### getOmegaMax

public double **getOmegaMax** (int *group*, int *hypothesis*)

### getStrainAdmissibleCut

public int **getStrainAdmissibleCut** ()

### getStrainCutMax

public double **getStrainCutMax** (int *group*, int *hypothesis*)

### getStrainMax

public double **getStrainMax** (int *group*, int *hypothesis*)

### getStrainMin

public double **getStrainMin** (int *group*, int *hypothesis*)

### getStrainMxyMax

public double **getStrainMxyMax** (int *group*, int *hypothesis*)

### getStrainMxyMin

public double **getStrainMxyMin** (int *group*, int *hypothesis*)

#### getStrainMxzMax

public double **getStrainMxzMax** (int *group*, int *hypothesis*)

#### getStrainMxzMin

public double **getStrainMxzMin** (int *group*, int *hypothesis*)

#### getStrainNxxMax

public double **getStrainNxxMax** (int *group*, int *hypothesis*)

#### getStrainNxxMin

public double **getStrainNxxMin** (int *group*, int *hypothesis*)

#### getStrainResidualCut

public double **getStrainResidualCut** (int *hypothesis*)

#### getStrainResidualMax

public double **getStrainResidualMax** (int *hypothesis*)

#### getStrainResidualMin

public double **getStrainResidualMin** (int *hypothesis*)

#### getStrainj

public double **getStrainj** (int *i*, int *element*, int *hypothesis*)

#### getVariablePosition

public int **getVariablePosition** (int *groupId*)

#### getWeightElement

public double **getWeightElement** (int *i*, int *j*)

#### getWeightElementItself

public double **getWeightElementItself** (int *i*, int *j*)

#### getWeightNode

public double **getWeightNode** (int *i*, int *j*)

#### getnumberOfConstraintsGeometric

public int **getnumberOfConstraintsGeometric** ()

#### getnumberOfGroupElements

public int **getnumberOfGroupElements** ()

#### nodeCheck

public double **nodeCheck** (int *i*, int *j*)

#### numberOfNodesRestricts

public void **numberOfNodesRestricts** (int *numberOfNodesRestricts*)

#### setElementsBetweenDiffGreat

public void **setElementsBetweenDiffGreat** (int *elementsBetweenDiffGreat*)

#### setMatrixWidthBand

public void **setMatrixWidthBand** (int *matrixWidthBand*)

#### setNumberOfConstraintsNodes

public void **setNumberOfConstraintsNodes** (int *numberOfConstraintsNodes*)

#### setNumberOfElements

public void **setNumberOfElements** (int *numberOfElements*)

#### setNumberOfNodes

public void **setNumberOfNodes** (int *numberOfNodes*)

#### setNumberOfWeigthHypothesis

public void **setNumberOfWeigthHypothesis** (int *numberOfWeigthHypothesis*)

#### setNumberOfWeigthsElements

public void **setNumberOfWeigthsElements** (int *numberOfWeigthsElements*)

#### setNumberOfWeigthsNodes

public void **setNumberOfWeigthsNodes** (int *numberOfWeigthsNodes*)

#### setStrainAdmissibleCut

public void **setStrainAdmissibleCut** (int *strainAdmissibleCut*)

#### setnumberOfConstraintsGeometric

public void **setnumberOfConstraintsGeometric** (int *i*)

#### setnumberOfGroupElements

public void **setnumberOfGroupElements** (int *i*)

## 2.60 org.uma.jmetal.problem.multiobjective.glt

### 2.60.1 GLT1

public class **GLT1** extends *AbstractDoubleProblem*

Problem GLT1. Defined in F. Gu, H.-L. Liu, and K. C. Tan, "A multiobjective evolutionary algorithm using dynamic weight design method," International Journal of Innovative Computing, Information and Control, vol. 8, no. 5B, pp. 3677–3688, 2012.

**Author** Antonio J. Nebro

#### Constructors

#### GLT1

public **GLT1** ()

Default constructor

#### GLT1

public **GLT1** (int *numberOfVariables*)

Constructor

**Parameters**

- **numberOfVariables** –

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution solution*)

### 2.60.2 GLT2

public class **GLT2** extends *AbstractDoubleProblem*

Problem GLT2. Defined in F. Gu, H.-L. Liu, and K. C. Tan, "A multiobjective evolutionary algorithm using dynamic weight design method," International Journal of Innovative Computing, Information and Control, vol. 8, no. 5B, pp. 3677–3688, 2012.

**Author** Antonio J. Nebro

#### Constructors

##### GLT2

public **GLT2** ()

Default constructor

##### GLT2

public **GLT2** (int *numberOfVariables*)

Constructor

**Parameters**

- **numberOfVariables** –

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution solution*)

### 2.60.3 GLT3

public class **GLT3** extends *AbstractDoubleProblem*

Problem GLT3. Defined in F. Gu, H.-L. Liu, and K. C. Tan, "A multiobjective evolutionary algorithm using dynamic weight design method," International Journal of Innovative Computing, Information and Control, vol. 8, no. 5B, pp. 3677–3688, 2012.

**Author** Antonio J. Nebro

#### Constructors

##### GLT3

public **GLT3** ()
Default constructor

##### GLT3

public **GLT3** (int *numberOfVariables*)
Constructor

**Parameters**

- **numberOfVariables** –

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution solution*)

### 2.60.4 GLT4

public class **GLT4** extends *AbstractDoubleProblem*
Problem GLT4. Defined in F. Gu, H.-L. Liu, and K. C. Tan, "A multiobjective evolutionary algorithm using dynamic weight design method," International Journal of Innovative Computing, Information and Control, vol. 8, no. 5B, pp. 3677–3688, 2012.

**Author** Antonio J. Nebro

#### Constructors

##### GLT4

public **GLT4** ()
Default constructor

##### GLT4

public **GLT4** (int *numberOfVariables*)
Constructor

**Parameters**

- **numberOfVariables** –

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution solution*)

### 2.60.5 GLT5

public class **GLT5** extends *AbstractDoubleProblem*

Problem GLT5. Defined in F. Gu, H.-L. Liu, and K. C. Tan, "A multiobjective evolutionary algorithm using dynamic weight design method," International Journal of Innovative Computing, Information and Control, vol. 8, no. 5B, pp. 3677–3688, 2012.

**Author** Antonio J. Nebro

#### Constructors

##### GLT5

public **GLT5** ()

Default constructor

##### GLT5

public **GLT5** (int *numberOfVariables*)

Constructor

**Parameters**

- **numberOfVariables** –

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution solution*)

### 2.60.6 GLT6

public class **GLT6** extends *AbstractDoubleProblem*

Problem GLT6. Defined in F. Gu, H.-L. Liu, and K. C. Tan, "A multiobjective evolutionary algorithm using dynamic weight design method," International Journal of Innovative Computing, Information and Control, vol. 8, no. 5B, pp. 3677–3688, 2012.

**Author** Antonio J. Nebro

#### Constructors

##### GLT6

public **GLT6**()
Default constructor

##### GLT6

public **GLT6**(int *numberOfVariables*)
Constructor

**Parameters**

- **numberOfVariables** –

#### Methods

##### evaluate

public void **evaluate**(*DoubleSolution solution*)

## 2.61 org.uma.jmetal.problem.multiobjective.lz09

### 2.61.1 LZ09

public class **LZ09**
Base class to implement the problem of the lz09 benchmark, which is defined in: H. Li and Q. Zhang. Multiobjective optimization problem with complicated pareto sets, MOEA/D and NSGA-II. IEEE Transactions on Evolutionary Computation, 12(2):284-302, April 2009.

#### Fields

##### dtype

int **dtype**

##### ltype

int **ltype**

##### nobj

int **nobj**

#### nvar

int **nvar**

#### ptype

int **ptype**

### Constructors

#### LZ09

public **LZ09** (int *nvar*, int *nobj*, int *ptype*, int *dtype*, int *ltype*)

### Methods

#### alphaFunction

void **alphaFunction** (double[] *alpha*, List<Double> *x*, int *dim*, int *type*)

#### betaFunction

double **betaFunction** (List<Double> *x*, int *type*)

#### objective

void **objective** (List<Double> *xVar*, List<Double> *yObj*)

#### psfunc2

double **psfunc2** (double *x*, double *t1*, int *dim*, int *type*, int *css*)

#### psfunc3

double **psfunc3** (double *x*, double *t1*, double *t2*, int *dim*, int *type*)

## 2.61.2 LZ09F1

public class **LZ09F1** extends *AbstractDoubleProblem*

Class representing problem LZ09F1

#### Constructors

##### LZ09F1

public **LZ09F1** ()
Creates a default LZ09F1 problem (10 variables and 2 objectives)

##### LZ09F1

public **LZ09F1** (Integer *ptype*, Integer *dtype*, Integer *ltype*)
Creates a LZ09F1 problem instance

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution* *solution*)
Evaluate() method

### 2.61.3 LZ09F2

public class **LZ09F2** extends *AbstractDoubleProblem*
Class representing problem LZ09F2

#### Constructors

##### LZ09F2

public **LZ09F2** ()
Creates a default LZ09F2 problem (30 variables and 3 objectives)

##### LZ09F2

public **LZ09F2** (Integer *ptype*, Integer *dtype*, Integer *ltype*)
Creates a LZ09F2 problem instance

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution* *solution*)
Evaluate() method

### 2.61.4 LZ09F3

public class **LZ09F3** extends *AbstractDoubleProblem*
Class representing problem LZ09F3

#### Constructors

##### LZ09F3

public **LZ09F3** ()
Creates a default LZ09F3 problem (30 variables and 2 objectives)

##### LZ09F3

public **LZ09F3** (Integer *ptype*, Integer *dtype*, Integer *ltype*)
Creates a LZ09F3 problem instance

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution* *solution*)
Evaluate() method

### 2.61.5 LZ09F4

public class **LZ09F4** extends *AbstractDoubleProblem*
Class representing problem LZ09F4

#### Constructors

##### LZ09F4

public **LZ09F4** ()
Creates a default LZ09F4 problem (30 variables and 2 objectives)

##### LZ09F4

public **LZ09F4** (Integer *ptype*, Integer *dtype*, Integer *ltype*)
Creates a LZ09F4 problem instance

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution* *solution*)
Evaluate() method

### 2.61.6 LZ09F5

public class **LZ09F5** extends *AbstractDoubleProblem*
Class representing problem LZ09F5

#### Constructors

##### LZ09F5

public **LZ09F5**()
Creates a default LZ09F5 problem (30 variables and 2 objectives)

##### LZ09F5

public **LZ09F5**(Integer *ptype*, Integer *dtype*, Integer *ltype*)
Creates a LZ09F5 problem instance

#### Methods

##### evaluate

public void **evaluate**(*DoubleSolution* *solution*)
Evaluate() method

### 2.61.7 LZ09F6

public class **LZ09F6** extends *AbstractDoubleProblem*
Class representing problem LZ09F6

#### Constructors

##### LZ09F6

public **LZ09F6**()
Creates a default LZ09F6 problem (30 variables and 2 objectives)

##### LZ09F6

public **LZ09F6**(Integer *ptype*, Integer *dtype*, Integer *ltype*)
Creates a LZ09F6 problem instance

#### Methods

##### evaluate

public void **evaluate**(*DoubleSolution* *solution*)
Evaluate() method

### 2.61.8 LZ09F7

public class **LZ09F7** extends *AbstractDoubleProblem*
Class representing problem LZ09F7

#### Constructors

##### LZ09F7

public **LZ09F7**()
Creates a default LZ09F7 problem (10 variables and 2 objectives)

##### LZ09F7

public **LZ09F7**(Integer *ptype*, Integer *dtype*, Integer *ltype*)
Creates a LZ09F7 problem instance

#### Methods

##### evaluate

public void **evaluate**(*DoubleSolution* *solution*)
Evaluate() method

### 2.61.9 LZ09F8

public class **LZ09F8** extends *AbstractDoubleProblem*
Class representing problem LZ09F8

#### Constructors

##### LZ09F8

public **LZ09F8**()
Creates a default LZ09F8 problem (10 variables and 2 objectives)

##### LZ09F8

public **LZ09F8**(Integer *ptype*, Integer *dtype*, Integer *ltype*)
Creates a LZ09F8 problem instance

#### Methods

##### evaluate

public void **evaluate**(*DoubleSolution* *solution*)
Evaluate() method

### 2.61.10 LZ09F9

public class **LZ09F9** extends *AbstractDoubleProblem*
Class representing problem LZ09F9

#### Constructors

##### LZ09F9

public **LZ09F9**()
Creates a default LZ09F9 problem (30 variables and 2 objectives)

##### LZ09F9

public **LZ09F9**(Integer *ptype*, Integer *dtype*, Integer *ltype*)
Creates a LZ09F9 problem instance

#### Methods

##### evaluate

public void **evaluate**(*DoubleSolution* *solution*)
Evaluate() method

## 2.62 org.uma.jmetal.problem.multiobjective.maf

### 2.62.1 MaF01

public class **MaF01** extends *AbstractDoubleProblem*
Class representing problem MaF01

#### Constructors

##### MaF01

public **MaF01**()
Default constructor

##### MaF01

public **MaF01**(Integer *numberOfVariables*, Integer *numberOfObjectives*)
Creates a MaF01 problem instance

**Parameters**

- **numberOfVariables** – Number of variables
- **numberOfObjectives** – Number of objective functions

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluates a solution

**Parameters**

- **solution** – The solution to evaluate

### 2.62.2 MaF02

public class **MaF02** extends *AbstractDoubleProblem*
Class representing problem MaF02, DTLZ2BZ

#### Fields

##### const2

public static int **const2**

#### Constructors

##### MaF02

public **MaF02** ()
Default constructor

##### MaF02

public **MaF02** (Integer *numberOfVariables*, Integer *numberOfObjectives*)
Creates a MaF02 problem instance

**Parameters**

- **numberOfVariables** – Number of variables
- **numberOfObjectives** – Number of objective functions

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluates a solution

**Parameters**

- **solution** – The solution to evaluate

## 2.62.3 MaF03

public class **MaF03** extends *AbstractDoubleProblem*
Class representing problem MaF03, convex DTLZ3

### Constructors

#### MaF03

public **MaF03**()
Default constructor

#### MaF03

public **MaF03**(Integer *numberOfVariables*, Integer *numberOfObjectives*)
Creates a MaF03 problem instance

**Parameters**

- **numberOfVariables** – Number of variables
- **numberOfObjectives** – Number of objective functions

### Methods

#### evaluate

public void **evaluate**(*DoubleSolution solution*)
Evaluates a solution

**Parameters**

- **solution** – The solution to evaluate

## 2.62.4 MaF04

public class **MaF04** extends *AbstractDoubleProblem*
Class representing problem MaF04

### Fields

#### const4

public static double **const4**

### Constructors

#### MaF04

public **MaF04**()
Default constructor

#### MaF04

public **MaF04** (Integer *numberOfVariables*, Integer *numberOfObjectives*)
Creates a MaF04 problem instance

**Parameters**

- **numberOfVariables** – Number of variables
- **numberOfObjectives** – Number of objective functions

#### Methods

#### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluates a solution

**Parameters**

- **solution** – The solution to evaluate

### 2.62.5 MaF05

public class **MaF05** extends *AbstractDoubleProblem*
Class representing problem MaF05

#### Fields

#### const5

public static double **const5**

#### Constructors

#### MaF05

public **MaF05** ()
Default constructor

#### MaF05

public **MaF05** (Integer *numberOfVariables*, Integer *numberOfObjectives*)
Creates a MaF05 problem instance

**Parameters**

- **numberOfVariables** – Number of variables
- **numberOfObjectives** – Number of objective functions

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluates a solution

**Parameters**

- **solution** – The solution to evaluate

### 2.62.6 MaF06

public class **MaF06** extends *AbstractDoubleProblem*
Class representing problem MaF06

#### Constructors

##### MaF06

public **MaF06** ()
Default constructor

##### MaF06

public **MaF06** (Integer *numberOfVariables*, Integer *numberOfObjectives*)
Creates a MaF06 problem instance

**Parameters**

- **numberOfVariables** – Number of variables
- **numberOfObjectives** – Number of objective functions

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluates a solution

**Parameters**

- **solution** – The solution to evaluate

### 2.62.7 MaF07

public class **MaF07** extends *AbstractDoubleProblem*
Class representing problem MaF07

#### Constructors

##### MaF07

public **MaF07** ()
Default constructor

##### MaF07

public **MaF07** (Integer *numberOfVariables*, Integer *numberOfObjectives*)
Creates a MaF07 problem instance

**Parameters**

- **numberOfVariables** – Number of variables
- **numberOfObjectives** – Number of objective functions

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluates a solution

**Parameters**

- **solution** – The solution to evaluate

### 2.62.8 MaF08

public class **MaF08** extends *AbstractDoubleProblem*
Class representing problem MaF08

#### Fields

##### const8

public static double **const8**

#### Constructors

##### MaF08

public **MaF08** ()
Default constructor

#### MaF08

public **MaF08** (Integer *numberOfVariables*, Integer *numberOfObjectives*)
Creates a MaF03 problem instance

**Parameters**

- **numberOfVariables** – Number of variables
- **numberOfObjectives** – Number of objective functions

#### Methods

#### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluates a solution

**Parameters**

- **solution** – The solution to evaluate

#### nextPoint

public static double[] **nextPoint** (double *arc*, double[] *startp*, double *r*)

#### polygonpoints

public static double[][] **polygonpoints** (int *m*, double *r*)

### 2.62.9 MaF09

public class **MaF09** extends *AbstractDoubleProblem*
Class representing problem MaF05

#### Fields

#### M9

public static int **M9**

#### maxinter9

public static int **maxinter9**

#### pindex9

public static int **pindex9**

#### points9

public static double **points9**

### Constructors

#### MaF09

public **MaF09** ()
Default constructor

#### MaF09

public **MaF09** (Integer *numberOfVariables*, Integer *numberOfObjectives*)
Creates a MaF09 problem instance

**Parameters**

- **numberOfVariables** – Number of variables
- **numberOfObjectives** – Number of objective functions

### Methods

#### checkWithJdkGeneralPath

public static boolean **checkWithJdkGeneralPath** (Point2D.Double *point*, List<Point2D.Double> *polygon*)

#### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluates a solution

**Parameters**

- **solution** – The solution to evaluate

#### generV

public static double **generV** (double *lb*, double *ub*)

#### if_infeasible

public static boolean **if_infeasible** (double[] *x*)

#### if_inside_polygon

public static boolean **if_inside_polygon** (double[] *p1*, double[][] *points*)

#### intersection

public static double[] **intersection** (double[] *kb1*, double[] *kb2*)

#### line_of_twoP

public static double[] **line_of_twoP** (double[] *p1*, double[] *p2*)

#### lines_of_polygon

public double[][] **lines_of_polygon** (double[][] *p*)

#### polygonpoints

public static double[][] **polygonpoints** (int *m*, double *r*)

## 2.62.10 MaF10

public class **MaF10** extends *AbstractDoubleProblem*
Class representing problem MaF10

### Fields

#### K10

public static int **K10**

### Constructors

#### MaF10

public **MaF10** ()
Default constructor

#### MaF10

public **MaF10** (Integer *numberOfVariables*, Integer *numberOfObjectives*)
Creates a MaF10 problem instance

**Parameters**

- **numberOfVariables** – Number of variables
- **numberOfObjectives** – Number of objective functions

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluates a solution

**Parameters**

- **solution** – The solution to evaluate

### 2.62.11 MaF11

public class **MaF11** extends *AbstractDoubleProblem*
Class representing problem MaF11

#### Fields

##### K11

public static int **K11**

#### Constructors

##### MaF11

public **MaF11** ()
Default constructor

##### MaF11

public **MaF11** (Integer *numberOfVariables*, Integer *numberOfObjectives*)
Creates a MaF11 problem instance

**Parameters**

- **numberOfVariables** – Number of variables
- **numberOfObjectives** – Number of objective functions

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluates a solution

**Parameters**

- **solution** – The solution to evaluate

### 2.62.12 MaF12

public class **MaF12** extends *AbstractDoubleProblem*
  Class representing problem MaF12

#### Fields

##### K12

public static int **K12**

#### Constructors

##### MaF12

public **MaF12** ()
  Default constructor

##### MaF12

public **MaF12** (Integer *numberOfVariables*, Integer *numberOfObjectives*)
  Creates a MaF12 problem instance

  **Parameters**

  - **numberOfVariables** – Number of variables
  - **numberOfObjectives** – Number of objective functions

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution solution*)
  Evaluates a solution

  **Parameters**

  - **solution** – The solution to evaluate

### 2.62.13 MaF13

public class **MaF13** extends *AbstractDoubleProblem*
  Class representing problem MaF13

#### Constructors

##### MaF13

public **MaF13** ()
  Default constructor

#### MaF13

public **MaF13** (Integer *numberOfVariables*, Integer *numberOfObjectives*)
Creates a MaF13 problem instance

**Parameters**

- **numberOfVariables** – Number of variables
- **numberOfObjectives** – Number of objective functions

### Methods

#### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluates a solution

**Parameters**

- **solution** – The solution to evaluate

## 2.62.14 MaF14

public class **MaF14** extends *AbstractDoubleProblem*
Class representing problem MaF14

### Fields

#### nk14

public static int **nk14**

#### sublen14

public static int **sublen14**

### Constructors

#### MaF14

public **MaF14** ()
Default constructor

#### MaF14

public **MaF14** (Integer *numberOfVariables*, Integer *numberOfObjectives*)
Creates a MaF14 problem instance

**Parameters**

- **numberOfVariables** – Number of variables
- **numberOfObjectives** – Number of objective functions

#### Methods

##### Rastrigin

public static double **Rastrigin** (double[] *x*)

##### Rosenbrock

public static double **Rosenbrock** (double[] *x*)

##### evaluate

public void **evaluate** (*DoubleSolution* *solution*)

### 2.62.15 MaF15

public class **MaF15** extends *AbstractDoubleProblem*
Class representing problem MaF15

#### Fields

##### nk15

public static int **nk15**

##### sublen15

public static int **sublen15**

#### Constructors

##### MaF15

public **MaF15** ()
Default constructor

##### MaF15

public **MaF15** (Integer *numberOfVariables*, Integer *numberOfObjectives*)
Creates a MaF15 problem instance

**Parameters**

- **numberOfVariables** – Number of variables

- **numberOfObjectives** – Number of objective functions

#### Methods

#### Griewank

public static double **Griewank** (double[] *x*)

#### Sphere

public static double **Sphere** (double[] *x*)

#### evaluate

public void **evaluate** (*DoubleSolution solution*)

Evaluates a solution

**Parameters**

- **solution** – The solution to evaluate

## 2.63 org.uma.jmetal.problem.multiobjective.mop

### 2.63.1 MOP1

public class **MOP1** extends *AbstractDoubleProblem*

Problem MOP1. Defined in H. L. Liu, F. Gu and Q. Zhang, "Decomposition of a Multiobjective Optimization Problem Into a Number of Simple Multiobjective Subproblems," in IEEE Transactions on Evolutionary Computation, vol. 18, no. 3, pp. 450-455, June 2014.

**Author** Mastermay

#### Constructors

#### MOP1

public **MOP1** ()

Constructor. Creates default instance of problem MOP1 (10 decision variables)

#### MOP1

public **MOP1** (Integer *numberOfVariables*)

Creates a new instance of problem MOP1.

**Parameters**

- **numberOfVariables** – Number of variables.

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluate() method

### 2.63.2 MOP2

public class **MOP2** extends *AbstractDoubleProblem*
Problem MOP2. Defined in H. L. Liu, F. Gu and Q. Zhang, "Decomposition of a Multiobjective Optimization Problem Into a Number of Simple Multiobjective Subproblems," in IEEE Transactions on Evolutionary Computation, vol. 18, no. 3, pp. 450-455, June 2014.

**Author** Mastermay

#### Constructors

##### MOP2

public **MOP2** ()
Constructor. Creates default instance of problem MOP2 (10 decision variables)

##### MOP2

public **MOP2** (Integer *numberOfVariables*)
Creates a new instance of problem MOP2.

**Parameters**

- **numberOfVariables** – Number of variables.

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluate() method

### 2.63.3 MOP3

public class **MOP3** extends *AbstractDoubleProblem*
Problem MOP3. Defined in H. L. Liu, F. Gu and Q. Zhang, "Decomposition of a Multiobjective Optimization Problem Into a Number of Simple Multiobjective Subproblems," in IEEE Transactions on Evolutionary Computation, vol. 18, no. 3, pp. 450-455, June 2014.

**Author** Mastermay

#### Constructors

##### MOP3

public **MOP3** ()
Constructor. Creates default instance of problem MOP3 (10 decision variables)

##### MOP3

public **MOP3** (Integer *numberOfVariables*)
Creates a new instance of problem MOP3.

**Parameters**

- **numberOfVariables** – Number of variables.

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluate() method

### 2.63.4 MOP4

public class **MOP4** extends *AbstractDoubleProblem*
Problem MOP4. Defined in H. L. Liu, F. Gu and Q. Zhang, "Decomposition of a Multiobjective Optimization Problem Into a Number of Simple Multiobjective Subproblems," in IEEE Transactions on Evolutionary Computation, vol. 18, no. 3, pp. 450-455, June 2014.

**Author** Mastermay

#### Constructors

##### MOP4

public **MOP4** ()
Constructor. Creates default instance of problem MOP4 (10 decision variables)

##### MOP4

public **MOP4** (Integer *numberOfVariables*)
Creates a new instance of problem MOP4.

**Parameters**

- **numberOfVariables** – Number of variables.

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluate() method

### 2.63.5 MOP5

public class **MOP5** extends *AbstractDoubleProblem*
Problem MOP5. Defined in H. L. Liu, F. Gu and Q. Zhang, "Decomposition of a Multiobjective Optimization Problem Into a Number of Simple Multiobjective Subproblems," in IEEE Transactions on Evolutionary Computation, vol. 18, no. 3, pp. 450-455, June 2014.

**Author** Mastermay

#### Constructors

##### MOP5

public **MOP5** ()
Constructor. Creates default instance of problem MOP5 (10 decision variables)

##### MOP5

public **MOP5** (Integer *numberOfVariables*)
Creates a new instance of problem MOP5.

**Parameters**

- **numberOfVariables** – Number of variables.

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluate() method

### 2.63.6 MOP6

public class **MOP6** extends *AbstractDoubleProblem*
Problem MOP6. Defined in H. L. Liu, F. Gu and Q. Zhang, "Decomposition of a Multiobjective Optimization Problem Into a Number of Simple Multiobjective Subproblems," in IEEE Transactions on Evolutionary Computation, vol. 18, no. 3, pp. 450-455, June 2014.

**Author** Mastermay

#### Constructors

##### MOP6

public **MOP6** ()
Constructor. Creates default instance of problem MOP6 (10 decision variables)

##### MOP6

public **MOP6** (Integer *numberOfVariables*)
Creates a new instance of problem MOP6.

**Parameters**

- **numberOfVariables** – Number of variables.

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluate() method

### 2.63.7 MOP7

public class **MOP7** extends *AbstractDoubleProblem*
Problem MOP7. Defined in H. L. Liu, F. Gu and Q. Zhang, "Decomposition of a Multiobjective Optimization Problem Into a Number of Simple Multiobjective Subproblems," in IEEE Transactions on Evolutionary Computation, vol. 18, no. 3, pp. 450-455, June 2014.

**Author** Mastermay

#### Constructors

##### MOP7

public **MOP7** ()
Constructor. Creates default instance of problem MOP7 (10 decision variables)

##### MOP7

public **MOP7** (Integer *numberOfVariables*)
Creates a new instance of problem MOP7.

**Parameters**

- **numberOfVariables** – Number of variables.

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluate() method

## 2.64 org.uma.jmetal.problem.multiobjective.wfg

### 2.64.1 Shapes

public class **Shapes**
Class implementing shape functions for wfg benchmark Reference: Simon Huband, Luigi Barone, Lyndon While, Phil Hingston A Scalable Multi-objective Test Problem Toolkit. Evolutionary Multi-Criterion Optimization: Third International Conference, EMO 2005. Proceedings, volume 3410 of Lecture Notes in Computer Science

#### Methods

##### concave

public float **concave** (float[] *x*, int *m*)
Calculate a concave shape

##### convex

public float **convex** (float[] *x*, int *m*)
Calculate a convex shape

##### disc

public float **disc** (float[] *x*, int *A*, float *alpha*, float *beta*)
Calculate a disc shape

##### linear

public float **linear** (float[] *x*, int *m*)
Calculate a linear shape

##### mixed

public float **mixed** (float[] *x*, int *A*, float *alpha*)
Calculate a mixed shape

### 2.64.2 Transformations

public class **Transformations**
Class implementing the basics transformations for wfg

#### Methods

#### bFlat

public float **bFlat** (float *y*, float *A*, float *B*, float *C*)
bFlat transformation

#### bParam

public float **bParam** (float *y*, float *u*, float *A*, float *B*, float *C*)
bParam transformation

#### bPoly

public float **bPoly** (float *y*, float *alpha*)
bPoly transformation

**Throws**

- *org.uma.jmetal.util.JMetalException* –

#### correctTo01

float **correctTo01** (float *a*)

#### rNonsep

public float **rNonsep** (float[] *y*, int *A*)
rNonsep transformation

#### rSum

public float **rSum** (float[] *y*, float[] *w*)
rSum transformation

#### sDecept

public float **sDecept** (float *y*, float *A*, float *B*, float *C*)
sDecept transformation

#### sLinear

public float **sLinear** (float *y*, float *A*)
sLinear transformation

#### sMulti

public float **sMulti** (float *y*, int *A*, int *B*, float *C*)
sMulti transformation

### 2.64.3 WFG

public abstract class **WFG** extends *AbstractDoubleProblem*
Implements a reference abstract class for all wfg org.uma.test problem Reference: Simon Huband, Luigi Barone, Lyndon While, Phil Hingston A Scalable Multi-objective Test Problem Toolkit. Evolutionary Multi-Criterion Optimization: Third International Conference, EMO 2005. Proceedings, volume 3410 of Lecture Notes in Computer Science

#### Fields

##### a

protected int[] **a**

##### d

protected int **d**

##### k

protected int **k**

##### l

protected int **l**

##### m

protected int **m**

##### random

protected Random **random**

#### s

protected int[] **s**

### Constructors

#### WFG

public **WFG** (Integer *k*, Integer *l*, Integer *M*)
Constructor Creates a wfg problem

**Parameters**

- **k** – position-related parameters
- **l** – distance-related parameters
- **M** – Number of objectives

### Methods

#### calculateX

public float[] **calculateX** (float[] *t*)
Gets the x vector

#### correctTo01

public float **correctTo01** (float *a*)

#### createSolution

public *DoubleSolution* **createSolution** ()

#### evaluate

public abstract float[] **evaluate** (float[] *variables*)
Evaluates a solution

**Parameters**

- **variables** – The solution to evaluate

**Returns** a double [] with the evaluation results

#### normalise

public float[] **normalise** (float[] *z*)
Normalizes a vector (consulte wfg toolkit reference)

#### subVector

public float[] **subVector** (float[] *z*, int *head*, int *tail*)

Gets a subvector of a given vector (Head inclusive and tail inclusive)

**Parameters**

- **z** – the vector

**Returns** the subvector

### 2.64.4 WFG1

public class **WFG1** extends *WFG*

This class implements the WFG1 problem Reference: Simon Huband, Luigi Barone, Lyndon While, Phil Hingston A Scalable Multi-objective Test Problem Toolkit. Evolutionary Multi-Criterion Optimization: Third International Conference, EMO 2005. Proceedings, volume 3410 of Lecture Notes in Computer Science

#### Constructors

#### WFG1

public **WFG1** ()

Constructor Creates a default WFG1 instance with 2 position-related parameters 4 distance-related parameters and 2 objectives

#### WFG1

public **WFG1** (Integer *k*, Integer *l*, Integer *m*)

Creates a WFG1 problem instance

**Parameters**

- **k** – Number of position parameters
- **l** – Number of distance parameters
- **m** – Number of objective functions

#### Methods

#### evaluate

public float[] **evaluate** (float[] *z*)

Evaluate

#### evaluate

public void **evaluate** (*DoubleSolution* *solution*)

Evaluates a solution

**Parameters**

- **solution** – The solution to runAlgorithm

**Throws**

- *org.uma.jmetal.util.JMetalException* –

#### t1

public float[] **t1** (float[] *z*, int *k*)
WFG1 t1 transformation

#### t2

public float[] **t2** (float[] *z*, int *k*)
WFG1 t2 transformation

#### t3

public float[] **t3** (float[] *z*)
WFG1 t3 transformation

**Throws**

- *org.uma.jmetal.util.JMetalException* –

#### t4

public float[] **t4** (float[] *z*, int *k*, int *M*)
WFG1 t4 transformation

## 2.64.5 WFG2

public class **WFG2** extends *WFG*
This class implements the WFG2 problem Reference: Simon Huband, Luigi Barone, Lyndon While, Phil Hingston A Scalable Multi-objective Test Problem Toolkit. Evolutionary Multi-Criterion Optimization: Third International Conference, EMO 2005. Proceedings, volume 3410 of Lecture Notes in Computer Science

### Constructors

#### WFG2

public **WFG2** ()
Creates a default WFG2 instance with 2 position-related parameters 4 distance-related parameters and 2 objectives

#### WFG2

public **WFG2** (Integer *k*, Integer *l*, Integer *m*)
Creates a WFG2 problem instance

**Parameters**

- **k** – Number of position parameters
- **l** – Number of distance parameters
- **m** – Number of objective functions

#### Methods

#### evaluate

public float[] **evaluate** (float[] *z*)

#### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluates a solution

**Parameters**

- **solution** – The solution to runAlgorithm

#### t1

public float[] **t1** (float[] *z*, int *k*)
WFG2 t1 transformation

#### t2

public float[] **t2** (float[] *z*, int *k*)
WFG2 t2 transformation

#### t3

public float[] **t3** (float[] *z*, int *k*, int *M*)
WFG2 t3 transformation

### 2.64.6 WFG3

public class **WFG3** extends *WFG*
This class implements the WFG3 problem Reference: Simon Huband, Luigi Barone, Lyndon While, Phil Hingston A Scalable Multi-objective Test Problem Toolkit. Evolutionary Multi-Criterion Optimization: Third International Conference, EMO 2005. Proceedings, volume 3410 of Lecture Notes in Computer Science

### Constructors

#### WFG3

public **WFG3**()
Creates a default WFG3 instances with 2 position-related parameters 4 distance-related parameters and 2 objectives

#### WFG3

public **WFG3**(Integer *k*, Integer *l*, Integer *m*)
Creates a WFG3 problem instance

**Parameters**

- **k** – Number of position parameters
- **l** – Number of distance parameters
- **m** – Number of objective functions

### Methods

#### evaluate

public float[] **evaluate**(float[] *z*)

#### evaluate

public void **evaluate**(*DoubleSolution solution*)
Evaluates a solution

**Parameters**

- **solution** – The solution to runAlgorithm

**Throws**

- *org.uma.jmetal.util.JMetalException* –

#### t1

public float[] **t1**(float[] *z*, int *k*)
WFG3 t1 transformation

#### t2

public float[] **t2**(float[] *z*, int *k*)
WFG3 t2 transformation

#### t3

public float[] **t3** (float[] *z*, int *k*, int *M*)
WFG3 t3 transformation

### 2.64.7 WFG4

public class **WFG4** extends *WFG*
This class implements the WFG4 problem Reference: Simon Huband, Luigi Barone, Lyndon While, Phil Hingston A Scalable Multi-objective Test Problem Toolkit. Evolutionary Multi-Criterion Optimization: Third International Conference, EMO 2005. Proceedings, volume 3410 of Lecture Notes in Computer Science

#### Constructors

#### WFG4

public **WFG4** ()
Creates a default WFG4 with 2 position-related parameter, 4 distance-related parameter and 2 objectives

#### WFG4

public **WFG4** (Integer *k*, Integer *l*, Integer *m*)
Creates a WFG4 problem instance

**Parameters**

- **k** – Number of position parameters
- **l** – Number of distance parameters
- **m** – Number of objective functions

#### Methods

#### evaluate

public float[] **evaluate** (float[] *z*)
Evaluate() method

#### evaluate

public void **evaluate** (*DoubleSolution* *solution*)
Evaluates a solution

**Parameters**

- **solution** – The solution to runAlgorithm

**Throws**

- *org.uma.jmetal.util.JMetalException* –

#### t1

public float[] **t1** (float[] *z*, int *k*)
WFG4 t1 transformation

#### t2

public float[] **t2** (float[] *z*, int *k*, int *M*)
WFG4 t2 transformation

### 2.64.8 WFG5

public class **WFG5** extends *WFG*
This class implements the WFG5 problem Reference: Simon Huband, Luigi Barone, Lyndon While, Phil Hingston A Scalable Multi-objective Test Problem Toolkit. Evolutionary Multi-Criterion Optimization: Third International Conference, EMO 2005. Proceedings, volume 3410 of Lecture Notes in Computer Science

#### Constructors

#### WFG5

public **WFG5** ()
Creates a default WFG5 instance with 2 position-related parameters 4 distance-related parameters and 2 objectives

#### WFG5

public **WFG5** (Integer *k*, Integer *l*, Integer *m*)
Creates a WFG5 problem instance

**Parameters**

- **k** – Number of position parameters
- **l** – Number of distance parameters
- **m** – Number of objective functions

#### Methods

#### evaluate

public float[] **evaluate** (float[] *z*)
Evaluate() method

#### evaluate

public void **evaluate** (*DoubleSolution* *solution*)
Evaluates a solution

**Parameters**

- **solution** – The solution to runAlgorithm

**Throws**

- *org.uma.jmetal.util.JMetalException* –

### t1

public float[] **t1** (float[] *z*, int *k*)
WFG5 t1 transformation

### t2

public float[] **t2** (float[] *z*, int *k*, int *M*)
WFG5 t2 transformation

## 2.64.9 WFG6

public class **WFG6** extends *WFG*
This class implements the WFG6 problem Reference: Simon Huband, Luigi Barone, Lyndon While, Phil Hingston A Scalable Multi-objective Test Problem Toolkit. Evolutionary Multi-Criterion Optimization: Third International Conference, EMO 2005. Proceedings, volume 3410 of Lecture Notes in Computer Science

### Constructors

### WFG6

public **WFG6** ()
Creates a default WFG6 with 2 position-related parameters, 4 distance-related parameters, and 2 objectives

### WFG6

public **WFG6** (Integer *k*, Integer *l*, Integer *m*)
Creates a WFG6 problem instance

**Parameters**

- **k** – Number of position parameters
- **l** – Number of distance parameters
- **m** – Number of objective functions

### Methods

### evaluate

public float[] **evaluate** (float[] *z*)
Evaluate() method

#### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluates a solution

**Parameters**

- **solution** – The solution to runAlgorithm

**Throws**

- ***org.uma.jmetal.util.JMetalException*** –

#### t1

public float[] **t1** (float[] *z*, int *k*)
WFG6 t1 transformation

#### t2

public float[] **t2** (float[] *z*, int *k*, int *M*)
WFG6 t2 transformation

### 2.64.10 WFG7

public class **WFG7** extends *WFG*

#### Constructors

#### WFG7

public **WFG7** ()
Creates a default WFG7 problem with 2 position-related parameters, 4 distance-related parameters, and 2 objectives

#### WFG7

public **WFG7** (Integer *k*, Integer *l*, Integer *m*)
Creates a WFG7 problem instance

**Parameters**

- **k** – Number of position parameters
- **l** – Number of distance parameters
- **m** – Number of objective functions

#### Methods

##### evaluate

public float[] **evaluate** (float[] *z*)
Evaluate() method

##### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluate() method

##### t1

public float[] **t1** (float[] *z*, int *k*)
WFG7 t1 transformation

##### t2

public float[] **t2** (float[] *z*, int *k*)
WFG7 t2 transformation

##### t3

public float[] **t3** (float[] *z*, int *k*, int *M*)
WFG7 t3 transformation

### 2.64.11 WFG8

public class **WFG8** extends *WFG*
Creates a default WFG8 problem with 2 position-related parameters, 4 distance-related parameters, and 2 objectives

#### Constructors

##### WFG8

public **WFG8** ()
Creates a default WFG8 with 2 position-related parameters, 4 distance-related parameters, and 2 objectives

##### WFG8

public **WFG8** (Integer *k*, Integer *l*, Integer *m*)
Creates a WFG8 problem instance

**Parameters**

- **k** – Number of position parameters

- **l** – Number of distance parameters
- **m** – Number of objective functions

### Methods

#### evaluate

public float[] **evaluate** (float[] *z*)
  Evaluate() method

#### evaluate

public void **evaluate** (*DoubleSolution solution*)
  Evaluates a solution

  **Parameters**
  - **solution** – The solution to runAlgorithm

  **Throws**
  - *org.uma.jmetal.util.JMetalException* –

#### t1

public float[] **t1** (float[] *z*, int *k*)
  WFG8 t1 transformation

#### t2

public float[] **t2** (float[] *z*, int *k*)
  WFG8 t2 transformation

#### t3

public float[] **t3** (float[] *z*, int *k*, int *M*)
  WFG8 t3 transformation

## 2.64.12 WFG9

public class **WFG9** extends *WFG*
  Creates a default WFG9 problem with 2 position-related parameters, 4 distance-related parameters, and 2 objectives

## Constructors

### WFG9

public **WFG9** ()

Creates a default WFG9 with 2 position-related parameters, 4 distance-related parameters, and 2 objectives

### WFG9

public **WFG9** (Integer *k*, Integer *l*, Integer *m*)

Creates a WFG9 problem instance

**Parameters**

- **k** – Number of position variables
- **l** – Number of distance variables
- **m** – Number of objective functions

## Methods

### evaluate

public float[] **evaluate** (float[] *z*)

Evaluate() method

### evaluate

public void **evaluate** (*DoubleSolution solution*)

Evaluates a solution

**Parameters**

- **solution** – The solution to runAlgorithm

**Throws**

- ***org.uma.jmetal.util.JMetalException*** –

### t1

public float[] **t1** (float[] *z*, int *k*)

WFG9 t1 transformation

### t2

public float[] **t2** (float[] *z*, int *k*)

WFG9 t2 transformation

#### t3

public float[] **t3** (float[] *z*, int *k*, int *M*)
WFG9 t3 transformation

## 2.65 org.uma.jmetal.problem.multiobjective.zdt

### 2.65.1 ZDT1

public class **ZDT1** extends *AbstractDoubleProblem*
Class representing problem ZDT1

#### Constructors

#### ZDT1

public **ZDT1** ()
Constructor. Creates default instance of problem ZDT1 (30 decision variables)

#### ZDT1

public **ZDT1** (Integer *numberOfVariables*)
Creates a new instance of problem ZDT1.

**Parameters**

- **numberOfVariables** – Number of variables.

#### Methods

#### evalH

public double **evalH** (double *f*, double *g*)
Returns the value of the ZDT1 function H.

**Parameters**

- **f** – First argument of the function H.
- **g** – Second argument of the function H.

#### evaluate

public void **evaluate** (*DoubleSolution* *solution*)
Evaluate() method

### 2.65.2 ZDT2

public class **ZDT2** extends *AbstractDoubleProblem*
Class representing problem ZDT2

#### Constructors

##### ZDT2

public **ZDT2** ()
Constructor. Creates default instance of problem ZDT2 (30 decision variables)

##### ZDT2

public **ZDT2** (Integer *numberOfVariables*)
Constructor. Creates a new ZDT2 problem instance.

**Parameters**

- **numberOfVariables** – Number of variables

#### Methods

##### evalH

public double **evalH** (double *f*, double *g*)
Returns the value of the ZDT2 function H.

**Parameters**

- **f** – First argument of the function H.
- **g** – Second argument of the function H.

##### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluate() method

### 2.65.3 ZDT3

public class **ZDT3** extends *AbstractDoubleProblem*
Class representing problem ZDT3

#### Constructors

##### ZDT3

public **ZDT3** ()
Constructor. Creates default instance of problem ZDT3 (30 decision variables)

#### ZDT3

public **ZDT3** (Integer *numberOfVariables*)
Constructor. Creates a instance of ZDT3 problem.

**Parameters**

- **numberOfVariables** – Number of variables.

### Methods

#### evalH

public double **evalH** (double *f*, double *g*)
Returns the value of the ZDT3 function H.

**Parameters**

- **f** – First argument of the function H.
- **g** – Second argument of the function H.

#### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluate() method

## 2.65.4 ZDT4

public class **ZDT4** extends *AbstractDoubleProblem*
Class representing problem ZDT4

### Constructors

#### ZDT4

public **ZDT4** ()
Constructor. Creates a default instance of problem ZDT4 (10 decision variables

#### ZDT4

public **ZDT4** (Integer *numberOfVariables*)
Creates a instance of problem ZDT4.

**Parameters**

- **numberOfVariables** – Number of variables.

#### Methods

##### evalG

public double **evalG** (*DoubleSolution solution*)
Returns the value of the ZDT4 function G.

