

# Package ‘ParamHelpers’

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**Title** Helpers for Parameters in Black-Box Optimization, Tuning and Machine Learning

**Version** 1.14.2

**Description** Functions for parameter descriptions and operations in black-box optimization, tuning and machine learning. Parameters can be described (type, constraints, defaults, etc.), combined to parameter sets and can in general be programmed on. A useful OptPath object (archive) to log function evaluations is also provided.

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**URL** <https://paramhelpers.mlr-org.com>,  
<https://github.com/mlr-org/ParamHelpers>

**BugReports** <https://github.com/mlr-org/ParamHelpers/issues>

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---

 addOptPathEl

*Add a new element to an optimization path.*


---

### Description

Changes the argument in-place. Note that when adding parameters that have associated transformations, it is probably best to add the untransformed values to the path. Otherwise you have to switch off the feasibility check, as constraints might now not hold anymore.

Dependent parameters whose requirements are not satisfied must be represented by a scalar NA in the input.

**Usage**

```

addOptPathEl(
  op,
  x,
  y,
  dob = getOptPathLength(op) + 1L,
  eol = as.integer(NA),
  error.message = NA_character_,
  exec.time = NA_real_,
  extra = NULL,
  check.feasible = !op$add.transformed.x
)

```

**Arguments**

op	<a href="#">OptPath</a> Optimization path.
x	(list) List of parameter values for a point in input space. Must be in same order as parameters.
y	(numeric) Vector of fitness values. Must be in same order as y.names.
dob	(integer(1)) Date of birth of the new parameters. Default is length of path + 1.
eol	(integer(1)) End of life of point. Default is NA.
error.message	(character(1)) Possible error message that occurred for this parameter values. Default is NA.
exec.time	(numeric(1)) Possible exec time for this evaluation. Default is NA.
extra	(list) Possible list of extra values to store. The list must be fully named. The list can contain nonscalar values, but these nonscalar entries must have a name starting with a dot (.). Other entries must be scalar, and must be in the same order of all calls of addOptPathEl. Watch out: if include.extra was set to TRUE in (makeOptPathDF()) the list of extras is mandatory. Default is NULL.
check.feasible	(logical(1)) Should x be checked with (isFeasible())? Default is TRUE.

**Value**

Nothing.

**See Also**

Other optpath: [OptPath](#), [getOptPathBestIndex\(\)](#), [getOptPathCol\(\)](#), [getOptPathCols\(\)](#), [getOptPathDOB\(\)](#), [getOptPathEOL\(\)](#), [getOptPathEl\(\)](#), [getOptPathErrorMessages\(\)](#), [getOptPathExecTimes\(\)](#),

```
getOptPathLength(), getOptPathParetoFront(), getOptPathX(), getOptPathY(), setOptPathEIDOB(),
setOptPathEIEOL()
```

### Examples

```
ps = makeParamSet(
  makeNumericParam("p1"),
  makeDiscreteParam("p2", values = c("a", "b"))
)
op = makeOptPathDF(par.set = ps, y.names = "y", minimize = TRUE)
addOptPathEl(op, x = list(p1 = 7, p2 = "b"), y = 1)
addOptPathEl(op, x = list(p1 = -1, p2 = "a"), y = 2)
as.data.frame(op)
```

---

```
as.data.frame.OptPathDF
```

*Convert optimization path to data.frame.*

---

### Description

The following types of columns are created:

x-numeric(vector)	numeric
x-integer(vector)	integer
x-discrete(vector)	factor (names of values = levels)
x-logical(vector)	logical
y-columns	numeric
dob	integer
eol	integer
error.message	character
exec.time	numeric
extra-columns	any

If you want to convert these, look at [BBmisc::convertDataFrameCols\(\)](#). Dependent parameters whose constraints are unsatisfied generate NA entries in their respective columns. Factor columns of discrete parameters always have their complete level set from the param.set.

### Usage

```
## S3 method for class 'OptPathDF'
as.data.frame(
  x,
  row.names = NULL,
  optional = FALSE,
  include.x = TRUE,
  include.y = TRUE,
```

```

include.rest = TRUE,
dob = x$env$dob,
eol = x$env$eol,
...
)

```

### Arguments

x	( <a href="#">OptPath()</a> ) Optimization path.
row.names	<a href="#">character</a> Row names for result. Default is none.
optional	(any) Currently ignored.
include.x	( <a href="#">logical(1)</a> ) Include all input params? Default is TRUE.
include.y	( <a href="#">logical(1)</a> ) Include all y-columns? Default is TRUE.
include.rest	( <a href="#">logical(1)</a> ) Include all other columns? Default is TRUE.
dob	<a href="#">integer</a> Vector of date-of-birth values to further subset the result. Only elements with a date-of-birth included in dob are selected. Default is all.
eol	<a href="#">integer</a> Vector of end-of-life values to further subset the result. Only elements with an end-of-life included in eol are selected. Default is all.
...	(any) Currently ignored.

### Value

[data.frame](#).

---

checkParamSet	<i>Sanity check expressions of a parameter set.</i>
---------------	---

---

### Description

Checks whether the default values of the numerical parameters are located within the corresponding boundaries. In case of discrete parameters it checks whether the values are a subset of the parameter's possible values.

### Usage

```
checkParamSet(par.set, dict = NULL)
```

**Arguments**

par.set	<a href="#">ParamSet</a> Parameter set.
dict	(environment   <a href="#">list</a>   NULL) Environment or list which will be used for evaluating the variables of expressions within a parameter, parameter set or list of parameters. The default is NULL.

**Value**

[TRUE](#) on success. An exception is raised otherwise.

**Examples**

```
ps = makeParamSet(
  makeNumericParam("u", lower = expression(p)),
  makeIntegerParam("v", lower = 1, upper = expression(3 * p)),
  makeDiscreteParam("w", default = expression(z), values = c("a", "b")),
  makeDiscreteParam("x", default = "a", values = c("a", "b")),
  keys = c("p", "z")
)
checkParamSet(ps, dict = list(p = 3, z = "b"))
```

---

 convertParamSetToIrace

*Converts a ParamSet object to a parameter object of the irace package.*

---

**Description**

Converts to a textual description used in irace and then potentially calls [readParameters](#).

**Usage**

```
convertParamSetToIrace(par.set, as.chars = FALSE)
```

**Arguments**

par.set	<a href="#">ParamSet</a> Parameter set.
as.chars	( <a href="#">logical</a> (1)) Return results as character vector of lines FALSE or call <a href="#">irace::readParameters()</a> on it (TRUE). Default is FALSE.

**Value**

[\[list\(\)\]](#).

---

dfRowsToList

Convert a data.frame row to list of parameter-value-lists.

---

### Description

Please note that (naturally) the columns of df have to be of the correct type w.r.t. the corresponding parameter. The only exception are integer parameters where the corresponding columns in df are allowed to be numerics. And also see the argument `enforce.col.types` as a way around this restriction.

numeric(vector)	numeric
integer(vector)	integer
discrete(vector)	factor (names of values = levels)
logical(vector)	logical

Dependent parameters whose requirements are not satisfied are represented by a scalar NA in the output.

### Usage

```
dfRowsToList(df, par.set, enforce.col.types = FALSE, ...)
```

```
dfRowToList(df, par.set, i, enforce.col.types = FALSE, ...)
```

### Arguments

df	(data.frame) Data.frame, potentially from <code>OptPathDF()</code> . Columns are assumed to be in the same order as <code>par.set</code> .
par.set	<a href="#">ParamSet</a> Parameter set.
enforce.col.types	(logical(1)) Should all df columns be initially converted to the type returned by <code>getParamTypes(df, df.cols = TRUE)</code> . This can help to work with “non-standard” data.frames where the types are slightly “off”. But note that there is no guarantee that this will work if the types are really wrong and there is no naturally correct way to convert them. Default is FALSE.
...	(any) Arguments passed to <code>BBmisc::convertDataFrameCols()</code>
i	(integer(1)) Row index.

### Value

`list`. Named by parameter ids.