**Parameters**

- **solution** – Solution

##### evalH

public double **evalH** (double *f*, double *g*)
Returns the value of the ZDT4 function H.

**Parameters**

- **f** – First argument of the function H.
- **g** – Second argument of the function H.

##### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluate() method

### 2.65.5 ZDT5

public class **ZDT5** extends *AbstractBinaryProblem*
Class representing problem ZDT5

#### Constructors

##### ZDT5

public **ZDT5** ()
Creates a default instance of problem ZDT5 (11 decision variables)

##### ZDT5

public **ZDT5** (Integer *numberOfVariables*)
Creates a instance of problem ZDT5

**Parameters**

- **numberOfVariables** – Number of variables.

#### Methods

##### evalG

public double **evalG** (*BinarySolution solution*)
Returns the value of the ZDT5 function G.

**Parameters**

- **solution** – The solution.

##### evalH

public double **evalH** (double *f*, double *g*)
Returns the value of the ZDT5 function H.

**Parameters**

- **f** – First argument of the function H.
- **g** – Second argument of the function H.

##### evalV

public double **evalV** (double *value*)
Returns the value of the ZDT5 function V.

**Parameters**

- **value** – The parameter of V function.

##### evaluate

public void **evaluate** (*BinarySolution solution*)
Evaluate() method

##### getBitsPerVariable

protected int **getBitsPerVariable** (int *index*)

### 2.65.6 ZDT6

public class **ZDT6** extends *AbstractDoubleProblem*
Class representing problem ZDT6

#### Constructors

##### ZDT6

public **ZDT6** ()
Constructor. Creates a default instance of problem ZDT6 (10 decision variables)

#### ZDT6

public **ZDT6**(Integer *numberOfVariables*)
Creates a instance of problem ZDT6

**Parameters**

- **numberOfVariables** – Number of variables

#### Methods

#### evalG

public double **evalG**(*DoubleSolution solution*)
Returns the value of the ZDT6 function G.

**Parameters**

- **solution** – Solution

#### evalH

public double **evalH**(double *f*, double *g*)
Returns the value of the ZDT6 function H.

**Parameters**

- **f** – First argument of the function H.
- **g** – Second argument of the function H.

#### evaluate

public void **evaluate**(*DoubleSolution solution*)
Evaluate() method

## 2.66 org.uma.jmetal.problem.singleobjective

### 2.66.1 CEC2005Problem

public class **CEC2005Problem** extends *AbstractDoubleProblem*
Class representing for solving the CEC2005 competition problems.

#### Fields

#### testFunction

*TestFunc* **testFunction**

#### Constructors

##### CEC2005Problem

public **CEC2005Problem** (int *problemID*, int *numberOfVariables*)
Constructor

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluate() method

### 2.66.2 Griewank

public class **Griewank** extends *AbstractDoubleProblem*
Class representing problem Griewank

#### Constructors

##### Griewank

public **Griewank** (Integer *numberOfVariables*)
Constructor Creates a default instance of the Griewank problem

**Parameters**

- **numberOfVariables** – Number of variables of the problem

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution solution*)
Evaluate() method

### 2.66.3 NIntegerMin

public class **NIntegerMin** extends *AbstractIntegerProblem*
Created by Antonio J. Nebro on 03/07/14. Single objective problem for testing integer encoding. Objective: minimizing the distance to value N

#### Constructors

##### NIntegerMin

public **NIntegerMin** ()

#### NIntegerMin

public **NIntegerMin** (int *numberOfVariables*, int *n*, int *lowerBound*, int *upperBound*)
Constructor

### Methods

#### evaluate

public void **evaluate** (*IntegerSolution solution*)
Evaluate() method

## 2.66.4 OneMax

public class **OneMax** extends *AbstractBinaryProblem*
Class representing problem OneMax. The problem consist of maximizing the number of '1's in a binary string.

### Constructors

#### OneMax

public **OneMax** ()
Constructor

#### OneMax

public **OneMax** (Integer *numberOfBits*)
Constructor

### Methods

#### createSolution

public *BinarySolution* **createSolution** ()

#### evaluate

public void **evaluate** (*BinarySolution solution*)
Evaluate() method

#### getBitsPerVariable

protected int **getBitsPerVariable** (int *index*)

### 2.66.5 Rastrigin

public class **Rastrigin** extends *AbstractDoubleProblem*

#### Constructors

##### Rastrigin

public **Rastrigin** (Integer *numberOfVariables*)
Constructor Creates a default instance of the Rastrigin problem

**Parameters**

- **numberOfVariables** – Number of variables of the problem

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution* *solution*)
Evaluate() method

### 2.66.6 Rosenbrock

public class **Rosenbrock** extends *AbstractDoubleProblem*

#### Constructors

##### Rosenbrock

public **Rosenbrock** (Integer *numberOfVariables*)
Constructor Creates a default instance of the Rosenbrock problem

**Parameters**

- **numberOfVariables** – Number of variables of the problem

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution* *solution*)
Evaluate() method

### 2.66.7 Sphere

public class **Sphere** extends *AbstractDoubleProblem*
Class representing a Sphere problem.

#### Constructors

##### Sphere

public **Sphere** ()
    Constructor

##### Sphere

public **Sphere** (Integer *numberOfVariables*)
    Constructor

#### Methods

##### evaluate

public void **evaluate** (*DoubleSolution* *solution*)
    Evaluate() method

### 2.66.8 TSP

public class **TSP** extends *AbstractIntegerPermutationProblem*
    Class representing a single-objective TSP (Traveling Salesman Problem) problem. It accepts data files from TSPLIB: http://www.iwr.uni-heidelberg.de/groups/comopt/software/TSPLIB95/tsp/

#### Constructors

##### TSP

public **TSP** (String *distanceFile*)
    Creates a new TSP problem instance

#### Methods

##### evaluate

public void **evaluate** (*PermutationSolution*<Integer> *solution*)
    Evaluate() method

##### getPermutationLength

public int **getPermutationLength** ()

## 2.67 org.uma.jmetal.problem.singleobjective.cec2005competitioncode

### 2.67.1 Benchmark

public class **Benchmark**

#### Fields

##### CEC2005SUPPORTDATADIRECTORY

public static final String **CEC2005SUPPORTDATADIRECTORY**

##### DEFAULT_FILE_BIAS

public static final String **DEFAULT_FILE_BIAS**

##### MAX_SUPPORT_DIM

public static final int **MAX_SUPPORT_DIM**

##### NUM_TEST_FUNC

public static final int **NUM_TEST_FUNC**

##### PIx2

public static final double **PIx2**

##### loader

public static final ClassLoader **loader**

##### numberFormatter

public static final DecimalFormat **numberFormatter**

##### percentageFormatter

public static final DecimalFormat **percentageFormatter**

##### random

public static final Random **random**

### scientificFormatter

public static final DecimalFormat **scientificFormatter**

### test_func_arg_types

static final Class<?>[] **test_func_arg_types**

### test_func_class_names

public static final String[] **test_func_class_names**

## Constructors

### Benchmark

public **Benchmark** ()

### Benchmark

public **Benchmark** (String *file_bias*)

## Methods

### Ax

public static void **Ax** (double[] *result*, double[][] *A*, double[] *x*)

### EScafferF6

public static double **EScafferF6** (double[] *x*)

### EScafferF6NonCont

public static double **EScafferF6NonCont** (double[] *x*)

### F2

public static double **F2** (double *x*, double *y*)

### F8

public static double **F8** (double *x*)

### F8F2

public static double **F8F2** (double[] *x*)

### ScafferF6

public static double **ScafferF6** (double *x*, double *y*)

### ackley

public static double **ackley** (double[] *x*)

### elliptic

public static double **elliptic** (double[] *x*)

### griewank

public static double **griewank** (double[] *x*)

### hybrid_composition

public static double **hybrid_composition** (double[] *x*, *HCJob* *job*)

### loadColumnVector

public static void **loadColumnVector** (BufferedReader *brSrc*, int *rows*, double[] *column*)

### loadColumnVectorFromFile

public static void **loadColumnVectorFromFile** (String *file*, int *rows*, double[] *column*)

### loadMatrix

public static void **loadMatrix** (BufferedReader *brSrc*, int *rows*, int *columns*, double[][] *matrix*)

### loadMatrixFromFile

public static void **loadMatrixFromFile** (String *file*, int *rows*, int *columns*, double[][] *matrix*)

### loadNMatrixFromFile

public static void **loadNMatrixFromFile** (String *file*, int *N*, int *rows*, int *columns*, double[][][] *matrix*)

### loadRowVector

public static void **loadRowVector** (BufferedReader *brSrc*, int *columns*, double[] *row*)

### loadRowVectorFromFile

public static void **loadRowVectorFromFile** (String *file*, int *columns*, double[] *row*)

### loadTestDataFromFile

public static void **loadTestDataFromFile** (String *file*, int *num_test_points*, int *test_dimension*, double[][] *x*, double[] *f*)

### main

public static void **main** (String[] *args*)

### myRound

public static double **myRound** (double *x*)

### myXRound

public static double **myXRound** (double *x*, double *o*)

### myXRound

public static double **myXRound** (double *x*)

### rastrigin

public static double **rastrigin** (double[] *x*)

### rastriginNonCont

public static double **rastriginNonCont** (double[] *x*)

### rosenbrock

public static double **rosenbrock** (double[] *x*)

### rotate

public static void **rotate** (double[] *results*, double[] *x*, double[][] *matrix*)

#### runTest

public void **runTest** ()

#### runTest

public void **runTest** (int *func_num*)

#### schwefel_102

public static double **schwefel_102** (double[] *x*)

#### shift

public static void **shift** (double[] *results*, double[] *x*, double[] *o*)

#### sphere

public static double **sphere** (double[] *x*)

#### sphere_noise

public static double **sphere_noise** (double[] *x*)

#### testFunctionFactory

public *TestFunc* **testFunctionFactory** (int *func_num*, int *dimension*)

#### weierstrass

public static double **weierstrass** (double[] *x*)

#### weierstrass

public static double **weierstrass** (double[] *x*, double *a*, double *b*, int *Kmax*)

#### xA

public static void **xA** (double[] *result*, double[] *x*, double[][] *A*)

#### xy

public static double **xy** (double[] *x*, double[] *y*)

## 2.67.2 F01ShiftedSphere

public class **F01ShiftedSphere** extends *TestFunc*

### Fields

#### DEFAULT_FILE_DATA

public static final String **DEFAULT_FILE_DATA**

#### FUNCTION_NAME

public static final String **FUNCTION_NAME**

### Constructors

#### F01ShiftedSphere

public **F01ShiftedSphere** (int *dimension*, double *bias*)

#### F01ShiftedSphere

public **F01ShiftedSphere** (int *dimension*, double *bias*, String *file_data*)

### Methods

#### f

public double **f** (double[] *x*)

## 2.67.3 F02ShiftedSchwefel

public class **F02ShiftedSchwefel** extends *TestFunc*

### Fields

#### DEFAULT_FILE_DATA

public static final String **DEFAULT_FILE_DATA**

#### FUNCTION_NAME

public static final String **FUNCTION_NAME**

#### Constructors

##### F02ShiftedSchwefel

public **F02ShiftedSchwefel** (int *dimension*, double *bias*)

##### F02ShiftedSchwefel

public **F02ShiftedSchwefel** (int *dimension*, double *bias*, String *file_data*)

#### Methods

##### f

public double **f** (double[] *x*)

### 2.67.4 F03ShiftedRotatedHighCondElliptic

public class **F03ShiftedRotatedHighCondElliptic** extends *TestFunc*

#### Fields

##### DEFAULT_FILE_DATA

public static final String **DEFAULT_FILE_DATA**

##### DEFAULT_FILE_MX_PREFIX

public static final String **DEFAULT_FILE_MX_PREFIX**

##### DEFAULT_FILE_MX_SUFFIX

public static final String **DEFAULT_FILE_MX_SUFFIX**

##### FUNCTION_NAME

public static final String **FUNCTION_NAME**

#### Constructors

##### F03ShiftedRotatedHighCondElliptic

public **F03ShiftedRotatedHighCondElliptic** (int *dimension*, double *bias*)

#### F03ShiftedRotatedHighCondElliptic

public **F03ShiftedRotatedHighCondElliptic**(int *dimension*, double *bias*, String *file_data*, String *file_m*)

### Methods

#### f

public double **f**(double[] *x*)

## 2.67.5 F04ShiftedSchwefelNoise

public class **F04ShiftedSchwefelNoise** extends *TestFunc*

### Fields

#### DEFAULT_FILE_DATA

public static final String **DEFAULT_FILE_DATA**

#### FUNCTION_NAME

public static final String **FUNCTION_NAME**

### Constructors

#### F04ShiftedSchwefelNoise

public **F04ShiftedSchwefelNoise**(int *dimension*, double *bias*)

#### F04ShiftedSchwefelNoise

public **F04ShiftedSchwefelNoise**(int *dimension*, double *bias*, String *file_data*)

### Methods

#### f

public double **f**(double[] *x*)

## 2.67.6 F05SchwefelGlobalOptBound

public class **F05SchwefelGlobalOptBound** extends *TestFunc*

#### Fields

##### DEFAULT_FILE_DATA

public static final String **DEFAULT_FILE_DATA**

##### FUNCTION_NAME

public static final String **FUNCTION_NAME**

#### Constructors

##### F05SchwefelGlobalOptBound

public **F05SchwefelGlobalOptBound** (int *dimension*, double *bias*)

##### F05SchwefelGlobalOptBound

public **F05SchwefelGlobalOptBound** (int *dimension*, double *bias*, String *file_data*)

#### Methods

##### f

public double **f** (double[] *x*)

### 2.67.7 F06ShiftedRosenbrock

public class **F06ShiftedRosenbrock** extends *TestFunc*

#### Fields

##### DEFAULT_FILE_DATA

public static final String **DEFAULT_FILE_DATA**

##### FUNCTION_NAME

public static final String **FUNCTION_NAME**

#### Constructors

##### F06ShiftedRosenbrock

public **F06ShiftedRosenbrock** (int *dimension*, double *bias*)

#### F06ShiftedRosenbrock

public **F06ShiftedRosenbrock** (int *dimension*, double *bias*, String *file_data*)

#### Methods

#### f

public double **f** (double[] *x*)

### 2.67.8 F07ShiftedRotatedGriewank

public class **F07ShiftedRotatedGriewank** extends *TestFunc*

#### Fields

#### DEFAULT_FILE_DATA

public static final String **DEFAULT_FILE_DATA**

#### DEFAULT_FILE_MX_PREFIX

public static final String **DEFAULT_FILE_MX_PREFIX**

#### DEFAULT_FILE_MX_SUFFIX

public static final String **DEFAULT_FILE_MX_SUFFIX**

#### FUNCTION_NAME

public static final String **FUNCTION_NAME**

#### Constructors

#### F07ShiftedRotatedGriewank

public **F07ShiftedRotatedGriewank** (int *dimension*, double *bias*)

#### F07ShiftedRotatedGriewank

public **F07ShiftedRotatedGriewank** (int *dimension*, double *bias*, String *file_data*, String *file_m*)

#### Methods

##### f

public double **f** (double[] *x*)

### 2.67.9 F08ShiftedRotatedAckleyGlobalOptBound

public class **F08ShiftedRotatedAckleyGlobalOptBound** extends *TestFunc*

#### Fields

##### DEFAULT_FILE_DATA

public static final String **DEFAULT_FILE_DATA**

##### DEFAULT_FILE_MX_PREFIX

public static final String **DEFAULT_FILE_MX_PREFIX**

##### DEFAULT_FILE_MX_SUFFIX

public static final String **DEFAULT_FILE_MX_SUFFIX**

##### FUNCTION_NAME

public static final String **FUNCTION_NAME**

#### Constructors

##### F08ShiftedRotatedAckleyGlobalOptBound

public **F08ShiftedRotatedAckleyGlobalOptBound** (int *dimension*, double *bias*)

##### F08ShiftedRotatedAckleyGlobalOptBound

public **F08ShiftedRotatedAckleyGlobalOptBound** (int *dimension*, double *bias*, String *file_data*, String *file_m*)

#### Methods

##### f

public double **f** (double[] *x*)

### 2.67.10 F09ShiftedRastrigin

public class **F09ShiftedRastrigin** extends *TestFunc*

#### Fields

##### DEFAULT_FILE_DATA

public static final String **DEFAULT_FILE_DATA**

##### FUNCTION_NAME

public static final String **FUNCTION_NAME**

#### Constructors

##### F09ShiftedRastrigin

public **F09ShiftedRastrigin** (int *dimension*, double *bias*)

##### F09ShiftedRastrigin

public **F09ShiftedRastrigin** (int *dimension*, double *bias*, String *file_data*)

#### Methods

##### f

public double **f** (double[] *x*)

### 2.67.11 F10ShiftedRotatedRastrigin

public class **F10ShiftedRotatedRastrigin** extends *TestFunc*

#### Fields

##### DEFAULT_FILE_DATA

public static final String **DEFAULT_FILE_DATA**

##### DEFAULT_FILE_MX_PREFIX

public static final String **DEFAULT_FILE_MX_PREFIX**

#### DEFAULT_FILE_MX_SUFFIX

public static final String **DEFAULT_FILE_MX_SUFFIX**

#### FUNCTION_NAME

public static final String **FUNCTION_NAME**

### Constructors

#### F10ShiftedRotatedRastrigin

public **F10ShiftedRotatedRastrigin** (int *dimension*, double *bias*)

#### F10ShiftedRotatedRastrigin

public **F10ShiftedRotatedRastrigin** (int *dimension*, double *bias*, String *file_data*, String *file_m*)

### Methods

#### f

public double **f** (double[] *x*)

## 2.67.12 F11ShiftedRotatedWeierstrass

public class **F11ShiftedRotatedWeierstrass** extends *TestFunc*

### Fields

#### DEFAULT_FILE_DATA

public static final String **DEFAULT_FILE_DATA**

#### DEFAULT_FILE_MX_PREFIX

public static final String **DEFAULT_FILE_MX_PREFIX**

#### DEFAULT_FILE_MX_SUFFIX

public static final String **DEFAULT_FILE_MX_SUFFIX**

#### FUNCTION_NAME

public static final String **FUNCTION_NAME**

#### Kmax

public static final int **Kmax**

#### PIx2

public static final double **PIx2**

#### a

public static final double **a**

#### b

public static final double **b**

### Constructors

#### F11ShiftedRotatedWeierstrass

public **F11ShiftedRotatedWeierstrass** (int *dimension*, double *bias*)

#### F11ShiftedRotatedWeierstrass

public **F11ShiftedRotatedWeierstrass** (int *dimension*, double *bias*, String *file_data*, String *file_m*)

### Methods

#### f

public double **f** (double[] *x*)

## 2.67.13 F12Schwefel

public class **F12Schwefel** extends *TestFunc*

### Fields

#### DEFAULT_FILE_DATA

public static final String **DEFAULT_FILE_DATA**

#### FUNCTION_NAME

public static final String **FUNCTION_NAME**

#### Constructors

##### F12Schwefel

public **F12Schwefel** (int *dimension*, double *bias*)

##### F12Schwefel

public **F12Schwefel** (int *dimension*, double *bias*, String *file_data*)

#### Methods

##### f

public double **f** (double[] *x*)

### 2.67.14 F13ShiftedExpandedGriewankRosenbrock

public class **F13ShiftedExpandedGriewankRosenbrock** extends *TestFunc*

#### Fields

##### DEFAULT_FILE_DATA

public static final String **DEFAULT_FILE_DATA**

##### FUNCTION_NAME

public static final String **FUNCTION_NAME**

#### Constructors

##### F13ShiftedExpandedGriewankRosenbrock

public **F13ShiftedExpandedGriewankRosenbrock** (int *dimension*, double *bias*)

##### F13ShiftedExpandedGriewankRosenbrock

public **F13ShiftedExpandedGriewankRosenbrock** (int *dimension*, double *bias*, String *file_data*)

#### Methods

##### f

public double **f** (double[] *x*)

### 2.67.15 F14ShiftedRotatedExpandedScaffer

public class **F14ShiftedRotatedExpandedScaffer** extends *TestFunc*

#### Fields

##### DEFAULT_FILE_DATA

public static final String **DEFAULT_FILE_DATA**

##### DEFAULT_FILE_MX_PREFIX

public static final String **DEFAULT_FILE_MX_PREFIX**

##### DEFAULT_FILE_MX_SUFFIX

public static final String **DEFAULT_FILE_MX_SUFFIX**

##### FUNCTION_NAME

public static final String **FUNCTION_NAME**

#### Constructors

##### F14ShiftedRotatedExpandedScaffer

public **F14ShiftedRotatedExpandedScaffer** (int *dimension*, double *bias*)

##### F14ShiftedRotatedExpandedScaffer

public **F14ShiftedRotatedExpandedScaffer** (int *dimension*, double *bias*, String *file_data*, String *file_m*)

#### Methods

##### f

public double **f** (double[] *x*)

### 2.67.16 F15HybridComposition1

public class **F15HybridComposition1** extends *TestFunc*

#### Fields

##### DEFAULT_FILE_DATA

public static final String **DEFAULT_FILE_DATA**

##### FUNCTION_NAME

public static final String **FUNCTION_NAME**

##### NUM_FUNC

public static final int **NUM_FUNC**

#### Constructors

##### F15HybridComposition1

public **F15HybridComposition1** (int *dimension*, double *bias*)

##### F15HybridComposition1

public **F15HybridComposition1** (int *dimension*, double *bias*, String *file_data*)

#### Methods

##### f

public double **f** (double[] *x*)

### 2.67.17 F16RotatedHybridComposition1

public class **F16RotatedHybridComposition1** extends *TestFunc*

#### Fields

##### DEFAULT_FILE_DATA

public static final String **DEFAULT_FILE_DATA**

##### DEFAULT_FILE_MX_PREFIX

public static final String **DEFAULT_FILE_MX_PREFIX**

#### DEFAULT_FILE_MX_SUFFIX

public static final String **DEFAULT_FILE_MX_SUFFIX**

#### FUNCTION_NAME

public static final String **FUNCTION_NAME**

#### NUM_FUNC

public static final int **NUM_FUNC**

### Constructors

#### F16RotatedHybridComposition1

public **F16RotatedHybridComposition1** (int *dimension*, double *bias*)

#### F16RotatedHybridComposition1

public **F16RotatedHybridComposition1** (int *dimension*, double *bias*, String *file_data*, String *file_m*)

### Methods

#### f

public double **f** (double[] *x*)

## 2.67.18 F17RotatedHybridComposition1Noise

public class **F17RotatedHybridComposition1Noise** extends *TestFunc*

### Fields

#### DEFAULT_FILE_DATA

public static final String **DEFAULT_FILE_DATA**

#### DEFAULT_FILE_MX_PREFIX

public static final String **DEFAULT_FILE_MX_PREFIX**

#### DEFAULT_FILE_MX_SUFFIX

public static final String **DEFAULT_FILE_MX_SUFFIX**

#### FUNCTION_NAME

public static final String **FUNCTION_NAME**

#### NUM_FUNC

public static final int **NUM_FUNC**

### Constructors

#### F17RotatedHybridComposition1Noise

public **F17RotatedHybridComposition1Noise** (int *dimension*, double *bias*)

#### F17RotatedHybridComposition1Noise

public **F17RotatedHybridComposition1Noise** (int *dimension*, double *bias*, String *file_data*, String *file_m*)

### Methods

#### f

public double **f** (double[] *x*)

## 2.67.19 F18RotatedHybridComposition2

public class **F18RotatedHybridComposition2** extends *TestFunc*

### Fields

#### DEFAULT_FILE_DATA

public static final String **DEFAULT_FILE_DATA**

#### DEFAULT_FILE_MX_PREFIX

public static final String **DEFAULT_FILE_MX_PREFIX**

#### DEFAULT_FILE_MX_SUFFIX

public static final String **DEFAULT_FILE_MX_SUFFIX**

#### FUNCTION_NAME

public static final String **FUNCTION_NAME**

#### NUM_FUNC

public static final int **NUM_FUNC**

### Constructors

#### F18RotatedHybridComposition2

public **F18RotatedHybridComposition2** (int *dimension*, double *bias*)

#### F18RotatedHybridComposition2

public **F18RotatedHybridComposition2** (int *dimension*, double *bias*, String *file_data*, String *file_m*)

### Methods

#### f

public double **f** (double[] *x*)

## 2.67.20 F19RotatedHybridComposition2NarrowBasinGlobalOpt

public class **F19RotatedHybridComposition2NarrowBasinGlobalOpt** extends *TestFunc*

### Fields

#### DEFAULT_FILE_DATA

public static final String **DEFAULT_FILE_DATA**

#### DEFAULT_FILE_MX_PREFIX

public static final String **DEFAULT_FILE_MX_PREFIX**

#### DEFAULT_FILE_MX_SUFFIX

public static final String **DEFAULT_FILE_MX_SUFFIX**

#### FUNCTION_NAME

public static final String **FUNCTION_NAME**

#### NUM_FUNC

public static final int **NUM_FUNC**

### Constructors

#### F19RotatedHybridComposition2NarrowBasinGlobalOpt

public **F19RotatedHybridComposition2NarrowBasinGlobalOpt** (int *dimension*, double *bias*)

#### F19RotatedHybridComposition2NarrowBasinGlobalOpt

public **F19RotatedHybridComposition2NarrowBasinGlobalOpt** (int *dimension*, double *bias*, String *file_data*, String *file_m*)

### Methods

#### f

public double **f** (double[] *x*)

## 2.67.21 F20RotatedHybridComposition2GlobalOptBound

public class **F20RotatedHybridComposition2GlobalOptBound** extends *TestFunc*

### Fields

#### DEFAULT_FILE_DATA

public static final String **DEFAULT_FILE_DATA**

#### DEFAULT_FILE_MX_PREFIX

public static final String **DEFAULT_FILE_MX_PREFIX**

#### DEFAULT_FILE_MX_SUFFIX

public static final String **DEFAULT_FILE_MX_SUFFIX**

#### FUNCTION_NAME

public static final String **FUNCTION_NAME**

#### NUM_FUNC

public static final int **NUM_FUNC**

### Constructors

#### F20RotatedHybridComposition2GlobalOptBound

public **F20RotatedHybridComposition2GlobalOptBound** (int *dimension*, double *bias*)

#### F20RotatedHybridComposition2GlobalOptBound

public **F20RotatedHybridComposition2GlobalOptBound** (int *dimension*, double *bias*, String *file_data*, String *file_m*)

### Methods

#### f

public double **f** (double[] *x*)

## 2.67.22 F21RotatedHybridComposition3

public class **F21RotatedHybridComposition3** extends *TestFunc*

### Fields

#### DEFAULT_FILE_DATA

public static final String **DEFAULT_FILE_DATA**

#### DEFAULT_FILE_MX_PREFIX

public static final String **DEFAULT_FILE_MX_PREFIX**

#### DEFAULT_FILE_MX_SUFFIX

public static final String **DEFAULT_FILE_MX_SUFFIX**

#### FUNCTION_NAME

public static final String **FUNCTION_NAME**

#### NUM_FUNC

public static final int **NUM_FUNC**

### Constructors

#### F21RotatedHybridComposition3

public **F21RotatedHybridComposition3** (int *dimension*, double *bias*)

#### F21RotatedHybridComposition3

public **F21RotatedHybridComposition3** (int *dimension*, double *bias*, String *file_data*, String *file_m*)

### Methods

#### f

public double **f** (double[] *x*)

## 2.67.23 F22RotatedHybridComposition3HighCondNumMatrix

public class **F22RotatedHybridComposition3HighCondNumMatrix** extends *TestFunc*

### Fields

#### DEFAULT_FILE_DATA

public static final String **DEFAULT_FILE_DATA**

#### DEFAULT_FILE_MX_PREFIX

public static final String **DEFAULT_FILE_MX_PREFIX**

#### DEFAULT_FILE_MX_SUFFIX

public static final String **DEFAULT_FILE_MX_SUFFIX**

#### FUNCTION_NAME

public static final String **FUNCTION_NAME**

#### NUM_FUNC

public static final int **NUM_FUNC**

#### Constructors

##### F22RotatedHybridComposition3HighCondNumMatrix

public **F22RotatedHybridComposition3HighCondNumMatrix** (int *dimension*, double *bias*)

##### F22RotatedHybridComposition3HighCondNumMatrix

public **F22RotatedHybridComposition3HighCondNumMatrix** (int *dimension*, double *bias*, String *file_data*, String *file_m*)

#### Methods

##### f

public double **f** (double[] *x*)

### 2.67.24 F23NoncontinuousRotatedHybridComposition3

public class **F23NoncontinuousRotatedHybridComposition3** extends *TestFunc*

#### Fields

##### DEFAULT_FILE_DATA

public static final String **DEFAULT_FILE_DATA**

##### DEFAULT_FILE_MX_PREFIX

public static final String **DEFAULT_FILE_MX_PREFIX**

##### DEFAULT_FILE_MX_SUFFIX

public static final String **DEFAULT_FILE_MX_SUFFIX**

##### FUNCTION_NAME

public static final String **FUNCTION_NAME**

##### NUM_FUNC

public static final int **NUM_FUNC**

#### Constructors

##### F23NoncontinuousRotatedHybridComposition3

public **F23NoncontinuousRotatedHybridComposition3** (int *dimension*, double *bias*)

##### F23NoncontinuousRotatedHybridComposition3

public **F23NoncontinuousRotatedHybridComposition3** (int *dimension*, double *bias*, String *file_data*, String *file_m*)

#### Methods

##### f

public double **f** (double[] *x*)

### 2.67.25 F24RotatedHybridComposition4

public class **F24RotatedHybridComposition4** extends *TestFunc*

#### Fields

##### DEFAULT_FILE_DATA

public static final String **DEFAULT_FILE_DATA**

##### DEFAULT_FILE_MX_PREFIX

public static final String **DEFAULT_FILE_MX_PREFIX**

##### DEFAULT_FILE_MX_SUFFIX

public static final String **DEFAULT_FILE_MX_SUFFIX**

##### FUNCTION_NAME

public static final String **FUNCTION_NAME**

##### NUM_FUNC

public static final int **NUM_FUNC**

#### Constructors

##### F24RotatedHybridComposition4

public **F24RotatedHybridComposition4** (int *dimension*, double *bias*)

##### F24RotatedHybridComposition4

public **F24RotatedHybridComposition4** (int *dimension*, double *bias*, String *file_data*, String *file_m*)

#### Methods

##### f

public double **f** (double[] *x*)

### 2.67.26 F25RotatedHybridComposition4Bound

public class **F25RotatedHybridComposition4Bound** extends *TestFunc*

#### Fields

##### DEFAULT_FILE_DATA

public static final String **DEFAULT_FILE_DATA**

##### DEFAULT_FILE_MX_PREFIX

public static final String **DEFAULT_FILE_MX_PREFIX**

##### DEFAULT_FILE_MX_SUFFIX

public static final String **DEFAULT_FILE_MX_SUFFIX**

##### FUNCTION_NAME

public static final String **FUNCTION_NAME**

##### NUM_FUNC

public static final int **NUM_FUNC**

#### Constructors

##### F25RotatedHybridComposition4Bound

public **F25RotatedHybridComposition4Bound** (int *dimension*, double *bias*)

##### F25RotatedHybridComposition4Bound

public **F25RotatedHybridComposition4Bound** (int *dimension*, double *bias*, String *file_data*, String *file_m*)

#### Methods

##### f

public double **f** (double[] *x*)

### 2.67.27 HCJob

public abstract class **HCJob**

#### Fields

##### C

public double **C**

##### biases

public double[] **biases**

##### fmax

public double[] **fmax**

##### lambda

public double[] **lambda**

##### linearTransformationMatrix

public double[][][] **linearTransformationMatrix**

#### numberOfBasicFunctions

public int **numberOfBasicFunctions**

#### numberOfDimensions

public int **numberOfDimensions**

#### shiftGlobalOptimum

public double[][] **shiftGlobalOptimum**

#### sigma

public double[] **sigma**

#### w

public double[] **w**

#### z

public double[][] **z**

#### zM

public double[][] **zM**

### Constructors

#### HCJob

public **HCJob** ()

### Methods

#### basicFunc

public abstract double **basicFunc** (int *func_no*, double[] *x*)

## 2.67.28 TestFunc

public abstract class **TestFunc**

## Fields

### mBias

protected double **mBias**

### mDimension

protected int **mDimension**

### mFuncName

protected String **mFuncName**

## Constructors

### TestFunc

public **TestFunc** (int *dimension*, double *bias*)

### TestFunc

public **TestFunc** (int *dimension*, double *bias*, String *funcName*)

## Methods

### bias

public double **bias** ()

### dimension

public int **dimension** ()

### f

public abstract double **f** (double[] *x*)

### name

public String **name** ()

## 2.68 org.uma.jmetal.qualityIndicator

### 2.68.1 CommandLineIndicatorRunner

public class **CommandLineIndicatorRunner**

Class for executing quality indicators from the command line. An optional argument allows to indicate whether the fronts are to be normalized by the quality indicators. Invoking command: mvn -pl jmetal-exec exec:java -Dexec.mainClass="org.uma.jmetal.qualityIndicator.CommandLineIndicatorRunner" -Dexec.args="indicator referenceFront front normalize"

**Author** Antonio J. Nebro

#### Methods

#### main

public static void **main**(String[] *args*)

## 2.69 org.uma.jmetal.qualityindicator

### 2.69.1 QualityIndicator

public interface **QualityIndicator**<Evaluate, Result> extends *DescribedEntity*, Serializable

**Author** Antonio J. Nebro

**Parameters**

- **<Evaluate>** – Entity to runAlgorithm
- **<Result>** – Result of the evaluation

#### Methods

#### evaluate

public Result **evaluate**(Evaluate *evaluate*)

## 2.70 org.uma.jmetal.qualityindicator.impl

### 2.70.1 Epsilon

public class **Epsilon**<S extends Solution<?>> extends *GenericIndicator*<S>

This class implements the unary epsilon additive indicator as proposed in E. Zitzler, E. Thiele, L. Laummanns, M., Fonseca, C., and Grunert da Fonseca. V (2003): Performance Assessment of Multiobjective Optimizers: An Analysis and Review. The code is the a Java version of the original metric implementation by Eckart Zitzler. It can be used also as a command line program just by typing $java org.uma.jmetal.qualityindicator.impl.Epsilon

**Author** Antonio J. Nebro , Juan J. Durillo

## Constructors

### Epsilon

public **Epsilon**()

Default constructor

### Epsilon

public **Epsilon**(String *referenceParetoFrontFile*)

Constructor

**Parameters**

- **referenceParetoFrontFile** –

**Throws**

- **FileNotFoundException** –

### Epsilon

public **Epsilon**(*Front* *referenceParetoFront*)

Constructor

**Parameters**

- **referenceParetoFront** –

## Methods

### evaluate

public Double **evaluate**(List<S> *solutionList*)

Evaluate() method

**Parameters**

- **solutionList** –

### getDescription

public String **getDescription**()

### getName

public String **getName**()

### isTheLowerTheIndicatorValueTheBetter

public boolean **isTheLowerTheIndicatorValueTheBetter**()

### 2.70.2 EpsilonTest

public class **EpsilonTest**

**Author** Antonio J. Nebro

#### Fields

##### exception

public ExpectedException **exception**

#### Methods

##### shouldExecuteRaiseAnExceptionIfTheFrontApproximationIsNull

public void **shouldExecuteRaiseAnExceptionIfTheFrontApproximationIsNull**()

##### shouldExecuteRaiseAnExceptionIfTheFrontApproximationListIsNull

public void **shouldExecuteRaiseAnExceptionIfTheFrontApproximationListIsNull**()

##### shouldExecuteReturnTheCorrectValueCaseA

public void **shouldExecuteReturnTheCorrectValueCaseA**()
Given a front with points [1.5,4.0], [2.0,3.0],[3.0,2.0] and a Pareto front with points [1.0,3.0], [1.5,2.0], [2.0, 1.5], the value of the epsilon indicator is 1

##### shouldExecuteReturnTheCorrectValueCaseB

public void **shouldExecuteReturnTheCorrectValueCaseB**()
Given a front with points [1.5,4.0], [1.5,2.0],[2.0,1.5] and a Pareto front with points [1.0,3.0], [1.5,2.0], [2.0, 1.5], the value of the epsilon indicator is 0.5

##### shouldExecuteReturnTheRightValueIfTheFrontsContainOnePointWhichIsNotTheSame

public void **shouldExecuteReturnTheRightValueIfTheFrontsContainOnePointWhichIsNotTheSame**()
Given a front with point [2,3] and a Pareto front with point [1,2], the value of the epsilon indicator is 1

##### shouldExecuteReturnZeroIfTheFrontsContainOnePointWhichIsTheSame

public void **shouldExecuteReturnZeroIfTheFrontsContainOnePointWhichIsTheSame**()

##### shouldGetNameReturnTheCorrectValue

public void **shouldGetNameReturnTheCorrectValue**()
The same case as shouldExecuteReturnTheCorrectValueCaseB() but using list of solutions

### 2.70.3 ErrorRatio

public class **ErrorRatio**<Evaluate extends List<? extends Solution<?>>> extends *SimpleDescribedEntity* implements *QualityIndica*

The Error Ratio (ER) quality indicator reports the ratio of solutions in a front of points that are not members of the true Pareto front. NOTE: the indicator merely checks if the solutions in the front are not members of the second front. No assumption is made about the second front is a true Pareto front, i.e, the front could contain solutions that dominate some of those of the supposed Pareto front. It is a responsibility of the caller to ensure that this does not happen.

**Author** Antonio J. Nebro TODO: using an epsilon value

#### Constructors

#### ErrorRatio

public **ErrorRatio** (String *referenceParetoFrontFile*)

Constructor

**Parameters**

- **referenceParetoFrontFile** –

**Throws**

- **FileNotFoundException** –

#### ErrorRatio

public **ErrorRatio** (*Front* *referenceParetoFront*)

Constructor

**Parameters**

- **referenceParetoFront** –

#### Methods

#### evaluate

public Double **evaluate** (Evaluate *solutionList*)

Evaluate() method

**Parameters**

- **solutionList** –

#### getName

public String **getName** ()

### 2.70.4 ErrorRatioTest

public class **ErrorRatioTest**

**Author** Antonio J. Nebro

#### Fields

##### exception

public ExpectedException **exception**

#### Methods

##### shouldExecuteRaiseAnExceptionIfTheFrontApproximationIsNull

public void **shouldExecuteRaiseAnExceptionIfTheFrontApproximationIsNull**()

##### shouldExecuteRaiseAnExceptionIfTheParetoFrontApproximationListIsNull

public void **shouldExecuteRaiseAnExceptionIfTheParetoFrontApproximationListIsNull**()

##### shouldExecuteReturnOneIfTheFrontsContainADifferentPoint

public void **shouldExecuteReturnOneIfTheFrontsContainADifferentPoint**()

##### shouldExecuteReturnTheCorrectValueCaseA

public void **shouldExecuteReturnTheCorrectValueCaseA**()

Given a front with points [1.5,4.0], [1.5,2.0],[2.0,1.5] and a Pareto front with points [1.0,3.0], [1.5,2.0], [2.0, 1.5], the value of the epsilon indicator is 2/3

##### shouldExecuteReturnTheCorrectValueCaseB

public void **shouldExecuteReturnTheCorrectValueCaseB**()

Given a list with solutions [1.5,3.0], [4.0,2.0] and another lists with solutions [-1.0,-1.0], [0.0,0.0], the value of the epsilon indicator is 1

##### shouldExecuteReturnZeroIfTheFrontsContainOnePointWhichIsTheSame

public void **shouldExecuteReturnZeroIfTheFrontsContainOnePointWhichIsTheSame**()

##### shouldGetNameReturnTheCorrectValue

public void **shouldGetNameReturnTheCorrectValue**()

## 2.70.5 GeneralizedSpread

public class **GeneralizedSpread**<S extends Solution<?>> extends *GenericIndicator*<S>

This class implements the generalized spread metric for two or more dimensions. Reference: A. Zhou, Y. Jin, Q. Zhang, B. Sendhoff, and E. Tsang Combining model-based and genetics-based offspring generation for multi-objective optimization using a convergence criterion, 2006 IEEE Congress on Evolutionary Computation, 2006, pp. 3234-3241.

**Author** Antonio J. Nebro , Juan J. Durillo

### Constructors

#### GeneralizedSpread

public **GeneralizedSpread**()

Default constructor

#### GeneralizedSpread

public **GeneralizedSpread**(String *referenceParetoFrontFile*)

Constructor

**Parameters**

- **referenceParetoFrontFile** –

**Throws**

- **FileNotFoundException** –

#### GeneralizedSpread

public **GeneralizedSpread**(*Front* *referenceParetoFront*)

Constructor

**Parameters**

- **referenceParetoFront** –

**Throws**

- **FileNotFoundException** –

### Methods

#### evaluate

public Double **evaluate**(List<S> *solutionList*)

Evaluate() method

**Parameters**

- **solutionList** –

#### generalizedSpread

public double **generalizedSpread** (*Front front*, *Front referenceFront*)

Calculates the generalized spread metric. Given the pareto front, the true pareto front as `double []` and the number of objectives, the method return the value for the metric.

**Parameters**

- **front** – The front.
- **referenceFront** – The reference pareto front.