---

discreteNameToValue    *Convert encoding name(s) to discrete value(s).*

---

### Description

For a discrete parameter or discrete vector. If the name is NA, indicating a missing parameter value due to unsatisfied requirements, NA is returned.

### Usage

```
discreteNameToValue(par, name)
```

### Arguments

par	<b>Param</b> Parameter.
name	(character) Name (string) encoding the value for a discrete parameter, or a character vector of names for a discrete vector.

### Value

**any**. Parameter value for a discrete parameter or a list of values for a discrete vector.

### Examples

```
p = makeDiscreteParam("u", values = c(x1 = "a", x2 = "b", x3 = "b"))
discreteNameToValue(p, "x3")
```

---

discreteValueToName    *Convert discrete value(s) to encoding name(s).*

---

### Description

For a discrete parameter or discrete vector. If the value x is NA, indicating a missing parameter value due to unsatisfied requirements, NA is returned.

### Usage

```
discreteValueToName(par, x)
```

### Arguments

par	<b>Param</b> Parameter.
x	<b>any</b> Parameter value or a list of values for a discrete vector.

**Value**

**character**. Single name for a discrete parameter or a character vector of names for a discrete vector.

**Examples**

```
p = makeDiscreteParam("u", values = c(x1 = "a", x2 = "b", x3 = "c"))
discreteValueToName(p, "b")
```

---

dropParams

*Drop Params from ParamSet by ids.*

---

**Description**

Drop Params from ParamSet by ids.

**Usage**

```
dropParams(par.set, drop)
```

**Arguments**

par.set	<a href="#">ParamSet</a> Parameter set.
drop	(character) ids of the <a href="#">Param()</a> s in the <a href="#">ParamSet()</a> to drop from the ParamSet.

**Value**

[[ParamSet\(\)](#)].

---

evaluateParamExpressions

*Evaluates all expressions within a parameter.*

---

**Description**

Evaluates the expressions of a parameter, parameter set or list of parameters for a given dictionary.

**Usage**

```
evaluateParamExpressions(obj, dict = NULL)
```

**Arguments**

obj	( <a href="#">Param()</a>   ParamHelpers::ParamSet()   list) Parameter, parameter set or list of parameter values. Expressions within len, lower or upper boundaries, default or values will be evaluated using the provided dictionary (dict).
dict	(environment   <a href="#">list</a>   NULL) Environment or list which will be used for evaluating the variables of expressions within a parameter, parameter set or list of parameters. The default is NULL.

**Value**

[[Param\(\)](#) | ParamHelpers::ParamSet() | list].

**Examples**

```
ps = makeParamSet(
  makeNumericParam("x", lower = expression(p), upper = expression(ceiling(3 * p))),
  makeIntegerParam("y", lower = 1, upper = 2)
)
evaluateParamExpressions(ps, dict = list(p = 3))

ps = makeParamSet(
  makeNumericParam("x", default = expression(sum(data$Species == "setosa"))),
  makeIntegerParam("y", lower = 1, upper = 2),
  keys = c("data", "Species")
)
evaluateParamExpressions(ps, dict = list(data = iris))

par.vals = list(
  x = expression(k),
  y = 5
)
evaluateParamExpressions(par.vals, dict = list(k = 3))
```

---

 filterParams

*Get parameter subset of only certain parameters.*


---

**Description**

Parameter order is not changed. It is possible to filter via multiple arguments, e.g., first filter based on id, then the type and lastly tunable. The order in which the filters are executed is always fixed (id > type > tunable).

**Usage**

```
filterParams(
  par.set,
  ids = NULL,
  type = NULL,
  tunable = c(TRUE, FALSE),
  check.requires = FALSE
)
```

```
filterParamsNumeric(
  par.set,
  ids = NULL,
  tunable = c(TRUE, FALSE),
  include.int = TRUE
)
```

```
filterParamsDiscrete(
  par.set,
  ids = NULL,
  tunable = c(TRUE, FALSE),
  include.logical = TRUE
)
```

**Arguments**

par.set	<a href="#">ParamSet</a> Parameter set.
ids	(NULL   character) Vector with id strings containing the parameters to select. Has to be a subset of the parameter names within the parameter set. Per default (ids = NULL) no filtering based on names is done.
type	(NULL   character) Vector of allowed types, subset of: “numeric”, “integer”, “numericvector”, “integervector”, “discrete”, “discretevector”, “logical”, “logicalvector”, “character”, “charactervector”, “function”, “untyped”. Setting type = NULL, which is the default, allows the consideration of all types.
tunable	(logical) Vector of allowed values for the property tunable. Accepted arguments are TRUE, FALSE or c(TRUE, FALSE). The default is c(TRUE, FALSE), i.e. none of the parameters will be filtered out.
check.requires	(logical(1)) Toggle whether it should be checked that all requirements in the (ParamSet()) are still valid after filtering or not. This check is done after filtering and will throw an error if those Params are filtered which other Params need for their requirements. Default is FALSE.
include.int	(logical(1)) Are integers also considered to be numeric? Default is TRUE.

```
include.logical
      (logical(1))
      Are logicals also considered to be discrete? Default is TRUE.
```

**Value**

[ParamSet\(\)](#).

**Examples**

```
ps = makeParamSet(
  makeNumericParam("u", lower = 1),
  makeIntegerParam("v", lower = 1, upper = 2),
  makeDiscreteParam("w", values = 1:2),
  makeLogicalParam("x"),
  makeCharacterParam("s"),
  makeNumericParam("y", tunable = FALSE)
)

# filter for numeric and integer parameters
filterParams(ps, type = c("integer", "numeric"))

# filter for tunable, numeric parameters
filterParams(ps, type = "numeric", tunable = TRUE)

# filter for all numeric parameters among "u", "v" and "x"
filterParams(ps, type = "numeric", ids = c("u", "v", "x"))
```

---

generateDesign      *Generates a statistical design for a parameter set.*

---

**Description**

The following types of columns are created:

numeric(vector)	numeric
integer(vector)	integer
discrete(vector)	factor (names of values = levels)
logical(vector)	logical

If you want to convert these, look at [BBmisc::convertDataFrameCols\(\)](#). Dependent parameters whose constraints are unsatisfied generate NA entries in their respective columns. For discrete vectors the levels and their order will be preserved, even if not all levels are present.

Currently only lhs designs are supported.

The algorithm currently iterates the following steps:

1. We create a space filling design for all parameters, disregarding requires, a trafo or the forbidden region.

2. Forbidden points are removed.
3. Parameters are trafoed (potentially, depending on the setting of argument trafo); dependent parameters whose constraints are unsatisfied are set to NA entries.
4. Duplicated design points are removed. Duplicated points are not generated in a reasonable space-filling design, but the way discrete parameters and also parameter dependencies are handled make this possible.
5. If we removed some points, we now try to augment the design in a space-filling way and iterate.

Note that augmenting currently is somewhat experimental as we simply generate missing points via new calls to `lhs::randomLHS()`, but do not add points so they are maximally far away from the already present ones. The reason is that the latter is quite hard to achieve with complicated dependencies and forbidden regions, if one wants to ensure that points actually get added... But we are working on it.

Note that if you have trafoes attached to your params, the complete creation of the design (except for the detection of invalid parameters w.r.t to their requires setting) takes place on the UNTRANSFORMED scale. So this function creates, e.g., a maximin LHS design on the UNTRANSFORMED scale, but not necessarily the transformed scale.

`generateDesign` will NOT work if there are dependencies over multiple levels of parameters and the dependency is only given with respect to the “previous” parameter. A current workaround is to state all dependencies on all parameters involved. (We are working on it.)