**Returns** the value of the generalized spread metric

#### getDescription

public String **getDescription** ()

#### getName

public String **getName** ()

#### isTheLowerTheIndicatorValueTheBetter

public boolean **isTheLowerTheIndicatorValueTheBetter** ()

### 2.70.6 GenerationalDistance

public class **GenerationalDistance**<S extends Solution<?>> extends *GenericIndicator*<S>

This class implements the generational distance indicator. Reference: Van Veldhuizen, D.A., Lamont, G.B.: Multiobjective Evolutionary Algorithm Research: A History and Analysis. Technical Report TR-98-03, Dept. Elec. Comput. Eng., Air Force Inst. Technol. (1998)

**Author** Antonio J. Nebro , Juan J. Durillo

#### Constructors

#### GenerationalDistance

public **GenerationalDistance** ()

Default constructor

#### GenerationalDistance

public **GenerationalDistance** (String *referenceParetoFrontFile*, double *p*)

Constructor

**Parameters**

- **referenceParetoFrontFile** –
- **p** –

**Throws**

- **FileNotFoundException** –

#### GenerationalDistance

public **GenerationalDistance** (String *referenceParetoFrontFile*)
Constructor

**Parameters**

- **referenceParetoFrontFile** –

**Throws**

- **FileNotFoundException** –

#### GenerationalDistance

public **GenerationalDistance** (*Front* *referenceParetoFront*)
Constructor

**Parameters**

- **referenceParetoFront** –

### Methods

#### evaluate

public Double **evaluate** (List<S> *solutionList*)
Evaluate() method

**Parameters**

- **solutionList** –

#### generationalDistance

public double **generationalDistance** (*Front* *front*, *Front* *referenceFront*)
Returns the generational distance value for a given front

**Parameters**

- **front** – The front
- **referenceFront** – The reference pareto front

#### getDescription

public String **getDescription** ()

#### getName

public String **getName**()

#### isTheLowerTheIndicatorValueTheBetter

public boolean **isTheLowerTheIndicatorValueTheBetter**()

### 2.70.7 GenerationalDistanceTest

public class **GenerationalDistanceTest**

**Author** Antonio J. Nebro

#### Fields

#### exception

public ExpectedException **exception**

#### Methods

#### shouldExecuteRaiseAnExceptionIfTheFrontApproximationIsNull

public void **shouldExecuteRaiseAnExceptionIfTheFrontApproximationIsNull**()

#### shouldExecuteRaiseAnExceptionIfTheParetoFrontIsNull

public void **shouldExecuteRaiseAnExceptionIfTheParetoFrontIsNull**()

#### shouldGetNameReturnTheCorrectValue

public void **shouldGetNameReturnTheCorrectValue**()

### 2.70.8 GenericIndicator

public abstract class **GenericIndicator**<S> extends *SimpleDescribedEntity* implements *QualityIndicator*<List<S>, Double>

Abstract class representing quality indicators that need a reference front to be computed

**Author** Antonio J. Nebro

#### Fields

#### referenceParetoFront

protected *Front* **referenceParetoFront**

#### Constructors

##### GenericIndicator

public **GenericIndicator**()
Default constructor

##### GenericIndicator

public **GenericIndicator**(String *referenceParetoFrontFile*)

##### GenericIndicator

public **GenericIndicator**(*Front* *referenceParetoFront*)

#### Methods

##### isTheLowerTheIndicatorValueTheBetter

public abstract boolean **isTheLowerTheIndicatorValueTheBetter**()
This method returns true if lower indicator values are preferred and false otherwise

##### setReferenceParetoFront

public void **setReferenceParetoFront**(String *referenceParetoFrontFile*)

##### setReferenceParetoFront

public void **setReferenceParetoFront**(*Front* *referenceFront*)

### 2.70.9 Hypervolume

public abstract class **Hypervolume**<S> extends *GenericIndicator*<S>
This interface represents implementations of the Hypervolume quality indicator

**Author** Antonio J. Nebro , Juan J. Durillo

#### Constructors

##### Hypervolume

public **Hypervolume**()

##### Hypervolume

public **Hypervolume**(String *referenceParetoFrontFile*)

#### Hypervolume

public **Hypervolume** (*Front referenceParetoFront*)

#### Methods

#### computeHypervolumeContribution

public abstract List<S> **computeHypervolumeContribution** (List<S> *solutionList*, List<S> *referenceFrontList*)

#### getName

public String **getName** ()

#### getOffset

public abstract double **getOffset** ()

#### isTheLowerTheIndicatorValueTheBetter

public boolean **isTheLowerTheIndicatorValueTheBetter** ()

#### setOffset

public abstract void **setOffset** (double *offset*)

### 2.70.10 HypervolumeTest

public class **HypervolumeTest**

**Author** Antonio J. Nebro

#### Fields

#### exception

public ExpectedException **exception**

#### Methods

#### shouldExecuteRaiseAnExceptionIfTheFrontApproximationIsNull

public void **shouldExecuteRaiseAnExceptionIfTheFrontApproximationIsNull** ()

#### shouldExecuteRaiseAnExceptionIfTheParetoFrontIsNull

public void **shouldExecuteRaiseAnExceptionIfTheParetoFrontIsNull**()

### 2.70.11 InvertedGenerationalDistance

public class **InvertedGenerationalDistance**<S extends Solution<?>> extends *GenericIndicator*<S>

This class implements the inverted generational distance metric. Reference: Van Veldhuizen, D.A., Lamont, G.B.: Multiobjective Evolutionary Algorithm Research: A History and Analysis. Technical Report TR-98-03, Dept. Elec. Comput. Eng., Air Force Inst. Technol. (1998)

**Author** Antonio J. Nebro , Juan J. Durillo

#### Constructors

#### InvertedGenerationalDistance

public **InvertedGenerationalDistance**()

Default constructor

#### InvertedGenerationalDistance

public **InvertedGenerationalDistance**(String *referenceParetoFrontFile*, double *p*)

Constructor

**Parameters**

- **referenceParetoFrontFile** –

**Throws**

- **FileNotFoundException** –

#### InvertedGenerationalDistance

public **InvertedGenerationalDistance**(String *referenceParetoFrontFile*)

Constructor

**Parameters**

- **referenceParetoFrontFile** –

**Throws**

- **FileNotFoundException** –

#### InvertedGenerationalDistance

public **InvertedGenerationalDistance**(*Front* *referenceParetoFront*)

Constructor

**Parameters**

- **referenceParetoFront** –

**Throws**

- **FileNotFoundException** –

### Methods

#### evaluate

public Double **evaluate** (List<S> *solutionList*)
Evaluate() method

**Parameters**

- **solutionList** –

#### getDescription

public String **getDescription** ()

#### getName

public String **getName** ()

#### invertedGenerationalDistance

public double **invertedGenerationalDistance** (*Front front*, *Front referenceFront*)
Returns the inverted generational distance value for a given front

**Parameters**

- **front** – The front
- **referenceFront** – The reference pareto front

#### isTheLowerTheIndicatorValueTheBetter

public boolean **isTheLowerTheIndicatorValueTheBetter** ()

## 2.70.12 InvertedGenerationalDistancePlus

public class **InvertedGenerationalDistancePlus**<S extends Solution<?>> extends *GenericIndicator*<S>
This class implements the inverted generational distance metric plust (IGD+) Reference: Ishibuchi et al 2015, "A Study on Performance Evaluation Ability of a Modified Inverted Generational Distance Indicator", GECCO 2015

**Author** Antonio J. Nebro

### Constructors

#### InvertedGenerationalDistancePlus

public **InvertedGenerationalDistancePlus**()
Default constructor

#### InvertedGenerationalDistancePlus

public **InvertedGenerationalDistancePlus**(String *referenceParetoFrontFile*)
Constructor

**Parameters**

- **referenceParetoFrontFile** –

#### InvertedGenerationalDistancePlus

public **InvertedGenerationalDistancePlus**(*Front* *referenceParetoFront*)
Constructor

**Parameters**

- **referenceParetoFront** –

**Throws**

- **FileNotFoundException** –

### Methods

#### evaluate

public Double **evaluate**(List<S> *solutionList*)
Evaluate() method

**Parameters**

- **solutionList** –

#### getDescription

public String **getDescription**()

#### getName

public String **getName**()

#### invertedGenerationalDistancePlus

public double **invertedGenerationalDistancePlus** (*Front front*, *Front referenceFront*)
Returns the inverted generational distance plus value for a given front

**Parameters**

- **front** – The front
- **referenceFront** – The reference pareto front

#### isTheLowerTheIndicatorValueTheBetter

public boolean **isTheLowerTheIndicatorValueTheBetter** ()

## 2.70.13 InvertedGenerationalDistancePlusTest

public class **InvertedGenerationalDistancePlusTest**

**Author** Antonio J. Nebro

### Fields

#### exception

public ExpectedException **exception**

### Methods

#### shouldConstructorRaiseAnExceptionIfFileNameIsNull

public void **shouldConstructorRaiseAnExceptionIfFileNameIsNull** ()

#### shouldConstructorRaiseAnExceptionIfTheParetoFrontIsNull

public void **shouldConstructorRaiseAnExceptionIfTheParetoFrontIsNull** ()

#### shouldEvaluateRaiseAnExceptionIfTheFrontApproximationIsNull

public void **shouldEvaluateRaiseAnExceptionIfTheFrontApproximationIsNull** ()

#### shouldEvaluateReturnTheCorrectValueCaseA

public void **shouldEvaluateReturnTheCorrectValueCaseA** ()

#### shouldEvaluateReturnTheCorrectValueCaseB

public void **shouldEvaluateReturnTheCorrectValueCaseB** ()

#### shouldEvaluateReturnZeroIfTheFrontAndTheReferenceFrontContainsTheSamePoints

public void **shouldEvaluateReturnZeroIfTheFrontAndTheReferenceFrontContainsTheSamePoints**()

### 2.70.14 R2

public class **R2**<Evaluate extends List<? extends Solution<?>>> extends *SimpleDescribedEntity* implements *QualityIndicator*<Evaluat

TODO: Add comments here

#### Constructors

##### R2

public **R2**(*Front referenceParetoFront*)

Creates a new instance of the R2 indicator for a problem with two objectives and 100 lambda vectors

##### R2

public **R2**()

Creates a new instance of the R2 indicator for a problem with two objectives and 100 lambda vectors

##### R2

public **R2**(int *nVectors*)

Creates a new instance of the R2 indicator for a problem with two objectives and N lambda vectors

##### R2

public **R2**(String *file*, *Front referenceParetoFront*)

Constructor Creates a new instance of the R2 indicator for nDimensiosn It loads the weight vectors from the file fileName

##### R2

public **R2**(int *nVectors*, *Front referenceParetoFront*)

Creates a new instance of the R2 indicator for a problem with two objectives and N lambda vectors

##### R2

public **R2**(String *file*)

Constructor Creates a new instance of the R2 indicator for nDimensiosn It loads the weight vectors from the file fileName

#### Methods

##### evaluate

public Double **evaluate** (Evaluate *solutionList*)

##### getName

public String **getName** ()

##### r2

public double **r2** (*Front front*)

### 2.70.15 R2Test

public class **R2Test**

#### Fields

##### description

String **description**

##### name

String **name**

#### Methods

##### testR2HasProperNameAndDescriptionWithEmptyConstructor

public void **testR2HasProperNameAndDescriptionWithEmptyConstructor** ()

##### testR2HasProperNameAndDescriptionWithFileConstructor

public void **testR2HasProperNameAndDescriptionWithFileConstructor** ()

##### testR2HasProperNameAndDescriptionWithFileFrontConstructor

public void **testR2HasProperNameAndDescriptionWithFileFrontConstructor** ()

##### testR2HasProperNameAndDescriptionWithFrontConstructor

public void **testR2HasProperNameAndDescriptionWithFrontConstructor** ()

#### testR2HasProperNameAndDescriptionWithVectorConstructor

public void **testR2HasProperNameAndDescriptionWithVectorConstructor**()

#### testR2HasProperNameAndDescriptionWithVectorFrontConstructor

public void **testR2HasProperNameAndDescriptionWithVectorFrontConstructor**()

## 2.70.16 SetCoverage

public class **SetCoverage** extends *SimpleDescribedEntity* implements *QualityIndicator*<Pair<List<? extends *Solution*<?>>, List<? e

Set coverage metric

**Author** Antonio J. Nebro

### Constructors

#### SetCoverage

public **SetCoverage**()

Constructor

### Methods

#### evaluate

public Pair<Double, Double> **evaluate**(Pair<List<? extends *Solution*<?>>, List<? extends *Solution*<?>>> *pairOfSolutionLists*)

#### evaluate

public double **evaluate**(List<? extends *Solution*<?>> *set1*, List<? extends *Solution*<?>> *set2*)

Calculates the set coverage of set1 over set2

**Parameters**

- **set1** –
- **set2** –

**Returns** The value of the set coverage

#### getName

public String **getName**()

### 2.70.17 SetCoverageTest

public class **SetCoverageTest**

**Author** Antonio J. Nebro

#### Fields

##### exception

public ExpectedException **exception**

#### Methods

##### setup

public void **setup**()

##### shouldExecuteRaiseAnExceptionIfTheFirstFrontIsNull

public void **shouldExecuteRaiseAnExceptionIfTheFirstFrontIsNull**()

##### shouldExecuteRaiseAnExceptionIfTheParetoFrontIsNull

public void **shouldExecuteRaiseAnExceptionIfTheParetoFrontIsNull**()

##### shouldExecuteReturnOneIfTheSecondFrontIsEmpty

public void **shouldExecuteReturnOneIfTheSecondFrontIsEmpty**()

##### shouldExecuteReturnTheCorrectValueCaseA

public void **shouldExecuteReturnTheCorrectValueCaseA**()

Given a frontA with points [0.0,6.0], [2.0,3.0],[4.0,2.0] and a frontB with points [1.0,7.0], [2.0,3.0], [3.5, 1.0], the value of setCoverage(frontA, frontB) == 1/3 and setCoverage(frontB, frontA) == 1/3

##### shouldExecuteReturnTheCorrectValueCaseB

public void **shouldExecuteReturnTheCorrectValueCaseB**()

Given a frontA with points [0.0,6.0], [2.0,3.0],[4.0,2.0] and a frontB with points [1.0,7.0], [2.5,3.0], [5.0, 2.5], the value of setCoverage(frontA, frontB) == 1 and setCoverage(frontB, frontA) == 0

##### shouldExecuteReturnTheRightValueIfTheFrontsContainOnePointWhichIsNotTheSame

public void **shouldExecuteReturnTheRightValueIfTheFrontsContainOnePointWhichIsNotTheSame**()

Given a frontA with point [2,3] and a frontB with point [1,2], the value of the setCoverage(frontA, frontB) == 0 and setCoverage(frontB, frontA) == 1

#### shouldExecuteReturnZeroIfBothFrontsAreEmpty

public void **shouldExecuteReturnZeroIfBothFrontsAreEmpty**()

#### shouldExecuteReturnZeroIfTheFrontsContainOnePointWhichIsTheSame

public void **shouldExecuteReturnZeroIfTheFrontsContainOnePointWhichIsTheSame**()

#### shouldGetNameReturnTheCorrectValue

public void **shouldGetNameReturnTheCorrectValue**()

The same case as shouldExecuteReturnTheCorrectValueCaseB() but using solution lists

## 2.70.18 Spread

public class **Spread**<S extends Solution<?>> extends *GenericIndicator*<S>

This class implements the spread quality indicator. It must be only to two bi-objective problem. Reference: Deb, K., Pratap, A., Agarwal, S., Meyarivan, T.: A fast and elitist multiobjective genetic algorithm: NSGA-II. IEEE Trans. on Evol. Computation 6 (2002) 182-197

**Author** Antonio J. Nebro , Juan J. Durillo

### Constructors

#### Spread

public **Spread**()

Default constructor

#### Spread

public **Spread**(String *referenceParetoFrontFile*)

Constructor

**Parameters**

- **referenceParetoFrontFile** –

**Throws**

- **FileNotFoundException** –

#### Spread

public **Spread**(*Front* *referenceParetoFront*)

Constructor

**Parameters**

- **referenceParetoFront** –

**Throws**

- **FileNotFoundException** –

### Methods

#### evaluate

public Double **evaluate** (List<S> *solutionList*)
Evaluate() method

**Parameters**

- **solutionList** –

#### getDescription

public String **getDescription** ()

#### getName

public String **getName** ()

#### isTheLowerTheIndicatorValueTheBetter

public boolean **isTheLowerTheIndicatorValueTheBetter** ()

#### spread

public double **spread** (*Front front*, *Front referenceFront*)
Calculates the Spread metric.

**Parameters**

- **front** – The front.
- **referenceFront** – The true pareto front.

## 2.71 org.uma.jmetal.qualityindicator.impl.hypervolume

### 2.71.1 PISAHypervolume

public class **PISAHypervolume**<S extends Solution<?>> extends *Hypervolume*<S>
This class implements the hypervolume indicator. The code is the a Java version of the original metric implementation by Eckart Zitzler. Reference: E. Zitzler and L. Thiele Multiobjective Evolutionary Algorithms: A Comparative Case Study and the Strength Pareto Approach, IEEE Transactions on Evolutionary Computation, vol. 3, no. 4, pp. 257-271, 1999.

**Author** Antonio J. Nebro , Juan J. Durillo

### Constructors

#### PISAHypervolume

public **PISAHypervolume** ()
Default constructor

#### PISAHypervolume

public **PISAHypervolume** (String *referenceParetoFrontFile*)
Constructor

**Parameters**

- **referenceParetoFrontFile** –

**Throws**

- **FileNotFoundException** –

#### PISAHypervolume

public **PISAHypervolume** (*Front* *referenceParetoFront*)
Constructor

**Parameters**

- **referenceParetoFront** –

**Throws**

- **FileNotFoundException** –

### Methods

#### calculateHypervolume

public double **calculateHypervolume** (double[][] *front*, int *noPoints*, int *noObjectives*)

#### computeHypervolumeContribution

public List<S> **computeHypervolumeContribution** (List<S> *solutionList*, List<S> *referenceFrontList*)

#### evaluate

public Double **evaluate** (List<S> *paretoFrontApproximation*)
Evaluate() method

**Parameters**

- **paretoFrontApproximation** –

#### getDescription

public String **getDescription**()

#### getOffset

public double **getOffset**()

#### setOffset

public void **setOffset**(double *offset*)

### 2.71.2 PISAHypervolumeTest

public class **PISAHypervolumeTest**

#### Methods

#### shouldEvaluateWorkProperlyCase1

public void **shouldEvaluateWorkProperlyCase1**()

CASE 1: solution set -> front obtained from the ZDT1.rf file. Reference front: [0,1], [1,0]

**Throws**

- **FileNotFoundException** –

### 2.71.3 WFGHypervolume

public class **WFGHypervolume**<S extends Solution<?>> extends *Hypervolume*<S>

Created by ajnebro on 2/2/15.

#### Constructors

#### WFGHypervolume

public **WFGHypervolume**()

Default constructor

#### WFGHypervolume

public **WFGHypervolume**(String *referenceParetoFrontFile*)

Constructor

**Parameters**

- **referenceParetoFrontFile** –

**Throws**

- **FileNotFoundException** –

### WFGHypervolume

public **WFGHypervolume** (*Front referenceParetoFront*)
Constructor

**Parameters**

- **referenceParetoFront** –

**Throws**

- **FileNotFoundException** –

### Methods

### computeHypervolume

public double **computeHypervolume** (List<S> *solutionList*, *Point referencePoint*)

### computeHypervolumeContribution

public List<S> **computeHypervolumeContribution** (List<S> *solutionList*, List<S> *referenceFrontList*)

### evaluate

public Double **evaluate** (List<S> *solutionList*)

### get2DHV

public double **get2DHV** (List<? extends *Solution*<?>> *solutionSet*)
Computes the HV of a solution list. REQUIRES: The problem is bi-objective REQUIRES: The setArchive is ordered in descending order by the second objective

### getDescription

public String **getDescription** ()

### getOffset

public double **getOffset** ()

### setOffset

public void **setOffset** (double *offset*)

### 2.71.4 WFGHypervolumeTest

public class **WFGHypervolumeTest**
Created by ajnebro on 17/12/15.

#### Methods

##### setup

public void **setup**()

##### shouldEvaluateWorkProperlyCase1

public void **shouldEvaluateWorkProperlyCase1**()
CASE 1: solution set -> front composed of the points [0.25, 0.75] and [0.75, 0.25]. Reference point: [1.0, 1.0]

##### shouldEvaluateWorkProperlyCase2

public void **shouldEvaluateWorkProperlyCase2**()
CASE 2: solution set -> front composed of the points [0.25, 0.75], [0.75, 0.25] and [0.5, 0.5]. Reference point: [1.0, 1.0]

##### shouldEvaluateWorkProperlyCase3

public void **shouldEvaluateWorkProperlyCase3**()
CASE 3: solution set -> front composed of the points [0.25, 0.75], [0.75, 0.25] and [0.5, 0.5]. Reference point: [1.5, 1.5]

##### shouldEvaluateWorkProperlyCase4

public void **shouldEvaluateWorkProperlyCase4**()
CASE 4: solution set -> front obtained from the ZDT1.rf file. Reference point: [1.0, 1,0]

**Throws**

- **FileNotFoundException** –

##### simpleTest

public void **simpleTest**()

## 2.72 org.uma.jmetal.qualityindicator.impl.hypervolume.util

### 2.72.1 WfgHypervolumeFront

public class **WfgHypervolumeFront** extends *ArrayFront*
Created by ajnebro on 3/2/15.

#### Constructors

##### WfgHypervolumeFront

public **WfgHypervolumeFront** ()

##### WfgHypervolumeFront

public **WfgHypervolumeFront** (List<? extends *Solution*<?>> *solutionList*)

##### WfgHypervolumeFront

public **WfgHypervolumeFront** (int *numberOfPoints*, int *dimensions*)

#### Methods

##### getNumberOfPoints

public int **getNumberOfPoints** ()

##### getPoint

public *Point* **getPoint** (int *index*)

##### setNumberOfPoints

public void **setNumberOfPoints** (int *numberOfPoints*)

##### setPoint

public void **setPoint** (int *index*, *Point* *point*)

### 2.72.2 WfgHypervolumeVersion

public class **WfgHypervolumeVersion**
Created by ajnebro on 2/2/15.

#### Fields

##### OPT

static final int **OPT**

#### fs

*WfgHypervolumeFront*[] **fs**

#### maximizing

boolean **maximizing**

### Constructors

#### WfgHypervolumeVersion

public **WfgHypervolumeVersion** (int *dimension*, int *maxNumberOfPoints*)

#### WfgHypervolumeVersion

public **WfgHypervolumeVersion** (int *dimension*, int *maxNumberOfPoints*, *Point* *referencePoint*)

### Methods

#### dominates2way

int **dominates2way** (*Point* *p*, *Point* *q*)

#### get2DHV

public double **get2DHV** (*WfgHypervolumeFront* *front*)

#### getExclusiveHV

public double **getExclusiveHV** (*WfgHypervolumeFront* *front*, int *point*)

#### getHV

public double **getHV** (*WfgHypervolumeFront* *front*)

#### getInclusiveHV

public double **getInclusiveHV** (*Point* *point*)

#### getLessContributorHV

public int **getLessContributorHV** (List<*Solution*<?>> *solutionList*)

#### main

public static void **main** (String[] *args*)

#### makeDominatedBit

public void **makeDominatedBit** (*WfgHypervolumeFront front*, int *p*)

## 2.73 org.uma.jmetal.runner.multiobjective

### 2.73.1 ABYSSRunner

public class **ABYSSRunner** extends *AbstractAlgorithmRunner*

This class is the main program used to configure and run AbYSS, a multiobjective scatter search metaheuristics, which is described in: A.J. Nebro, F. Luna, E. Alba, B. Dorronsoro, J.J. Durillo, A. Beham "AbYSS: Adapting Scatter Search to Multiobjective Optimization." IEEE Transactions on Evolutionary Computation. Vol. 12, No. 4 (August 2008), pp. 439-457

**Author** Antonio J. Nebro

#### Methods

#### main

public static void **main** (String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- ***JMetalException*** –
- **FileNotFoundException** – Invoking command: java org.uma.jmetal.runner.multiobjective.AbYSSRunner problemName [referenceFront]

### 2.73.2 CDGRunner

public class **CDGRunner** extends *AbstractAlgorithmRunner*

Class for configuring and running the CDG algorithm The paper and Matlab code can be download at http://xinyecai.github.io/

**Author** Feng Zhang

#### Methods

#### main

public static void **main** (String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- **ClassNotFoundException** –
- **SecurityException** – Invoking command: java org.uma.jmetal.runner.multiobjective.CDGRunner problemName [referenceFront]

### 2.73.3 CellDERunner

public class **CellDERunner** extends *AbstractAlgorithmRunner*

Class to configure and run the MOCell algorithm

**Author** Antonio J. Nebro

#### Methods

#### main

public static void **main** (String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- ***JMetalException*** –
- **FileNotFoundException** – Invoking command: java org.uma.jmetal.runner.multiobjective.MOCellRunner problemName [referenceFront]

### 2.73.4 DMOPSOMeasuresRunner

public class **DMOPSOMeasuresRunner** extends *AbstractAlgorithmRunner*

Class for configuring and running the DMOPSO algorithm

**Author** Antonio J. Nebro

#### Methods

#### main

public static void **main** (String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- **SecurityException** – Invoking command: java org.uma.jmetal.runner.multiobjective.DMOPSORunner problemName [referenceFront]

### 2.73.5 DMOPSORunner

public class **DMOPSORunner** extends *AbstractAlgorithmRunner*

Class for configuring and running the DMOPSO algorithm

**Author** Antonio J. Nebro

#### Methods

#### main

public static void **main**(String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- *org.uma.jmetal.util.JMetalException* –
- java.io.IOException –
- SecurityException – Invoking command: java org.uma.jmetal.runner.multiobjective.DMOPSORunner problemName [referenceFront]

### 2.73.6 ESPEARunner

public class **ESPEARunner** extends *AbstractAlgorithmRunner*

Class to configure and run the ESPEA algorithm

**Author** Marlon Braun

#### Methods

#### main

public static void **main**(String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- **FileNotFoundException** – Invoking command: java org.uma.jmetal.runner.multiobjective.ESPEARunner problemName [referenceFront]

### 2.73.7 GDE3BigDataRunner

public class **GDE3BigDataRunner**

Class for configuring and running the GDE3 algorithm for solving a problem of the Big Optimization competition at CEC2015

**Author** Antonio J. Nebro

#### Methods

##### main

public static void **main** (String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- **SecurityException** – Invoking command: mvn -pl jmetal-exec exec:java -Dexec.mainClass="org.uma.jmetal.runner.multiobjective.GDE3BigDataRunner" -Dexec.args="[problemName]"

### 2.73.8 GDE3Runner

public class **GDE3Runner** extends *AbstractAlgorithmRunner*

Class for configuring and running the GDE3 algorithm

**Author** Antonio J. Nebro

#### Methods

##### main

public static void **main** (String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- **SecurityException** – Invoking command: java org.uma.jmetal.runner.multiobjective.GDE3Runner problemName [referenceFront]

### 2.73.9 GNSGAIIMeasuresWithChartsRunner

public class **GNSGAIIMeasuresWithChartsRunner** extends *AbstractAlgorithmRunner*

Class to configure and run the NSGA-II algorithm (variant with measures) with the G-Dominance Comparator.

#### Methods

##### main

public static void **main** (String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- **SecurityException** – Invoking command: java org.uma.jmetal.runner.multiobjective.NSGAIIMeasuresRunner problemName [referenceFront]

### 2.73.10 GWASGFARunner

public class **GWASGFARunner** extends *AbstractAlgorithmRunner*

#### Methods

#### main

public static void **main**(String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- ***JMetalException*** –
- **FileNotFoundException** – Invoking command: java org.uma.jmetal.runner.multiobjective.GWASGFARunner problemName [referenceFront]

### 2.73.11 IBEARunner

public class **IBEARunner** extends *AbstractAlgorithmRunner*

Class for configuring and running the IBEA algorithm

**Author** Antonio J. Nebro

#### Methods

#### main

public static void **main**(String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- **java.io.IOException** –
- **SecurityException** –
- **ClassNotFoundException** – Invoking command: java org.uma.jmetal.runner.multiobjective.IBEARunner problemName [referenceFront]

### 2.73.12 MOCHC45Runner

public class **MOCHC45Runner** extends *AbstractAlgorithmRunner*

This class executes the algorithm described in: A.J. Nebro, E. Alba, G. Molina, F. Chicano, F. Luna, J.J. Durillo "Optimal antenna placement using a new multi-objective chc algorithm". GECCO '07: Proceedings of the 9th annual conference on Genetic and evolutionary computation. London, England. July 2007.

#### Methods

#### main

public static void **main**(String[] *args*)

### 2.73.13 MOCHCRunner

public class **MOCHCRunner** extends *AbstractAlgorithmRunner*

This class executes the algorithm described in: A.J. Nebro, E. Alba, G. Molina, F. Chicano, F. Luna, J.J. Durillo "Optimal antenna placement using a new multi-objective chc algorithm". GECCO '07: Proceedings of the 9th annual conference on Genetic and evolutionary computation. London, England. July 2007.

#### Methods

#### main

public static void **main**(String[] *args*)

### 2.73.14 MOCellHVRunner

public class **MOCellHVRunner** extends *AbstractAlgorithmRunner*

Class to configure and run the MOCell algorithm

**Author** Antonio J. Nebro

#### Methods

#### main

public static void **main**(String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- *JMetalException* –
- **FileNotFoundException** – Invoking command: java org.uma.jmetal.runner.multiobjective.MOCellRunner problemName [referenceFront]

### 2.73.15 MOCellRunner

public class **MOCellRunner** extends *AbstractAlgorithmRunner*
Class to configure and run the MOCell algorithm

**Author** Antonio J. Nebro

#### Methods

#### main

public static void **main** (String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- *JMetalException* –
- **FileNotFoundException** – Invoking command: java org.uma.jmetal.runner.multiobjective.MOCellRunner problemName [referenceFront]

### 2.73.16 MOEADDRunner

public class **MOEADDRunner** extends *AbstractAlgorithmRunner*
Class for configuring and running the MOEA/DD algorithm

**Author**

#### Methods

#### main

public static void **main** (String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- **SecurityException** – Invoking command: java org.uma.jmetal.runner.multiobjective.MOEADRunner problemName [referenceFront]

### 2.73.17 MOEADRunner

public class **MOEADRunner** extends *AbstractAlgorithmRunner*
Class for configuring and running the MOEA/D algorithm

**Author** Antonio J. Nebro

#### Methods

##### main

public static void **main** (String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- **SecurityException** – Invoking command: java org.uma.jmetal.runner.multiobjective.MOEADRunner problemName [referenceFront]

### 2.73.18 MOEADSTMRunner

public class **MOEADSTMRunner** extends *AbstractAlgorithmRunner*

Class for configuring and running the MOEA/D algorithm

**Author** Antonio J. Nebro

#### Methods

##### main

public static void **main** (String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- **SecurityException** – Invoking command: java org.uma.jmetal.runner.multiobjective.MOEADRunner problemName [referenceFront]

### 2.73.19 MOMBI2Runner

public class **MOMBI2Runner** extends *AbstractAlgorithmRunner*

Class to configure and run the MOMBI2 algorithm

**Author** Juan J. Durillo Reference: Improved Metaheuristic Based on the R2 Indicator for Many-Objective Optimization. R. Hernández Gómez, C.A. Coello Coello. Proceeding GECCO '15 Proceedings of the 2015 on Genetic and Evolutionary Computation Conference. Pages 679-686 DOI: 10.1145/2739480.2754776

#### Methods

##### main

public static void **main** (String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- *JMetalException* –
- **FileNotFoundException** – Invoking command: java org.uma.jmetal.runner.multiobjective.MOMBIRunner problemName [referenceFront]

### 2.73.20 MOMBIRunner

public class **MOMBIRunner** extends *AbstractAlgorithmRunner*

Class to configure and run the MOMBI algorithm

**Author** Juan J. Durillo

#### Methods

#### main

public static void **main**(String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- *JMetalException* –
- **FileNotFoundException** – Invoking command: java org.uma.jmetal.runner.multiobjective.MOMBIRunner problemName [referenceFront]

### 2.73.21 NSGAII45Runner

public class **NSGAII45Runner** extends *AbstractAlgorithmRunner*

Class to configure and run the implementation of the NSGA-II algorithm included in *NSGAII45*

**Author** Antonio J. Nebro

#### Methods

#### main

public static void **main**(String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- *JMetalException* –
- **FileNotFoundException** – Invoking command: java org.uma.jmetal.runner.multiobjective.NSGAII45Runner problemName [referenceFront]

### 2.73.22 NSGAIIBigDataRunner

public class **NSGAIIBigDataRunner** extends *AbstractAlgorithmRunner*

Class for configuring and running the NSGA-II algorithm to solve a problem of the CEC 2015 Big Optimization competition

**Author** Antonio J. Nebro

#### Methods

#### main

public static void **main** (String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- **java.io.IOException** –
- **SecurityException** –
- **ClassNotFoundException** – Invoking command: java org.uma.jmetal.runner.multiobjective.NSGAIIBigDataRunner problemName [referenceFront]

### 2.73.23 NSGAIIBinaryRunner

public class **NSGAIIBinaryRunner** extends *AbstractAlgorithmRunner*

Class for configuring and running the NSGA-II algorithm (binary encoding)

**Author** Antonio J. Nebro

#### Methods

#### main

public static void **main** (String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- ***org.uma.jmetal.util.JMetalException*** –
- **java.io.IOException** –
- **SecurityException** –
- **ClassNotFoundException** – Invoking command: java org.uma.jmetal.runner.multiobjective.NSGAIIBinaryRunner problemName [referenceFront]

### 2.73.24 NSGAIIEbesRunner

public class **NSGAIIEbesRunner** extends *AbstractAlgorithmRunner*

Class to configure and run the NSGA-II algorithm to solve the Ebes problem

**Author** Antonio J. Nebro

#### Methods

#### main

public static void **main** (String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- ***JMetalException*** –
- **FileNotFoundException** – Invoking command: java org.uma.jmetal.runner.multiobjective.NSGAIIRunner problemName [referenceFront]

### 2.73.25 NSGAIIIRunner

public class **NSGAIIIRunner** extends *AbstractAlgorithmRunner*

Class to configure and run the NSGA-III algorithm

#### Methods

#### main

public static void **main** (String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- **java.io.IOException** –
- **SecurityException** –
- **ClassNotFoundException** – Usage: three options - org.uma.jmetal.runner.multiobjective.NSGAIIIRunner - org.uma.jmetal.runner.multiobjective.NSGAIIIRunner problemName - org.uma.jmetal.runner.multiobjective.NSGAIIIRunner problemName paretoFrontFile

### 2.73.26 NSGAIIIntegerRunner

public class **NSGAIIIntegerRunner** extends *AbstractAlgorithmRunner*

Class for configuring and running the NSGA-II algorithm (integer encoding)

**Author** Antonio J. Nebro

#### Methods

##### main

public static void **main** (String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- *org.uma.jmetal.util.JMetalException* –
- **java.io.IOException** –
- **SecurityException** –
- **ClassNotFoundException** – Invoking command: java org.uma.jmetal.runner.multiobjective.NSGAIIIntegerRunner problemName [referenceFront]

### 2.73.27 NSGAIIMeasuresRunner

public class **NSGAIIMeasuresRunner** extends *AbstractAlgorithmRunner*
Class to configure and run the NSGA-II algorithm (variant with measures)

#### Methods

##### main

public static void **main** (String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- **SecurityException** – Invoking command: java org.uma.jmetal.runner.multiobjective.NSGAIIMeasuresRunner problemName [referenceFront]

### 2.73.28 NSGAIIMeasuresWithChartsRunner

public class **NSGAIIMeasuresWithChartsRunner** extends *AbstractAlgorithmRunner*
Class to configure and run the NSGA-II algorithm (variant with measures)

#### Methods

##### main

public static void **main** (String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- **SecurityException** – Invoking command: java org.uma.jmetal.runner.multiobjective.NSGAIIMeasuresRunner problemName [referenceFront]

### 2.73.29 NSGAIIMeasuresWithHypervolumeRunner

public class **NSGAIIMeasuresWithHypervolumeRunner** extends *AbstractAlgorithmRunner*
Class to configure and run the NSGA-II algorithm (variant with measures)

#### Methods

#### main

public static void **main** (String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- **SecurityException** – Invoking command: java org.uma.jmetal.runner.multiobjective.NSGAIIMeasuresRunner problemName [referenceFront]

### 2.73.30 NSGAIIRunner

public class **NSGAIIRunner** extends *AbstractAlgorithmRunner*
Class to configure and run the NSGA-II algorithm

**Author** Antonio J. Nebro

#### Methods

#### main

public static void **main** (String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- ***JMetalException*** –
- **FileNotFoundException** – Invoking command: java org.uma.jmetal.runner.multiobjective.NSGAIIRunner problemName [referenceFront]

### 2.73.31 NSGAIIStoppingByTimeRunner

public class **NSGAIIStoppingByTimeRunner** extends *AbstractAlgorithmRunner*
Class to configure and run the NSGA-II algorithm (version NSGAIIStoppingByTime)

**Author** Antonio J. Nebro

#### Methods

#### main

public static void **main** (String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- ***JMetalException*** –
- **FileNotFoundException** – Invoking command: java org.uma.jmetal.runner.multiobjective.NSGAIIRunner problemName [referenceFront]

### 2.73.32 NSGAIITSPRunner

public class **NSGAIITSPRunner** extends *AbstractAlgorithmRunner*
Class for configuring and running the NSGA-II algorithm to solve the bi-objective TSP

**Author** Antonio J. Nebro

#### Methods

#### main

public static void **main** (String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- **java.io.IOException** –
- **SecurityException** –
- **ClassNotFoundException** – Invoking command: java org.uma.jmetal.runner.multiobjective.NSGAIITSPRunner problemName [referenceFront]

### 2.73.33 OMOPSORunner

public class **OMOPSORunner** extends *AbstractAlgorithmRunner*
Class for configuring and running the OMOPSO algorithm

**Author** Antonio J. Nebro

#### Methods

##### main

public static void **main** (String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- *org.uma.jmetal.util.JMetalException* –
- **java.io.IOException** –
- **SecurityException** – Invoking command: java org.uma.jmetal.runner.multiobjective.OMOPSORunner problemName [referenceFront]

### 2.73.34 PAESRunner

public class **PAESRunner** extends *AbstractAlgorithmRunner*

Class for configuring and running the PAES algorithm

**Author** Antonio J. Nebro

#### Methods

##### main

public static void **main** (String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- **SecurityException** – Invoking command: java org.uma.jmetal.runner.multiobjective.PAESRunner problemName [referenceFront]

### 2.73.35 PESA2Runner

public class **PESA2Runner** extends *AbstractAlgorithmRunner*

Class for configuring and running the PESA2 algorithm

**Author** Antonio J. Nebro

#### Methods

##### main

public static void **main** (String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- **SecurityException** – Invoking command: java org.uma.jmetal.runner.multiobjective.PESA2Runner problemName [referenceFront]

### 2.73.36 ParallelGDE3Runner

public class **ParallelGDE3Runner** extends *AbstractAlgorithmRunner*

Class for configuring and running the GDE3 algorithm (parallel version)

**Author** Antonio J. Nebro

#### Methods

#### main

public static void **main**(String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- **SecurityException** – Invoking command: java org.uma.jmetal.runner.multiobjective.ParallelGDE3Runner problemName [referenceFront]

### 2.73.37 ParallelNSGAIIRunner

public class **ParallelNSGAIIRunner** extends *AbstractAlgorithmRunner*

Class for configuring and running the NSGA-II algorithm (parallel version)

**Author** Antonio J. Nebro

#### Methods

#### main

public static void **main**(String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- **SecurityException** – Invoking command: java org.uma.jmetal.runner.multiobjective.ParallelNSGAIIRunner problemName [referenceFront]

### 2.73.38 ParallelPESA2Runner

public class **ParallelPESA2Runner** extends *AbstractAlgorithmRunner*

Class for configuring and running the PESA2 algorithm (parallel version)

**Author** Antonio J. Nebro

#### Methods

#### main

public static void **main**(String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- **SecurityException** – Invoking command: java org.uma.jmetal.runner.multiobjective.ParallelPESA2Runner problemName [referenceFront]

### 2.73.39 ParallelSMPSORunner

public class **ParallelSMPSORunner** extends *AbstractAlgorithmRunner*

Class for configuring and running the SMPSO algorithm (parallel version)

**Author** Antonio J. Nebro

#### Methods

#### main

public static void **main**(String[] *args*)

**Parameters**

- **args** – Command line arguments. The first (optional) argument specifies the problem to solve.

**Throws**

- ***org.uma.jmetal.util.JMetalException*** –
- **java.io.IOException** –
- **SecurityException** – Invoking command: java org.uma.jmetal.runner.multiobjective.ParallelSMPSORunner problemName [referenceFront]

### 2.73.40 ParallelSPEA2Runner

public class **ParallelSPEA2Runner** extends *AbstractAlgorithmRunner*

/** Class for configuring and running the SPEA2 algorithm

**Author** Antonio J. Nebro

#### Methods

##### main

public static void **main** (String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- **SecurityException** – Invoking command: java org.uma.jmetal.runner.multiobjective.ParallelSPEA2Runner problemName [referenceFront]

### 2.73.41 RNSGAIIConstraintRunner

public class **RNSGAIIConstraintRunner** extends *AbstractAlgorithmRunner*

Class to configure and run the R-NSGA-II algorithm

**Author** Antonio J. Nebro , Cristobal Barba

#### Methods

##### main

public static void **main** (String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- ***JMetalException*** –
- **FileNotFoundException** – Invoking command: java org.uma.jmetal.runner.multiobjective.RNSGAIIRunner problemName [referenceFront]

### 2.73.42 RNSGAIIRunner

public class **RNSGAIIRunner** extends *AbstractAlgorithmRunner*

Class to configure and run the R-NSGA-II algorithm

**Author** Antonio J. Nebro , Cristobal Barba

#### Methods

##### main

public static void **main** (String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- *JMetalException* –
- **FileNotFoundException** – Invoking command: java org.uma.jmetal.runner.multiobjective.RNSGAIIRunner problemName [referenceFront]

### 2.73.43 RandomSearchRunner

public class **RandomSearchRunner** extends *AbstractAlgorithmRunner*

Class for configuring and running the random search algorithm

**Author** Antonio J. Nebro

#### Methods

#### main

public static void **main** (String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- **SecurityException** – Invoking command: java org.uma.jmetal.runner.multiobjective.RandomSearchRunner problemName [referenceFront]

### 2.73.44 SMPSOBigDataRunner

public class **SMPSOBigDataRunner** extends *AbstractAlgorithmRunner*

Class for configuring and running the SMPSO algorithm to solve a problem of the CEC2015 Big Optimization competition

**Author** Antonio J. Nebro

#### Methods

#### main

public static void **main** (String[] *args*)

**Parameters**

- **args** – Command line arguments. The first (optional) argument specifies the problem to solve.

**Throws**

- *org.uma.jmetal.util.JMetalException* –
- **java.io.IOException** –

- **SecurityException** – Invoking command: java org.uma.jmetal.runner.multiobjective.SMPSOBigDataRunner problemName [referenceFront]

### 2.73.45 SMPSOHv2Runner

public class **SMPSOHv2Runner** extends *AbstractAlgorithmRunner*

Class for configuring and running the SMPSO algorithm using an HypervolumeArchive, i.e, the SMPSOhv algorithm described in: A.J Nebro, J.J. Durillo, C.A. Coello Coello. Analysis of Leader Selection Strategies in a Multi-Objective Particle Swarm Optimizer. 2013 IEEE Congress on Evolutionary Computation. June 2013 DOI: 10.1109/CEC.2013.6557955 This is a variant using the WFG Hypervolume implementation

**Author** Antonio J. Nebro

#### Methods

#### main

public static void **main**(String[] *args*)

**Parameters**

- **args** – Command line arguments. The first (optional) argument specifies the problem to solve.

**Throws**

- *org.uma.jmetal.util.JMetalException* –
- **java.io.IOException** –
- **SecurityException** – Invoking command: java org.uma.jmetal.runner.multiobjective.SMPSOHvRunner problemName [referenceFront]

### 2.73.46 SMPSOHvRunner

public class **SMPSOHvRunner** extends *AbstractAlgorithmRunner*

Class for configuring and running the SMPSO algorithm using an HypervolumeArchive, i.e, the SMPSOhv algorithm described in: A.J Nebro, J.J. Durillo, C.A. Coello Coello. Analysis of Leader Selection Strategies in a Multi-Objective Particle Swarm Optimizer. 2013 IEEE Congress on Evolutionary Computation. June 2013 DOI: 10.1109/CEC.2013.6557955

**Author** Antonio J. Nebro

#### Methods

#### main

public static void **main**(String[] *args*)

**Parameters**

- **args** – Command line arguments. The first (optional) argument specifies the problem to solve.

**Throws**

- *org.uma.jmetal.util.JMetalException* –
- java.io.IOException –
- SecurityException – Invoking command: java org.uma.jmetal.runner.multiobjective.SMPSOHvRunner problemName [referenceFront]

### 2.73.47 SMPSOMeasuresRunner

public class **SMPSOMeasuresRunner** extends *AbstractAlgorithmRunner*
Class to configure and run the NSGA-II algorithm (variant with measures)

#### Methods

#### main

public static void **main**(String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- SecurityException – Invoking command: java org.uma.jmetal.runner.multiobjective.NSGAIIMeasuresRunner problemName [referenceFront]

### 2.73.48 SMPSOMeasuresWithChartsRunner

public class **SMPSOMeasuresWithChartsRunner** extends *AbstractAlgorithmRunner*
Class to configure and run the NSGA-II algorithm (variant with measures)

#### Methods

#### main

public static void **main**(String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- SecurityException – Invoking command: java org.uma.jmetal.runner.multiobjective.NSGAIIMeasuresRunner problemName [referenceFront]

### 2.73.49 SMPSORPChangingTheReferencePointsAndChartsRunner

public class **SMPSORPChangingTheReferencePointsAndChartsRunner**

#### Methods

##### main

public static void **main** (String[] *args*)

Program to run the SMPSORP algorithm allowing to change a reference point interactively. SMPSORP is described in "Extending the Speed-constrained Multi-Objective PSO (SMPSO) With Reference Point Based Preference Articulation. Antonio J. Nebro, Juan J. Durillo, José García-Nieto, Cristóbal Barba-González, Javier Del Ser, Carlos A. Coello Coello, Antonio Benítez-Hidalgo, José F. Aldana-Montes. Parallel Problem Solving from Nature – PPSN XV. Lecture Notes In Computer Science, Vol. 11101, pp. 298-310. 2018." This runner is the one used in the use case included in the paper. In the current implementation, only one reference point can be modified interactively.

**Author** Antonio J. Nebro

### 2.73.50 SMPSORPWithMultipleReferencePointsAndChartsRunner

public class **SMPSORPWithMultipleReferencePointsAndChartsRunner**

#### Methods

##### main

public static void **main** (String[] *args*)

Program to run the SMPSORP algorithm with three reference points and plotting a graph during the algorithm execution. SMPSORP is described in "Extending the Speed-constrained Multi-Objective PSO (SMPSO) With Reference Point Based Preference Articulation. Antonio J. Nebro, Juan J. Durillo, José García-Nieto, Cristóbal Barba-González, Javier Del Ser, Carlos A. Coello Coello, Antonio Benítez-Hidalgo, José F. Aldana-Montes. Parallel Problem Solving from Nature – PPSN XV. Lecture Notes In Computer Science, Vol. 11101, pp. 298-310. 2018".

**Author** Antonio J. Nebro

### 2.73.51 SMPSORPWithMultipleReferencePointsRunner

public class **SMPSORPWithMultipleReferencePointsRunner**

#### Methods

##### main

public static void **main** (String[] *args*)

Program to run the SMPSORP algorithm with two reference points. SMPSORP is described in "Extending the Speed-constrained Multi-Objective PSO (SMPSO) With Reference Point Based Preference Articulation. Antonio J. Nebro, Juan J. Durillo, José García-Nieto, Cristóbal Barba-González, Javier Del Ser, Carlos A. Coello Coello, Antonio Benítez-Hidalgo, José F. Aldana-Montes. Parallel Problem Solving from Nature – PPSN XV. Lecture Notes In Computer Science, Vol. 11101, pp. 298-310. 2018"

**Author** Antonio J. Nebro

### 2.73.52 SMPSORPWithOneReferencePointRunner

public class **SMPSORPWithOneReferencePointRunner**

#### Methods

#### main

public static void **main**(String[] *args*)

Program to run the SMPSORP algorithm with one reference point. SMPSORP is described in "Extending the Speed-constrained Multi-Objective PSO (SMPSO) With Reference Point Based Preference * Articulation. Antonio J. Nebro, Juan J. Durillo, José García-Nieto, Cristóbal Barba-González, * Javier Del Ser, Carlos A. Coello Coello, Antonio Benítez-Hidalgo, José F. Aldana-Montes. * Parallel Problem Solving from Nature – PPSN XV. Lecture Notes In Computer Science, Vol. 11101, * pp. 298-310. 2018

**Author** Antonio J. Nebro

### 2.73.53 SMPSORunner

public class **SMPSORunner** extends *AbstractAlgorithmRunner*

Class for configuring and running the SMPSO algorithm

**Author** Antonio J. Nebro

#### Methods

#### main

public static void **main**(String[] *args*)

**Parameters**

- **args** – Command line arguments. The first (optional) argument specifies the problem to solve.

**Throws**

- ***org.uma.jmetal.util.JMetalException*** –
- **java.io.IOException** –
- **SecurityException** – Invoking command: java org.uma.jmetal.runner.multiobjective.SMPSORunner problemName [referenceFront]

### 2.73.54 SMSEMOARunner

public class **SMSEMOARunner** extends *AbstractAlgorithmRunner*

Class to configure and run the SMSEMOA algorithm

**Author** Antonio J. Nebro

#### Methods

##### main

public static void **main** (String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- **SecurityException** – Invoking command: java org.uma.jmetal.runner.multiobjective.SMSEMOARunner problemName [referenceFront]

### 2.73.55 SPEA2BinaryRunner

public class **SPEA2BinaryRunner** extends *AbstractAlgorithmRunner*

Class for configuring and running the SPEA2 algorithm (binary encoding)

**Author** Antonio J. Nebro

#### Methods

##### main

public static void **main** (String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- **SecurityException** – Invoking command: java org.uma.jmetal.runner.multiobjective.SPEA2BinaryRunner problemName [referenceFront]

### 2.73.56 SPEA2Runner

public class **SPEA2Runner** extends *AbstractAlgorithmRunner*

Class for configuring and running the SPEA2 algorithm

**Author** Antonio J. Nebro

#### Methods

##### main

public static void **main** (String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- `java.io.IOException` –
- `SecurityException` –
- `ClassNotFoundException` – Invoking command: java org.uma.jmetal.runner.multiobjective.SPEA2BinaryRunner problemName [referenceFront]

### 2.73.57 SteadyStateNSGAIIRunner

public class **SteadyStateNSGAIIRunner** extends *AbstractAlgorithmRunner*

Class to configure and run the NSGA-II (steady state version) algorithm

**Author** Antonio J. Nebro

#### Methods

#### main

public static void **main**(String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- *JMetalException* –
- **FileNotFoundException** – Invoking command: java org.uma.jmetal.runner.multiobjective.SteadyStateNSGAIIRunner problemName [referenceFront]

### 2.73.58 WASFGABinaryRunner

public class **WASFGABinaryRunner** extends *AbstractAlgorithmRunner*

#### Methods

#### main

public static void **main**(String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- *JMetalException* –
- **FileNotFoundException** – Invoking command: java org.uma.jmetal.runner.multiobjective.WASFGARunner problemName [referenceFront]

### 2.73.59 WASFGAMeasuresRunner

public class **WASFGAMeasuresRunner** extends *AbstractAlgorithmRunner*

#### Methods

#### main

public static void **main** (String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- ***JMetalException*** –
- **IOException** –

### 2.73.60 WASFGAMeasuresRunner3D

public class **WASFGAMeasuresRunner3D** extends *AbstractAlgorithmRunner*

#### Methods

#### main

public static void **main** (String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- ***JMetalException*** –
- **IOException** –

### 2.73.61 WASFGARunner

public class **WASFGARunner** extends *AbstractAlgorithmRunner*

#### Methods

#### main

public static void **main** (String[] *args*)

**Parameters**

- **args** – Command line arguments.

**Throws**

- *JMetalException* –
- **FileNotFoundException** – Invoking command: java org.uma.jmetal.runner.multiobjective.WASFGABinaryRunner problemName [referenceFront]

## 2.74 org.uma.jmetal.runner.singleobjective

### 2.74.1 CoralReefsOptimizationRunner

public class **CoralReefsOptimizationRunner**

Class to configure and run a coral reefs optimization algorithm. The target problem is OneMax.

**Author** Inacio Medeiros

#### Methods

#### main

public static void **main**(String[] *args*)

Usage: java org.uma.jmetal.runner.singleobjective.CoralReefsOptimizationRunner

### 2.74.2 CovarianceMatrixAdaptationEvolutionStrategyRunner

public class **CovarianceMatrixAdaptationEvolutionStrategyRunner**

#### Methods

#### main

public static void **main**(String[] *args*)

### 2.74.3 DifferentialEvolutionRunner

public class **DifferentialEvolutionRunner**

Class to configure and run a differential evolution algorithm. The algorithm can be configured to use threads. The number of cores is specified as an optional parameter. The target problem is Sphere.

**Author** Antonio J. Nebro

#### Methods

#### main

public static void **main**(String[] *args*)

Usage: java org.uma.jmetal.runner.singleobjective.DifferentialEvolutionRunner [cores]

### 2.74.4 ElitistEvolutionStrategyRunner

public class **ElitistEvolutionStrategyRunner**

Class to configure and run an elitist (mu + lambda) evolution strategy. The target problem is OneMax.

**Author** Antonio J. Nebro

#### Methods

#### main

public static void **main**(String[] *args*)

Usage: java org.uma.jmetal.runner.singleobjective.ElitistEvolutionStrategyRunner

### 2.74.5 GenerationalGeneticAlgorithmBinaryEncodingRunner

public class **GenerationalGeneticAlgorithmBinaryEncodingRunner**

Class to configure and run a generational genetic algorithm. The target problem is OneMax.

**Author** Antonio J. Nebro

#### Methods

#### main

public static void **main**(String[] *args*)

Usage: java org.uma.jmetal.runner.singleobjective.GenerationalGeneticAlgorithmBinaryEncodingRunner

### 2.74.6 GenerationalGeneticAlgorithmDoubleEncodingRunner

public class **GenerationalGeneticAlgorithmDoubleEncodingRunner**

Class to configure and run a generational genetic algorithm. The target problem is OneMax.

**Author** Antonio J. Nebro

#### Methods

#### main

public static void **main**(String[] *args*)

Usage: java org.uma.jmetal.runner.singleobjective.GenerationalGeneticAlgorithmDoubleEncodingRunner

### 2.74.7 GenerationalGeneticAlgorithmTSPRunner

public class **GenerationalGeneticAlgorithmTSPRunner**

Class to configure and run a generational genetic algorithm. The target problem is TSP.

**Author** Antonio J. Nebro

#### Methods

##### main

public static void **main** (String[] *args*)
Usage: java org.uma.jmetal.runner.singleobjective.BinaryGenerationalGeneticAlgorithmRunner

### 2.74.8 LocalSearchRunner

public class **LocalSearchRunner**
Class to configure and run a single objective local search. The target problem is OneMax.

**Author** Antonio J. Nebro

#### Methods

##### main

public static void **main** (String[] *args*)
Usage: java org.uma.jmetal.runner.singleobjective.LocalSearchRunner

### 2.74.9 NonElitistEvolutionStrategyRunner

public class **NonElitistEvolutionStrategyRunner**
Class to configure and run a non elitist (mu,lamba) evolution strategy. The target problem is OneMax.

**Author** Antonio J. Nebro

#### Methods

##### main

public static void **main** (String[] *args*)
Usage: java org.uma.jmetal.runner.singleobjective.NonElitistEvolutionStrategyRunner

### 2.74.10 ParallelGenerationalGeneticAlgorithmRunner

public class **ParallelGenerationalGeneticAlgorithmRunner**
Class to configure and run a parallel (multithreaded) generational genetic algorithm. The number of cores is specified as an optional parameter. A default value is used is the parameter is not provided. The target problem is OneMax

**Author** Antonio J. Nebro

#### Methods

##### main

public static void **main** (String[] *args*)
Usage: java org.uma.jmetal.runner.singleobjective.ParallelGenerationalGeneticAlgorithmRunner [cores]

### 2.74.11 SMPSORunner

public class **SMPSORunner** extends *AbstractAlgorithmRunner*

Class for configuring and running the SMPSO algorithm to solve a single-objective problem

**Author** Antonio J. Nebro

#### Methods

#### main

public static void **main** (String[] *args*)

**Parameters**

- **args** – Command line arguments. The first (optional) argument specifies the problem to solve.

**Throws**

- ***org.uma.jmetal.util.JMetalException*** –
- **java.io.IOException** –
- **SecurityException** – Invoking command: java org.uma.jmetal.runner.multiobjective.SMPSORunner problemName [referenceFront]

### 2.74.12 StandardPSO2007Runner

public class **StandardPSO2007Runner**

Class to configure and run a StandardPSO2007. The algorithm can be configured to use threads. The number of cores is specified as an optional parameter. The target problem is Sphere.

**Author** Antonio J. Nebro

#### Methods

#### main

public static void **main** (String[] *args*)

Usage: java org.uma.jmetal.runner.singleobjective.StandardPSO2007Runner [cores]

### 2.74.13 StandardPSO2011Runner

public class **StandardPSO2011Runner**

Class to configure and run a StandardPSO2007. The algorithm can be configured to use threads. The number of cores is specified as an optional parameter. The target problem is Sphere.

**Author** Antonio J. Nebro

#### Methods

#### main

public static void **main** (String[] *args*)
Usage: java org.uma.jmetal.runner.singleobjective.StandardPSO2007Runner [cores]

### 2.74.14 SteadyStateGeneticAlgorithmBinaryEncodingRunner

public class **SteadyStateGeneticAlgorithmBinaryEncodingRunner**
Class to configure and run a steady-state genetic algorithm. The target problem is TSP

**Author** Antonio J. Nebro

#### Methods

#### main

public static void **main** (String[] *args*)
Usage: java org.uma.jmetal.runner.singleobjective.SteadyStateGeneticAlgorithmBinaryEncodingRunner

### 2.74.15 SteadyStateGeneticAlgorithmRunner

public class **SteadyStateGeneticAlgorithmRunner**
Class to configure and run a steady-state genetic algorithm. The target problem is Sphere

**Author** Antonio J. Nebro

#### Methods

#### main

public static void **main** (String[] *args*)
Usage: java org.uma.jmetal.runner.singleobjective.SteadyStateGeneticAlgorithmRunner

## 2.75 org.uma.jmetal.solution

### 2.75.1 BinarySolution

public interface **BinarySolution** extends *Solution*<*BinarySet*>
Interface representing a binary (bitset) solutions

**Author** Antonio J. Nebro

#### Methods

##### getNumberOfBits

public int **getNumberOfBits** (int *index*)

##### getTotalNumberOfBits

public int **getTotalNumberOfBits** ()

### 2.75.2 DoubleBinarySolution

public interface **DoubleBinarySolution** extends *Solution*<Object>
Interface representing a solution having an array of real values and a bitset

**Author** Antonio J. Nebro

#### Methods

##### getLowerBound

public Double **getLowerBound** (int *index*)

##### getNumberOfBits

public int **getNumberOfBits** ()

##### getNumberOfDoubleVariables

public int **getNumberOfDoubleVariables** ()

##### getUpperBound

public Double **getUpperBound** (int *index*)

### 2.75.3 DoubleSolution

public interface **DoubleSolution** extends *Solution*<Double>
Interface representing a double solutions

**Author** Antonio J. Nebro

#### Methods

##### getLowerBound

public Double **getLowerBound** (int *index*)

#### getUpperBound

public Double **getUpperBound**(int *index*)

### 2.75.4 IntegerDoubleSolution

public interface **IntegerDoubleSolution** extends *Solution*<Number>
Interface representing a solution composed of integers and real values

**Author** Antonio J. Nebro

#### Methods

#### getLowerBound

public Number **getLowerBound**(int *index*)

#### getNumberOfDoubleVariables

public int **getNumberOfDoubleVariables**()

#### getNumberOfIntegerVariables

public int **getNumberOfIntegerVariables**()

#### getUpperBound

public Number **getUpperBound**(int *index*)

### 2.75.5 IntegerSolution

public interface **IntegerSolution** extends *Solution*<Integer>
Interface representing a integer solutions

**Author** Antonio J. Nebro

#### Methods

#### getLowerBound

public Integer **getLowerBound**(int *index*)

#### getUpperBound

public Integer **getUpperBound**(int *index*)

### 2.75.6 PermutationSolution

public interface **PermutationSolution**<T> extends *Solution*<T>
Interface representing permutation based solutions

**Author** Antonio J. Nebro

### 2.75.7 Solution

public interface **Solution**<T> extends Serializable
Interface representing a Solution

**Author** Antonio J. Nebro

**Parameters**

- **<T>** – Type (Double, Integer, etc.)

#### Methods

#### copy

*Solution*<T> **copy**()

#### getAttribute

Object **getAttribute**(Object *id*)

#### getNumberOfObjectives

int **getNumberOfObjectives**()

#### getNumberOfVariables

int **getNumberOfVariables**()

#### getObjective

double **getObjective**(int *index*)

#### getObjectives

double[] **getObjectives**()

#### getVariableValue

T **getVariableValue**(int *index*)

#### getVariableValueString

String **getVariableValueString**(int *index*)

#### setAttribute

void **setAttribute**(Object *id*, Object *value*)

#### setObjective

void **setObjective**(int *index*, double *value*)

#### setVariableValue

void **setVariableValue**(int *index*, T *value*)

### 2.75.8 SolutionBuilder

public interface **SolutionBuilder**<Solution>

A *SolutionBuilder* allows to generate a *Solution* by setting its fundamental information, in other words by providing the values of its *Variable*s.

**Author** Matthieu Vergne

**Parameters**

- **<Solution>** –

#### Methods

#### build

public *Solution* **build**()

This method generates a valid *Solution* based on all the Values prepared by calling *prepare(Variable,Object)*. Usually, all the *Variable*s should have been prepared before to be able to build a valid *Solution*, but it depends on the definition of the *Solution* (e.g. there could have *Variable*s depending on each other, such that preparing one is equivalent to prepare others). Specific implementation could provide a method to know whether or not *build()* can be called, or other facilities to ensure that a *Solution* is properly prepared when *build()* is called.

**Returns** a new *Solution* instance

#### getVariables

public Collection<*Variable*<*Solution*, ?>> **getVariables**()

**Returns** the list of *Variable*s managed by this *SolutionBuilder*

#### prepare

public <Value> void **prepare** (*Variable*<*Solution*, Value> *variable*, Value *value*)

This method tells which `Value` to assign to the next *`Solution`*, generated by *`build()`*, for a given *`Variable`*. Once all the required *`Variable`*s are prepared, *`build()`* can be called to generate the *`Solution`*. If this method is called several time on the same *`Variable`* before to call *`build()`*, the last prepared `Value` should be considered.

**Parameters**

- **`variable`** – the *`Variable`* to consider
- **`value`** – the `Value` to prepare for this *`Variable`*

### 2.75.9 SolutionBuilder.Variable

public static interface **Variable**<Solution, Value> extends *DescribedEntity*

A *`Variable`* represents the fundamental information of a set of homogeneous *`Solution`*s (e.g. a population of solutions returned by an *`Algorithm`*). For instance, an *`Algorithm`* used to solve a TSP problem would manage a whole population of *`Solution`*s, each representing a different path, and a *`Variable`* would represent a type of information which defines these *`Solution`*s, like the path they represent or something more fine grained like the $i^{th}$ city.

**Author** Matthieu Vergne

**Parameters**

- **`<Solution>`** –
- **`<Value>`** –

#### Methods

#### get

public Value **get** (*Solution solution*)

**Parameters**

- **`solution`** – the *`Solution`* to read

**Returns** the `Value` of the *`Variable`* for this *`Solution`*

### 2.75.10 SolutionEvaluator

public interface **SolutionEvaluator**<Solution>

A *`SolutionEvaluator`* allows to evaluate a *`Solution`* on one or several dimensions, in other words to compute its *`Objective`* values.

**Author** Matthieu Vergne

**Parameters**

- **`<Solution>`** –

#### Methods

##### getObjectives

public Collection<*Objective*<*Solution*, ?>> **getObjectives**()

**Returns** the list of *Objective*s managed by this *SolutionEvaluator*

### 2.75.11 SolutionEvaluator.Objective

public static interface **Objective**<Solution, Value> extends *DescribedEntity*

An *Objective* represents the evaluation information of a set of homogeneous *Solution*s (e.g. a population of solutions returned by an *Algorithm*). For instance, an *Algorithm* used to solve a TSP problem would manage a whole population of *Solution*s, each representing a different path, and an *Objective* would represent a type of information which evaluates these *Solution*s, like the length of the path, the time needed to travel through this path, or the amount of fuel consumed.

**Author** Matthieu Vergne

**Parameters**

- **<Solution>** –
- **<Value>** –

#### Methods

##### get

public Value **get**(*Solution solution*)

**Parameters**

- **solution** – the *Solution* to read

**Returns** the `Value` of the *Objective* for this *Solution*

## 2.76 org.uma.jmetal.solution.impl

### 2.76.1 AbstractGenericSolution

public abstract class **AbstractGenericSolution**<T, P extends Problem<?>> implements *Solution*<T>

Abstract class representing a generic solution

**Author** Antonio J. Nebro

#### Fields

##### attributes

protected Map<Object, Object> **attributes**

#### problem

protected P **problem**

#### randomGenerator

protected final *JMetalRandom* **randomGenerator**

### Constructors

#### AbstractGenericSolution

protected **AbstractGenericSolution**(P *problem*)
Constructor

### Methods

#### equals

public boolean **equals**(Object *o*)

#### getAttribute

public Object **getAttribute**(Object *id*)

#### getNumberOfObjectives

public int **getNumberOfObjectives**()

#### getNumberOfVariables

public int **getNumberOfVariables**()

#### getObjective

public double **getObjective**(int *index*)

#### getObjectives

public double[] **getObjectives**()

#### getVariableValue

public T **getVariableValue**(int *index*)

#### hashCode

public int **hashCode**()

#### initializeObjectiveValues

protected void **initializeObjectiveValues**()

#### setAttribute

public void **setAttribute**(Object *id*, Object *value*)

#### setObjective

public void **setObjective**(int *index*, double *value*)

#### setVariableValue

public void **setVariableValue**(int *index*, T *value*)

#### toString

public String **toString**()

## 2.76.2 ArrayDoubleSolution

public class **ArrayDoubleSolution** implements *DoubleSolution*

Implementation of *DoubleSolution* using arrays.

**Author** Antonio J. Nebro

### Fields

#### attributes

protected Map<Object, Object> **attributes**

#### problem

protected *DoubleProblem* **problem**

#### randomGenerator

protected final *JMetalRandom* **randomGenerator**

#### Constructors

##### ArrayDoubleSolution

public **ArrayDoubleSolution**(*DoubleProblem problem*)
Constructor

##### ArrayDoubleSolution

public **ArrayDoubleSolution**(*ArrayDoubleSolution solution*)
Copy constructor

**Parameters**

- **solution** – to copy

#### Methods

##### copy

public *Solution*<Double> **copy**()

##### equals

public boolean **equals**(Object *o*)

##### getAttribute

public Object **getAttribute**(Object *id*)

##### getLowerBound

public Double **getLowerBound**(int *index*)

##### getNumberOfObjectives

public int **getNumberOfObjectives**()

##### getNumberOfVariables

public int **getNumberOfVariables**()

##### getObjective

public double **getObjective**(int *index*)

#### getObjectives

public double[] **getObjectives**()

#### getUpperBound

public Double **getUpperBound**(int *index*)

#### getVariableValue

public Double **getVariableValue**(int *index*)

#### getVariableValueString

public String **getVariableValueString**(int *index*)

#### hashCode

public int **hashCode**()

#### setAttribute

public void **setAttribute**(Object *id*, Object *value*)

#### setObjective

public void **setObjective**(int *index*, double *value*)

#### setVariableValue

public void **setVariableValue**(int *index*, Double *value*)

## 2.76.3 ArrayDoubleSolutionTest

public class **ArrayDoubleSolutionTest**

**Author** Antonio J. Nebro

### Methods

#### setup

public void **setup**()

#### shouldConstructorCreateAnObject

public void **shouldConstructorCreateAnObject**()

#### shouldCopyConstructorCreateAnIdenticalSolution

public void **shouldCopyConstructorCreateAnIdenticalSolution**()

#### shouldGetLowerBoundReturnTheRightValue

public void **shouldGetLowerBoundReturnTheRightValue**()

#### shouldGetUpperBoundReturnTheRightValue

public void **shouldGetUpperBoundReturnTheRightValue**()

## 2.76.4 DefaultBinarySolution

public class **DefaultBinarySolution** extends *AbstractGenericSolution*<*BinarySet*, *BinaryProblem*> implements *BinarySolution*

Defines an implementation of a binary solution

**Author** Antonio J. Nebro

### Constructors

#### DefaultBinarySolution

public **DefaultBinarySolution**(*BinaryProblem problem*)

Constructor

#### DefaultBinarySolution

public **DefaultBinarySolution**(*DefaultBinarySolution solution*)

Copy constructor

### Methods

#### copy

public *DefaultBinarySolution* **copy**()

#### getNumberOfBits

public int **getNumberOfBits**(int *index*)

#### getTotalNumberOfBits

public int **getTotalNumberOfBits** ()

#### getVariableValueString

public String **getVariableValueString** (int *index*)

### 2.76.5 DefaultBinarySolutionTest

public class **DefaultBinarySolutionTest**

#### Fields

#### problem

*BinaryProblem* **problem**

#### Methods

#### setUp

public void **setUp** ()

#### shouldCopyReturnAnIdenticalVariable

public void **shouldCopyReturnAnIdenticalVariable** ()

#### shouldGetNumberOfBitsBeEqualToTheNumberOfOfBitsPerVariable

public void **shouldGetNumberOfBitsBeEqualToTheNumberOfOfBitsPerVariable** ()

#### shouldGetTotalNumberOfBitsBeEqualToTheSumOfBitsPerVariable

public void **shouldGetTotalNumberOfBitsBeEqualToTheSumOfBitsPerVariable** ()

#### shouldGetVariableValueStringReturnARightStringRepresentation

public void **shouldGetVariableValueStringReturnARightStringRepresentation** ()

#### shouldTheHashCodeOfTwoIdenticalSolutionsBeTheSame

public void **shouldTheHashCodeOfTwoIdenticalSolutionsBeTheSame** ()

#### shouldTheSumOfGetNumberOfBitsBeEqualToTheSumOfBitsPerVariable

public void **shouldTheSumOfGetNumberOfBitsBeEqualToTheSumOfBitsPerVariable**()

#### tearDown

public void **tearDown**()

## 2.76.6 DefaultDoubleBinarySolution

public class **DefaultDoubleBinarySolution** extends *AbstractGenericSolution*<Object, *DoubleBinaryProblem*<?>> implements

Description: - this solution contains an array of double value + a binary string - getNumberOfVariables() returns the number of double values + 1 (the string) - getNumberOfDoubleVariables() returns the number of double values - getNumberOfVariables() = getNumberOfDoubleVariables() + 1 - the bitset is the last variable

**Author** Antonio J. Nebro

### Constructors

#### DefaultDoubleBinarySolution

public **DefaultDoubleBinarySolution**(*DoubleBinaryProblem*<?> *problem*)

Constructor

#### DefaultDoubleBinarySolution

public **DefaultDoubleBinarySolution**(*DefaultDoubleBinarySolution* *solution*)

Copy constructor

### Methods

#### copy

public *DefaultDoubleBinarySolution* **copy**()

#### getLowerBound

public Double **getLowerBound**(int *index*)

#### getNumberOfBits

public int **getNumberOfBits**()

#### getNumberOfDoubleVariables

public int **getNumberOfDoubleVariables**()

#### getUpperBound

public Double **getUpperBound** (int *index*)

#### getVariableValueString

public String **getVariableValueString** (int *index*)

### 2.76.7 DefaultDoubleSolution

public class **DefaultDoubleSolution** extends *AbstractGenericSolution*<Double, *DoubleProblem*> implements *DoubleSolution*

Defines an implementation of a double solution

**Author** Antonio J. Nebro

#### Constructors

#### DefaultDoubleSolution

public **DefaultDoubleSolution** (*DoubleProblem problem*)

Constructor

#### DefaultDoubleSolution

public **DefaultDoubleSolution** (*DefaultDoubleSolution solution*)

Copy constructor

#### Methods

#### copy

public *DefaultDoubleSolution* **copy** ()

#### getLowerBound

public Double **getLowerBound** (int *index*)

#### getUpperBound

public Double **getUpperBound** (int *index*)

#### getVariableValueString

public String **getVariableValueString** (int *index*)

### 2.76.8 DefaultIntegerDoubleSolution

public class **DefaultIntegerDoubleSolution** extends *AbstractGenericSolution*<Number, *IntegerDoubleProblem*<?>> implem

Defines an implementation of a class for solutions having integers and doubles

**Author** Antonio J. Nebro

#### Constructors

##### DefaultIntegerDoubleSolution

public **DefaultIntegerDoubleSolution** (*IntegerDoubleProblem*<?> *problem*)

Constructor

##### DefaultIntegerDoubleSolution

public **DefaultIntegerDoubleSolution** (*DefaultIntegerDoubleSolution* *solution*)

Copy constructor

#### Methods

##### copy

public *DefaultIntegerDoubleSolution* **copy** ()

##### getLowerBound

public Number **getLowerBound** (int *index*)

##### getNumberOfDoubleVariables

public int **getNumberOfDoubleVariables** ()

##### getNumberOfIntegerVariables

public int **getNumberOfIntegerVariables** ()

##### getUpperBound

public Number **getUpperBound** (int *index*)

##### getVariableValueString

public String **getVariableValueString** (int *index*)

### 2.76.9 DefaultIntegerPermutationSolution

public class **DefaultIntegerPermutationSolution** extends *AbstractGenericSolution*<Integer, *PermutationProblem*<?>> imp

Defines an implementation of solution composed of a permuation of integers

**Author** Antonio J. Nebro

#### Constructors

#### DefaultIntegerPermutationSolution

public **DefaultIntegerPermutationSolution** (*PermutationProblem*<?> *problem*)

Constructor

#### DefaultIntegerPermutationSolution

public **DefaultIntegerPermutationSolution** (*DefaultIntegerPermutationSolution* *solution*)

Copy Constructor

#### Methods

#### copy

public *DefaultIntegerPermutationSolution* **copy** ()

#### getVariableValueString

public String **getVariableValueString** (int *index*)

### 2.76.10 DefaultIntegerPermutationSolutionTest

public class **DefaultIntegerPermutationSolutionTest**

**Author** Antonio J. Nebro

#### Methods

#### shouldConstructorCreateAValidSolution

public void **shouldConstructorCreateAValidSolution** ()

### 2.76.11 DefaultIntegerSolution

public class **DefaultIntegerSolution** extends *AbstractGenericSolution*<Integer, *IntegerProblem*> implements *IntegerSolution*

Defines an implementation of an integer solution

**Author** Antonio J. Nebro

#### Constructors

##### DefaultIntegerSolution

public **DefaultIntegerSolution** (*IntegerProblem problem*)
Constructor

##### DefaultIntegerSolution

public **DefaultIntegerSolution** (*DefaultIntegerSolution solution*)
Copy constructor

#### Methods

##### copy

public *DefaultIntegerSolution* **copy** ()

##### getLowerBound

public Integer **getLowerBound** (int *index*)

##### getUpperBound

public Integer **getUpperBound** (int *index*)

##### getVariableValueString

public String **getVariableValueString** (int *index*)

### 2.76.12 DoubleSolutionComparisonIT

public class **DoubleSolutionComparisonIT**
Integration test to compare the performance of `ArrayDoubleSolution` against `DefaultDoubleSolution`

**Author** Antonio J. Nebro

#### Methods

##### compareDoubleSolutionImplementationsWhenCreatingSolutions

public void **compareDoubleSolutionImplementationsWhenCreatingSolutions** ()

#### compareDoubleSolutionImplementationsWhenEvaluatingSolutions

public void **compareDoubleSolutionImplementationsWhenEvaluatingSolutions**()

### 2.76.13 ObjectiveFactory

public class **ObjectiveFactory**

This factory provides facilities to generate *Objective*s from usual situations.

**Author** Matthieu Vergne

#### Methods

#### createFromGetters

public <Solution> Collection<*Objective*<*Solution*, ?>> **createFromGetters**(Class<*Solution*> *solutionClass*)

This method retrieves all the values accessible through a getter ( getX() method) in order to build the corresponding set of *Objective*s. Notice that *Objective*s are supposed to represent evaluations of a *Solution*, so if the *Solution* has other kinds of information accessible through getters, they will also be retrieved as *Objective*s. In such a case, you should filter the returned *Objective*s, rely on more advanced methods, or generate the *Objective*s manually.

**Parameters**

- **solutionClass** – the *Solution* class to analyze

**Returns** the set of *Objective*s retrieved from this class

**See also:** .createFromLonelyGetters(Class)

#### createFromGettersWithoutSetters

public <Solution> Collection<*Objective*<*Solution*, ?>> **createFromGettersWithoutSetters**(Class<*Solution*> *solutionClass*)

This method retrieves all the values accessible through a getter ( getX() method) in order to build the corresponding set of *Objective*s. At the opposite of *createFromGetters(Class)*, an additional filter is used: we build an *Objective* for each getter which does not correspond to a setter (setX() method with the same X than the getter). This method is adapted for *Solution* implementations which provide setters only for their fundamental values (e.g. the path of a TSP *Solution*) and use getters only for the computed values (e.g. the length of such a path). Notice that, if all the relevant getters are not present, the corresponding *Objective*s will not be retrieved. On the opposite, any additional getter which does not correspond to a relevant *Objective* will be mistakenly retrieved. So be sure that the relevant elements (and only these ones) have their getter (and no setter). Otherwise, you should use a different method or generate the *Objective*s manually.

**Parameters**

- **solutionClass** – the *Solution* class to analyze

**Returns** the set of *Objective*s retrieved from this class

### 2.76.14 ObjectiveFactoryTest

public class **ObjectiveFactoryTest**

#### Methods

##### testCreateFromGettersRetrievesAllGetters

public void **testCreateFromGettersRetrievesAllGetters**()

##### testCreateFromGettersWithoutSettersRetrievesOnlyGettersWithoutSetters

public void **testCreateFromGettersWithoutSettersRetrievesOnlyGettersWithoutSetters**()

##### testRetrieveObjectiveNames

public void **testRetrieveObjectiveNames**()

### 2.76.15 VariableFactory

public class **VariableFactory**

This factory provides facilities to generate `Variable`s from usual situations.

**Author** Matthieu Vergne

#### Methods

##### createFromGetters

public <Solution> Collection<*Variable*<*Solution*, ?>> **createFromGetters**(Class<*Solution*> *solutionClass*)

This method retrieves all the values accessible through a getter (`getX()` method) in order to build the corresponding set of `Variable`s. Notice that `Variable`s are supposed to represent the fundamental description of a `Solution`, so if the `Solution` has computation or other additional methods which are named as getters, they will also be retrieved as `Variable`s. In such a case, you should filter the returned `Variable`s, rely on more advanced methods, or generate the `Variable`s manually.

**Parameters**

- **solutionClass** – the `Solution` class to analyze

**Returns** the set of `Variable`s retrieved from this class

**See also:** `.createFromGettersAndSetters(Class)`, `.createFromGettersAndConstructors(Class)`

### createFromGettersAndConstructors

public <Solution> Collection<*Variable*<*Solution*, ?>> **createFromGettersAndConstructors**(Class<*Solution*> *solutionClass*)

This method retrieves all the values accessible through a getter ( `getX()` method) in order to build the corresponding set of `Variable`s. At the opposite of `createFromGetters(Class)`, an additional filter is used: we build a `Variable` for each getter which corresponds to a constructor argument (argument of the same type). This method is adapted for static `Solution` implementations, which usually have a constructor which takes all the relevant values and provide getters to retrieve them. Because Java reflection does not always provide the required information (e.g. names of constructor arguments), this method can be applied only on solution classes which meet strict constraints:

- only one getter should return a given type
- for each constructor and between constructors, only one argument should be of a given type (it can appear in several constructors, but it should be always the same argument)

If all the constraints are not met, an exception will be thrown.

**Parameters**

- **solutionClass** – the `Solution` class to analyze

**Throws**

- **IllegalArgumentException** – if one of the constraints is not met
- ***IsInterfaceException*** – if the `Solution` class to analyze is an interface, thus constructors make no sense

**Returns** the set of `Variable`s retrieved from this class

### createFromGettersAndSetters

public <Solution> Collection<*Variable*<*Solution*, ?>> **createFromGettersAndSetters**(Class<*Solution*> *solutionClass*)

This method retrieves all the values accessible through a getter ( `getX()` method) in order to build the corresponding set of `Variable`s. At the opposite of `createFromGetters(Class)`, an additional filter is used: we build a `Variable` for each getter which corresponds to a setter (`setX()` method with the same `X` than the getter). This method is adapted for dynamic `Solution` implementations, thus allowing to change the value of its `Variable`s (e.g. change the path of a TSP `Solution`). Notice that, if all the relevant setters are not present (or they do not strictly respect the naming of the getter), the corresponding `Variable`s will not be retrieved. On the opposite, any additional setter/getter couple which does not correspond to a relevant `Variable` will be mistakenly retrieved. So be sure that the relevant elements (and only these ones) have their setter and getter. Otherwise, you should use a different method or generate the `Variable`s manually.

**Parameters**

- **solutionClass** – the `Solution` class to analyze

**Returns** the set of `Variable`s retrieved from this class

## 2.76.16 VariableFactory.IsInterfaceException

public static class **IsInterfaceException** extends RuntimeException

#### Constructors

#### IsInterfaceException

public **IsInterfaceException** (Class<?> *solutionClass*)

### 2.76.17 VariableFactoryTest

public class **VariableFactoryTest**

#### Methods

#### testCreateFromGettersAndConstructorsRetrievesOnlyGettersWithConstructorArgument

public void **testCreateFromGettersAndConstructorsRetrievesOnlyGettersWithConstructorArgument** ()

#### testCreateFromGettersAndConstructorsThrowExceptionIfInterface

public void **testCreateFromGettersAndConstructorsThrowExceptionIfInterface** ()

#### testCreateFromGettersAndConstructorsThrowExceptionIfOverlappingTypes

public void **testCreateFromGettersAndConstructorsThrowExceptionIfOverlappingTypes** ()

#### testCreateFromGettersAndSettersRetrievesOnlyGettersWithSetters

public void **testCreateFromGettersAndSettersRetrievesOnlyGettersWithSetters** ()

#### testCreateFromGettersRetrievesAllGetters

public void **testCreateFromGettersRetrievesAllGetters** ()

#### testRetrieveVariableNames

public void **testRetrieveVariableNames** ()

## 2.77 org.uma.jmetal.solution.util

### 2.77.1 RepairDoubleSolution

public interface **RepairDoubleSolution** extends Serializable

**Author** Antonio J. Nebro

#### Methods

##### repairSolutionVariableValue

public double **repairSolutionVariableValue**(double *value*, double *lowerBound*, double *upperBound*)

Checks if a given value is between its bounds and repairs it otherwise

**Parameters**

- **value** – The value to be checked
- **lowerBound** –
- **upperBound** –

**Returns** The same value if it is between the limits or a repaired value otherwise

### 2.77.2 RepairDoubleSolutionAtBounds

public class **RepairDoubleSolutionAtBounds** implements *RepairDoubleSolution*

**Author** Antonio J. Nebro

#### Methods

##### repairSolutionVariableValue

public double **repairSolutionVariableValue**(double *value*, double *lowerBound*, double *upperBound*)

Checks if the value is between its bounds; if not, the lower or upper bound is returned

**Parameters**

- **value** – The value to be checked
- **lowerBound** –
- **upperBound** –

**Returns** The same value if it is in the limits or a repaired value otherwise

### 2.77.3 RepairDoubleSolutionAtBoundsTest

public class **RepairDoubleSolutionAtBoundsTest**

**Author** Antonio J. Nebro

#### Methods

##### setup

public void **setup**()

#### shouldRRepairDoubleSolutionAtBoundsAssignTheLowerBoundIfValueIsLessThanIt

public void **shouldRRepairDoubleSolutionAtBoundsAssignTheLowerBoundIfValueIsLessThanIt**()

#### shouldRRepairDoubleSolutionAtBoundsAssignTheUpperBoundIfValueIsGreaterThanIt

public void **shouldRRepairDoubleSolutionAtBoundsAssignTheUpperBoundIfValueIsGreaterThanIt**()

#### shouldRRepairDoubleSolutionAtBoundsRaiseAnExceptionIfTheBoundsAreIncorrect

public void **shouldRRepairDoubleSolutionAtBoundsRaiseAnExceptionIfTheBoundsAreIncorrect**()

## 2.77.4 RepairDoubleSolutionAtRandom

public class **RepairDoubleSolutionAtRandom** implements *RepairDoubleSolution*

**Author** Antonio J. Nebro

### Constructors

#### RepairDoubleSolutionAtRandom

public **RepairDoubleSolutionAtRandom**()

Constructor

#### RepairDoubleSolutionAtRandom

public **RepairDoubleSolutionAtRandom**(*BoundedRandomGenerator*<Double> *randomGenerator*)

Constructor

### Methods

#### repairSolutionVariableValue

public double **repairSolutionVariableValue**(double *value*, double *lowerBound*, double *upperBound*)

Checks if the value is between its bounds; if not, a random value between the limits is returned

**Parameters**

- **value** – The value to be checked
- **lowerBound** –
- **upperBound** –

**Returns** The same value if it is between the limits or a repaired value otherwise

### 2.77.5 RepairDoubleSolutionAtRandomTest

public class **RepairDoubleSolutionAtRandomTest**

**Author** Antonio J. Nebro

#### Methods

#### setup

public void **setup**()

#### shouldJMetalRandomGeneratorNotBeUsedWhenCustomRandomGeneratorProvided

public void **shouldJMetalRandomGeneratorNotBeUsedWhenCustomRandomGeneratorProvided**()

#### shouldRRepairDoubleSolutionAtRandomAssignARandomValueIfValueIsGreaterThanTheUpperBound

public void **shouldRRepairDoubleSolutionAtRandomAssignARandomValueIfValueIsGreaterThanTheUpperBo**

#### shouldRRepairDoubleSolutionAtRandomAssignARandomValueIfValueIsLessThanTheLowerBound

public void **shouldRRepairDoubleSolutionAtRandomAssignARandomValueIfValueIsLessThanTheLowerBounc**

#### shouldRRepairDoubleSolutionAtRandomRaiseAnExceptionIfTheBoundsAreIncorrect

public void **shouldRRepairDoubleSolutionAtRandomRaiseAnExceptionIfTheBoundsAreIncorrect**()

## 2.78 org.uma.jmetal.util

### 2.78.1 AbstractAlgorithmRunner

public abstract class **AbstractAlgorithmRunner**

Abstract class for Runner classes

**Author** Antonio J. Nebro

#### Methods

#### printFinalSolutionSet

public static void **printFinalSolutionSet**(List<? extends *Solution*<?>> *population*)

Write the population into two files and prints some data on screen

**Parameters**

- **population** –

#### printQualityIndicators

public static <S extends Solution<?>> void **printQualityIndicators** (List<S> *population*, String *paretoFrontFile*)

Print all the available quality indicators

**Parameters**

- **population** –
- **paretoFrontFile** –

**Throws**

- **FileNotFoundException** –

### 2.78.2 AdaptiveGrid

public class **AdaptiveGrid**<S extends Solution<?>>

This class defines an adaptive grid over a list of solutions as the one used by algorithm PAES.

**Author** Antonio J. Nebro, Juan J. Durillo

#### Constructors

#### AdaptiveGrid

public **AdaptiveGrid** (int *bisections*, int *objectives*)

Constructor. Creates an instance of AdaptiveGrid.

**Parameters**

- **bisections** – Number of bi-divisions of the objective space.
- **objectives** – Number of numberOfObjectives of the problem.

#### Methods

#### addSolution

public void **addSolution** (int *location*)

Increases the number of solutions into a specific hypercube.

**Parameters**

- **location** – Number of hypercube.

#### calculateOccupied

public void **calculateOccupied** ()

Calculates the number of hypercubes having one or more solutions. return the number of hypercubes with more than zero solutions.

### getAverageOccupation

public double **getAverageOccupation**()
Return the average number of solutions in the occupied hypercubes

### getBisections

public int **getBisections**()
Returns the number of bi-divisions performed in each objective.

**Returns** the number of bi-divisions.

### getHypercubes

public int[] **getHypercubes**()

### getLocationDensity

public int **getLocationDensity**(int *location*)
Returns the number of solutions into a specific hypercube.

**Parameters**

- **location** – Number of the hypercube.

**Returns** The number of solutions into a specific hypercube.

### getMostPopulatedHypercube

public int **getMostPopulatedHypercube**()
Returns the value of the most populated hypercube.

**Returns** The hypercube with the maximum number of solutions.

### location

public int **location**(S *solution*)
Calculates the hypercube of a solution

**Parameters**

- **solution** – The `Solution`.

### occupiedHypercubes

public int **occupiedHypercubes**()
Returns the number of hypercubes with more than zero solutions.

**Returns** the number of hypercubes with more than zero solutions.

#### randomOccupiedHypercube

public int **randomOccupiedHypercube**()
Returns a random hypercube that has more than zero solutions.

**Returns** The hypercube.

#### randomOccupiedHypercube

public int **randomOccupiedHypercube**(*BoundedRandomGenerator*<Integer> *randomGenerator*)
Returns a random hypercube that has more than zero solutions.

**Parameters**

- **randomGenerator** – the *BoundedRandomGenerator* to use for selecting the hypercube

**Returns** The hypercube.

#### removeSolution

public void **removeSolution**(int *location*)
Decreases the number of solutions into a specific hypercube.

**Parameters**

- **location** – Number of hypercube.

#### rouletteWheel

public int **rouletteWheel**()
Returns a random hypercube using a rouleteWheel method.

**Returns** the number of the selected hypercube.

#### rouletteWheel

public int **rouletteWheel**(*BoundedRandomGenerator*<Double> *randomGenerator*)
Returns a random hypercube using a rouleteWheel method.

**Parameters**

- **randomGenerator** – the *BoundedRandomGenerator* to use for the roulette

**Returns** the number of the selected hypercube.

#### toString

public String **toString**()
Returns a String representing the grid.

**Returns** The String.

#### updateGrid

public void **updateGrid**(List<S> *solutionList*)
Updates the grid limits and the grid content adding the solutions contained in a specific `solutionList`.

**Parameters**

- **solutionList** – The `solutionList`.

#### updateGrid

public void **updateGrid**(S *solution*, List<S> *solutionSet*)
Updates the grid limits and the grid content adding a new `Solution`. If the solution falls out of the grid bounds, the limits and content of the grid must be re-calculated.

**Parameters**

- **solution** – `Solution` considered to update the grid.
- **solutionSet** – `SolutionSet` used to update the grid.

## 2.78.3 AdaptiveGridTest

public class **AdaptiveGridTest**
Created by ajnebro on 16/3/17.

### Methods

#### shouldConstructorCreateAValidInstance

public void **shouldConstructorCreateAValidInstance**()

#### shouldGetAverageOccupationReturnTheRightValue

public void **shouldGetAverageOccupationReturnTheRightValue**()

#### shouldGetAverageOccupationReturnZeroIfThereAreNoOccupiedHypercubes

public void **shouldGetAverageOccupationReturnZeroIfThereAreNoOccupiedHypercubes**()

#### shouldJMetalRandomGeneratorNotBeUsedWhenCustomRandomGeneratorProvidedInRandomOccupiedHypercube

public void **shouldJMetalRandomGeneratorNotBeUsedWhenCustomRandomGeneratorProvidedInRandomOccupi**

#### shouldJMetalRandomGeneratorNotBeUsedWhenCustomRandomGeneratorProvidedInRouletteWheel

public void **shouldJMetalRandomGeneratorNotBeUsedWhenCustomRandomGeneratorProvidedInRouletteWhee**

#### shouldOccupiedHypercubesReturnTheNumberOfOccupiedHypercubes

public void **shouldOccupiedHypercubesReturnTheNumberOfOccupiedHypercubes**()

#### shouldOccupiedHypercubesReturnZeroIfThereAreNotOccupiedHypercubes

public void **shouldOccupiedHypercubesReturnZeroIfThereAreNotOccupiedHypercubes**()

## 2.78.4 AlgorithmBuilder

public interface **AlgorithmBuilder**<A extends Algorithm<?>>
Interface representing algorithm builders

**Author** Antonio J. Nebro

### Methods

#### build

public A **build**()

## 2.78.5 AlgorithmRunner

public class **AlgorithmRunner**
Class for running algorithms in a concurrent thread

**Author** Antonio J. Nebro

### Methods

#### getComputingTime

public long **getComputingTime**()

## 2.78.6 AlgorithmRunner.Executor

public static class **Executor**
Executor class

### Fields

#### algorithm

*Algorithm*<?> **algorithm**

#### computingTime

long **computingTime**

#### Constructors

#### Executor

public **Executor** (*Algorithm*<?> *algorithm*)

#### Methods

#### execute

public *AlgorithmRunner* **execute** ()

### 2.78.7 JMetalException

public class **JMetalException** extends RuntimeException implements Serializable
jMetal exception class

**Author** Antonio J. Nebro

#### Constructors

#### JMetalException

public **JMetalException** (String *message*)

#### JMetalException

public **JMetalException** (Exception *e*)

#### JMetalException

public **JMetalException** (String *message*, Exception *e*)

### 2.78.8 JMetalLogger

public class **JMetalLogger** implements Serializable
This class provides some facilities to manage loggers. One might use the static logger of this class or use its own, custom logger. Also, we provide the static method `configureLoggers(File)` for configuring the loggers easily. This method is automatically called before any use of the static logger, but if you want it to apply on other loggers it is preferable to call it explicitly at the beginning of your main() method.

**Author** Antonio J. Nebro , Matthieu Vergne

#### Fields

#### logger

public static final Logger **logger**

#### Methods

#### configureLoggers

public static void **configureLoggers**(File *propertyFile*)

This method provides a single-call method to configure the `Logger` instances. A default configuration is considered, enriched with a custom property file for more convenient logging. The custom file is considered after the default configuration, so it can override it if necessary. The custom file might be provided as an argument of this method, otherwise we look for a file named "jMetal.log.ini". If no custom file is provided, then only the default configuration is considered.

**Parameters**

- **propertyFile** – the property file to use for custom configuration, `null` to use only the default configuration

**Throws**

- **IOException** –

### 2.78.9 ProblemUtils

public class **ProblemUtils**

**Author** Antonio J. Nebro

#### Methods

#### loadProblem

public static <S> *Problem*<S> **loadProblem**(String *problemName*)

Create an instance of problem passed as argument

**Parameters**

- **problemName** – A full qualified problem name

**Returns** An instance of the problem

### 2.78.10 SolutionListUtils

public class **SolutionListUtils**

Created by Antonio J. Nebro on 04/10/14. Modified by Juanjo 13/03/15

### Methods

#### distanceMatrix

public static <S extends Solution<?>> double[][] **distanceMatrix** (List<S> *solutionSet*)

Returns a matrix with the euclidean distance between each pair of solutions in the population. Distances are measured in the objective space

**Parameters**

- **solutionSet** –

#### fillPopulationWithNewSolutions

public static <S> void **fillPopulationWithNewSolutions** (List<S> *solutionList*, Problem<S> *problem*, int *maxListSize*)

Fills a population with new solutions until its size is maxListSize

**Parameters**

- **solutionList** – The list of solutions
- **problem** – The problem being solved
- **maxListSize** – The target size of the list
- **<S>** – The type of the solutions to be created

#### findBestSolution

public static <S> S **findBestSolution** (List<S> *solutionList*, Comparator<S> *comparator*)

#### findIndexOfBestSolution

public static <S> int **findIndexOfBestSolution** (List<S> *solutionList*, Comparator<S> *comparator*)

Finds the index of the best solution in the list according to a comparator

**Parameters**

- **solutionList** –
- **comparator** –

**Returns** The index of the best solution

#### findIndexOfWorstSolution

public static <S> int **findIndexOfWorstSolution** (List<? extends S> *solutionList*, Comparator<S> *comparator*)

Finds the index of the worst solution in the list according to a comparator

**Parameters**

- **solutionList** –
- **comparator** –

**Returns** The index of the best solution

### findWorstSolution

public <S> S **findWorstSolution** (Collection<S> *solutionList*, Comparator<S> *comparator*)

### getInvertedFront

public static <S extends Solution<?>> List<S> **getInvertedFront** (List<S> *solutionSet*)

This method receives a normalized list of non-dominated solutions and return the inverted one. This operation is needed for minimization problem

**Parameters**

- **solutionSet** – The front to invert

**Returns** The inverted front

### getNondominatedSolutions

public static <S extends Solution<?>> List<S> **getNondominatedSolutions** (List<S> *solutionList*)

### getNormalizedFront

public static List<*Solution*<?>> **getNormalizedFront** (List<*Solution*<?>> *solutionList*, List<Double> *maximumValue*, List<Double> *minimumValue*)

This method receives a list of non-dominated solutions and maximum and minimum values of the objectives, and returns a the normalized set of solutions.

**Parameters**

- **solutionList** – A list of non-dominated solutions
- **maximumValue** – The maximum values of the objectives
- **minimumValue** – The minimum values of the objectives

**Returns** the normalized list of non-dominated solutions

### getObjectiveArrayFromSolutionList

public static <S extends Solution<?>> double[] **getObjectiveArrayFromSolutionList** (List<S> *solutionList*, int *objective*)

Given a solution list and the identifier of an objective (0, 1, etc), returns an array with the values of that objective in all the solutions of the list

**Parameters**

- **solutionList** –
- **objective** –
- **<S>** –

### isSolutionDominatedBySolutionList

public static <S extends Solution<?>> boolean **isSolutionDominatedBySolutionList** (S *solution*, List<? extends S> *solutionSet*)

### removeSolutionsFromList

public static <S> void **removeSolutionsFromList** (List<S> *solutionList*, int *numberOfSolutionsToRemove*)

Removes a number of solutions from a list

**Parameters**

- **solutionList** – The list of solutions
- **numberOfSolutionsToRemove** –

### restart

public static <S> void **restart** (List<S> *solutionList*, *Problem*<S> *problem*, int *percentageOfSolutionsToRemove*)

This methods takes a list of solutions, removes a percentage of its solutions, and it is filled with new random generated solutions

**Parameters**

- **solutionList** –
- **problem** –
- **percentageOfSolutionsToRemove** –

### selectNRandomDifferentSolutions

public static <S> List<S> **selectNRandomDifferentSolutions** (int *numberOfSolutionsToBeReturned*, List<S> *solutionList*)

This method receives a normalized list of non-dominated solutions and return the inverted one. This operation is needed for minimization problem

**Parameters**

- **solutionList** – The front to invert

**Returns** The inverted front

### selectNRandomDifferentSolutions

public static <S> List<S> **selectNRandomDifferentSolutions** (int *numberOfSolutionsToBeReturned*, List<S> *solutionList*, *BoundedRandomGenerator*<Integer> *randomGenerator*)

This method receives a normalized list of non-dominated solutions and return the inverted one. This operation is needed for minimization problem

**Parameters**

- **solutionList** – The front to invert
- **randomGenerator** – The random generator to use

**Returns** The inverted front

#### solutionListsAreEquals

public static <S> boolean **solutionListsAreEquals** (List<S> *solutionList*, List<S> *newSolutionList*)
Compares two solution lists to determine if both are equals

**Parameters**

- **solutionList** – A `Solution list`
- **newSolutionList** – A `Solution list`

**Returns** true if both are contains the same solutions, false in other case

#### writeObjectivesToMatrix

public static <S extends Solution<?>> double[][] **writeObjectivesToMatrix** (List<S> *solutionList*)

### 2.78.11 SolutionListUtilsTest

public class **SolutionListUtilsTest**

**Author** Antonio J. Nebro

#### Fields

#### exception

public ExpectedException **exception**

#### Methods

#### shouldExecuteReturnTheSolutionInTheListIfTheListContainsASolution

public void **shouldExecuteReturnTheSolutionInTheListIfTheListContainsASolution** ()

#### shouldFillPopulationWithNewSolutionsDoNothingIfTheMaxSizeIsLowerThanTheListSize

public void **shouldFillPopulationWithNewSolutionsDoNothingIfTheMaxSizeIsLowerThanTheListSize** ()

#### shouldFillPopulationWithNewSolutionsIncreaseTheListLengthToTheIndicatedValue

public void **shouldFillPopulationWithNewSolutionsIncreaseTheListLengthToTheIndicatedValue** ()

#### shouldFindBestSolutionRaiseAnExceptionIfTheComparatorIsNull

public void **shouldFindBestSolutionRaiseAnExceptionIfTheComparatorIsNull**()

#### shouldFindBestSolutionRaiseAnExceptionIfTheSolutionListIsEmpty

public void **shouldFindBestSolutionRaiseAnExceptionIfTheSolutionListIsEmpty**()

#### shouldFindBestSolutionRaiseAnExceptionIfTheSolutionListIsNull

public void **shouldFindBestSolutionRaiseAnExceptionIfTheSolutionListIsNull**()
** Unit tests to method findBestSolution ***

#### shouldFindBestSolutionReturnTheLastOneIfThisIsTheBestSolutionInALastInAListWithFiveSolutions

public void **shouldFindBestSolutionReturnTheLastOneIfThisIsTheBestSolutionInALastInAListWithFive**

#### shouldFindBestSolutionReturnTheSecondSolutionInTheListIfIsTheBestOufOfTwoSolutions

public void **shouldFindBestSolutionReturnTheSecondSolutionInTheListIfIsTheBestOufOfTwoSolutions**

#### shouldFindBestSolutionReturnTheSolutionInTheListWhenItContainsOneSolution

public void **shouldFindBestSolutionReturnTheSolutionInTheListWhenItContainsOneSolution**()

#### shouldFindIndexOfBestSolutionRaiseAnExceptionIfTheComparatorIsNull

public void **shouldFindIndexOfBestSolutionRaiseAnExceptionIfTheComparatorIsNull**()

#### shouldFindIndexOfBestSolutionRaiseAnExceptionIfTheSolutionListIsEmpty

public void **shouldFindIndexOfBestSolutionRaiseAnExceptionIfTheSolutionListIsEmpty**()

#### shouldFindIndexOfBestSolutionRaiseAnExceptionIfTheSolutionListIsNull

public void **shouldFindIndexOfBestSolutionRaiseAnExceptionIfTheSolutionListIsNull**()
** Unit tests to method findIndexOfBestSolution ***

#### shouldFindIndexOfBestSolutionReturn4IfTheBestSolutionIsTheLastInAListWithFiveSolutions

public void **shouldFindIndexOfBestSolutionReturn4IfTheBestSolutionIsTheLastInAListWithFiveSoluti**

#### shouldFindIndexOfBestSolutionReturnOneIfTheSecondSolutionItTheBestOutOfTwoSolutionInTheList

public void **shouldFindIndexOfBestSolutionReturnOneIfTheSecondSolutionItTheBestOutOfTwoSolutionI**

#### shouldFindIndexOfBestSolutionReturnZeroIfTheFirstSolutionItTheBestOutOfTwoSolutionsInTheList

public void **shouldFindIndexOfBestSolutionReturnZeroIfTheFirstSolutionItTheBestOutOfTwoSolutions**

#### shouldFindIndexOfBestSolutionReturnZeroIfTheListWhenItContainsOneSolution

public void **shouldFindIndexOfBestSolutionReturnZeroIfTheListWhenItContainsOneSolution**()

#### shouldJMetalRandomGeneratorNotBeUsedWhenCustomRandomGeneratorProvidedInSelectNRandomDifferentSol

public void **shouldJMetalRandomGeneratorNotBeUsedWhenCustomRandomGeneratorProvidedInSelectNRando**

#### shouldRestartRemoveTheRequestedPercentageOfSolutions

public void **shouldRestartRemoveTheRequestedPercentageOfSolutions**()
TODO

#### shouldSelectNRandomDifferentSolutionsRaiseAnExceptionIfTheListSizeIsOneAndTwoSolutionsAreRequested

public void **shouldSelectNRandomDifferentSolutionsRaiseAnExceptionIfTheListSizeIsOneAndTwoSoluti**

#### shouldSelectNRandomDifferentSolutionsRaiseAnExceptionIfTheSolutionListIsEmpty

public void **shouldSelectNRandomDifferentSolutionsRaiseAnExceptionIfTheSolutionListIsEmpty**()

#### shouldSelectNRandomDifferentSolutionsRaiseAnExceptionIfTheSolutionListIsNull

public void **shouldSelectNRandomDifferentSolutionsRaiseAnExceptionIfTheSolutionListIsNull**()
** Unit tests to method selectNRandomDifferentSolutions ***

#### shouldSelectNRandomDifferentSolutionsReturnASingleSolution

public void **shouldSelectNRandomDifferentSolutionsReturnASingleSolution**()

#### shouldSelectNRandomDifferentSolutionsReturnTheCorrectListOfSolutions

public void **shouldSelectNRandomDifferentSolutionsReturnTheCorrectListOfSolutions**()
If the list contains 4 solutions, the result list must return all of them

#### shouldSelectNRandomDifferentSolutionsReturnTheCorrectNumberOfSolutions

public void **shouldSelectNRandomDifferentSolutionsReturnTheCorrectNumberOfSolutions**()

#### shouldSelectNRandomDifferentSolutionsReturnTheSolutionSInTheListIfTheListContainsTwoSolutions

public void **shouldSelectNRandomDifferentSolutionsReturnTheSolutionSInTheListIfTheListContainsTw**

#### shouldSolutionListsAreEqualsReturnIfTwoIdenticalSolutionListsAreCompared

public void **shouldSolutionListsAreEqualsReturnIfTwoIdenticalSolutionListsAreCompared**()

#### shouldSolutionListsAreEqualsReturnIfTwoSolutionListsWithIdenticalSolutionsAreCompared

public void **shouldSolutionListsAreEqualsReturnIfTwoSolutionListsWithIdenticalSolutionsAreCompar**

#### shouldelectNRandomDifferentSolutionsRaiseAnExceptionIfTheListSizeIsTwoAndFourSolutionsAreRequested

public void **shouldelectNRandomDifferentSolutionsRaiseAnExceptionIfTheListSizeIsTwoAndFourSoluti**

## 2.78.12 SolutionUtils

public class **SolutionUtils**

Created by Antonio J. Nebro on 6/12/14.

### Methods

#### averageDistanceToSolutionList

public static <S extends Solution<?>> double **averageDistanceToSolutionList**(S *solution*, List<S> *solutionList*)

Returns the average euclidean distance of a solution to the solutions of a list.

#### distanceBetweenObjectives

public static <S extends Solution<?>> double **distanceBetweenObjectives**(S *firstSolution*, S *secondSolution*)

Returns the euclidean distance between a pair of solutions in the objective space

#### distanceBetweenSolutionsInObjectiveSpace

public static double **distanceBetweenSolutionsInObjectiveSpace**(*DoubleSolution solutionI*, *DoubleSolution solutionJ*)

Returns the distance between two solutions in the search space.

**Parameters**

- **solutionI** – The first `Solution`.

- **solutionJ** – The second `Solution`.

**Returns** the distance between solutions.

### distanceToSolutionListInSolutionSpace

public static double **distanceToSolutionListInSolutionSpace** (*DoubleSolution solution*, List<*DoubleSolution*> *solutionList*)

Returns the minimum distance from a `Solution` to a SolutionSet according to the encodings.variable values.

**Parameters**

- **solution** – The `Solution`.
- **solutionList** – The `List>`.

**Returns** The minimum distance between solution and the set.

### getBestSolution

public static <S extends Solution<?>> S **getBestSolution** (S *solution1*, S *solution2*, Comparator<S> *comparator*)

Return the best solution between those passed as arguments. If they are equal or incomparable one of them is chosen randomly.

**Returns** The best solution

### getBestSolution

public static <S extends Solution<?>> S **getBestSolution** (S *solution1*, S *solution2*, Comparator<S> *comparator*, *RandomGenerator*<Double> *randomGenerator*)

Return the best solution between those passed as arguments. If they are equal or incomparable one of them is chosen randomly.

**Parameters**

- **randomGenerator** – *`RandomGenerator`* for the equality case

**Returns** The best solution

### getBestSolution

public static <S extends Solution<?>> S **getBestSolution** (S *solution1*, S *solution2*, Comparator<S> *comparator*, BinaryOperator<S> *equalityPolicy*)

Return the best solution between those passed as arguments. If they are equal or incomparable one of them is chosen based on the given policy.

**Returns** The best solution

## 2.78.13 SolutionUtilsTest

public class **SolutionUtilsTest**

#### Methods

##### shouldAverageDistanceToSolutionListWorkProperlyCaseA

public void **shouldAverageDistanceToSolutionListWorkProperlyCaseA**()
Case A. Solution = [1], solutionList = [1]]

##### shouldAverageDistanceToSolutionListWorkProperlyCaseB

public void **shouldAverageDistanceToSolutionListWorkProperlyCaseB**()
Case B. Solution = [1], solutionList = [[2]]

##### shouldAverageDistanceToSolutionListWorkProperlyCaseC

public void **shouldAverageDistanceToSolutionListWorkProperlyCaseC**()
Case C. Solution = [1], solutionList = [[1], [2]]

##### shouldDistanceBetweenObjectivesWorkProperlyWithTwoSolutionsWithOneObjectiveCaseA

public void **shouldDistanceBetweenObjectivesWorkProperlyWithTwoSolutionsWithOneObjectiveCaseA**()
Case A: the two solutions are the same

##### shouldDistanceBetweenObjectivesWorkProperlyWithTwoSolutionsWithOneObjectiveCaseB

public void **shouldDistanceBetweenObjectivesWorkProperlyWithTwoSolutionsWithOneObjectiveCaseB**()
Case B: the two solutions are not the same

##### shouldDistanceBetweenObjectivesWorkProperlyWithTwoSolutionsWithTwoObjectivesCaseA

public void **shouldDistanceBetweenObjectivesWorkProperlyWithTwoSolutionsWithTwoObjectivesCaseA**()
Case A: the two solutions are the same

##### shouldDistanceBetweenObjectivesWorkProperlyWithTwoSolutionsWithTwoObjectivesCaseB

public void **shouldDistanceBetweenObjectivesWorkProperlyWithTwoSolutionsWithTwoObjectivesCaseB**()
Case B: the two solutions are not the same

## 2.79 org.uma.jmetal.util.archive

### 2.79.1 Archive

public interface **Archive**<S> extends Serializable
Interface representing an archive of solutions

**Author** Antonio J. Nebro

#### Methods

##### add

boolean **add** (S *solution*)

##### get

S **get** (int *index*)

##### getSolutionList

List<S> **getSolutionList** ()

##### size

int **size** ()

### 2.79.2 BoundedArchive

public interface **BoundedArchive**<S> extends *Archive*<S>

Interface representing a bounded archive of solutions

**Author** Antonio J. Nebro

#### Methods

##### computeDensityEstimator

void **computeDensityEstimator** ()

##### getComparator

Comparator<S> **getComparator** ()

##### getMaxSize

int **getMaxSize** ()

##### sortByDensityEstimator

void **sortByDensityEstimator** ()

# 2.80 org.uma.jmetal.util.archive.impl

## 2.80.1 AbstractBoundedArchive

public abstract class **AbstractBoundedArchive**<S extends Solution<?>> implements *BoundedArchive*<S>

**Author** Antonio J. Nebro

**Parameters**

- **<S>** –

### Fields

#### archive

protected *NonDominatedSolutionListArchive*<S> **archive**

#### maxSize

protected int **maxSize**

### Constructors

#### AbstractBoundedArchive

public **AbstractBoundedArchive** (int *maxSize*)

### Methods

#### add

public boolean **add** (S *solution*)

#### get

public S **get** (int *index*)

#### getMaxSize

public int **getMaxSize** ()

#### getSolutionList

public List<S> **getSolutionList** ()

#### join

public *Archive*<S> **join** (*Archive*<S> *archive*)

#### prune

public abstract void **prune** ()

#### size

public int **size** ()

### 2.80.2 AdaptiveGridArchive

public class **AdaptiveGridArchive**<S extends Solution<?>> extends *AbstractBoundedArchive*<S>

This class implements an archive (solution list) based on an adaptive grid used in PAES

**Author** Antonio J. Nebro , Juan J. Durillo

#### Constructors

#### AdaptiveGridArchive

public **AdaptiveGridArchive** (int *maxSize*, int *bisections*, int *objectives*)

Constructor.

**Parameters**

- **maxSize** – The maximum size of the setArchive
- **bisections** – The maximum number of bi-divisions for the adaptive grid.
- **objectives** – The number of objectives.

#### Methods

#### add

public boolean **add** (S *solution*)

Adds a `Solution` to the setArchive. If the `Solution` is dominated by any member of the setArchive then it is discarded. If the `Solution` dominates some members of the setArchive, these are removed. If the setArchive is full and the `Solution` has to be inserted, one `Solution` of the most populated hypercube of the adaptive grid is removed.

**Parameters**

- **solution** – The `Solution`

**Returns** true if the `Solution` has been inserted, false otherwise.

#### computeDensityEstimator

public void **computeDensityEstimator**()

#### getComparator

public Comparator<S> **getComparator**()

#### getGrid

public *AdaptiveGrid*<S> **getGrid**()

#### prune

public void **prune**()

#### sortByDensityEstimator

public void **sortByDensityEstimator**()

### 2.80.3 AdaptiveGridArchiveTest

public class **AdaptiveGridArchiveTest**
Created by ajnebro on 16/11/16.

#### Methods

#### shouldConstructorCreateAnArchiveWithTheRightCapacity

public void **shouldConstructorCreateAnArchiveWithTheRightCapacity**()

#### shouldConstructorCreateAnEmptyArchive

public void **shouldConstructorCreateAnEmptyArchive**()

#### shouldProneDoNothingIfTheArchiveIsEmpty

public void **shouldProneDoNothingIfTheArchiveIsEmpty**()

### 2.80.4 CrowdingDistanceArchive

public class **CrowdingDistanceArchive**<S extends Solution<?>> extends *AbstractBoundedArchive*<S>
Created by Antonio J. Nebro on 24/09/14. Modified by Juanjo on 07/04/2015

#### Constructors

##### CrowdingDistanceArchive

public **CrowdingDistanceArchive** (int *maxSize*)

#### Methods

##### computeDensityEstimator

public void **computeDensityEstimator** ()

##### getComparator

public Comparator<S> **getComparator** ()

##### prune

public void **prune** ()

##### sortByDensityEstimator

public void **sortByDensityEstimator** ()

### 2.80.5 HypervolumeArchive

public class **HypervolumeArchive**<S extends Solution<?>> extends *AbstractBoundedArchive*<S>
Created by Antonio J. Nebro on 24/09/14.

#### Fields

##### hypervolume

*Hypervolume*<S> **hypervolume**

#### Constructors

##### HypervolumeArchive

public **HypervolumeArchive** (int *maxSize*, *Hypervolume*<S> *hypervolume*)

#### Methods

##### computeDensityEstimator

public void **computeDensityEstimator** ()

#### getComparator

public Comparator<S> **getComparator**()

#### prune

public void **prune**()

#### sortByDensityEstimator

public void **sortByDensityEstimator**()

### 2.80.6 NonDominatedSolutionListArchive

public class **NonDominatedSolutionListArchive**<S extends Solution<?>> implements *Archive*<S>
This class implements an archive containing non-dominated solutions

**Author** Antonio J. Nebro , Juan J. Durillo

#### Constructors

#### NonDominatedSolutionListArchive

public **NonDominatedSolutionListArchive**()
Constructor

#### NonDominatedSolutionListArchive

public **NonDominatedSolutionListArchive**(*DominanceComparator*<S> *comparator*)
Constructor

#### Methods

#### add

public boolean **add**(S *solution*)
Inserts a solution in the list

**Parameters**

- **solution** – The solution to be inserted.

**Returns** true if the operation success, and false if the solution is dominated or if an identical individual exists. The decision variables can be null if the solution is read from a file; in that case, the domination tests are omitted

#### get

public S **get**(int *index*)

#### getSolutionList

public List<S> **getSolutionList** ()

#### join

public *Archive*<S> **join** (*Archive*<S> *archive*)

#### main

public static void **main** (String[] *args*)

#### size

public int **size** ()

### 2.80.7 NonDominatedSolutionListArchiveTest

public class **NonDominatedSolutionListArchiveTest**

**Author** Antonio J. Nebro .

#### Methods

#### shouldAddADominantSolutionInAnArchiveOfSize1DiscardTheExistingSolution

public void **shouldAddADominantSolutionInAnArchiveOfSize1DiscardTheExistingSolution** ()

#### shouldAddADominantSolutionInAnArchiveOfSize3DiscardTheRestOfSolutions

public void **shouldAddADominantSolutionInAnArchiveOfSize3DiscardTheRestOfSolutions** ()

#### shouldAddADominatedSolutionInAnArchiveOfSize1DiscardTheNewSolution

public void **shouldAddADominatedSolutionInAnArchiveOfSize1DiscardTheNewSolution** ()

#### shouldAddANonDominantSolutionInAnArchiveOfSize1IncorporateTheNewSolution

public void **shouldAddANonDominantSolutionInAnArchiveOfSize1IncorporateTheNewSolution** ()

#### shouldAddASolutionEqualsToOneAlreadyInTheArchiveDoNothing

public void **shouldAddASolutionEqualsToOneAlreadyInTheArchiveDoNothing** ()

#### shouldAddOnAnEmptyListHaveSizeOne

public void **shouldAddOnAnEmptyListHaveSizeOne**()

#### shouldAddOnAnEmptyListInsertTheElement

public void **shouldAddOnAnEmptyListInsertTheElement**()

#### shouldConstructorAssignThePassedComparator

public void **shouldConstructorAssignThePassedComparator**()

#### shouldConstructorCreateAnEmptyArchive

public void **shouldConstructorCreateAnEmptyArchive**()

#### shouldJoinAnEAnEmptyArchiveProduceAnArchiveWithTheSameSolutions

public void **shouldJoinAnEAnEmptyArchiveProduceAnArchiveWithTheSameSolutions**()

#### shouldJoinTwoEmptyArchivesReturnAnEmptyArchive

public void **shouldJoinTwoEmptyArchivesReturnAnEmptyArchive**()

#### shouldJoinWithAnEmptyArchivesRemainTheArchiveWithTheSameNumberOfSolutions

public void **shouldJoinWithAnEmptyArchivesRemainTheArchiveWithTheSameNumberOfSolutions**()

## 2.81 org.uma.jmetal.util.archivewithreferencepoint

### 2.81.1 ArchiveWithReferencePoint

public abstract class **ArchiveWithReferencePoint**<S extends Solution<?>> extends *AbstractBoundedArchive*<S>

This class defines a bounded archive that has associated a reference point as described in the paper "Extending the Speed-constrained Multi-Objective PSO (SMPSO) With Reference Point Based Preference Articulation Accepted in PPSN 2018.

**Parameters**

- **<S>** –

#### Fields

#### comparator

protected Comparator<S> **comparator**

#### referencePoint

protected List<Double> **referencePoint**

#### referencePointSolution

protected S **referencePointSolution**

### Constructors

#### ArchiveWithReferencePoint

public **ArchiveWithReferencePoint** (int *maxSize*, List<Double> *referencePoint*, Comparator<S> *comparator*)

### Methods

#### add

public synchronized boolean **add** (S *solution*)

#### changeReferencePoint

public synchronized void **changeReferencePoint** (List<Double> *newReferencePoint*)

#### prune

public synchronized void **prune** ()

# 2.82 org.uma.jmetal.util.archivewithreferencepoint.impl

## 2.82.1 CrowdingDistanceArchiveWithReferencePoint

public class **CrowdingDistanceArchiveWithReferencePoint**<S extends Solution<?>> extends *ArchiveWithReferencePoint*

Class representing a `ArchiveWithReferencePoint` archive using a crowding distance based density estimator

**Author** Antonio J. Nebro

### Constructors

#### CrowdingDistanceArchiveWithReferencePoint

public **CrowdingDistanceArchiveWithReferencePoint** (int *maxSize*, List<Double> *refPointDM*)

#### Methods

##### computeDensityEstimator

public void **computeDensityEstimator**()

##### getComparator

public Comparator<S> **getComparator**()

##### sortByDensityEstimator

public void **sortByDensityEstimator**()

### 2.82.2 HypervolumeArchiveWithReferencePoint

public class **HypervolumeArchiveWithReferencePoint**<S extends Solution<?>> extends *ArchiveWithReferencePoint*<S>
Class representing a `ArchiveWithReferencePoint` archive using a hypervolume contribution based density estimator.

**Author** Antonio J. Nebro

#### Constructors

##### HypervolumeArchiveWithReferencePoint

public **HypervolumeArchiveWithReferencePoint**(int *maxSize*, List<Double> *refPointDM*)

#### Methods

##### computeDensityEstimator

public void **computeDensityEstimator**()

##### getComparator

public Comparator<S> **getComparator**()

##### sortByDensityEstimator

public void **sortByDensityEstimator**()

# 2.83 org.uma.jmetal.util.artificialdecisionmaker

## 2.83.1 ArtificialDecisionMaker

public abstract class **ArtificialDecisionMaker**<S, R> implements *Algorithm*<R>

### Fields

#### algorithm

protected *InteractiveAlgorithm*<S, R> **algorithm**

#### indexOfRelevantObjectiveFunctions

protected List<Integer> **indexOfRelevantObjectiveFunctions**

#### paretoOptimalSolutions

protected List<S> **paretoOptimalSolutions**

#### problem

protected *Problem*<S> **problem**

### Constructors

#### ArtificialDecisionMaker

public **ArtificialDecisionMaker**(*Problem*<S> *problem*, *InteractiveAlgorithm*<S, R> *algorithm*)

### Methods

#### calculateReferencePoints

protected abstract List<Double> **calculateReferencePoints**(List<Integer> *indexOfRelevantObjectiveFunctions*, R *front*, List<S> *paretoOptimalSolutions*)

#### generatePreferenceInformation

protected abstract List<Double> **generatePreferenceInformation**()

#### getDescription

public String **getDescription**()

#### getDistances

public abstract List<Double> **getDistances** ()

#### getName

public String **getName** ()

#### getReferencePoints

public abstract List<Double> **getReferencePoints** ()

#### getResult

public R **getResult** ()

#### initProgress

protected abstract void **initProgress** ()

#### isStoppingConditionReached

protected abstract boolean **isStoppingConditionReached** ()

#### relevantObjectiveFunctions

protected abstract List<Integer> **relevantObjectiveFunctions** (R *front*)

#### run

public void **run** ()

#### updateParetoOptimal

protected abstract void **updateParetoOptimal** (R *front*, List<S> *paretoOptimalSolutions*)

#### updateProgress

protected abstract void **updateProgress** ()

### 2.83.2 DecisionTreeEstimator

public class **DecisionTreeEstimator**<S extends Solution<?>>

#### Constructors

#### DecisionTreeEstimator

public **DecisionTreeEstimator**(List<S> *solutionList*)

#### Methods

#### doPrediction

public double **doPrediction**(int *index*, S *testSolution*)

#### doPredictionVariable

public double **doPredictionVariable**(int *index*, S *testSolution*)

## 2.84 org.uma.jmetal.util.artificialdecisionmaker.impl

### 2.84.1 ArtificialDecisionMakerDecisionTree

public class **ArtificialDecisionMakerDecisionTree**<S extends Solution<?>> extends *ArtificialDecisionMaker*<S, List<S>

Class implementing the Towards automatic testing of reference point based interactive methods described in: Ojalehto, V., Podkopaev, D., & Miettinen, K. (2016, September). Towards automatic testing of reference point based interactive methods. In International Conference on Parallel Problem Solving from Nature (pp. 483-492). Springer, Cham.

**Author** Cristobal Barba

#### Fields

#### allReferencePoints

protected List<Double> **allReferencePoints**

#### asp

protected List<Double> **asp**

#### considerationProbability

protected double **considerationProbability**

#### currentReferencePoint

protected List<Double> **currentReferencePoint**

#### distances

protected List<Double> **distances**

#### evaluations

protected int **evaluations**

#### idealOjectiveVector

protected List<Double> **idealOjectiveVector**

#### maxEvaluations

protected int **maxEvaluations**

#### nadirObjectiveVector

protected List<Double> **nadirObjectiveVector**

#### numberOfObjectives

protected int **numberOfObjectives**

#### random

protected *JMetalRandom* **random**

#### rankingCoeficient

protected List<Double> **rankingCoeficient**

#### tolerance

protected double **tolerance**

#### varyingProbability

protected double **varyingProbability**

#### Constructors

#### ArtificialDecisionMakerDecisionTree

public **ArtificialDecisionMakerDecisionTree** (*Problem*<S> *problem*, *InteractiveAlgorithm*<S, List<S>> *algorithm*, double *considerationProbability*, double *tolerance*, int *maxEvaluations*, List<Double> *rankingCoeficient*, List<Double> *asp*)

#### Methods

#### calculateReferencePoints

protected List<Double> **calculateReferencePoints** (List<Integer> *indexOfRelevantObjectiveFunctions*, List<S> *front*, List<S> *paretoOptimalSolutions*)

#### generatePreferenceInformation

protected List<Double> **generatePreferenceInformation** ()

#### getDistances

public List<Double> **getDistances** ()

#### getReferencePoints

public List<Double> **getReferencePoints** ()

#### initProgress

protected void **initProgress** ()

#### isStoppingConditionReached

protected boolean **isStoppingConditionReached** ()

#### relevantObjectiveFunctions

protected List<Integer> **relevantObjectiveFunctions** (List<S> *front*)

#### updateParetoOptimal

protected void **updateParetoOptimal** (List<S> *front*, List<S> *paretoOptimalSolutions*)

#### updateProgress

protected void **updateProgress** ()

### 2.84.2 ArtificiallDecisionMakerBuilder

public class **ArtificiallDecisionMakerBuilder**<S extends Solution<?>> implements *AlgorithmBuilder*<*ArtificialDecisionM*

**Author** Antonio J. Nebro

#### Constructors

#### ArtificiallDecisionMakerBuilder

public **ArtificiallDecisionMakerBuilder** (*Problem*<S> *problem*, *InteractiveAlgorithm*<S, List<S>> *algorithm*)

ArtificiallDecisionMakerBuilder constructor

#### Methods

#### build

public *ArtificialDecisionMakerDecisionTree*<S> **build** ()

#### getMaxIterations

public int **getMaxIterations** ()

#### getProblem

public *Problem*<S> **getProblem** ()

#### setAlgorithm

public *ArtificiallDecisionMakerBuilder*<S> **setAlgorithm** (*InteractiveAlgorithm*<S, List<S>> *algorithm*)

#### setAsp

public *ArtificiallDecisionMakerBuilder*<S> **setAsp** (List<Double> *asp*)

#### setConsiderationProbability

public *ArtificiallDecisionMakerBuilder*<S> **setConsiderationProbability** (double *considerationProbability*)

#### setMaxEvaluations

public *ArtificiallDecisionMakerBuilder*<S> **setMaxEvaluations** (int *maxEvaluations*)

#### setNumberReferencePoints

public *ArtificiallDecisionMakerBuilder*<S> **setNumberReferencePoints** (int *numberReferencePoints*)

#### setRankingCoeficient

public *ArtificiallDecisionMakerBuilder*<S> **setRankingCoeficient** (List<Double> *rankingCoeficient*)

#### setTolerance

public *ArtificiallDecisionMakerBuilder*<S> **setTolerance** (double *tolerance*)

## 2.85 org.uma.jmetal.util.binarySet

### 2.85.1 BinarySet

public class **BinarySet** extends BitSet

Class representing a bit set including a method to get the total number of bits

**Author** Antonio J. Nebro

#### Constructors

#### BinarySet

public **BinarySet** (int *numberOfBits*)

Constructor

**Parameters**

- **numberOfBits** –

#### Methods

#### getBinarySetLength

public int **getBinarySetLength** ()

Returns the total number of bits

**Returns** the number of bits of the binary set

## 2.86 org.uma.jmetal.util.chartcontainer

### 2.86.1 ChartContainer

public class **ChartContainer**

Class for configuring and displaying a XChart.

**Author** Jorge Rodriguez Ordonez

#### Constructors

#### ChartContainer

public **ChartContainer** (String *name*)

#### ChartContainer

public **ChartContainer** (String *name*, int *delay*)

#### Methods

#### addIndicatorChart

public void **addIndicatorChart** (String *indicator*)

#### getChart

public XYChart **getChart** (String *chartName*)

#### getDelay

public int **getDelay** ()

#### getFrontChart

public XYChart **getFrontChart** ()

#### getName

public String **getName** ()

#### getVarChart

public XYChart **getVarChart** ()

### initChart

public void **initChart** ()

### refreshCharts

public void **refreshCharts** ()

### refreshCharts

public void **refreshCharts** (int *delay*)

### removeIndicator

public void **removeIndicator** (String *indicator*)

### repaint

public void **repaint** ()

### saveChart

public void **saveChart** (String *fileName*, BitmapFormat *format*)

### setDelay

public *ChartContainer* **setDelay** (int *delay*)

### setFrontChart

public void **setFrontChart** (int *objective1*, int *objective2*)

### setFrontChart

public void **setFrontChart** (int *objective1*, int *objective2*, String *referenceFrontFileName*)

### setName

public *ChartContainer* **setName** (String *name*)

### setReferencePoint

public void **setReferencePoint** (List<Double> *referencePoint*)

#### setVarChart

public void **setVarChart** (int *variable1*, int *variable2*)

#### updateFrontCharts

public void **updateFrontCharts** (List<*DoubleSolution*> *solutionList*)

#### updateIndicatorChart

public void **updateIndicatorChart** (String *indicator*, Double *value*)

## 2.86.2 ChartContainerWithReferencePoints

public class **ChartContainerWithReferencePoints**

Class for configuring and displaying a char with a number of subpopulations and reference points. Designed to be used with the SMPSORP.

**Author** Antonio J. Nebro

### Constructors

#### ChartContainerWithReferencePoints

public **ChartContainerWithReferencePoints** (String *name*)

#### ChartContainerWithReferencePoints

public **ChartContainerWithReferencePoints** (String *name*, int *delay*)

### Methods

#### getChart

public XYChart **getChart** (String *chartName*)

#### getDelay

public int **getDelay** ()

#### getFrontChart

public XYChart **getFrontChart** ()

#### getName

public String **getName**()

#### getVarChart

public XYChart **getVarChart**()

#### initChart

public void **initChart**()

#### refreshCharts

public void **refreshCharts**()

#### refreshCharts

public void **refreshCharts**(int *delay*)

#### repaint

public void **repaint**()

#### saveChart

public void **saveChart**(String *fileName*, BitmapFormat *format*)

#### setDelay

public *ChartContainerWithReferencePoints* **setDelay**(int *delay*)

#### setFrontChart

public void **setFrontChart**(int *objective1*, int *objective2*)

#### setFrontChart

public void **setFrontChart**(int *objective1*, int *objective2*, String *referenceFrontFileName*)

#### setName

public *ChartContainerWithReferencePoints* **setName**(String *name*)

#### setReferencePoint

public synchronized void **setReferencePoint** (List<List<Double>> *referencePoint*)

#### updateFrontCharts

public void **updateFrontCharts** (List<*DoubleSolution*> *solutionList*)

#### updateReferencePoint

public synchronized void **updateReferencePoint** (List<List<Double>> *referencePoint*)

## 2.87 org.uma.jmetal.util.comparator

### 2.87.1 ConstraintViolationComparator

public interface **ConstraintViolationComparator**<S> extends Comparator<S>, Serializable

#### Methods

#### compare

public int **compare** (S *solution1*, S *solution2*)

### 2.87.2 CrowdingDistanceComparator

public class **CrowdingDistanceComparator**<S extends Solution<?>> implements Comparator<S>, Serializable

Compares two solutions according to the crowding distance attribute. The higher the distance the better

**Author** Antonio J. Nebro

#### Methods

#### compare

public int **compare** (S *solution1*, S *solution2*)

Compare two solutions.

**Parameters**

- **solution1** – Object representing the first `Solution`.
- **solution2** – Object representing the second `Solution`.

**Returns** -1, or 0, or 1 if solution1 is has greater, equal, or less distance value than solution2, respectively.

### 2.87.3 CrowdingDistanceComparatorTest

public class **CrowdingDistanceComparatorTest**

**Author** Antonio J. Nebro

#### Methods

##### setup

public void **setup**()

##### shouldCompareReturnMinusOneIfSolutionBHasHigherDistance

public void **shouldCompareReturnMinusOneIfSolutionBHasHigherDistance**()

##### shouldCompareReturnMinusOneIfTheSecondSolutionIsNull

public void **shouldCompareReturnMinusOneIfTheSecondSolutionIsNull**()

##### shouldCompareReturnOneIfSolutionAHasLessDistance

public void **shouldCompareReturnOneIfSolutionAHasLessDistance**()

##### shouldCompareReturnOneIfTheFirstSolutionIsNull

public void **shouldCompareReturnOneIfTheFirstSolutionIsNull**()

##### shouldCompareReturnZeroIfBothSolutionsAreNull

public void **shouldCompareReturnZeroIfBothSolutionsAreNull**()

##### shouldCompareReturnZeroIfBothSolutionsHaveNoCrowdingDistanceAttribute

public void **shouldCompareReturnZeroIfBothSolutionsHaveNoCrowdingDistanceAttribute**()

##### shouldCompareReturnZeroIfBothSolutionsHaveTheSameDistance

public void **shouldCompareReturnZeroIfBothSolutionsHaveTheSameDistance**()

### 2.87.4 DominanceComparator

public class **DominanceComparator**<S extends Solution<?>> implements Comparator<S>, Serializable

This class implements a solution comparator taking into account the violation constraints

**Author** Antonio J. Nebro

#### Constructors

##### DominanceComparator

public **DominanceComparator**()
Constructor

##### DominanceComparator

public **DominanceComparator**(double *epsilon*)
Constructor

##### DominanceComparator

public **DominanceComparator**(*ConstraintViolationComparator*<S> *constraintComparator*)
Constructor

##### DominanceComparator

public **DominanceComparator**(*ConstraintViolationComparator*<S> *constraintComparator*, double *epsilon*)
Constructor

#### Methods

##### compare

public int **compare**(S *solution1*, S *solution2*)
Compares two solutions.

**Parameters**

- **solution1** – Object representing the first `Solution`.
- **solution2** – Object representing the second `Solution`.

**Returns** -1, or 0, or 1 if solution1 dominates solution2, both are non-dominated, or solution1 is dominated by solution2, respectively.

### 2.87.5 DominanceComparatorTest

public class **DominanceComparatorTest**

**Author** Antonio J. Nebro

#### Fields

##### exception

public ExpectedException **exception**

### Methods

#### shouldCompareRaiseAnExceptionIfTheFirstSolutionIsNull

public void **shouldCompareRaiseAnExceptionIfTheFirstSolutionIsNull**()

#### shouldCompareRaiseAnExceptionIfTheSecondSolutionIsNull

public void **shouldCompareRaiseAnExceptionIfTheSecondSolutionIsNull**()

#### shouldCompareRaiseAnExceptionIfTheSolutionsHaveNotTheSameNumberOfObjectives

public void **shouldCompareRaiseAnExceptionIfTheSolutionsHaveNotTheSameNumberOfObjectives**()

#### shouldCompareReturnMinusOneIfTheFirstSolutionDominatesTheSecondOneCaseA

public void **shouldCompareReturnMinusOneIfTheFirstSolutionDominatesTheSecondOneCaseA**()
Case A: solution1 has objectives [-1.0, 5.0, 9.0] and solution2 has [2.0, 6.0, 15.0]

#### shouldCompareReturnMinusOneIfTheFirstSolutionDominatesTheSecondOneCaseB

public void **shouldCompareReturnMinusOneIfTheFirstSolutionDominatesTheSecondOneCaseB**()
Case B: solution1 has objectives [-1.0, 5.0, 9.0] and solution2 has [-1.0, 5.0, 10.0]

#### shouldCompareReturnMinusOneIfTheTwoSolutionsHasOneObjectiveAndTheFirstOneIsLower

public void **shouldCompareReturnMinusOneIfTheTwoSolutionsHasOneObjectiveAndTheFirstOneIsLower**()

#### shouldCompareReturnOneIfTheSecondSolutionDominatesTheFirstOneCaseC

public void **shouldCompareReturnOneIfTheSecondSolutionDominatesTheFirstOneCaseC**()
Case C: solution1 has objectives [-1.0, 5.0, 9.0] and solution2 has [-2.0, 5.0, 9.0]

#### shouldCompareReturnOneIfTheSecondSolutionDominatesTheFirstOneCaseD

public void **shouldCompareReturnOneIfTheSecondSolutionDominatesTheFirstOneCaseD**()
Case D: solution1 has objectives [-1.0, 5.0, 9.0] and solution2 has [-1.0, 5.0, 8.0]

#### shouldCompareReturnOneIfTheTwoSolutionsHasOneObjectiveAndTheSecondOneIsLower

public void **shouldCompareReturnOneIfTheTwoSolutionsHasOneObjectiveAndTheSecondOneIsLower**()

#### shouldCompareReturnTheValueReturnedByTheConstraintViolationComparator

public void **shouldCompareReturnTheValueReturnedByTheConstraintViolationComparator**()

#### shouldCompareReturnZeroIfTheTwoSolutionsHaveOneObjectiveWithTheSameValue

public void **shouldCompareReturnZeroIfTheTwoSolutionsHaveOneObjectiveWithTheSameValue**()

### 2.87.6 EqualSolutionsComparator

public class **EqualSolutionsComparator**<S extends Solution<?>> implements Comparator<S>, Serializable

This class implements a `Comparator` (a method for comparing `Solution` objects) based whether all the objective values are equal or not. A dominance test is applied to decide about what solution is the best.

**Author** Antonio J. Nebro

#### Methods

#### compare

public int **compare**(S *solution1*, S *solution2*)

Compares two solutions.

**Parameters**

- **solution1** – First `Solution`.
- **solution2** – Second `Solution`.

**Returns** -1, or 0, or 1, or 2 if solution1 is dominates solution2, solution1 and solution2 are equals, or solution1 is greater than solution2, respectively.

### 2.87.7 FitnessComparator

public class **FitnessComparator**<S extends Solution<?>> implements Comparator<S>, Serializable

This class implements a `Comparator` (a method for comparing `Solution` objects) based on the fitness value returned by the method `getFitness`.

**Author** Antonio J. Nebro

#### Methods

#### compare

public int **compare**(S *solution1*, S *solution2*)

Compares two solutions.

**Parameters**

- **solution1** – Object representing the first `Solution`.
- **solution2** – Object representing the second `Solution`.

**Returns** -1, or 0, or 1 if o1 is less than, equal, or greater than o2, respectively.

### 2.87.8 GDominanceComparator

public class **GDominanceComparator**<S extends Solution<?>> implements Comparator<S>, Serializable

This class implements a solution comparator according to the concept of g-dominance (https://doi.org/10.1016/j.ejor.2008.07.015)

**Author** Antonio J. Nebro

#### Constructors

#### GDominanceComparator

public **GDominanceComparator** (List<Double> *referencePoint*)

Constructor

#### Methods

#### compare

public int **compare** (S *solution1*, S *solution2*)

Compares two solutions.

**Parameters**

- **solution1** – Object representing the first `Solution`.
- **solution2** – Object representing the second `Solution`.

**Returns** -1, or 0, or 1 if solution1 dominates solution2, both are non-dominated, or solution1 is dominated by solution2, respectively.

### 2.87.9 HypervolumeContributionComparator

public class **HypervolumeContributionComparator**<S extends Solution<?>> implements Comparator<S>, Serializable

Compares two solutions according to the crowding distance attribute. The higher the distance the better

**Author** Antonio J. Nebro

#### Methods

#### compare

public int **compare** (S *solution1*, S *solution2*)

Compare two solutions.

**Parameters**

- **solution1** – Object representing the first `Solution`.
- **solution2** – Object representing the second `Solution`.

**Returns** -1, or 0, or 1 if solution1 is has lower, equal, or higher contribution value than solution2, respectively.

### 2.87.10 ObjectiveComparator

public class **ObjectiveComparator**<S extends Solution<?>> implements Comparator<S>, Serializable
This class implements a comparator based on a given objective

**Author** Antonio J. Nebro

#### Constructors

##### ObjectiveComparator

public **ObjectiveComparator** (int *objectiveId*)
Constructor.

**Parameters**

- **objectiveId** – The index of the objective to compare

##### ObjectiveComparator

public **ObjectiveComparator** (int *objectiveId*, *Ordering* *order*)
Comparator.

**Parameters**

- **objectiveId** – The index of the objective to compare
- **order** – Ascending or descending order

#### Methods

##### compare

public int **compare** (S *solution1*, S *solution2*)
Compares two solutions according to a given objective.

**Parameters**

- **solution1** – The first solution
- **solution2** – The second solution

**Returns** -1, or 0, or 1 if solution1 is less than, equal, or greater than solution2, respectively, according to the established order

### 2.87.11 ObjectiveComparator.Ordering

public enum **Ordering**

#### Enum Constants

##### ASCENDING

public static final *ObjectiveComparator.Ordering* **ASCENDING**

#### DESCENDING

public static final *ObjectiveComparator.Ordering* **DESCENDING**

### 2.87.12 ObjectiveComparatorTest

public class **ObjectiveComparatorTest**

**Author** Antonio J. Nebro

#### Fields

#### exception

public ExpectedException **exception**

#### Methods

#### shouldCompareRaiseAnExceptionIfSolution1HasLessObjectivesThanTheOneRequested

public void **shouldCompareRaiseAnExceptionIfSolution1HasLessObjectivesThanTheOneRequested**()

#### shouldCompareRaiseAnExceptionIfSolution2HasLessObjectivesThanTheOneRequested

public void **shouldCompareRaiseAnExceptionIfSolution2HasLessObjectivesThanTheOneRequested**()

#### shouldCompareReturnMinusOneIfTheObjectiveOfSolution1IsGreaterInDescendingOrder

public void **shouldCompareReturnMinusOneIfTheObjectiveOfSolution1IsGreaterInDescendingOrder**()

#### shouldCompareReturnMinusOneIfTheObjectiveOfSolution1IsLower

public void **shouldCompareReturnMinusOneIfTheObjectiveOfSolution1IsLower**()

#### shouldCompareReturnMinusOneIfTheSecondSolutionIsNull

public void **shouldCompareReturnMinusOneIfTheSecondSolutionIsNull**()

#### shouldCompareReturnOneIfTheFirstSolutionIsNull

public void **shouldCompareReturnOneIfTheFirstSolutionIsNull**()

#### shouldCompareReturnOneIfTheObjectiveOfSolution2IsGreaterInDescendingOrder

public void **shouldCompareReturnOneIfTheObjectiveOfSolution2IsGreaterInDescendingOrder**()

#### shouldCompareReturnOneIfTheObjectiveOfSolution2IsLower

public void **shouldCompareReturnOneIfTheObjectiveOfSolution2IsLower**()

#### shouldCompareReturnZeroIfBothSolutionsAreNull

public void **shouldCompareReturnZeroIfBothSolutionsAreNull**()

#### shouldCompareReturnZeroIfTheObjectiveOfTheSolutionsIsTheSame

public void **shouldCompareReturnZeroIfTheObjectiveOfTheSolutionsIsTheSame**()

## 2.87.13 RankingAndCrowdingDistanceComparator

public class **RankingAndCrowdingDistanceComparator**<S extends Solution<?>> implements Comparator<S>, Serializable

**Author** Antonio J. Nebro

### Methods

#### compare

public int **compare**(S *solution1*, S *solution2*)

Compares two solutions.

**Parameters**

- **solution1** – Object representing the first solution
- **solution2** – Object representing the second solution.

**Returns** -1, or 0, or 1 if solution1 is less than, equal, or greater than solution2, respectively.

## 2.87.14 RankingAndCrowdingDistanceComparatorTest

public class **RankingAndCrowdingDistanceComparatorTest**

**Author** Antonio J. Nebro

### Methods

#### setup

public void **setup**()

#### shouldCompareTwoNullSolutionsReturnZero

public void **shouldCompareTwoNullSolutionsReturnZero**()

#### shouldCompareWhenRankingYieldingAZeroReturnTheCrowdingDistanceValue

public void **shouldCompareWhenRankingYieldingAZeroReturnTheCrowdingDistanceValue**()

#### shouldCompareWithANullSolutionAsFirstArgumentReturnOne

public void **shouldCompareWithANullSolutionAsFirstArgumentReturnOne**()

#### shouldCompareWithANullSolutionAsSecondArgumentReturnMinusOne

public void **shouldCompareWithANullSolutionAsSecondArgumentReturnMinusOne**()

#### shouldCompareWithNullRankingAttributeSolutionAsFirstArgumentReturnOne

public void **shouldCompareWithNullRankingAttributeSolutionAsFirstArgumentReturnOne**()

#### shouldCompareWithRankingYieldingANonZeroValueReturnThatValue

public void **shouldCompareWithRankingYieldingANonZeroValueReturnThatValue**()

#### teardown

public void **teardown**()

## 2.87.15 RankingComparator

public class **RankingComparator**<S extends Solution<?>> implements Comparator<S>, Serializable

**Author** Antonio J. Nebro This class implements a comparator based on the rank of the solutions.

### Methods

#### compare

public int **compare**(S *solution1*, S *solution2*)

Compares two solutions according to the ranking attribute. The lower the ranking the better

**Parameters**

- **solution1** – Object representing the first solution.
- **solution2** – Object representing the second solution.

**Returns** -1, or 0, or 1 if o1 is less than, equal, or greater than o2, respectively.

### 2.87.16 RankingComparatorTest

public class **RankingComparatorTest**

**Author** Antonio J. Nebro

#### Methods

#### setup

public void **setup**()

#### shouldCompareReturnMinusOneIfSolutionAHasLessRanking

public void **shouldCompareReturnMinusOneIfSolutionAHasLessRanking**()

#### shouldCompareReturnMinusOneIfTheSecondSolutionIsNull

public void **shouldCompareReturnMinusOneIfTheSecondSolutionIsNull**()

#### shouldCompareReturnOneIfSolutionBHasLessRanking

public void **shouldCompareReturnOneIfSolutionBHasLessRanking**()

#### shouldCompareReturnOneIfTheFirstSolutionIsNull

public void **shouldCompareReturnOneIfTheFirstSolutionIsNull**()

#### shouldCompareReturnZeroIfBothSolutionsAreNull

public void **shouldCompareReturnZeroIfBothSolutionsAreNull**()

#### shouldCompareReturnZeroIfBothSolutionsHaveNoRankingAttribute

public void **shouldCompareReturnZeroIfBothSolutionsHaveNoRankingAttribute**()

#### shouldCompareReturnZeroIfBothSolutionsHaveTheSameRanking

public void **shouldCompareReturnZeroIfBothSolutionsHaveTheSameRanking**()

### 2.87.17 StrengthFitnessComparator

public class **StrengthFitnessComparator**<S extends Solution<?>> implements Comparator<S>, Serializable

**Author** Juan J. Durillo

**Parameters**

- **<S>** –

#### Methods

#### compare

public int **compare**(S *solution1*, S *solution2*)

## 2.88 org.uma.jmetal.util.comparator.impl

### 2.88.1 OverallConstraintViolationComparator

public class **OverallConstraintViolationComparator**<S extends Solution<?>> implements *ConstraintViolationComparato*

This class implements a `Comparator` (a method for comparing `Solution` objects) based on the overall constraint violation of the solutions, as done in NSGA-II.

**Author** Antonio J. Nebro

#### Constructors

#### OverallConstraintViolationComparator

public **OverallConstraintViolationComparator**()

Constructor

#### Methods

#### compare

public int **compare**(S *solution1*, S *solution2*)

Compares two solutions. If the solutions has no constraints the method return 0

**Parameters**

- **solution1** – Object representing the first `Solution`.
- **solution2** – Object representing the second `Solution`.

**Returns** -1, or 0, or 1 if o1 is less than, equal, or greater than o2, respectively.

### 2.88.2 ViolationThresholdComparator

public class **ViolationThresholdComparator**<S extends Solution<?>> implements *ConstraintViolationComparator*<S>

This class implements the ViolationThreshold Comparator *

**Author** Juan J. Durillo

#### Constructors

##### ViolationThresholdComparator

public **ViolationThresholdComparator**()

Constructor

#### Methods

##### compare

public int **compare**(S *solution1*, S *solution2*)

Compares two solutions. If the solutions has no constraints the method return 0

**Parameters**

- **solution1** – Object representing the first `Solution`.
- **solution2** – Object representing the second `Solution`.

**Returns** -1, or 0, or 1 if o1 is less than, equal, or greater than o2, respectively.

##### feasibilityRatio

public double **feasibilityRatio**(List<S> *solutionSet*)

Computes the feasibility ratio Return the ratio of feasible solutions

##### meanOverallViolation

public double **meanOverallViolation**(List<S> *solutionSet*)

Computes the feasibility ratio Return the ratio of feasible solutions

##### needToCompare

public boolean **needToCompare**(S *solution1*, S *solution2*)

Returns true if solutions s1 and/or s2 have an overall constraint violation with value less than 0

##### updateThreshold

public void **updateThreshold**(List<S> *set*)

Updates the threshold value using the population

## 2.89 org.uma.jmetal.util.distance

### 2.89.1 Distance

public interface **Distance**<E, J>
Interface representing distances between two entities

**Author**

#### Methods

#### getDistance

double **getDistance**(E *element1*, J *element2*)

## 2.90 org.uma.jmetal.util.distance.impl

### 2.90.1 CosineDistanceBetweenSolutionsInObjectiveSpace

public class **CosineDistanceBetweenSolutionsInObjectiveSpace**<S extends Solution<?>> implements *Distance*<S, S>
Class for calculating the cosine distance between two `Solution` objects in objective space.

**Author**

#### Constructors

#### CosineDistanceBetweenSolutionsInObjectiveSpace

public **CosineDistanceBetweenSolutionsInObjectiveSpace**(S *referencePoint*)

#### Methods

#### getDistance

public double **getDistance**(S *solution1*, S *solution2*)

### 2.90.2 CosineDistanceBetweenSolutionsInObjectiveSpaceTest

public class **CosineDistanceBetweenSolutionsInObjectiveSpaceTest**
Created by ajnebro on 12/2/16.

#### Methods

#### shouldIdenticalPointsHaveADistanceOfOne

public void **shouldIdenticalPointsHaveADistanceOfOne**()

#### shouldPointsInTheSameDirectionHaveADistanceOfOne

public void **shouldPointsInTheSameDirectionHaveADistanceOfOne**()

#### shouldTwoPerpendicularPointsHaveADistanceOfZero

public void **shouldTwoPerpendicularPointsHaveADistanceOfZero**()

## 2.90.3 EuclideanDistanceBetweenSolutionAndASolutionListInObjectiveSpace

public class **EuclideanDistanceBetweenSolutionAndASolutionListInObjectiveSpace**<S extends Solution<Doub

Class for calculating the Euclidean distance between a *Solution* object a list of *Solution* objects in objective space.

**Author**

### Constructors

#### EuclideanDistanceBetweenSolutionAndASolutionListInObjectiveSpace

public **EuclideanDistanceBetweenSolutionAndASolutionListInObjectiveSpace**()

### Methods

#### getDistance

public double **getDistance**(S *solution*, L *solutionList*)

## 2.90.4 EuclideanDistanceBetweenSolutionsInObjectiveSpace

public class **EuclideanDistanceBetweenSolutionsInObjectiveSpace**<S extends Solution<?>> implements *Distance*<S

Class for calculating the Euclidean distance between two *Solution* objects in objective space.

**Author**

### Methods

#### getDistance

public double **getDistance**(S *solution1*, S *solution2*)

## 2.90.5 EuclideanDistanceBetweenSolutionsInSolutionSpace

public class **EuclideanDistanceBetweenSolutionsInSolutionSpace**<S extends Solution<Double>> implements *Distan*

Class for calculating the Euclidean distance between two *DoubleSolution* objects in solution space.

**Author**

#### Methods

##### getDistance

public double **getDistance** (S *solution1*, S *solution2*)

## 2.91 org.uma.jmetal.util.evaluator

### 2.91.1 SolutionListEvaluator

public interface **SolutionListEvaluator**<S> extends Serializable
Created by Antonio J. Nebro on 30/05/14.

#### Methods

##### evaluate

List<S> **evaluate** (List<S> *solutionList*, *Problem*<S> *problem*)

##### shutdown

void **shutdown** ()

## 2.92 org.uma.jmetal.util.evaluator.impl

### 2.92.1 MultithreadedSolutionListEvaluator

public class **MultithreadedSolutionListEvaluator**<S> implements *SolutionListEvaluator*<S>

**Author** Antonio J. Nebro

#### Constructors

##### MultithreadedSolutionListEvaluator

public **MultithreadedSolutionListEvaluator** (int *numberOfThreads*, *Problem*<S> *problem*)

#### Methods

##### evaluate

public List<S> **evaluate** (List<S> *solutionList*, *Problem*<S> *problem*)

#### getNumberOfThreads

public int **getNumberOfThreads** ()

#### shutdown

public void **shutdown** ()

### 2.92.2 SequentialSolutionListEvaluator

public class **SequentialSolutionListEvaluator**<S> implements *SolutionListEvaluator*<S>

**Author** Antonio J. Nebro

#### Methods

#### evaluate

public List<S> **evaluate** (List<S> *solutionList*, *Problem*<S> *problem*)

#### shutdown

public void **shutdown** ()

## 2.93 org.uma.jmetal.util.experiment

### 2.93.1 Experiment

public class **Experiment**<S extends Solution<?>, Result>

Class for describing the configuration of a jMetal experiment. Created by Antonio J. Nebro on 17/07/14.

#### Constructors

#### Experiment

public **Experiment** (*ExperimentBuilder*<S, Result> *builder*)

Constructor

#### Methods

#### getAlgorithmList

public List<*ExperimentAlgorithm*<S, Result>> **getAlgorithmList** ()

#### getExperimentBaseDirectory

public String **getExperimentBaseDirectory**()

#### getExperimentName

public String **getExperimentName**()

#### getIndependentRuns

public int **getIndependentRuns**()

#### getIndicatorList

public List<*GenericIndicator*<S>> **getIndicatorList**()

#### getNumberOfCores

public int **getNumberOfCores**()

#### getOutputParetoFrontFileName

public String **getOutputParetoFrontFileName**()

#### getOutputParetoSetFileName

public String **getOutputParetoSetFileName**()

#### getProblemList

public List<*ExperimentProblem*<S>> **getProblemList**()

#### getReferenceFrontDirectory

public String **getReferenceFrontDirectory**()

#### removeDuplicatedAlgorithms

public void **removeDuplicatedAlgorithms**()

The list of algorithms contain an algorithm instance per problem. This is not convenient for calculating statistical data, because a same algorithm will appear many times. This method remove duplicated algorithms and leave only an instance of each one.

#### setAlgorithmList

public void **setAlgorithmList** (List<*ExperimentAlgorithm*<S, Result>> *algorithmList*)

#### setReferenceFrontDirectory

public void **setReferenceFrontDirectory** (String *referenceFrontDirectory*)

### 2.93.2 ExperimentBuilder

public class **ExperimentBuilder**<S extends Solution<?>, Result>
Builder for class *Experiment*

**Author** Antonio J. Nebro

#### Constructors

#### ExperimentBuilder

public **ExperimentBuilder** (String *experimentName*)

#### Methods

#### build

public *Experiment*<S, Result> **build** ()

#### getAlgorithmList

public List<*ExperimentAlgorithm*<S, Result>> **getAlgorithmList** ()

#### getExperimentBaseDirectory

public String **getExperimentBaseDirectory** ()

#### getExperimentName

public String **getExperimentName** ()

#### getIndependentRuns

public int **getIndependentRuns** ()

#### getIndicatorList

public List<*GenericIndicator*<S>> **getIndicatorList**()

#### getNumberOfCores

public int **getNumberOfCores**()

#### getOutputParetoFrontFileName

public String **getOutputParetoFrontFileName**()

#### getOutputParetoSetFileName

public String **getOutputParetoSetFileName**()

#### getProblemList

public List<*ExperimentProblem*<S>> **getProblemList**()

#### getReferenceFrontDirectory

public String **getReferenceFrontDirectory**()

#### setAlgorithmList

public *ExperimentBuilder*<S, Result> **setAlgorithmList**(List<*ExperimentAlgorithm*<S, Result>> *algorithmList*)

#### setExperimentBaseDirectory

public *ExperimentBuilder*<S, Result> **setExperimentBaseDirectory**(String *experimentBaseDirectory*)

#### setIndependentRuns

public *ExperimentBuilder*<S, Result> **setIndependentRuns**(int *independentRuns*)

#### setIndicatorList

public *ExperimentBuilder*<S, Result> **setIndicatorList**(List<*GenericIndicator*<S>> *indicatorList*)

#### setNumberOfCores

public *ExperimentBuilder*<S, Result> **setNumberOfCores** (int *numberOfCores*)

#### setOutputParetoFrontFileName

public *ExperimentBuilder*<S, Result> **setOutputParetoFrontFileName** (String *outputParetoFrontFileName*)

#### setOutputParetoSetFileName

public *ExperimentBuilder*<S, Result> **setOutputParetoSetFileName** (String *outputParetoSetFileName*)

#### setProblemList

public *ExperimentBuilder*<S, Result> **setProblemList** (List<*ExperimentProblem*<S>> *problemList*)

#### setReferenceFrontDirectory

public *ExperimentBuilder*<S, Result> **setReferenceFrontDirectory** (String *referenceFrontDirectory*)

### 2.93.3 ExperimentComponent

public interface **ExperimentComponent**

An experiment is composed of instances of this interface.

**Author** Antonio J. Nebro

#### Methods

#### run

void **run** ()

## 2.94 org.uma.jmetal.util.experiment.component

### 2.94.1 ComputeQualityIndicators

public class **ComputeQualityIndicators**<S extends Solution<?>, Result> implements *ExperimentComponent*

This class computes the `QualityIndicator`s of an experiment. Once the algorithms of an experiment have been executed through running an instance of class `ExecuteAlgorithms`, the list of indicators in obtained from the `#getIndicatorsList()` method. Then, for every combination algorithm + problem, the indicators are applied to all the FUN files and the resulting values are store in a file called as `#getName()`, which is located in the same directory of the FUN files.

**Author** Antonio J. Nebro

#### Constructors

##### ComputeQualityIndicators

public **ComputeQualityIndicators** (*Experiment*<S, Result> *experiment*)

#### Methods

##### findBestIndicatorFronts

public void **findBestIndicatorFronts** (*Experiment*<?, Result> *experiment*)

##### run

public void **run** ()

### 2.94.2 ExecuteAlgorithms

public class **ExecuteAlgorithms**<S extends Solution<?>, Result> implements *ExperimentComponent*

This class executes the algorithms the have been configured with a instance of class `Experiment`. Java 8 parallel streams are used to run the algorithms in parallel.

The result of the execution is a pair of files FUNrunId.tsv and VARrunID.tsv per experiment, which are stored in the directory `#getExperimentBaseDirectory()`/algorithmName/problemName.

**Author** Antonio J. Nebro

#### Constructors

##### ExecuteAlgorithms

public **ExecuteAlgorithms** (*Experiment*<S, Result> *configuration*)

Constructor

#### Methods

##### run

public void **run** ()

### 2.94.3 GenerateBoxplotsWithR

public class **GenerateBoxplotsWithR**<Result> implements *ExperimentComponent*

This class generates a R script that generates an eps file containing boxplots The results are a set of R files that are written in the directory `#getExperimentBaseDirectory()`/R. Each file is called as indicatorName.Wilcoxon.R To run the R script: Rscript indicatorName.Wilcoxon.R To generate the resulting Latex file: pdflatex indicatorName.Wilcoxon.tex

**Author** Antonio J. Nebro

#### Constructors

#### GenerateBoxplotsWithR

public **GenerateBoxplotsWithR** (*Experiment*<?, Result> *experimentConfiguration*)

#### Methods

#### run

public void **run** ()

#### setColumns

public *GenerateBoxplotsWithR*<Result> **setColumns** (int *columns*)

#### setDisplayNotch

public *GenerateBoxplotsWithR*<Result> **setDisplayNotch** ()

#### setRows

public *GenerateBoxplotsWithR*<Result> **setRows** (int *rows*)

### 2.94.4 GenerateFriedmanTestTables

public class **GenerateFriedmanTestTables**<Result> implements *ExperimentComponent*

This class computes the Friedman test ranking and generates a Latex script that produces a table per quality indicator containing the ranking The results are a set of Latex files that are written in the directory `#getExperimentBaseDirectory()`/latex. Each file is called as FriedmanTest[indicatorName].tex The implementation is based on the one included in Keel: J. Alcalá-Fdez, L. Sánchez, S. García, M.J. del Jesus, S. Ventura, J.M. Garrell, J. Otero, C. Romero, J. Bacardit, V.M. Rivas, J.C. Fernández, F. Herrera. KEEL: A Software Tool to Assess Evolutionary Algorithms to Data Mining Problems. Soft Computing 13:3 (2009) 307-318 Doi: 10.1007/s00500-008-0323-y

**Author** Antonio J. Nebro

#### Constructors

#### GenerateFriedmanTestTables

public **GenerateFriedmanTestTables** (*Experiment*<?, Result> *experimentConfiguration*)

#### Methods

##### prepareFileOutputContents

public String **prepareFileOutputContents** (double[] *averageRanking*)

##### run

public void **run** ()

### 2.94.5 GenerateLatexTablesWithStatistics

public class **GenerateLatexTablesWithStatistics** implements *ExperimentComponent*

This class computes a number of statistical values (mean, median, standard deviation, interquartile range) from the indicator files generated after executing `ExecuteAlgorithms` and `ComputeQualityIndicators`. After reading the data files and calculating the values, a Latex file is created containing an script that generates tables with the best and second best values per indicator. The name of the file is `#getExperimentName()`.tex, which is located by default in the directory `#getExperimentBaseDirectory()`/latex Although the maximum, minimum, and total number of items are also computed, no tables are generated with them (this is a pending work).

**Author** Antonio J. Nebro

#### Constructors

##### GenerateLatexTablesWithStatistics

public **GenerateLatexTablesWithStatistics** (*Experiment*<?, ?> *configuration*)

#### Methods

##### printEndLatexCommands

void **printEndLatexCommands** (String *fileName*)

##### printHeaderLatexCommands

void **printHeaderLatexCommands** (String *fileName*)

##### run

public void **run** ()

### 2.94.6 GenerateReferenceParetoFront

public class **GenerateReferenceParetoFront** implements *ExperimentComponent*

This class computes a reference Pareto front from a set of files. Once the algorithms of an experiment have been executed through running an instance of class `ExecuteAlgorithms`, all the obtained fronts of all the algorithms are gathered per problem; then, the dominated solutions are removed and the final result is a file per problem containing the reference Pareto front. By default, the files are stored in a directory called "referenceFront", which is located in the experiment base directory. Each front is named following the scheme "problemName.rf".

**Author** Antonio J. Nebro

#### Constructors

#### GenerateReferenceParetoFront

public **GenerateReferenceParetoFront** (*Experiment*<?, ?> *experimentConfiguration*)

#### Methods

#### run

public void **run** ()

The run() method creates de output directory and compute the fronts

### 2.94.7 GenerateReferenceParetoSetAndFrontFromDoubleSolutions

public class **GenerateReferenceParetoSetAndFrontFromDoubleSolutions** implements *ExperimentComponent*

This class computes the reference Pareto set and front from a set of data files containing the variable (VARx.tsv file) and objective (FUNx.tsv) values. A requirement is that the variable values MUST correspond to `DoubleSolution` solutions, i.e., the solved problems must be instances of `DoubleProblem`. Once the algorithms of an experiment have been executed through running an instance of class `ExecuteAlgorithms`, all the obtained fronts of all the algorithms are gathered per problem; then, the dominated solutions are removed thus yielding to the reference Pareto front. By default, the files are stored in a directory called "referenceFront", which is located in the experiment base directory. The following files are generated per problem: - "problemName.pf": the reference Pareto front. - "problemName.ps": the reference Pareto set (i.e., the variable values of the solutions of the reference Pareto front. - "problemName.algorithmName.pf": the objectives values of the contributed solutions by the algorithm called "algorithmName" to "problemName.pf" - "problemName.algorithmName.ps": the variable values of the contributed solutions by the algorithm called "algorithmName" to "problemName.ps"

**Author** Antonio J. Nebro

#### Constructors

#### GenerateReferenceParetoSetAndFrontFromDoubleSolutions

public **GenerateReferenceParetoSetAndFrontFromDoubleSolutions** (*Experiment*<?, ?> *experimentConfiguration*)

#### Methods

##### run

public void **run**()
    The run() method creates de output directory and compute the fronts

### 2.94.8 GenerateWilcoxonTestTablesWithR

public class **GenerateWilcoxonTestTablesWithR**<Result> implements *ExperimentComponent*
    This class generates a R script that computes the Wilcoxon Signed Rank Test and generates a Latex script that produces a table per quality indicator containing the pairwise comparison between all the algorithms on all the solved problems. The results are a set of R files that are written in the directory `#getExperimentBaseDirectory()`/R. Each file is called as indicatorName.Wilcoxon.R To run the R script: Rscript indicatorName.Wilcoxon.R To generate the resulting Latex file: pdflatex indicatorName.Wilcoxon.tex

        **Author** Antonio J. Nebro

#### Constructors

##### GenerateWilcoxonTestTablesWithR

public **GenerateWilcoxonTestTablesWithR**(*Experiment*<?, Result> *experimentConfiguration*)

#### Methods

##### run

public void **run**()

## 2.95 org.uma.jmetal.util.experiment.util

### 2.95.1 ExperimentAlgorithm

public class **ExperimentAlgorithm**<S extends Solution<?>, Result>
    Class defining tasks for the execution of algorithms in parallel.

        **Author** Antonio J. Nebro

#### Constructors

##### ExperimentAlgorithm

public **ExperimentAlgorithm**(*Algorithm*<Result> *algorithm*, String *algorithmTag*, *ExperimentProblem*<S> *problem*, int *runId*)
    Constructor

#### ExperimentAlgorithm

public **ExperimentAlgorithm**(*Algorithm*<Result> *algorithm*, *ExperimentProblem*<S> *problem*, int *runId*)

#### Methods

#### getAlgorithm

public *Algorithm*<Result> **getAlgorithm**()

#### getAlgorithmTag

public String **getAlgorithmTag**()

#### getProblemTag

public String **getProblemTag**()

#### getReferenceParetoFront

public String **getReferenceParetoFront**()

#### getRunId

public int **getRunId**()

#### runAlgorithm

public void **runAlgorithm**(*Experiment*<?, ?> *experimentData*)

### 2.95.2 ExperimentProblem

public class **ExperimentProblem**<S extends Solution<?>>
Class used to add a tag field to a problem.

**Author** Antonio J. Nebro

#### Constructors

#### ExperimentProblem

public **ExperimentProblem**(*Problem*<S> *problem*, String *tag*)

#### ExperimentProblem

public **ExperimentProblem** (*Problem*<S> *problem*)

#### Methods

#### changeReferenceFrontTo

public *ExperimentProblem*<S> **changeReferenceFrontTo** (String *referenceFront*)

#### getProblem

public *Problem*<S> **getProblem** ()

#### getReferenceFront

public String **getReferenceFront** ()

#### getTag

public String **getTag** ()

## 2.96 org.uma.jmetal.util.extremevalues

### 2.96.1 ExtremeValuesFinder

public interface **ExtremeValuesFinder**<Source, Result>

Interface representing classes aimed at finding the extreme values of Source objects (e.g., lists)

**Author** Antonio J. Nebro

**Parameters**

- **<Source>** –
- **<Result>** –

#### Methods

#### findHighestValues

Result **findHighestValues** (Source *source*)

#### findLowestValues

Result **findLowestValues** (Source *source*)

## 2.97 org.uma.jmetal.util.extremevalues.impl

### 2.97.1 FrontExtremeValues

public class **FrontExtremeValues** implements *ExtremeValuesFinder*<*Front*, List<Double>>

Class for finding the extreme values of front objects

**Author** Antonio J. Nebro

#### Methods

#### findHighestValues

public List<Double> **findHighestValues**(*Front front*)

#### findLowestValues

public List<Double> **findLowestValues**(*Front front*)

### 2.97.2 SolutionListExtremeValues

public class **SolutionListExtremeValues** implements *ExtremeValuesFinder*<List<*Solution*<?>>, List<Double>>

Class for finding the extreme values of a list of objects

**Author** Antonio J. Nebro

#### Methods

#### findHighestValues

public List<Double> **findHighestValues**(List<*Solution*<?>> *solutionList*)

#### findLowestValues

public List<Double> **findLowestValues**(List<*Solution*<?>> *solutionList*)

## 2.98 org.uma.jmetal.util.fileinput.util

### 2.98.1 ReadDoubleDataFile

public class **ReadDoubleDataFile**

Utiliy class that reads a file containing a double value per line and returns an array with all of them.

**Author** Antonio J. Nebro

#### Methods

##### readFile

public double[] **readFile**(String *fileName*)

## 2.99 org.uma.jmetal.util.fileoutput

### 2.99.1 FileOutputContext

public interface **FileOutputContext** extends Serializable

This interface represents output contexts, which are classes providing a mean for getting a buffer reader object.

**Author** Antonio J. Nebro

#### Methods

##### getFileName

public String **getFileName**()

##### getFileWriter

public BufferedWriter **getFileWriter**()

##### getSeparator

public String **getSeparator**()

##### setSeparator

public void **setSeparator**(String *separator*)

### 2.99.2 SolutionListOutput

public class **SolutionListOutput**

**Author** Antonio J. Nebro

#### Constructors

##### SolutionListOutput

public **SolutionListOutput**(List<? extends *Solution*<?>> *solutionList*)

## Methods

### print

public void **print** ()

### printObjectivesToFile

public void **printObjectivesToFile** (*FileOutputContext context*, List<? extends *Solution*<?>> *solutionList*)

### printObjectivesToFile

public void **printObjectivesToFile** (*FileOutputContext context*, List<? extends *Solution*<?>> *solutionList*, List<Boolean> *minimizeObjective*)

### printObjectivesToFile

public void **printObjectivesToFile** (String *fileName*)

### printObjectivesToFile

public void **printObjectivesToFile** (String *fileName*, List<Boolean> *minimizeObjective*)

### printVariablesToFile

public void **printVariablesToFile** (*FileOutputContext context*, List<? extends *Solution*<?>> *solutionList*)

### printVariablesToFile

public void **printVariablesToFile** (String *fileName*)

### setFunFileOutputContext

public *SolutionListOutput* **setFunFileOutputContext** (*FileOutputContext fileContext*)

### setObjectiveMinimizingObjectiveList

public *SolutionListOutput* **setObjectiveMinimizingObjectiveList** (List<Boolean> *isObjectiveToBeMinimized*)

### setSeparator

public *SolutionListOutput* **setSeparator** (String *separator*)

#### setVarFileOutputContext

public *SolutionListOutput* **setVarFileOutputContext** (*FileOutputContext fileContext*)

## 2.100 org.uma.jmetal.util.fileoutput.impl

### 2.100.1 DefaultFileOutputContext

public class **DefaultFileOutputContext** implements *FileOutputContext*

Class using the default method for getting a buffered writer

**Author** Antonio J. Nebro

#### Fields

#### fileName

protected String **fileName**

#### separator

protected String **separator**

#### Constructors

#### DefaultFileOutputContext

public **DefaultFileOutputContext** (String *fileName*)

#### Methods

#### getFileName

public String **getFileName** ()

#### getFileWriter

public BufferedWriter **getFileWriter** ()

#### getSeparator

public String **getSeparator** ()

#### setSeparator

public void **setSeparator**(String *separator*)

## 2.101 org.uma.jmetal.util.front

### 2.101.1 Front

public interface **Front** extends Serializable

A front is a list of points

**Author** Antonio J. Nebro

#### Methods

#### getNumberOfPoints

public int **getNumberOfPoints**()

#### getPoint

public *Point* **getPoint**(int *index*)

#### getPointDimensions

public int **getPointDimensions**()

#### setPoint

public void **setPoint**(int *index*, *Point* *point*)

#### sort

public void **sort**(Comparator<*Point*> *comparator*)

## 2.102 org.uma.jmetal.util.front.imp

### 2.102.1 ArrayFront

public class **ArrayFront** implements *Front*

This class implements the `Front` interface by using an array of `Point` objects

**Author** Antonio J. Nebro

### Fields

#### numberOfPoints

protected int **numberOfPoints**

#### points

protected *Point*[] **points**

### Constructors

#### ArrayFront

public **ArrayFront**()
Constructor

#### ArrayFront

public **ArrayFront**(List<? extends *Solution*<?>> *solutionList*)
Constructor

#### ArrayFront

public **ArrayFront**(*Front front*)
Copy Constructor

#### ArrayFront

public **ArrayFront**(int *numberOfPoints*, int *dimensions*)
Constructor

#### ArrayFront

public **ArrayFront**(String *fileName*)
Constructor

**Parameters**

- **fileName** – File containing the data. Each line of the file is a list of objective values

**Throws**

- **FileNotFoundException** –

#### Methods

##### createInputStream

public InputStream **createInputStream** (String *fileName*)

##### equals

public boolean **equals** (Object *o*)

##### getNumberOfPoints

public int **getNumberOfPoints** ()

##### getPoint

public *Point* **getPoint** (int *index*)

##### getPointDimensions

public int **getPointDimensions** ()

##### hashCode

public int **hashCode** ()

##### setPoint

public void **setPoint** (int *index*, *Point* *point*)

##### sort

public void **sort** (Comparator<*Point*> *comparator*)

##### toString

public String **toString** ()

### 2.102.2 ArrayFrontTest

public class **ArrayFrontTest**

**Author** Antonio J. Nebro

#### Fields

##### exception

public ExpectedException **exception**

#### Methods

##### shouldConstructorCreateAnArranFrontFromAFileContainingA2DFront

public void **shouldConstructorCreateAnArranFrontFromAFileContainingA2DFront**()

##### shouldConstructorCreateAnArranFrontFromAFileContainingA3DFront

public void **shouldConstructorCreateAnArranFrontFromAFileContainingA3DFront**()

##### shouldCreateAnArrayFrontFromAListOfSolutionsHavingOneDoubleSolutionObject

public void **shouldCreateAnArrayFrontFromAListOfSolutionsHavingOneDoubleSolutionObject**()

##### shouldCreateAnArrayFrontFromAListOfSolutionsHavingOneSingleSolutionObject

public void **shouldCreateAnArrayFrontFromAListOfSolutionsHavingOneSingleSolutionObject**()

##### shouldCreateAnArrayFrontFromAListOfSolutionsHavingTwoDoubleSolutionObject

public void **shouldCreateAnArrayFrontFromAListOfSolutionsHavingTwoDoubleSolutionObject**()

##### shouldCreateAnArrayFrontFromANullFrontRaiseAnException

public void **shouldCreateAnArrayFrontFromANullFrontRaiseAnException**()

##### shouldCreateAnArrayFrontFromANullListRaiseAnAnException

public void **shouldCreateAnArrayFrontFromANullListRaiseAnAnException**()

##### shouldCreateAnArrayFrontFromASolutionListResultInTwoEqualsFronts

public void **shouldCreateAnArrayFrontFromASolutionListResultInTwoEqualsFronts**()

##### shouldCreateAnArrayFrontFromAnEmptyFrontRaiseAnException

public void **shouldCreateAnArrayFrontFromAnEmptyFrontRaiseAnException**()

#### shouldCreateAnArrayFrontFromAnEmptyListRaiseAnException

public void **shouldCreateAnArrayFrontFromAnEmptyListRaiseAnException**()

#### shouldCreateAnArrayFrontFromAnotherFrontResultInTwoEqualsFrontssss

public void **shouldCreateAnArrayFrontFromAnotherFrontResultInTwoEqualsFrontssss**()

#### shouldCreateInputStreamThrownAnExceptionIfFileDoesNotExist

public void **shouldCreateInputStreamThrownAnExceptionIfFileDoesNotExist**()

#### shouldDefaultConstructorCreateAnEmptyArrayFront

public void **shouldDefaultConstructorCreateAnEmptyArrayFront**()

#### shouldEqualsReturnFalseIfPointDimensionsOfTheFrontsIsDifferent

public void **shouldEqualsReturnFalseIfPointDimensionsOfTheFrontsIsDifferent**()

#### shouldEqualsReturnFalseIfTheArgumentIsFromAWrongClass

public void **shouldEqualsReturnFalseIfTheArgumentIsFromAWrongClass**()

#### shouldEqualsReturnFalseIfTheArgumentIsNull

public void **shouldEqualsReturnFalseIfTheArgumentIsNull**()

#### shouldEqualsReturnFalseIfTheComparedFrontHasADifferentNumberOfPoints

public void **shouldEqualsReturnFalseIfTheComparedFrontHasADifferentNumberOfPoints**()

#### shouldEqualsReturnFalseIfTheFrontsAreDifferent

public void **shouldEqualsReturnFalseIfTheFrontsAreDifferent**()

#### shouldEqualsReturnTrueIfTheArgumentIsEqual

public void **shouldEqualsReturnTrueIfTheArgumentIsEqual**()

#### shouldEqualsReturnTrueIfTheArgumentIsTheSameObject

public void **shouldEqualsReturnTrueIfTheArgumentIsTheSameObject**()

#### shouldGetPointRaiseAnExceptionWhenTheIndexIsGreaterThanTheFrontSize

public void **shouldGetPointRaiseAnExceptionWhenTheIndexIsGreaterThanTheFrontSize**()

#### shouldGetPointRaiseAnExceptionWhenTheIndexIsNegative

public void **shouldGetPointRaiseAnExceptionWhenTheIndexIsNegative**()

#### shouldGetPointReturnTheCorrectObject

public void **shouldGetPointReturnTheCorrectObject**()

#### shouldReadFrontAFileWithOnePointCreateTheCorrectFront

public void **shouldReadFrontAFileWithOnePointCreateTheCorrectFront**()
Test using a file containing: 1.0 2.0 -3.0

#### shouldReadFrontAnEmptyFileCreateAnEmptyFront

public void **shouldReadFrontAnEmptyFileCreateAnEmptyFront**()

#### shouldReadFrontFourPointsCreateTheCorrectFront

public void **shouldReadFrontFourPointsCreateTheCorrectFront**()
Test using a file containing: 1 2 3 4 5 6 7 8 9 10 11 12 -1 -2 -3 -4

#### shouldReadFrontWithALineContainingWrongDataRaiseAnException

public void **shouldReadFrontWithALineContainingWrongDataRaiseAnException**()
Test using a file containing: 3.0 2.3 asdfg

#### shouldReadFrontWithALineWithALineMissingDataRaiseAnException

public void **shouldReadFrontWithALineWithALineMissingDataRaiseAnException**()
Test using a file containing: -30 234.234 90.25 15 -5.23

#### shouldSetPointAssignTheCorrectObject

public void **shouldSetPointAssignTheCorrectObject**()

#### shouldSetPointRaiseAnExceptionWhenTheIndexIsGreaterThanTheFrontSize

public void **shouldSetPointRaiseAnExceptionWhenTheIndexIsGreaterThanTheFrontSize**()

#### shouldSetPointRaiseAnExceptionWhenTheIndexIsNegative

public void **shouldSetPointRaiseAnExceptionWhenTheIndexIsNegative**()

#### shouldSetPointRaiseAnExceptionWhenThePointIsNull

public void **shouldSetPointRaiseAnExceptionWhenThePointIsNull**()

#### shouldSortReturnAnOrderedFront

public void **shouldSortReturnAnOrderedFront**()

## 2.102.3 FrontUtilsTest

public class **FrontUtilsTest**

**Author** Antonio J. Nebro

### Fields

#### exception

public ExpectedException **exception**

### Methods

#### shouldConvertFrontToArrayRaiseAnExceptionIfTheFrontIsNull

public void **shouldConvertFrontToArrayRaiseAnExceptionIfTheFrontIsNull**()

#### shouldConvertFrontToArrayReturnAnEmptyArrayIfTheFrontIsEmpty

public void **shouldConvertFrontToArrayReturnAnEmptyArrayIfTheFrontIsEmpty**()

#### shouldConvertFrontToArrayReturnTheCorrectArrayCaseA

public void **shouldConvertFrontToArrayReturnTheCorrectArrayCaseA**()

Case A: The front has one point

#### shouldConvertFrontToArrayReturnTheCorrectArrayCaseB

public void **shouldConvertFrontToArrayReturnTheCorrectArrayCaseB**()

Case A: The front has one three points

#### shouldConvertFrontToSolutionListRaiseAnExceptionIfTheFrontIsNull

public void **shouldConvertFrontToSolutionListRaiseAnExceptionIfTheFrontIsNull**()

#### shouldConvertFrontToSolutionListReturnAnEmptyListIfTheFrontIsEmpty

public void **shouldConvertFrontToSolutionListReturnAnEmptyListIfTheFrontIsEmpty**()

#### shouldConvertFrontToSolutionListReturnTheCorrectListCaseA

public void **shouldConvertFrontToSolutionListReturnTheCorrectListCaseA**()
Case A: The front has one point

#### shouldConvertFrontToSolutionListReturnTheCorrectListCaseB

public void **shouldConvertFrontToSolutionListReturnTheCorrectListCaseB**()
Case A: The front has one three points

#### shouldDistanceToClosestPointRaiseAnExceptionIfTheFrontIsEmpty

public void **shouldDistanceToClosestPointRaiseAnExceptionIfTheFrontIsEmpty**()

#### shouldDistanceToClosestPointRaiseAnExceptionIfTheFrontIsNull

public void **shouldDistanceToClosestPointRaiseAnExceptionIfTheFrontIsNull**()

#### shouldDistanceToClosestPointRaiseAnExceptionIfThePointIsNull

public void **shouldDistanceToClosestPointRaiseAnExceptionIfThePointIsNull**()

#### shouldDistanceToClosestPointReturnMaxZeroIfThePointIsTheOnlyPointInTheFront

public void **shouldDistanceToClosestPointReturnMaxZeroIfThePointIsTheOnlyPointInTheFront**()

#### shouldDistanceToClosestPointReturnTheCorrectValueIfTheFrontHasHasOnePoint

public void **shouldDistanceToClosestPointReturnTheCorrectValueIfTheFrontHasHasOnePoint**()

#### shouldDistanceToNearestPointClosestTheCorrectValueIfTheFrontHasTwoPointsCaseA

public void **shouldDistanceToNearestPointClosestTheCorrectValueIfTheFrontHasTwoPointsCaseA**()
Case A: the front has two points and one of them is the point passed as a parameter

#### shouldDistanceToNearestPointClosestTheCorrectValueIfTheFrontHasTwoPointsCaseB

public void **shouldDistanceToNearestPointClosestTheCorrectValueIfTheFrontHasTwoPointsCaseB**()
Case B: the front has two points and none of them is the point passed as a parameter. The dimensions of the points are ordered

#### shouldDistanceToNearestPointClosestTheCorrectValueIfTheFrontHasTwoPointsCaseC

public void **shouldDistanceToNearestPointClosestTheCorrectValueIfTheFrontHasTwoPointsCaseC**()
Case B: the front has two points and none of them is the point passed as a parameter. The dimensions of the points are not ordered

#### shouldDistanceToNearestPointRaiseAnExceptionIfTheFrontIsEmpty

public void **shouldDistanceToNearestPointRaiseAnExceptionIfTheFrontIsEmpty**()

#### shouldDistanceToNearestPointRaiseAnExceptionIfTheFrontIsNull

public void **shouldDistanceToNearestPointRaiseAnExceptionIfTheFrontIsNull**()

#### shouldDistanceToNearestPointRaiseAnExceptionIfThePointIsNull

public void **shouldDistanceToNearestPointRaiseAnExceptionIfThePointIsNull**()

#### shouldDistanceToNearestPointReturnMaxDoubleIfThePointIsTheOnlyPointInTheFront

public void **shouldDistanceToNearestPointReturnMaxDoubleIfThePointIsTheOnlyPointInTheFront**()

#### shouldDistanceToNearestPointReturnTheCorrectValueIfTheFrontHasHasOnePoint

public void **shouldDistanceToNearestPointReturnTheCorrectValueIfTheFrontHasHasOnePoint**()

#### shouldDistanceToNearestPointReturnTheCorrectValueIfTheFrontHasTwoPointsCaseA

public void **shouldDistanceToNearestPointReturnTheCorrectValueIfTheFrontHasTwoPointsCaseA**()
Case A: the front has two points and one of them is the point passed as a parameter

#### shouldGetInvertedFrontRaiseAnExceptionIfTheFrontIsEmpty

public void **shouldGetInvertedFrontRaiseAnExceptionIfTheFrontIsEmpty**()

#### shouldGetInvertedFrontRaiseAnExceptionIfTheFrontIsNull

public void **shouldGetInvertedFrontRaiseAnExceptionIfTheFrontIsNull**()

#### shouldGetInvertedFrontReturnTheCorrectFrontIfItComposedOfFourPoints

public void **shouldGetInvertedFrontReturnTheCorrectFrontIfItComposedOfFourPoints**()
The front has the points [0.1, 0.9], [0.2, 0.8], [0.3, 0.7], [0.4, 0.6]. The inverted front is [0.9, 0.1], [0.8, 0.2], [0.7, 0.3], [0.6, 0.4]

#### shouldGetInvertedFrontReturnTheCorrectFrontIfItComposedOfOnePointCaseA

public void **shouldGetInvertedFrontReturnTheCorrectFrontIfItComposedOfOnePointCaseA**()
Case A: the front has the point [0.5, 0.5]. The inverted front is the same

#### shouldGetInvertedFrontReturnTheCorrectFrontIfItComposedOfOnePointCaseB

public void **shouldGetInvertedFrontReturnTheCorrectFrontIfItComposedOfOnePointCaseB**()
Case B: the front has the point [0.0, 1.0]. The inverted front is [1.0, 0.0]

#### shouldGetInvertedFrontReturnTheCorrectFrontIfItComposedOfOnePointCaseC

public void **shouldGetInvertedFrontReturnTheCorrectFrontIfItComposedOfOnePointCaseC**()
Case C: the front has the point [3.0, -2.0]. The inverted front is [0.0, 1.0]

#### shouldGetMaximumValuesRaiseAnExceptionIfTheFrontIsEmpty

public void **shouldGetMaximumValuesRaiseAnExceptionIfTheFrontIsEmpty**()

#### shouldGetMaximumValuesRaiseAnExceptionIfTheFrontIsNull

public void **shouldGetMaximumValuesRaiseAnExceptionIfTheFrontIsNull**()

#### shouldGetMaximumValuesWithAFrontWithOnePointReturnTheCorrectValue

public void **shouldGetMaximumValuesWithAFrontWithOnePointReturnTheCorrectValue**()

#### shouldGetMaximumValuesWithAFrontWithThreePointReturnTheCorrectValue

public void **shouldGetMaximumValuesWithAFrontWithThreePointReturnTheCorrectValue**()

#### shouldGetMinimumValuesRaiseAnExceptionIfTheFrontIsEmpty

public void **shouldGetMinimumValuesRaiseAnExceptionIfTheFrontIsEmpty**()

#### shouldGetMinimumValuesRaiseAnExceptionIfTheFrontIsNull

public void **shouldGetMinimumValuesRaiseAnExceptionIfTheFrontIsNull**()

#### shouldGetMinimumValuesWithAFrontWithOnePointReturnTheCorrectValue

public void **shouldGetMinimumValuesWithAFrontWithOnePointReturnTheCorrectValue** ()

#### shouldGetMinimumValuesWithAFrontWithThreePointReturnTheCorrectValue

public void **shouldGetMinimumValuesWithAFrontWithThreePointReturnTheCorrectValue** ()

## 2.103 org.uma.jmetal.util.front.util

### 2.103.1 FrontNormalizer

public class **FrontNormalizer**
Class for normalizing *Front* objects

**Author** Antonio J. Nebro

#### Constructors

#### FrontNormalizer

public **FrontNormalizer** (List<? extends *Solution*<?>> *referenceFront*)
Constructor.

**Parameters**

- **referenceFront** –

#### FrontNormalizer

public **FrontNormalizer** (*Front* *referenceFront*)
Constructor.

**Parameters**

- **referenceFront** –

#### FrontNormalizer

public **FrontNormalizer** (double[] *minimumValues*, double[] *maximumValues*)
Constructor

**Parameters**

- **minimumValues** –
- **maximumValues** –

#### Methods

##### normalize

public List<? extends *Solution*<?>> **normalize** (List<? extends *Solution*<?>> *solutionList*)

Returns a normalized front

**Parameters**

- **solutionList** –

##### normalize

public *Front* **normalize** (*Front front*)

Returns a normalized front

**Parameters**

- **front** –

### 2.103.2 FrontNormalizerTest

public class **FrontNormalizerTest**

**Author** Antonio J. Nebro

#### Fields

##### exception

public ExpectedException **exception**

#### Methods

##### shouldFrontNormalizerConstructorRaiseAnExceptionIsTheReferenceFrontIsNull

public void **shouldFrontNormalizerConstructorRaiseAnExceptionIsTheReferenceFrontIsNull** ()

##### shouldFrontNormalizerConstructorRaiseAnExceptionIsTheReferenceSolutionListIsNull

public void **shouldFrontNormalizerConstructorRaiseAnExceptionIsTheReferenceSolutionListIsNull** ()

##### shouldFrontNormalizerConstructorRaiseAnExceptionIsTheVectorOfMaximumValuesIsNull

public void **shouldFrontNormalizerConstructorRaiseAnExceptionIsTheVectorOfMaximumValuesIsNull** ()

##### shouldFrontNormalizerConstructorRaiseAnExceptionIsTheVectorOfMinimumValuesIsNull

public void **shouldFrontNormalizerConstructorRaiseAnExceptionIsTheVectorOfMinimumValuesIsNull** ()

#### shouldFrontNormalizerContructorRaiseAnExceptionTheDimensionOfTheMaximumAndMinimumArrayIsNotEqual

public void **shouldFrontNormalizerContructorRaiseAnExceptionTheDimensionOfTheMaximumAndMinimumAr**

#### shouldGetNormalizedFrontReturnTheCorrectFrontIfTheSolutionListContainsTwoPoints

public void **shouldGetNormalizedFrontReturnTheCorrectFrontIfTheSolutionListContainsTwoPoints**()
Points: [2,4], [-2, 3] Maximum values: [6, 8] Minimum values: [-10, 1] Result: [0.5, 1.0], []

#### shouldGetNormalizedFrontReturnTheCorrectFrontIfThisContainsTwoPoints

public void **shouldGetNormalizedFrontReturnTheCorrectFrontIfThisContainsTwoPoints**()
Points: [2,4], [-2, 3] Maximum values: [6, 8] Minimum values: [-10, 1] Result: [0.5, 1.0], []

#### shouldNormalizeRaiseAnExceptionIfTheFrontIsEmpty

public void **shouldNormalizeRaiseAnExceptionIfTheFrontIsEmpty**()

#### shouldNormalizeRaiseAnExceptionIfTheMaxAndMinValuesAreTheSame

public void **shouldNormalizeRaiseAnExceptionIfTheMaxAndMinValuesAreTheSame**()
Point: [2,4] Maximum values: [2, 4] Minimum values: [2, 4] Result: [0.5, 1.0]

#### shouldNormalizeRaiseAnExceptionIfTheSolutionListIsEmpty

public void **shouldNormalizeRaiseAnExceptionIfTheSolutionListIsEmpty**()

#### shouldNormalizeRaiseAnExceptionTheDimensionOfTheMaximumArrayPointsIsNotCorrect

public void **shouldNormalizeRaiseAnExceptionTheDimensionOfTheMaximumArrayPointsIsNotCorrect**()

#### shouldNormalizeRaiseAnExceptionTheFrontIsNull

public void **shouldNormalizeRaiseAnExceptionTheFrontIsNull**()

#### shouldNormalizeRaiseAnExceptionTheSolutionListIsNull

public void **shouldNormalizeRaiseAnExceptionTheSolutionListIsNull**()

#### shouldNormalizeReturnTheCorrectFrontIfThisContainsOnePoint

public void **shouldNormalizeReturnTheCorrectFrontIfThisContainsOnePoint**()
Point: [2,4] Maximum values: [4, 4] Minimum values: [0, 0] Result: [0.5, 1.0]

### 2.103.3 FrontUtils

public class **FrontUtils**

A Front is a list of points. This class includes utilities to work with *Front* objects.

**Author** Antonio J. Nebro

#### Methods

##### convertFrontToArray

public static double[][] **convertFrontToArray** (*Front front*)

Given a front, converts it to an array of double values

**Parameters**

- **front** –

**Returns** A front as double[][] array

##### convertFrontToSolutionList

public static List<*PointSolution*> **convertFrontToSolutionList** (*Front front*)

Given a front, converts it to a Solution set of PointSolutions

**Parameters**

- **front** –

**Returns** A front as a List

##### distanceToClosestPoint

public static double **distanceToClosestPoint** (*Point point*, *Front front*)

Gets the distance between a point and the nearest one in a given front. The Euclidean distance is assumed

**Parameters**

- **point** – The point
- **front** – The front that contains the other points to calculate the distances

**Returns** The minimum distance between the point and the front

##### distanceToClosestPoint

public static double **distanceToClosestPoint** (*Point point*, *Front front*, *PointDistance distance*)

Gets the distance between a point and the nearest one in a given front

**Parameters**

- **point** – The point
- **front** – The front that contains the other points to calculate the distances

**Returns** The minimum distance between the point and the front

#### distanceToNearestPoint

public static double **distanceToNearestPoint** (*Point point*, *Front front*)

Gets the distance between a point and the nearest one in a front. If a distance equals to 0 is found, that means that the point is in the front, so it is excluded

**Parameters**

- **point** – The point
- **front** – The front that contains the other points to calculate the distances

**Returns** The minimum distance between the point and the front

#### distanceToNearestPoint

public static double **distanceToNearestPoint** (*Point point*, *Front front*, *PointDistance distance*)

Gets the distance between a point and the nearest one in a front. If a distance equals to 0 is found, that means that the point is in the front, so it is excluded

**Parameters**

- **point** – The point
- **front** – The front that contains the other points to calculate the distances

**Returns** The minimum distance between the point and the front

#### getInvertedFront

public static *Front* **getInvertedFront** (*Front front*)

This method receives a normalized pareto front and return the inverted one. This method is for minimization problems

**Parameters**

- **front** – The pareto front to inverse

**Returns** The inverted pareto front

#### getMaximumValues

public static double[] **getMaximumValues** (*Front front*)

Gets the maximum values for each objectives in a front

**Parameters**

- **front** – A front of objective values

**Returns** double [] An array with the maximum values for each objective

#### getMinimumValues

public static double[] **getMinimumValues** (*Front front*)

Gets the minimum values for each objectives in a given front

**Parameters**

- **front** – The front

**Returns** double [] An array with the minimum value for each objective

## 2.104 org.uma.jmetal.util.naming

### 2.104.1 DescribedEntity

public interface **DescribedEntity**

A *DescribedEntity* is identified through its name (*getName()*) and further detailed through its description (*getDescription()*).

**Author** Matthieu Vergne

#### Methods

#### getDescription

public String **getDescription**()

**Returns** the description of the *DescribedEntity*

#### getName

public String **getName**()

**Returns** the name of the *DescribedEntity*

## 2.105 org.uma.jmetal.util.naming.impl

### 2.105.1 DescribedEntitySet

public class **DescribedEntitySet**<Entity extends DescribedEntity> implements Set<Entity>

#### Methods

#### add

public boolean **add**(Entity *e*)

#### addAll

public boolean **addAll**(Collection<? extends Entity> *c*)

#### clear

public void **clear**()

#### contains

public boolean **contains** (Object *o*)

#### contains

public boolean **contains** (String *name*)

#### containsAll

public boolean **containsAll** (Collection<?> *c*)

#### get

public <E extends Entity> E **get** (String *name*)

#### isEmpty

public boolean **isEmpty** ()

#### iterator

public Iterator<Entity> **iterator** ()

#### remove

public boolean **remove** (Object *o*)

#### remove

public boolean **remove** (String *name*)

#### removeAll

public boolean **removeAll** (Collection<?> *c*)

#### retainAll

public boolean **retainAll** (Collection<?> *c*)

#### size

public int **size** ()

#### toArray

public Object[] **toArray** ()

#### toArray

public <T> T[] **toArray** (T[] *a*)

#### toString

public String **toString** ()

### 2.105.2 DescribedEntitySetTest

public class **DescribedEntitySetTest**

#### Methods

#### testAddingDifferentEntityWithDifferentNameProperlyAdds

public void **testAddingDifferentEntityWithDifferentNameProperlyAdds** ()

#### testAddingDifferentEntityWithSameNameThrowsException

public void **testAddingDifferentEntityWithSameNameThrowsException** ()

#### testAddingSameEntityModifiesNothing

public void **testAddingSameEntityModifiesNothing** ()

#### testGetReturnsCorrectEntity

public void **testGetReturnsCorrectEntity** ()

#### testToStringInCaseInsensitiveOrder

public void **testToStringInCaseInsensitiveOrder** ()

### 2.105.3 SimpleDescribedEntity

public class **SimpleDescribedEntity** implements *DescribedEntity*

`SimpleDescribedEntity` is a basic implementation of `DescribedEntity`. It provides a basic support for the most generic properties required by this interface.

**Author** Matthieu Vergne

### Constructors

#### SimpleDescribedEntity

public **SimpleDescribedEntity** (String *name*, String *description*)

Create a *SimpleDescribedEntity* with a given name and a given description.

**Parameters**

- **name** – the name of the *DescribedEntity*
- **description** – the description of the *DescribedEntity*

#### SimpleDescribedEntity

public **SimpleDescribedEntity** (String *name*)

Create a *SimpleDescribedEntity* with a given name and a `null` description.

**Parameters**

- **name** – the name of the *DescribedEntity*

#### SimpleDescribedEntity

public **SimpleDescribedEntity** ()

Create a *SimpleDescribedEntity* with the class name as its name and a `null` description.

### Methods

#### getDescription

public String **getDescription** ()

#### getName

public String **getName** ()

#### setDescription

public void **setDescription** (String *description*)

**Parameters**

- **description** – the new description of this *DescribedEntity*

#### setName

public void **setName** (String *name*)

**Parameters**

- **name** – the new name of this *DescribedEntity*

#### toString

public String **toString**()

### 2.105.4 SimpleDescribedEntityTest

public class **SimpleDescribedEntityTest**

#### Methods

#### testClassNameWhenNoName

public void **testClassNameWhenNoName**()

#### testCorrectDescriptionWhenProvided

public void **testCorrectDescriptionWhenProvided**()

#### testCorrectNameWhenProvided

public void **testCorrectNameWhenProvided**()

#### testNullDescriptionWhenNoDescription

public void **testNullDescriptionWhenNoDescription**()

#### testSetGetDescription

public void **testSetGetDescription**()

#### testSetGetName

public void **testSetGetName**()

### 2.105.5 SimpleDescribedEntityTest.TestedClass

class **TestedClass** extends *SimpleDescribedEntity*

## 2.106 org.uma.jmetal.util.neighborhood

### 2.106.1 Neighborhood

public interface **Neighborhood**<S> extends Serializable

Interface representing a neighborhood of a given solution in a list of solutions

**Author** Antonio J. Nebro

#### Methods

##### getNeighbors

public List<S> **getNeighbors** (List<S> *solutionList*, int *solutionIndex*)

## 2.107 org.uma.jmetal.util.neighborhood.impl

### 2.107.1 AdaptiveRandomNeighborhood

public class **AdaptiveRandomNeighborhood**<S> implements *Neighborhood*<S>

This class implements the adaptive random neighborhood (topology) defined by M. Clerc. Each solution in a solution list must have a neighborhood composed by it itself and K random selected neighbors (the same solution can be chosen several times).

**Author** Antonio J. Nebro

#### Constructors

##### AdaptiveRandomNeighborhood

public **AdaptiveRandomNeighborhood** (int *solutionListSize*, int *numberOfRandomNeighbours*)

Constructor

**Parameters**

- **solutionListSize** – The expected size of the list of solutions
- **numberOfRandomNeighbours** – The number of neighbors per solution

##### AdaptiveRandomNeighborhood

public **AdaptiveRandomNeighborhood** (int *solutionListSize*, int *numberOfRandomNeighbours*, *BoundedRandomGenerator*<Integer> *randomGenerator*)

Constructor

**Parameters**

- **solutionListSize** – The expected size of the list of solutions
- **numberOfRandomNeighbours** – The number of neighbors per solution
- **randomGenerator** – the `BoundedRandomGenerator` to use for the randomisation

#### Methods

##### getNeighbors

public List<S> **getNeighbors** (List<S> *solutionList*, int *solutionIndex*)

#### recompute

public void **recompute**()
Recomputes the neighbors

### 2.107.2 AdaptiveRandomNeighborhoodTest

public class **AdaptiveRandomNeighborhoodTest**

**Author** Antonio J. Nebro

#### Fields

#### exception

public ExpectedException **exception**

#### Methods

#### shouldConstructorCreateAnInstanceIfTheParamtersAreValid

public void **shouldConstructorCreateAnInstanceIfTheParamtersAreValid**()

#### shouldConstructorThrowAnExceptionWhenTheNumberOfNeighboursIsEqualThanTheListSize

public void **shouldConstructorThrowAnExceptionWhenTheNumberOfNeighboursIsEqualThanTheListSize**()

#### shouldConstructorThrowAnExceptionWhenTheNumberOfNeighboursIsGreaterThanTheListSize

public void **shouldConstructorThrowAnExceptionWhenTheNumberOfNeighboursIsGreaterThanTheListSize**

#### shouldConstructorThrowAnExceptionWhenTheNumberOfNeighboursIsNegative

public void **shouldConstructorThrowAnExceptionWhenTheNumberOfNeighboursIsNegative**()

#### shouldGetNeighborsReturnThreeNeighborsPlusTheCurrentSolution

public void **shouldGetNeighborsReturnThreeNeighborsPlusTheCurrentSolution**()
Case 1 Solution list size: 3 Number of neighbors: 1 Neighbors: - solution 0: 0, 2 - solution 1: 1, 0 - solution 2: 2, 0

#### shouldGetNeighborsReturnTwoNeighborsPlusTheCurrentSolution

public void **shouldGetNeighborsReturnTwoNeighborsPlusTheCurrentSolution**()
Case 1 Solution list size: 4 Number of neighbors: 2

#### shouldGetNeighborsThrowAnExceptionIfTheListSizeIsNotCorrect

public void **shouldGetNeighborsThrowAnExceptionIfTheListSizeIsNotCorrect**()

#### shouldGetNeighborsWithANegativeSolutionIndexThrowAnException

public void **shouldGetNeighborsWithANegativeSolutionIndexThrowAnException**()

#### shouldGetNeighborsWithANullListOfSolutionsThrowAnException

public void **shouldGetNeighborsWithANullListOfSolutionsThrowAnException**()

#### shouldGetNeighborsWithATooBigSolutionIndexThrowAnException

public void **shouldGetNeighborsWithATooBigSolutionIndexThrowAnException**()

#### shouldJMetalRandomGeneratorNotBeUsedWhenCustomRandomGeneratorProvided

public void **shouldJMetalRandomGeneratorNotBeUsedWhenCustomRandomGeneratorProvided**()

## 2.107.3 C25

public class **C25**<S extends Solution<?>> extends *TwoDimensionalMesh*<S>

Class defining an C25 neighborhood of a solution belonging to a list of solutions which is structured as a bi-dimensional mesh. The neighbors are those solutions that are in 2-hop distance or less Shape: * * * * * * * * * * * * o * * * * * * * * * * * *

**Author** Esteban López Camacho

### Constructors

#### C25

public **C25**(int *rows*, int *columns*)

Constructor. Defines a neighborhood for solutionSetSize

## 2.107.4 C49

public class **C49**<S extends Solution<?>> extends *TwoDimensionalMesh*<S>

Class defining an C49 neighborhood of a solution belonging to a list of solutions which is structured as a bi-dimensional mesh. The neighbors are those solutions that are in 3-hop distance or less Shape: * * * * * * * * * * * * * * * * * * * * * * * * o * * * * * * * * * * * * * * * * * * * * * * * *

**Author** Esteban López Camacho

#### Constructors

##### C49

public **C49** (int *rows*, int *columns*)
Constructor. Defines a neighborhood for solutionSetSize

### 2.107.5 C9

public class **C9**<S> extends *TwoDimensionalMesh*<S>
Class defining an L9 neighborhood of a solution belonging to a list of solutions which is structured as a bi-dimensional mesh. The neighbors are those solutions that are in 1-hop distance Shape: * * * * o * * * *

**Author** Antonio J. Nebro , Juan J. Durillo

#### Constructors

##### C9

public **C9** (int *rows*, int *columns*)
Constructor Defines a neighborhood for a solution set of rows x columns solutions

**Parameters**

- **rows** – the number of rows
- **columns** – the number of columns

### 2.107.6 C9Test

public class **C9Test**
Created by ajnebro on 26/5/15.

#### Methods

##### shouldGetNeighborsReturnFourNeighborsCase1

public void **shouldGetNeighborsReturnFourNeighborsCase1** ()
Case 1 Solution list: 0 The solution location is 0, the neighborhood is 0

##### shouldGetNeighborsReturnFourNeighborsCase10

public void **shouldGetNeighborsReturnFourNeighborsCase10** ()
Case 10 Solution list: 0 1 2 3 4 5 6 7 8 9 10 11 The solution location is 5, the neighborhood is 0, 1, 2, 4, 6, 8, 9

##### shouldGetNeighborsReturnFourNeighborsCase11

public void **shouldGetNeighborsReturnFourNeighborsCase11** ()
Case 11 Solution list: 0 1 2 3 4 5 6 7 8 9 10 11 The solution location is 11, the neighborhood is 6, 7, 10, 3, 2, 8

#### shouldGetNeighborsReturnFourNeighborsCase2

public void **shouldGetNeighborsReturnFourNeighborsCase2**()
Case 2 Solution list: 0 1 The solution location is 0, the neighborhood is 0, 1

#### shouldGetNeighborsReturnFourNeighborsCase3

public void **shouldGetNeighborsReturnFourNeighborsCase3**()
Case 3 Solution list: 0 1 The solution location is 1, the neighborhood is 0, 1

#### shouldGetNeighborsReturnFourNeighborsCase4

public void **shouldGetNeighborsReturnFourNeighborsCase4**()
Case 4 Solution list: 0 1 2 3 The solution location is 0, the neighborhood is 1, 2, 3

#### shouldGetNeighborsReturnFourNeighborsCase5

public void **shouldGetNeighborsReturnFourNeighborsCase5**()
Case 5 Solution list: 0 1 2 3 The solution location is 1, the neighborhood is 0, 2, 3

#### shouldGetNeighborsReturnFourNeighborsCase6

public void **shouldGetNeighborsReturnFourNeighborsCase6**()
Case 6 Solution list: 0 1 2 3 The solution location is 2, the neighborhood is 0, 1, 3

#### shouldGetNeighborsReturnFourNeighborsCase7

public void **shouldGetNeighborsReturnFourNeighborsCase7**()
Case 7 Solution list: 0 1 2 3 The solution location is 3, the neighborhood is 0, 1, 2

#### shouldGetNeighborsReturnFourNeighborsCase8

public void **shouldGetNeighborsReturnFourNeighborsCase8**()
Case 8 Solution list: 0 1 2 3 4 5 6 7 The solution location is 0, the neighborhood is 1, 4, 5, 3, 7

#### shouldGetNeighborsReturnFourNeighborsCase9

public void **shouldGetNeighborsReturnFourNeighborsCase9**()
Case 9 Solution list: 0 1 2 3 4 5 6 7 The solution location is 5, the neighborhood is 0, 1, 2, 4, 6

### 2.107.7 KNearestNeighborhood

public class **KNearestNeighborhood**<S extends Solution<?>> implements *Neighborhood*<S>
This class implements a neighborhood that select the k-nearest solutions according to a distance measure. By default, the Euclidean distance between objectives is used.

**Parameters**

- **<S>** –

### Constructors

#### KNearestNeighborhood

public **KNearestNeighborhood**(int *neighborSize*)

#### KNearestNeighborhood

public **KNearestNeighborhood**(int *neighborSize*, Distance<S, S> *distance*)

### Methods

#### getNeighbors

public List<S> **getNeighbors**(List<S> *solutionList*, int *solutionIndex*)

## 2.107.8 KNearestNeighborhoodTest

public class **KNearestNeighborhoodTest**

### Methods

#### shouldGetNeighborsWorkProperlyCaseA

public void **shouldGetNeighborsWorkProperlyCaseA**()
Case A: The solution list has two solutions and the neighbor size is 1

#### shouldGetNeighborsWorkProperlyCaseB

public void **shouldGetNeighborsWorkProperlyCaseB**()
Case B: The solution list has three solutions, the index of the solution is 0, and the neighbor size is 2

#### shouldGetNeighborsWorkProperlyCaseC

public void **shouldGetNeighborsWorkProperlyCaseC**()
Case C: The solution list has three solutions, the index of the solution is 1, and the neighbor size is 2

#### shouldGetNeighborsWorkProperlyCaseD

public void **shouldGetNeighborsWorkProperlyCaseD**()
Case D: The solution list has three solutions, the index of the solution is 2, and the neighbor size is 2

#### shouldGetNeighborsWorkProperlyCaseE

public void **shouldGetNeighborsWorkProperlyCaseE**()
Case E: The solution list has five solutions, the index of the solution is 0, and the neighbor size is 3

#### shouldGetNeighborsWorkProperlyCaseF

public void **shouldGetNeighborsWorkProperlyCaseF**()
Case F: The solution list has five solutions, the index of the solution is 2, and the neighbor size is 3

## 2.107.9 L13

public class **L13**<S extends Solution<?>> extends *TwoDimensionalMesh*<S>
Class defining an L9 neighborhood of a solution belonging to a list of solutions which is structured as a bi-dimensional mesh. The neighbors is illustrated as follows: * * * * * * o * * * * * *

**Author** Esteban López Camacho

### Constructors

#### L13

public **L13**(int *rows*, int *columns*)
Constructor. Defines a neighborhood for a solution set of rows x columns solutions

## 2.107.10 L13Test

public class **L13Test**
Created by ajnebro on 20/12/17.

### Methods

#### shouldGetNeighborsReturnFourNeighborsCase1

public void **shouldGetNeighborsReturnFourNeighborsCase1**()
Case 1 Solution list: 0 The solution location is 0, the neighborhood is 0

#### shouldGetNeighborsReturnFourNeighborsCase10

public void **shouldGetNeighborsReturnFourNeighborsCase10**()
Case 10 Solution list: 0 1 2 3 4 5 6 7 The solution location is 0, the neighborhood is 1, 2, 6

#### shouldGetNeighborsReturnFourNeighborsCase11

public void **shouldGetNeighborsReturnFourNeighborsCase11**()
Case 11 Solution list: 0 1 2 3 4 5 6 7 8 The solution location is 4, the neighborhood is 1, 3, 5, 7

### shouldGetNeighborsReturnFourNeighborsCase12

public void **shouldGetNeighborsReturnFourNeighborsCase12**()
Case 12 Solution list: 0 1 2 3 4 5 6 7 8 The solution location is 8, the neighborhood is 2, 6, 5, 7

### shouldGetNeighborsReturnFourNeighborsCase2

public void **shouldGetNeighborsReturnFourNeighborsCase2**()
Case 2 Solution list: 0 1 The solution location is 0, the neighborhood is 0, 1

### shouldGetNeighborsReturnFourNeighborsCase3

public void **shouldGetNeighborsReturnFourNeighborsCase3**()
Case 3 Solution list: 0 1 The solution location is 1, the neighborhood is 0, 1

### shouldGetNeighborsReturnFourNeighborsCase4

public void **shouldGetNeighborsReturnFourNeighborsCase4**()
Case 4 Solution list: 0 1 2 3 The solution location is 0, the neighborhood is 1, 2

### shouldGetNeighborsReturnFourNeighborsCase5

public void **shouldGetNeighborsReturnFourNeighborsCase5**()
Case 5 Solution list: 0 1 2 3 The solution location is 1, the neighborhood is 0, 3

### shouldGetNeighborsReturnFourNeighborsCase6

public void **shouldGetNeighborsReturnFourNeighborsCase6**()
Case 6 Solution list: 0 1 2 3 The solution location is 2, the neighborhood is 0, 3

### shouldGetNeighborsReturnFourNeighborsCase7

public void **shouldGetNeighborsReturnFourNeighborsCase7**()
Case 7 Solution list: 0 1 2 3 The solution location is 3, the neighborhood is 1, 2

### shouldGetNeighborsReturnFourNeighborsCase8

public void **shouldGetNeighborsReturnFourNeighborsCase8**()
Case 8 Solution list: 0 1 2 3 4 5 6 7 The solution location is 5, the neighborhood is 1, 1, 4, 6

### shouldGetNeighborsReturnFourNeighborsCase9

public void **shouldGetNeighborsReturnFourNeighborsCase9**()
Case 9 Solution list: 0 1 2 3 4 5 6 7 The solution location is 5, the neighborhood is 3, 4, 7

### 2.107.11 L25

public class **L25**<S extends Solution<?>> extends *TwoDimensionalMesh*<S>
Class representing neighborhoods for a solution into a list of solutions

**Author** Esteban López Camacho

#### Constructors

##### L25

public **L25** (int *rows*, int *columns*)
Constructor. Defines a neighborhood for solutionSetSize

### 2.107.12 L41

public class **L41**<S extends Solution<?>> extends *TwoDimensionalMesh*<S>
Class representing neighborhoods for a solution into a list of solutions

**Author** Esteban López Camacho

#### Constructors

##### L41

public **L41** (int *rows*, int *columns*)
Constructor. Defines a neighborhood for solutionSetSize

### 2.107.13 L5

public class **L5**<S> extends *TwoDimensionalMesh*<S>
Class defining an L5 neighborhood of a solution belonging to a list of solutions which is structured as a bi-dimensional mesh. The neighbors are those solutions that are in the positions North, South, East and West Shape: * * o * *

**Author** Antonio J. Nebro , Juan J. Durillo

#### Constructors

##### L5

public **L5** (int *rows*, int *columns*)
Constructor. Defines a neighborhood for a solution set of rows x columns solutions

### 2.107.14 L5Test

public class **L5Test**
Created by ajnebro on 26/5/15.

#### Methods

##### shouldGetNeighborsReturnFourNeighborsCase1

public void **shouldGetNeighborsReturnFourNeighborsCase1**()
Case 1 Solution list: 0 The solution location is 0, the neighborhood is 0

##### shouldGetNeighborsReturnFourNeighborsCase2

public void **shouldGetNeighborsReturnFourNeighborsCase2**()
Case 2 Solution list: 0 1 The solution location is 0, the neighborhood is 0, 1

##### shouldGetNeighborsReturnFourNeighborsCase3

public void **shouldGetNeighborsReturnFourNeighborsCase3**()
Case 3 Solution list: 0 1 The solution location is 1, the neighborhood is 0, 1

##### shouldGetNeighborsReturnFourNeighborsCase4

public void **shouldGetNeighborsReturnFourNeighborsCase4**()
Case 4 Solution list: 0 1 2 3 The solution location is 0, the neighborhood is 1, 2

### 2.107.15 WeightVectorNeighborhood

public class **WeightVectorNeighborhood**<S> implements *Neighborhood*<S>
This class implements a neighborhood based on the weight vectors of MOEA/D

**Author** Antonio J. Nebro

#### Constructors

##### WeightVectorNeighborhood

public **WeightVectorNeighborhood**(int *numberOfWeightVectors*, int *neighborSize*)

##### WeightVectorNeighborhood

public **WeightVectorNeighborhood**(int *numberOfWeightVectors*, int *weightVectorSize*, int *neighborSize*, String *vectorFileName*)

#### Methods

##### getNeighborSize

public int **getNeighborSize**()

#### getNeighborhood

public int[][] **getNeighborhood**()

#### getNeighbors

public List<S> **getNeighbors**(List<S> *solutionList*, int *solutionIndex*)

#### getNumberOfWeightVectors

public int **getNumberOfWeightVectors**()

#### getWeightVector

public double[][] **getWeightVector**()

#### getWeightVectorSize

public int **getWeightVectorSize**()

### 2.107.16 WeightVectorNeighborhoodTest

public class **WeightVectorNeighborhoodTest**

#### Methods

#### shouldConstructorRaiseAnExceptionIfTheWeightFileDoesNotExist

public void **shouldConstructorRaiseAnExceptionIfTheWeightFileDoesNotExist**()

#### shouldDefaultConstructorBeCorrectlyInitialized

public void **shouldDefaultConstructorBeCorrectlyInitialized**()

#### shouldGetNeighborsWorksProperlyWithTwoObjectives

public void **shouldGetNeighborsWorksProperlyWithTwoObjectives**()

## 2.108 org.uma.jmetal.util.neighborhood.util

### 2.108.1 TwoDimensionalMesh

public class **TwoDimensionalMesh**<S> implements *Neighborhood*<S>

Class defining a bi-dimensional mesh.

#### Constructors

#### TwoDimensionalMesh

public **TwoDimensionalMesh** (int *rows*, int *columns*, int[][] *neighborhood*)
Constructor. Defines a neighborhood for list of solutions

#### Methods

#### getNeighbors

public List<S> **getNeighbors** (List<S> *solutionList*, int *solutionPosition*)
Returns the north,south, east, and west solutions of a given solution

**Parameters**

- **solutionList** – the solution set from where the neighbors are taken
- **solutionPosition** – Represents the position of the solution

### 2.108.2 TwoDimensionalMeshTest

public class **TwoDimensionalMeshTest**
Created by ajnebro on 21/5/15.

#### Fields

#### exception

public ExpectedException **exception**

#### Methods

#### shouldGetNeighborsReturnFourNeighborsCase1

public void **shouldGetNeighborsReturnFourNeighborsCase1** ()
Case 1 Solution list: 0 1 2 3 4 5 6 7 8 The solution location is 4, the neighborhood is 1, 3, 5, 7

#### shouldGetNeighborsReturnFourNeighborsCase2

public void **shouldGetNeighborsReturnFourNeighborsCase2** ()
Case 2 Solution list: 0 1 2 3 4 5 6 7 8 The solution location is 1, the neighborhood is 7, 0, 2, 4

#### shouldGetNeighborsReturnFourNeighborsCase3

public void **shouldGetNeighborsReturnFourNeighborsCase3** ()
Case 3 Solution list: 0 1 2 3 4 5 6 7 8 The solution location is 0, the neighborhood is 1, 2, 3, 6

### shouldGetNeighborsReturnFourNeighborsCase4

public void **shouldGetNeighborsReturnFourNeighborsCase4**()
Case 4 Solution list: 0 1 2 3 4 5 6 7 8 The solution location is 2, the neighborhood is 1, 0, 5, 8

### shouldGetNeighborsReturnFourNeighborsCase5

public void **shouldGetNeighborsReturnFourNeighborsCase5**()
Case 5 Solution list: 0 1 2 3 4 5 6 7 8 The solution location is 2, the neighborhood is 2, 6, 7, 5

### shouldGetNeighborsReturnFourNeighborsCase6

public void **shouldGetNeighborsReturnFourNeighborsCase6**()
Case 6 Solution list: 0 1 2 3 4 5 The solution location is 0, the neighborhood is 1, 3, 3, 2

### shouldGetNeighborsReturnFourNeighborsCase7

public void **shouldGetNeighborsReturnFourNeighborsCase7**()
Case 7 Solution list: 0 1 2 3 4 5 The solution location is 3, the neighborhood is 0, 4, 5, 0

### shouldGetNeighborsReturnFourNeighborsCase8

public void **shouldGetNeighborsReturnFourNeighborsCase8**()
Case 8 Solution list: 0 1 2 3 The solution location is 0, the neighborhood is 2, 1, 2, 1

### shouldGetNeighborsWithANegativeSolutionIndexThrowAnException

public void **shouldGetNeighborsWithANegativeSolutionIndexThrowAnException**()

### shouldGetNeighborsWithANullListOfSolutionsThrowAnException

public void **shouldGetNeighborsWithANullListOfSolutionsThrowAnException**()

### shouldGetNeighborsWithASolutionIndexValueEqualToTheListSizeThrowAnException

public void **shouldGetNeighborsWithASolutionIndexValueEqualToTheListSizeThrowAnException**()

### shouldGetNeighborsWithASolutionIndexValueGreaterThanTheListSizeThrowAnException

public void **shouldGetNeighborsWithASolutionIndexValueGreaterThanTheListSizeThrowAnException**()

### shouldGetNeighborsWithAnEmptyListOfSolutionsThrowAnException

public void **shouldGetNeighborsWithAnEmptyListOfSolutionsThrowAnException**()

# 2.109 org.uma.jmetal.util.point

## 2.109.1 Point

public interface **Point**

Interface representing a point

**Author** Antonio J. Nebro

### Methods

#### getDimension

int **getDimension**()

#### getValue

double **getValue**(int *index*)

#### getValues

double[] **getValues**()

#### setValue

void **setValue**(int *index*, double *value*)

#### update

void **update**(double[] *point*)

## 2.109.2 PointSolution

public class **PointSolution** implements *Solution*<Double>

Solution used to wrap a `Point` object. Only objectives are used.

**Author** Antonio J. Nebro

### Fields

#### attributes

protected Map<Object, Object> **attributes**

### Constructors

#### PointSolution

public **PointSolution** (int *numberOfObjectives*)
Constructor

**Parameters**

- **numberOfObjectives** –

#### PointSolution

public **PointSolution** (*Point point*)
Constructor

**Parameters**

- **point** –

#### PointSolution

public **PointSolution** (*Solution*<?> *solution*)
Constructor

**Parameters**

- **solution** –

#### PointSolution

public **PointSolution** (*PointSolution point*)
Copy constructor

**Parameters**

- **point** –

### Methods

#### copy

public *PointSolution* **copy** ()

#### equals

public boolean **equals** (Object *o*)

#### getAttribute

public Object **getAttribute** (Object *id*)

#### getNumberOfObjectives

public int **getNumberOfObjectives** ()

#### getNumberOfVariables

public int **getNumberOfVariables** ()

#### getObjective

public double **getObjective** (int *index*)

#### getObjectives

public double[] **getObjectives** ()

#### getVariableValue

public Double **getVariableValue** (int *index*)

#### getVariableValueString

public String **getVariableValueString** (int *index*)

#### hashCode

public int **hashCode** ()

#### setAttribute

public void **setAttribute** (Object *id*, Object *value*)

#### setObjective

public void **setObjective** (int *index*, double *value*)

#### setVariableValue

public void **setVariableValue** (int *index*, Double *value*)

#### toString

public String **toString** ()

# 2.110 org.uma.jmetal.util.point.impl

## 2.110.1 ArrayPoint

public class **ArrayPoint** implements *Point*

Class representing a point (i.e, an array of double values)

**Author** Antonio J. Nebro

### Fields

#### point

protected double[] **point**

### Constructors

#### ArrayPoint

public **ArrayPoint**()

Default constructor

#### ArrayPoint

public **ArrayPoint**(int *dimension*)

Constructor

**Parameters**

- **dimension** – Dimension of the point

#### ArrayPoint

public **ArrayPoint**(*Point point*)

Copy constructor

**Parameters**

- **point** –

#### ArrayPoint

public **ArrayPoint**(double[] *point*)

Constructor from an array of double values

**Parameters**

- **point** –

### ArrayPoint

public **ArrayPoint** (String *fileName*)
Constructor reading the values from a file

**Parameters**

- **fileName** –

### Methods

#### equals

public boolean **equals** (Object *o*)

#### getDimension

public int **getDimension** ()

#### getValue

public double **getValue** (int *index*)

#### getValues

public double[] **getValues** ()

#### hashCode

public int **hashCode** ()

#### setValue

public void **setValue** (int *index*, double *value*)

#### toString

public String **toString** ()

#### update

public void **update** (double[] *point*)

### 2.110.2 ArrayPointTest

public class **ArrayPointTest**

**Author** Antonio J. Nebro

#### Methods

##### shouldConstructAPointFromANullPointRaiseAnException

public void **shouldConstructAPointFromANullPointRaiseAnException**()

##### shouldConstructAPointFromOtherPointReturnAnIdenticalPoint

public void **shouldConstructAPointFromOtherPointReturnAnIdenticalPoint**()

##### shouldConstructAPointOfAGivenDimension

public void **shouldConstructAPointOfAGivenDimension**()

##### shouldConstructFromASolutionReturnTheCorrectPoint

public void **shouldConstructFromASolutionReturnTheCorrectPoint**()

##### shouldConstructFromArrayReturnTheCorrectPoint

public void **shouldConstructFromArrayReturnTheCorrectPoint**()

##### shouldConstructFromNullArrayRaiseAnException

public void **shouldConstructFromNullArrayRaiseAnException**()

##### shouldEqualsReturnFalseIfTheClassIsNotAPoint

public void **shouldEqualsReturnFalseIfTheClassIsNotAPoint**()

##### shouldEqualsReturnFalseIfThePointIsNull

public void **shouldEqualsReturnFalseIfThePointIsNull**()

##### shouldEqualsReturnFalseIfThePointsAreNotIdentical

public void **shouldEqualsReturnFalseIfThePointsAreNotIdentical**()

#### shouldEqualsReturnTrueIfThePointsAreIdentical

public void **shouldEqualsReturnTrueIfThePointsAreIdentical**()

#### shouldEqualsReturnTrueIfTheTwoPointsAreTheSame

public void **shouldEqualsReturnTrueIfTheTwoPointsAreTheSame**()

#### shouldGetDimensionValueReturnTheCorrectValue

public void **shouldGetDimensionValueReturnTheCorrectValue**()

#### shouldGetDimensionValueWithInvalidIndexesRaiseAnException

public void **shouldGetDimensionValueWithInvalidIndexesRaiseAnException**()

#### shouldGetNumberOfDimensionsReturnTheCorrectValue

public void **shouldGetNumberOfDimensionsReturnTheCorrectValue**()

#### shouldGetValuesReturnTheCorrectValues

public void **shouldGetValuesReturnTheCorrectValues**()

#### shouldHashCodeReturnTheCorrectValue

public void **shouldHashCodeReturnTheCorrectValue**()

#### shouldSetDimensionValueAssignTheCorrectValue

public void **shouldSetDimensionValueAssignTheCorrectValue**()

#### shouldSetDimensionValueWithInvalidIndexesRaiseAnException

public void **shouldSetDimensionValueWithInvalidIndexesRaiseAnException**()

### 2.110.3 IdealPoint

public class **IdealPoint** extends *ArrayPoint*

d Class representing an ideal point (minimization is assumed)

**Author** Antonio J.Nebro

#### Constructors

##### IdealPoint

public **IdealPoint** (int *dimension*)

#### Methods

##### update

public void **update** (double[] *point*)

##### update

public void **update** (List<? extends *Solution*<?>> *solutionList*)

### 2.110.4 IdealPointTest

public class **IdealPointTest**
Created by ajnebro on 12/2/16.

#### Methods

##### shouldConstructorCreateAnIdealPointWithAllObjectiveValuesCorrectlyInitialized

public void **shouldConstructorCreateAnIdealPointWithAllObjectiveValuesCorrectlyInitialized** ()

##### shouldUpdateWithOneSolutionMakeTheIdealPointHaveTheSolutionValues

public void **shouldUpdateWithOneSolutionMakeTheIdealPointHaveTheSolutionValues** ()

##### shouldUpdateWithThreeSolutionsLeadToTheCorrectIdealPoint

public void **shouldUpdateWithThreeSolutionsLeadToTheCorrectIdealPoint** ()

##### shouldUpdateWithTwoSolutionsLeadToTheCorrectIdealPoint

public void **shouldUpdateWithTwoSolutionsLeadToTheCorrectIdealPoint** ()

### 2.110.5 LexicographicalPointComparatorTest

public class **LexicographicalPointComparatorTest**

**Author** Antonio J. Nebro

### Methods

#### shouldCompareDifferentLengthPointsReturnTheCorrectValue

public void **shouldCompareDifferentLengthPointsReturnTheCorrectValue**()

#### shouldCompareEmptyPointsReturnZero

public void **shouldCompareEmptyPointsReturnZero**()

#### shouldCompareIdenticalPointsButTheFirstValueReturnMinus1

public void **shouldCompareIdenticalPointsButTheFirstValueReturnMinus1**()

#### shouldCompareIdenticalPointsButTheFirstValueReturnPlus1

public void **shouldCompareIdenticalPointsButTheFirstValueReturnPlus1**()

#### shouldCompareIdenticalPointsButTheLastValueReturnMinus1

public void **shouldCompareIdenticalPointsButTheLastValueReturnMinus1**()

#### shouldCompareIdenticalPointsButTheLastValueReturnPlus1

public void **shouldCompareIdenticalPointsButTheLastValueReturnPlus1**()

#### shouldCompareIdenticalPointsReturnZero

public void **shouldCompareIdenticalPointsReturnZero**()

#### shouldFirstPointToCompareEqualsToNullRaiseAnException

public void **shouldFirstPointToCompareEqualsToNullRaiseAnException**()

#### shouldSecondPointToCompareEqualsToNullRaiseAnException

public void **shouldSecondPointToCompareEqualsToNullRaiseAnException**()

#### startup

public void **startup**()

### 2.110.6 NadirPoint

public class **NadirPoint** extends *ArrayPoint*

Class representing a nadir point (minimization is assumed)

**Author** Antonio J.Nebro

#### Constructors

##### NadirPoint

public **NadirPoint** (int *dimension*)

#### Methods

##### update

public void **update** (double[] *point*)

##### update

public void **update** (List<? extends *Solution*<?>> *solutionList*)

### 2.110.7 NadirPointTest

public class **NadirPointTest**

Created by ajnebro on 12/2/16.

#### Methods

##### shouldConstructorCreateANadirPointWithAllObjectiveValuesCorrectlyInitialized

public void **shouldConstructorCreateANadirPointWithAllObjectiveValuesCorrectlyInitialized** ()

##### shouldUpdateAListOfSolutionsLeadToTheCorrectNadirPoint

public void **shouldUpdateAListOfSolutionsLeadToTheCorrectNadirPoint** ()

##### shouldUpdateWithOneSolutionMakeTheNadirPointHaveTheSolutionValues

public void **shouldUpdateWithOneSolutionMakeTheNadirPointHaveTheSolutionValues** ()

##### shouldUpdateWithThreeSolutionsLeadToTheCorrectNadirPoint

public void **shouldUpdateWithThreeSolutionsLeadToTheCorrectNadirPoint** ()

#### shouldUpdateWithTwoSolutionsLeadToTheCorrectNadirPoint

public void **shouldUpdateWithTwoSolutionsLeadToTheCorrectNadirPoint**()

### 2.110.8 PointComparatorTest

public class **PointComparatorTest**

**Author** Antonio J. Nebro

#### Methods

#### shouldCompareBetterReturnZeroIfBothPointsAreEqualWhenMaximizing

public void **shouldCompareBetterReturnZeroIfBothPointsAreEqualWhenMaximizing**()

#### shouldCompareBetterReturnZeroIfBothPointsAreEqualWhenMinimizing

public void **shouldCompareBetterReturnZeroIfBothPointsAreEqualWhenMinimizing**()

#### shouldCompareReturnMinusOneIfTheFirstPointIsBetterThanTheSecondOneWhenMaximizing

public void **shouldCompareReturnMinusOneIfTheFirstPointIsBetterThanTheSecondOneWhenMaximizing**()

#### shouldCompareReturnOneIfTheSecondPointIsBetterThanTheFirstOneWhenMaximizing

public void **shouldCompareReturnOneIfTheSecondPointIsBetterThanTheFirstOneWhenMaximizing**()

#### shouldComparingDifferentLengthPointsRaiseAnException

public void **shouldComparingDifferentLengthPointsRaiseAnException**()

#### shouldFirstPointToCompareEqualsToNullRaiseAnException

public void **shouldFirstPointToCompareEqualsToNullRaiseAnException**()

#### shouldSecondPointToCompareEqualsToNullRaiseAnException

public void **shouldSecondPointToCompareEqualsToNullRaiseAnException**()

### 2.110.9 PointDimensionComparatorTest

public class **PointDimensionComparatorTest**

**Author** Antonio J. Nebro

#### Methods

##### clean

public void **clean** ()

##### setup

public void **setup** ()

##### shouldCompareReturnMinusOneIfTheFirstValueIsLower

public void **shouldCompareReturnMinusOneIfTheFirstValueIsLower** ()

##### shouldCompareReturnPlusOneIfTheFirstValueIsGreater

public void **shouldCompareReturnPlusOneIfTheFirstValueIsGreater** ()

##### shouldCompareReturnZeroIfTheComparedValuesAreEqual

public void **shouldCompareReturnZeroIfTheComparedValuesAreEqual** ()

##### shouldFirstPointToCompareEqualsToNullRaiseAnException

public void **shouldFirstPointToCompareEqualsToNullRaiseAnException** ()

##### shouldIndexLessThanZeroRaiseAnException

public void **shouldIndexLessThanZeroRaiseAnException** ()

##### shouldIndexValueGreaterThanFirstPointDimensionsRaiseAnException

public void **shouldIndexValueGreaterThanFirstPointDimensionsRaiseAnException** ()

##### shouldIndexValueGreaterThanSecondPointDimensionsRaiseAnException

public void **shouldIndexValueGreaterThanSecondPointDimensionsRaiseAnException** ()

##### shouldSecondPointToCompareEqualsToNullRaiseAnException

public void **shouldSecondPointToCompareEqualsToNullRaiseAnException** ()

### 2.110.10 PointSolutionTest

public class **PointSolutionTest**

**Author** Antonio J. Nebro

#### Methods

##### idleTestToCoverTheUnusedMethods

public void **idleTestToCoverTheUnusedMethods**()

##### shouldCopyConstructorCreateAnIdenticalObject

public void **shouldCopyConstructorCreateAnIdenticalObject**()

##### shouldCopyReturnACopyOfTheSolution

public void **shouldCopyReturnACopyOfTheSolution**()

##### shouldDefaultConstructorCreateTheObjectCorrectly

public void **shouldDefaultConstructorCreateTheObjectCorrectly**()

##### shouldEqualsReturnFalseIfTheClassIsNotAPoint

public void **shouldEqualsReturnFalseIfTheClassIsNotAPoint**()

##### shouldEqualsReturnFalseIfThePointsAreNotIdentical

public void **shouldEqualsReturnFalseIfThePointsAreNotIdentical**()

##### shouldEqualsReturnFalseIfTheSolutionIsNull

public void **shouldEqualsReturnFalseIfTheSolutionIsNull**()

##### shouldEqualsReturnFalseIfTheTwoSolutionsHaveDifferentNumberOfObjectives

public void **shouldEqualsReturnFalseIfTheTwoSolutionsHaveDifferentNumberOfObjectives**()

##### shouldEqualsReturnTrueIfTheSolutionsAreIdentical

public void **shouldEqualsReturnTrueIfTheSolutionsAreIdentical**()

#### shouldEqualsReturnTrueIfTheTwoPointsAreTheSame

public void **shouldEqualsReturnTrueIfTheTwoPointsAreTheSame**()

#### shouldGetNumberOfObjectivesReturnTheCorrectValue

public void **shouldGetNumberOfObjectivesReturnTheCorrectValue**()

#### shouldGetObjectiveReturnTheCorrectValue

public void **shouldGetObjectiveReturnTheCorrectValue**()

#### shouldHashCodeReturnTheCorrectValue

public void **shouldHashCodeReturnTheCorrectValue**()

#### shouldSetObjectiveAssignTheTheCorrectValue

public void **shouldSetObjectiveAssignTheTheCorrectValue**()

## 2.111 org.uma.jmetal.util.point.util

### 2.111.1 DominanceDistanceTest

public class **DominanceDistanceTest**

**Author** Antonio J. Nebro

#### Methods

#### setup

public void **setup**()

#### shouldCalculatingDistanceOfPointsWithOneDimensionReturnTheCorrectValue

public void **shouldCalculatingDistanceOfPointsWithOneDimensionReturnTheCorrectValue**()

#### shouldCalculatingDistanceOfPointsWithTwoDimensionsReturnTheCorrectValueCaseA

public void **shouldCalculatingDistanceOfPointsWithTwoDimensionsReturnTheCorrectValueCaseA**()

#### shouldCalculatingDistanceOfPointsWithTwoDimensionsReturnTheCorrectValueCaseB

public void **shouldCalculatingDistanceOfPointsWithTwoDimensionsReturnTheCorrectValueCaseB**()

#### shouldCalculatingDistanceOfPointsWithTwoDimensionsReturnTheCorrectValueCaseC

public void **shouldCalculatingDistanceOfPointsWithTwoDimensionsReturnTheCorrectValueCaseC**()

#### shouldCalculatingDistanceOfPointsWithTwoDimensionsReturnTheCorrectValueCaseD

public void **shouldCalculatingDistanceOfPointsWithTwoDimensionsReturnTheCorrectValueCaseD**()

#### shouldCalculatingDistanceOfPointsWithTwoDimensionsReturnTheCorrectValueCaseE

public void **shouldCalculatingDistanceOfPointsWithTwoDimensionsReturnTheCorrectValueCaseE**()

#### shouldCalculatingDistanceOfPointsWithTwoDimensionsReturnTheCorrectValueCaseF

public void **shouldCalculatingDistanceOfPointsWithTwoDimensionsReturnTheCorrectValueCaseF**()

#### shouldCalculatingDistanceOfPointsWithZeroDimensionReturnZero

public void **shouldCalculatingDistanceOfPointsWithZeroDimensionReturnZero**()

#### shouldFirstPointToCompareEqualsToNullRaiseAnException

public void **shouldFirstPointToCompareEqualsToNullRaiseAnException**()

#### shouldPassingPointsWithDifferentDimensionsRaiseAnException

public void **shouldPassingPointsWithDifferentDimensionsRaiseAnException**()

#### shouldSecondPointToCompareEqualsToNullRaiseAnException

public void **shouldSecondPointToCompareEqualsToNullRaiseAnException**()

### 2.111.2 EuclideanDistanceTest

public class **EuclideanDistanceTest**

**Author** Antonio J. Nebro

#### Methods

##### setup

public void **setup**()

##### shouldCalculatingDistanceOfPointsWithOneDimensionReturnTheCorrectValue

public void **shouldCalculatingDistanceOfPointsWithOneDimensionReturnTheCorrectValue**()

##### shouldCalculatingDistanceOfPointsWithTwoDimensionsReturnTheCorrectValueCaseA

public void **shouldCalculatingDistanceOfPointsWithTwoDimensionsReturnTheCorrectValueCaseA**()

##### shouldCalculatingDistanceOfPointsWithTwoDimensionsReturnTheCorrectValueCaseB

public void **shouldCalculatingDistanceOfPointsWithTwoDimensionsReturnTheCorrectValueCaseB**()

##### shouldCalculatingDistanceOfPointsWithZeroDimensionReturnZero

public void **shouldCalculatingDistanceOfPointsWithZeroDimensionReturnZero**()

##### shouldFirstPointToCompareEqualsToNullRaiseAnException

public void **shouldFirstPointToCompareEqualsToNullRaiseAnException**()

##### shouldPassingPointsWithDifferentDimensionsRaiseAnException

public void **shouldPassingPointsWithDifferentDimensionsRaiseAnException**()

##### shouldSecondPointToCompareEqualsToNullRaiseAnException

public void **shouldSecondPointToCompareEqualsToNullRaiseAnException**()

## 2.112 org.uma.jmetal.util.point.util.comparator

### 2.112.1 LexicographicalPointComparator

public class **LexicographicalPointComparator** implements Comparator<*Point*>

This class implements the Comparator interface for comparing tow points. The order used is lexicographical order.

**Author** Antonio J. Nebro , Juan J. Durillo

#### Methods

##### compare

public int **compare** (*Point pointOne*, *Point pointTwo*)
The compare method compare the objects o1 and o2.

**Parameters**

- **pointOne** – An object that reference a double[]
- **pointTwo** – An object that reference a double[]

**Returns** The following value: -1 if point1 < point2, 1 if point1 > point2 or 0 in other case.

### 2.112.2 PointComparator

public class **PointComparator** implements Comparator<*Point*>
Point comparator. Starts the comparison from front last point dimension to the first one

**Author** Antonio J. Nebro

#### Constructors

##### PointComparator

public **PointComparator** ()

#### Methods

##### compare

public int **compare** (*Point pointOne*, *Point pointTwo*)
Compares two Point objects

**Parameters**

- **pointOne** – An object that reference a Point
- **pointTwo** – An object that reference a Point

**Returns** -1 if o1 < o1, 1 if o1 > o2 or 0 in other case.

##### setMaximizing

public void **setMaximizing** ()

##### setMinimizing

public void **setMinimizing** ()

### 2.112.3 PointDimensionComparator

public class **PointDimensionComparator** implements Comparator<*Point*>

This class implements the `Comparator` interface. It is used to compare two points according the value of a particular dimension.

**Author** Antonio J. Nebro , Juan J. Durillo

#### Constructors

#### PointDimensionComparator

public **PointDimensionComparator**(int *index*)

Constructor

#### Methods

#### compare

public int **compare**(*Point pointOne*, *Point pointTwo*)

Compares the objects o1 and o2.

**Parameters**

- **pointOne** – An object that reference a double[]
- **pointTwo** – An object that reference a double[]

**Returns** -1 if o1 < o1, 1 if o1 > o2 or 0 in other case.

## 2.113 org.uma.jmetal.util.point.util.distance

### 2.113.1 DominanceDistance

public class **DominanceDistance** implements *PointDistance*

Computes the distance between two points a y b according to the dominance relationship. Point a is supposed to be point of the Pareto front

**Author** Antonio J. Nebro

#### Methods

#### compute

public double **compute**(*Point a*, *Point b*)

### 2.113.2 EuclideanDistance

public class **EuclideanDistance** implements *PointDistance*

Computes the Euclidean distance between two points

**Author** Antonio J. Nebro

#### Methods

#### compute

public double **compute** (*Point a*, *Point b*)

### 2.113.3 PointDistance

public interface **PointDistance**

Interface representing classes for computing a distance between two points

**Author** Antonio J. Nebro

#### Methods

#### compute

public double **compute** (*Point pointA*, *Point pointB*)

## 2.114 org.uma.jmetal.util.pseudorandom

### 2.114.1 BoundedRandomGenerator

public interface **BoundedRandomGenerator**<Value extends Comparable<Value>>

A *BoundedRandomGenerator* aims to provide a random value within a specific range. The range is inclusive, such that the lower bound and upper bound can be generated. Because lower and upper bounds make no sense if values cannot be compared, only `Comparable` values can be generated through this kind of generator. A *BoundedRandomGenerator* is a `FunctionalInterface`. It is not intended to be directly implemented by a class, but instead to request a method for generating random values, usually by using lambda expressions.

**Author** Matthieu Vergne

**Parameters**

- **<Value>** – The type of value to generate

#### Methods

#### bound

static *BoundedRandomGenerator*<Double> **bound** (*RandomGenerator*<Double> *unboundedGenerator*)

Create a *BoundedRandomGenerator* from a *RandomGenerator* which generate `Double` values between 0 and 1 (inclusive or exclusive). The distribution is preserved.

**Parameters**

- **unboundedGenerator** – *RandomGenerator* which generates values between 0 and 1

**Returns** *BoundedRandomGenerator* which generates `Double` values based on the provided generator

#### fromDoubleToInteger

static *BoundedRandomGenerator*<Integer> **fromDoubleToInteger**(*BoundedRandomGenerator*<Double> *doubleGenerator*)

Create a `BoundedRandomGenerator` which generates `Integer` values from a `BoundedRandomGenerator` which generate `Double` values. The distribution is preserved.

**Parameters**

- **doubleGenerator** – `BoundedRandomGenerator` which generates `Double` values

**Returns** `BoundedRandomGenerator` which generates `Integer` values based on the provided generator

#### fromDoubleToInteger

static *BoundedRandomGenerator*<Integer> **fromDoubleToInteger**(*RandomGenerator*<Double> *doubleGenerator*)

Create a `BoundedRandomGenerator` which generates `Integer` values from a `BoundedRandomGenerator` which generate `Double` values between 0 and 1 (inclusive or exclusive). The distribution is preserved.

**Parameters**

- **doubleGenerator** – `RandomGenerator` which generates `Double` values

**Returns** `BoundedRandomGenerator` which generates `Integer` values based on the provided generator

#### getRandomValue

Value **getRandomValue**(Value *lowerBound*, Value *upperBound*)

Generate a random value within the provided range.

**Parameters**

- **lowerBound** – the minimal value which can be generated
- **upperBound** – the maximal value which can be generated

**Returns** the value generated

## 2.114.2 BoundedRandomGeneratorTest

public class **BoundedRandomGeneratorTest**

### Methods

#### testBoundedDoubleToIntegerFactoryMethodReturnsGeneratorWithCorrectDistribution

public void **testBoundedDoubleToIntegerFactoryMethodReturnsGeneratorWithCorrectDistribution**()

#### testBoundedDoubleToIntegerFactoryMethodReturnsGeneratorWithCorrectValues

public void **testBoundedDoubleToIntegerFactoryMethodReturnsGeneratorWithCorrectValues**()

#### testBoundingFactoryMethodReturnsGeneratorWithCorrectValues

public void **testBoundingFactoryMethodReturnsGeneratorWithCorrectValues**()

#### testUnboundedDoubleToIntegerFactoryMethodReturnsGeneratorWithCorrectDistribution

public void **testUnboundedDoubleToIntegerFactoryMethodReturnsGeneratorWithCorrectDistribution**()

#### testUnboundedDoubleToIntegerFactoryMethodReturnsGeneratorWithCorrectValues

public void **testUnboundedDoubleToIntegerFactoryMethodReturnsGeneratorWithCorrectValues**()

### 2.114.3 JMetalRandom

public class **JMetalRandom** implements Serializable

**Author** Antonio J. Nebro

#### Methods

#### getGeneratorName

public String **getGeneratorName**()

#### getInstance

public static *JMetalRandom* **getInstance**()

#### getRandomGenerator

public *PseudoRandomGenerator* **getRandomGenerator**()

#### getSeed

public long **getSeed**()

#### nextDouble

public double **nextDouble**()

#### nextDouble

public double **nextDouble** (double *lowerBound*, double *upperBound*)

#### nextInt

public int **nextInt** (int *lowerBound*, int *upperBound*)

#### setRandomGenerator

public void **setRandomGenerator** (*PseudoRandomGenerator randomGenerator*)

#### setSeed

public void **setSeed** (long *seed*)

## 2.114.4 PseudoRandomGenerator

public interface **PseudoRandomGenerator** extends Serializable

**Author** Antonio J. Nebro

### Methods

#### getName

public String **getName** ()

#### getSeed

public long **getSeed** ()

#### nextDouble

public double **nextDouble** (double *lowerBound*, double *upperBound*)

#### nextDouble

public double **nextDouble** ()

#### nextInt

public int **nextInt** (int *lowerBound*, int *upperBound*)

#### setSeed

public void **setSeed**(long *seed*)

### 2.114.5 RandomGenerator

public interface **RandomGenerator**<Value>

A *RandomGenerator* aims to provide a random value of a given type. Any value of this type can be generated. A *RandomGenerator* is a `FunctionalInterface`. It is not intended to be directly implemented by a class, but instead to request a method for generating random values, usually by using lambda expressions.

**Author** Matthieu Vergne

**Parameters**

- **<Value>** – The type of value to generate

#### Methods

#### filter

static <T> *RandomGenerator*<T> **filter**(*RandomGenerator*<T> *generator*, Predicate<T> *filter*)

Reduce a *RandomGenerator* range. The returned *RandomGenerator* uses the provided one to generate random values, but regenerate them if they do not pass the filter. Consequently, the initial *RandomGenerator* may be called several times o generate a single value. The impact on performance depends on the part of the distribution which is filtered out: if a significant part of the distribution is rejected, it might be more interesting to create a dedicated *RandomGenerator*.

**Parameters**

- **generator** – the *RandomGenerator* to filter
- **filter** – the filter to pass to be an acceptable value

**Returns** a *RandomGenerator* which provides only acceptable values

#### forArray

static <T> *RandomGenerator*<T> **forArray**(*BoundedRandomGenerator*<Integer> *indexSelector*, T... *values*)

Create a *RandomGenerator* over an array based on a random selector.

**Parameters**

- **indexSelector** – the random selector
- **values** – the values to return

**Returns** a *RandomGenerator* on the provided values

#### forCollection

static <T> *RandomGenerator*<T> **forCollection**(*BoundedRandomGenerator*<Integer> *indexSelector*, Collection<T> *values*)

Create a *RandomGenerator* over a `Collection` based on a random selector.

**Parameters**

- **indexSelector** – the random selector
- **values** – the values to return

**Returns** a *RandomGenerator* on the provided values

#### forEnum

static <T extends Enum<T>> *RandomGenerator*<T> **forEnum**(*BoundedRandomGenerator*<Integer> *indexSelector*, Class<T> *enumClass*)

Create a *RandomGenerator* over `Enum` values based on a random selector.

**Parameters**

- **indexSelector** – the random selector
- **enumClass** – the `Enum` to cover

**Returns** a *RandomGenerator* on the `Enum` values

#### getRandomValue

public Value **getRandomValue**()

Generate a random value.

**Returns** the value generated

## 2.114.6 RandomGeneratorTest

public class **RandomGeneratorTest**

### Methods

#### testArrayGeneratorGeneratesAllValues

public void **testArrayGeneratorGeneratesAllValues**()

#### testCollectionGeneratorGeneratesAllValues

public void **testCollectionGeneratorGeneratesAllValues**()

#### testEnumGeneratorGeneratesAllValues

public void **testEnumGeneratorGeneratesAllValues**()

#### testFilteredGeneratorGeneratesCorrectValues

public void **testFilteredGeneratorGeneratesCorrectValues**()

### 2.114.7 RandomGeneratorTest.EnumValues

enum **EnumValues**

#### Enum Constants

#### VAL1

public static final *RandomGeneratorTest*.*EnumValues* **VAL1**

#### VAL2

public static final *RandomGeneratorTest*.*EnumValues* **VAL2**

#### VAL3

public static final *RandomGeneratorTest*.*EnumValues* **VAL3**

## 2.115 org.uma.jmetal.util.pseudorandom.impl

### 2.115.1 AuditableRandomGenerator

public class **AuditableRandomGenerator** implements *PseudoRandomGenerator*

An `AuditableRandomGenerator` is a `PseudoRandomGenerator` which can be audited to know when a random generation method is called.

**Author** Matthieu Vergne

#### Constructors

#### AuditableRandomGenerator

public **AuditableRandomGenerator**(*PseudoRandomGenerator generator*)

#### Methods

#### addListener

public void **addListener**(Consumer<*Audit*> *listener*)

#### getName

public String **getName**()

#### getSeed

public long **getSeed**()

#### nextDouble

public double **nextDouble**(double *lowerBound*, double *upperBound*)

#### nextDouble

public double **nextDouble**()

#### nextInt

public int **nextInt**(int *lowerBound*, int *upperBound*)

#### removeListener

public void **removeListener**(Consumer<*Audit*> *listener*)

#### setSeed

public void **setSeed**(long *seed*)

## 2.115.2 AuditableRandomGenerator.Audit

public static class **Audit**

### Constructors

#### Audit

public **Audit**(*RandomMethod* *method*, *Bounds* *bounds*, Number *result*)

### Methods

#### getBounds

public Optional<*Bounds*> **getBounds**()

#### getMethod

public *RandomMethod* **getMethod**()

#### getResult

public Number **getResult** ()

### 2.115.3 AuditableRandomGenerator.Bounds

public static class **Bounds**

#### Fields

#### lower

final Number **lower**

#### upper

final Number **upper**

#### Constructors

#### Bounds

public **Bounds** (Number *lower*, Number *upper*)

### 2.115.4 AuditableRandomGenerator.RandomMethod

public static enum **RandomMethod**

#### Enum Constants

#### BOUNDED_DOUBLE

public static final *AuditableRandomGenerator.RandomMethod* **BOUNDED_DOUBLE**

#### BOUNDED_INT

public static final *AuditableRandomGenerator.RandomMethod* **BOUNDED_INT**

#### DOUBLE

public static final *AuditableRandomGenerator.RandomMethod* **DOUBLE**

### 2.115.5 AuditableRandomGeneratorTest

public class **AuditableRandomGeneratorTest**

#### Methods

##### testAuditableRandomGeneratorProvidesCorrectAuditWhenGettingBoundedDouble

public void **testAuditableRandomGeneratorProvidesCorrectAuditWhenGettingBoundedDouble**()

##### testAuditableRandomGeneratorProvidesCorrectAuditWhenGettingBoundedInteger

public void **testAuditableRandomGeneratorProvidesCorrectAuditWhenGettingBoundedInteger**()

##### testAuditableRandomGeneratorProvidesCorrectAuditWhenGettingDouble

public void **testAuditableRandomGeneratorProvidesCorrectAuditWhenGettingDouble**()

### 2.115.6 ExtendedPseudoRandomGenerator

public class **ExtendedPseudoRandomGenerator** implements *PseudoRandomGenerator*

Extended pseudo random number generator based on the decorator pattern. Two new methods are added: randNormal() and randSphere()

**Author** Antonio J. Nebro

#### Constructors

##### ExtendedPseudoRandomGenerator

public **ExtendedPseudoRandomGenerator**(*PseudoRandomGenerator randomGenerator*)

#### Methods

##### getName

public String **getName**()

##### getSeed

public long **getSeed**()

##### nextDouble

public double **nextDouble**(double *lowerBound*, double *upperBound*)

##### nextDouble

public double **nextDouble**()

#### nextInt

public int **nextInt** (int *lowerBound*, int *upperBound*)

#### randNormal

public double **randNormal** (double *mean*, double *standardDeviation*)

Use the polar form of the Box-Muller transformation to obtain a pseudo random number from a Gaussian distribution Code taken from Maurice Clerc's implementation

**Parameters**

- **mean** –
- **standardDeviation** –

**Returns** A pseudo random number

#### randSphere

public double[] **randSphere** (int *dimension*)

Get a random point from an hypersphere (center = 0, radius = 1) Code taken from Maurice Clerc's implementation

**Parameters**

- **dimension** –

**Returns** A pseudo random point

#### randSphere

public double[] **randSphere** (int *dimension*, double *center*, double *radius*)

Ger a random point from an hypersphere Code taken from Maurice Clerc's implementation

**Parameters**

- **center** –
- **radius** –

**Returns** A pseudo random number

#### setSeed

public void **setSeed** (long *seed*)

### 2.115.7 JavaRandomGenerator

public class **JavaRandomGenerator** implements *PseudoRandomGenerator*

**Author** Antonio J. Nebro

#### Constructors

##### JavaRandomGenerator

public **JavaRandomGenerator** ()
Constructor

##### JavaRandomGenerator

public **JavaRandomGenerator** (long *seed*)
Constructor

#### Methods

##### getName

public String **getName** ()

##### getSeed

public long **getSeed** ()

##### nextDouble

public double **nextDouble** (double *lowerBound*, double *upperBound*)

##### nextDouble

public double **nextDouble** ()

##### nextInt

public int **nextInt** (int *lowerBound*, int *upperBound*)

##### setSeed

public void **setSeed** (long *seed*)

### 2.115.8 MersenneTwisterGenerator

public class **MersenneTwisterGenerator** implements *PseudoRandomGenerator*

**Author** Antonio J. Nebro

#### Constructors

##### MersenneTwisterGenerator

public **MersenneTwisterGenerator**()
Constructor

##### MersenneTwisterGenerator

public **MersenneTwisterGenerator**(long *seed*)
Constructor

#### Methods

##### getName

public String **getName**()

##### getSeed

public long **getSeed**()

##### nextDouble

public double **nextDouble**(double *lowerBound*, double *upperBound*)

##### nextDouble

public double **nextDouble**()

##### nextInt

public int **nextInt**(int *lowerBound*, int *upperBound*)

##### setSeed

public void **setSeed**(long *seed*)

### 2.115.9 Well44497bGenerator

public class **Well44497bGenerator** implements *PseudoRandomGenerator*

**Author** Antonio J. Nebro

#### Constructors

##### Well44497bGenerator

public **Well44497bGenerator**()
Constructor

##### Well44497bGenerator

public **Well44497bGenerator**(long *seed*)
Constructor

#### Methods

##### getName

public String **getName**()

##### getSeed

public long **getSeed**()

##### nextDouble

public double **nextDouble**(double *lowerBound*, double *upperBound*)

##### nextDouble

public double **nextDouble**()

##### nextInt

public int **nextInt**(int *lowerBound*, int *upperBound*)

##### setSeed

public void **setSeed**(long *seed*)

## 2.116 org.uma.jmetal.util.solutionattribute

### 2.116.1 DensityEstimator

public interface **DensityEstimator**<S> extends *SolutionAttribute*<S, Double>
Interface representing implementations to compute the crowding distance

**Author** Antonio J. Nebro

#### Methods

##### computeDensityEstimator

public void **computeDensityEstimator** (List<S> *solutionSet*)

### 2.116.2 Ranking

public interface **Ranking**<S> extends *SolutionAttribute*<S, Integer>

Ranks a list of solutions according to the dominance relationship

**Author** Antonio J. Nebro

#### Methods

##### computeRanking

public *Ranking*<S> **computeRanking** (List<S> *solutionList*)

##### getNumberOfSubfronts

public int **getNumberOfSubfronts** ()

##### getSubfront

public List<S> **getSubfront** (int *rank*)

### 2.116.3 SolutionAttribute

public interface **SolutionAttribute**<S, V> extends Serializable

Attributes allows to extend the solution classes to incorporate data required by operators or algorithms manipulating them.

**Author** Antonio J. Nebro

#### Methods

##### getAttribute

public V **getAttribute** (S *solution*)

##### getAttributeIdentifier

public Object **getAttributeIdentifier** ()

#### setAttribute

public void **setAttribute** (S *solution*, V *value*)

## 2.117 org.uma.jmetal.util.solutionattribute.impl

### 2.117.1 CrowdingDistance

public class **CrowdingDistance**<S extends Solution<?>> extends *GenericSolutionAttribute*<S, Double> implements *DensityEstima*
This class implements the crowding distance

**Author** Antonio J. Nebro

#### Methods

#### computeDensityEstimator

public void **computeDensityEstimator** (List<S> *solutionList*)
Assigns crowding distances to all solutions in a `SolutionSet`.

**Parameters**

- **solutionList** – The `SolutionSet`.

**Throws**

- *org.uma.jmetal.util.JMetalException* –

#### getAttributeIdentifier

public Object **getAttributeIdentifier** ()

### 2.117.2 CrowdingDistanceTest

public class **CrowdingDistanceTest**

**Author** Antonio J. Nebro

#### Methods

#### shouldTheCrowdingDistanceOfASingleSolutionBeInfinity

public void **shouldTheCrowdingDistanceOfASingleSolutionBeInfinity** ()

#### shouldTheCrowdingDistanceOfAnEmptySetDoNothing

public void **shouldTheCrowdingDistanceOfAnEmptySetDoNothing** ()

#### shouldTheCrowdingDistanceOfThreeSolutionsCorrectlyAssigned

public void **shouldTheCrowdingDistanceOfThreeSolutionsCorrectlyAssigned**()

#### shouldTheCrowdingDistanceOfTwoSolutionsBeInfinity

public void **shouldTheCrowdingDistanceOfTwoSolutionsBeInfinity**()

## 2.117.3 DistanceToSolutionListAttribute

public class **DistanceToSolutionListAttribute** extends *GenericSolutionAttribute*<*Solution*<?>, Double>

Created by cbarba on 24/3/15.

## 2.117.4 DominanceRanking

public class **DominanceRanking**<S extends Solution<?>> extends *GenericSolutionAttribute*<S, Integer> implements *Ranking*<S>

This class implements some facilities for ranking set of solutions. Given a collection of solutions, they are ranked according to scheme proposed in NSGA-II; as an output, a set of subsets are obtained. The subsets are numbered starting from 0 (in NSGA-II, the numbering starts from 1); thus, subset 0 contains the non-dominated solutions, subset 1 contains the non-dominated solutions after removing those belonging to subset 0, and so on.

**Author** Antonio J. Nebro , Juan J. Durillo

### Constructors

#### DominanceRanking

public **DominanceRanking**(Comparator<S> *comparator*)

Constructor

#### DominanceRanking

public **DominanceRanking**()

Constructor

#### DominanceRanking

public **DominanceRanking**(Object *id*)

### Methods

#### computeRanking

public *Ranking*<S> **computeRanking**(List<S> *solutionSet*)

#### getNumberOfSubfronts

public int **getNumberOfSubfronts** ()

#### getSubfront

public List<S> **getSubfront** (int *rank*)

### 2.117.5 DominanceRankingTest

public class **DominanceRankingTest**

**Author** Antonio J. Nebro

#### Methods

#### shouldRankingOfAPopulationWithFiveSolutionsWorkProperly

public void **shouldRankingOfAPopulationWithFiveSolutionsWorkProperly** ()

#### shouldRankingOfAPopulationWithThreeDominatedSolutionsReturnThreeSubfronts

public void **shouldRankingOfAPopulationWithThreeDominatedSolutionsReturnThreeSubfronts** ()

#### shouldRankingOfAPopulationWithTwoDominatedSolutionsReturnTwoSubfronts

public void **shouldRankingOfAPopulationWithTwoDominatedSolutionsReturnTwoSubfronts** ()

#### shouldRankingOfAPopulationWithTwoNonDominatedSolutionsReturnOneSubfront

public void **shouldRankingOfAPopulationWithTwoNonDominatedSolutionsReturnOneSubfront** ()

#### shouldTheRankingOfAnEmptyPopulationReturnOneSubfronts

public void **shouldTheRankingOfAnEmptyPopulationReturnOneSubfronts** ()

#### shouldTheRankingOfAnEmptyPopulationReturnZeroSubfronts

public void **shouldTheRankingOfAnEmptyPopulationReturnZeroSubfronts** ()

### 2.117.6 Fitness

public class **Fitness**<S extends Solution<?>> extends *GenericSolutionAttribute*<S, Double>

**Author** Antonio J. Nebro

## 2.117.7 GenericSolutionAttribute

public class **GenericSolutionAttribute**<S extends Solution<?>, V> implements *SolutionAttribute*<S, V>

Generic class for implementing `SolutionAttribute` classes. By default, the identifier of a `SolutionAttribute` is the class object, but it can be set to a different value when constructing an instance.

**Author** Antonio J. Nebro

### Constructors

#### GenericSolutionAttribute

public **GenericSolutionAttribute**()

Constructor

#### GenericSolutionAttribute

public **GenericSolutionAttribute**(Object *id*)

Constructor

**Parameters**

- **id** – Attribute identifier

### Methods

#### getAttribute

public V **getAttribute**(S *solution*)

#### getAttributeIdentifier

public Object **getAttributeIdentifier**()

#### setAttribute

public void **setAttribute**(S *solution*, V *value*)

## 2.117.8 GenericSolutionAttributeTest

public class **GenericSolutionAttributeTest**

**Author** Antonio J. Nebro

### Methods

#### shouldConstructorCreateASolutionAttributedWithThePassedIdentifier

public void **shouldConstructorCreateASolutionAttributedWithThePassedIdentifier**()

#### shouldDefaultConstructorCreateASolutionAttributedWithAnIdentifierEqualToTheClassObject

public void **shouldDefaultConstructorCreateASolutionAttributedWithAnIdentifierEqualToTheClassObj**

#### shouldGetAttributeIdentifierReturnTheRightIdentifier

public void **shouldGetAttributeIdentifierReturnTheRightIdentifier**()

#### shouldGetAttributeReturnNullIfTheSolutionHasNoAttribute

public void **shouldGetAttributeReturnNullIfTheSolutionHasNoAttribute**()

#### shouldGetAttributeReturnTheAttributeValue

public void **shouldGetAttributeReturnTheAttributeValue**()

#### shouldSetAttributeAssignTheAttributeValueToTheSolution

public void **shouldSetAttributeAssignTheAttributeValueToTheSolution**()

### 2.117.9 HypervolumeContributionAttribute

public class **HypervolumeContributionAttribute**<S extends Solution<?>> extends *GenericSolutionAttribute*<S, Double>

**Author** Antonio J. Nebro

### 2.117.10 LocationAttribute

public class **LocationAttribute**<S extends Solution<?>> extends *GenericSolutionAttribute*<S, Integer>

Assign to each solution in a solution list an attribute containing the position of the solutions in the list.

**Author** Antonio J. Nebro

**Parameters**

- **<S>** –

#### Constructors

#### LocationAttribute

public **LocationAttribute**(List<S> *solutionList*)

### 2.117.11 NumberOfViolatedConstraints

public class **NumberOfViolatedConstraints**<S extends Solution<?>> extends *GenericSolutionAttribute*<S, Integer>

**Author** Antonio J. Nebro

### 2.117.12 OverallConstraintViolation

public class **OverallConstraintViolation**<S extends Solution<?>> extends *GenericSolutionAttribute*<S, Double>

**Author** Antonio J. Nebro

### 2.117.13 PreferenceDistance

public class **PreferenceDistance**<S extends Solution<?>> extends *GenericSolutionAttribute*<S, Double> implements *DensityEst*

#### Constructors

#### PreferenceDistance

public **PreferenceDistance** (List<Double> *interestPoint*, double *epsilon*)

#### Methods

#### computeDensityEstimator

public void **computeDensityEstimator** (List<S> *solutionList*)

#### epsilonClean

public List<S> **epsilonClean** (List<S> *solutionList*)

#### getSize

public int **getSize** ()

#### updatePointOfInterest

public void **updatePointOfInterest** (List<Double> *newInterestPoint*)

### 2.117.14 StrengthRawFitness

public class **StrengthRawFitness**<S extends Solution<?>> extends *GenericSolutionAttribute*<S, Double> implements *DensityEst*

#### Methods

#### computeDensityEstimator

public void **computeDensityEstimator** (List<S> *solutionSet*)

# 2.118 org.uma.jmetal.utility

## 2.118.1 GenerateReferenceFrontFromFile

public class **GenerateReferenceFrontFromFile**

This utility reads a file or the files in a directory and creates a reference front. The file(s) must contain only objective values. The program receives two parameters: 1. the name of the file or directory containing the data 2. the output file name which will contain the generated front

**Author** Antonio J. Nebro

### Methods

### main

public static void **main** (String[] *args*)

# 2.119 org.uma.jmetal.workingTest

## 2.119.1 BLXAlphaCrossoverWorkingTest

public class **BLXAlphaCrossoverWorkingTest**

**Author** Antonio J. Nebro

### Methods

### main

public static void **main** (String[] *args*)

Program to generate data representing the distribution of points generated by a SBX crossover operator. The parameters to be introduced by the command line are: - numberOfSolutions: number of solutions to generate - granularity: number of subdivisions to be considered. - alpha: alpha value - outputFile: file containing the results

**Parameters**

- **args** – Command line arguments

## 2.119.2 BLXAlphaCrossoverWorkingTest.VariableComparator

public static class **VariableComparator** implements Comparator<*DoubleSolution*>

### Methods

### compare

public int **compare** (*DoubleSolution solution1*, *DoubleSolution solution2*)

Compares two solutions according to the first variable value

**Parameters**

- **solution1** – Object representing the first `Solution`.
- **solution2** – Object representing the second `Solution`.

**Returns** -1, or 0, or 1 if o1 is less than, equal, or greater than o2, respectively.

### 2.119.3 IntegerPolynomialMutationWorkingTest

public class **IntegerPolynomialMutationWorkingTest**

**Author** Antonio J. Nebro

#### Methods

#### main

public static void **main** (String[] *args*)

Program to generate data representing the distribution of points generated by a polynomial mutation operator. The parameters to be introduced by the command line are: - numberOfSolutions: number of solutions to generate - granularity: number of subdivisions to be considered. - distributionIndex: distribution index of the polynomial mutation operator - outputFile: file containing the results

**Parameters**

- **args** – Command line arguments

### 2.119.4 IntegerPolynomialMutationWorkingTest.VariableComparator

public static class **VariableComparator** implements Comparator<*IntegerSolution*>

#### Methods

#### compare

public int **compare** (*IntegerSolution solution1*, *IntegerSolution solution2*)

Compares two solutions according to the first variable value

**Parameters**

- **solution1** – Object representing the first `Solution`.
- **solution2** – Object representing the second `Solution`.

**Returns** -1, or 0, or 1 if o1 is less than, equal, or greater than o2, respectively.

### 2.119.5 IntegerSBXCrossoverWorkingTest

public class **IntegerSBXCrossoverWorkingTest**

**Author** Antonio J. Nebro

#### Methods

#### main

public static void **main**(String[] *args*)

Program to generate data representing the distribution of points generated by a SBX crossover operator. The parameters to be introduced by the command line are: - numberOfSolutions: number of solutions to generate - granularity: number of subdivisions to be considered. - distributionIndex: distribution index of the polynomial mutation operator - outputFile: file containing the results

**Parameters**

- **args** – Command line arguments

### 2.119.6 IntegerSBXCrossoverWorkingTest.VariableComparator

public static class **VariableComparator** implements Comparator<*IntegerSolution*>

#### Methods

#### compare

public int **compare**(*IntegerSolution* *solution1*, *IntegerSolution* *solution2*)

Compares two solutions according to the first variable value

**Parameters**

- **solution1** – Object representing the first `Solution`.
- **solution2** – Object representing the second `Solution`.

**Returns** -1, or 0, or 1 if o1 is less than, equal, or greater than o2, respectively.

### 2.119.7 PolynomialMutationWorkingTest

public class **PolynomialMutationWorkingTest**

**Author** Antonio J. Nebro

#### Methods

#### main

public static void **main**(String[] *args*)

Program to generate data representing the distribution of points generated by a polynomial mutation operator. The parameters to be introduced by the command line are: - numberOfSolutions: number of solutions to generate - granularity: number of subdivisions to be considered. - distributionIndex: distribution index of the polynomial mutation operator - outputFile: file containing the results

**Parameters**

- **args** – Command line arguments

### 2.119.8 PolynomialMutationWorkingTest.VariableComparator

public static class **VariableComparator** implements Comparator<*DoubleSolution*>

#### Methods

#### compare

public int **compare** (*DoubleSolution solution1*, *DoubleSolution solution2*)
Compares two solutions according to the first variable value

**Parameters**

- **solution1** – Object representing the first `Solution`.
- **solution2** – Object representing the second `Solution`.

**Returns** -1, or 0, or 1 if o1 is less than, equal, or greater than o2, respectively.

### 2.119.9 SBXCrossoverWorkingTest

public class **SBXCrossoverWorkingTest**

**Author** Antonio J. Nebro

#### Methods

#### main

public static void **main** (String[] *args*)
Program to generate data representing the distribution of points generated by a SBX crossover operator. The parameters to be introduced by the command line are: - numberOfSolutions: number of solutions to generate - granularity: number of subdivisions to be considered. - distributionIndex: distribution index of the polynomial mutation operator - outputFile: file containing the results

**Parameters**

- **args** – Command line arguments

### 2.119.10 SBXCrossoverWorkingTest.VariableComparator

public static class **VariableComparator** implements Comparator<*DoubleSolution*>

#### Methods

#### compare

public int **compare** (*DoubleSolution solution1*, *DoubleSolution solution2*)
Compares two solutions according to the first variable value

**Parameters**

- **solution1** – Object representing the first `Solution`.

- **solution2** – Object representing the second `Solution`.

**Returns** -1, or 0, or 1 if o1 is less than, equal, or greater than o2, respectively.

# CHAPTER 3

## About

jMetal is being developed by Antonio J. Nebro, associate professor at the University of Málaga.

### 3.1 References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CHAPTER 4

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