## Usage

```
generateDesign(
  n = 10L,
  par.set,
  fun,
  fun.args = list(),
  trafo = FALSE,
  augment = 20L
)
```

## Arguments

<code>n</code>	(integer(1)) Number of samples in design. Default is 10.
<code>par.set</code>	<a href="#">ParamSet</a> Parameter set.
<code>fun</code>	(function) Function from package lhs. Possible are: <a href="#">lhs::maximinLHS()</a> , <a href="#">lhs::randomLHS()</a> , <a href="#">lhs::geneticLHS()</a> , <a href="#">lhs::improvedLHS()</a> , <a href="#">lhs::optAugmentLHS()</a> , <a href="#">lhs::optimumLHS()</a> Default is <a href="#">lhs::randomLHS()</a> .
<code>fun.args</code>	(list) List of further arguments passed to fun.

trafo	(logical(1)) Transform all parameters by using their respective transformation functions. Default is FALSE.
augment	(integer(1)) Duplicated values and forbidden regions in the parameter space can lead to the design becoming smaller than n. With this option it is possible to augment the design again to size n. It is not guaranteed that this always works (to full size) and augment specifies the number of tries to augment. If the the design is of size less than n after all tries, a warning is issued and the smaller design is returned. Default is 20.

### Value

[data.frame](#). Columns are named by the ids of the parameters. If the `par.set` argument contains a vector parameter, its corresponding column names in the design are the parameter id concatenated with 1 to dimension of the vector. The result will have an `logical(1)` attribute “trafo”, which is set to the value of argument `trafo`.

### Examples

```
ps = makeParamSet(
  makeNumericParam("x1", lower = -2, upper = 1),
  makeIntegerParam("x2", lower = 10, upper = 20)
)
# random latin hypercube design with 5 samples:
generateDesign(5, ps)

# with trafo
ps = makeParamSet(
  makeNumericParam("x", lower = -2, upper = 1),
  makeNumericVectorParam("y", len = 2, lower = 0, upper = 1, trafo = function(x) x / sum(x))
)
generateDesign(10, ps, trafo = TRUE)
```

---

```
generateDesignOfDefaults
```

*Generates a design with the defaults of a parameter set.*

---

### Description

The following types of columns are created:

numeric(vector)	numeric
integer(vector)	integer
discrete(vector)	factor (names of values = levels)
logical(vector)	logical

This will create a design containing only one point at the default values of the supplied param set. In most cases you will combine the resulting `data.frame` with a different generation function e.g. `generateDesign()`, `generateRandomDesign()` or `generateGridDesign()`. This is useful to force an evaluation at the default location of the parameters while still generating a design. Parameters default values, whose conditions (requires) are not fulfilled will be set to NA in the result.

### Usage

```
generateDesignOfDefaults(par.set, trafo = FALSE)
```

### Arguments

<code>par.set</code>	<a href="#">ParamSet</a> Parameter set.
<code>trafo</code>	( <code>logical(1)</code> ) Transform all parameters by using their respective transformation functions. Default is FALSE.

### Value

[data.frame](#). Columns are named by the ids of the parameters. If the `par.set` argument contains a vector parameter, its corresponding column names in the design are the parameter id concatenated with 1 to dimension of the vector. The result will have an `logical(1)` attribute “trafo”, which is set to the value of argument `trafo`.

---

<code>generateGridDesign</code>	<i>Generates a grid design for a parameter set.</i>
---------------------------------	---

---

### Description

The following types of columns are created:

<code>numeric(vector)</code>	<code>numeric</code>
<code>integer(vector)</code>	<code>integer</code>
<code>discrete(vector)</code>	<code>factor</code> (names of values = levels)
<code>logical(vector)</code>	<code>logical</code>

If you want to convert these, look at `BBmisc::convertDataFrameCols()`. Dependent parameters whose constraints are unsatisfied generate NA entries in their respective columns. For discrete vectors the levels and their order will be preserved.

The algorithm currently performs these steps:

1. We create a grid. For numerics and integers we use the specified resolution. For discretets all values will be taken.
2. Forbidden points are removed.



3. Parameters are trafoed (potentially, depending on the setting of argument trafo); dependent parameters whose constraints are unsatisfied are set to NA entries.
4. Duplicated points are removed. Duplicated points are not generated in a grid design, but the way parameter dependencies are handled make this possible.

Note that if you have trafoes attached to your params, the complete creation of the design (except for the detection of invalid parameters w.r.t to their requires setting) takes place on the UNTRANSFORMED scale. So this function creates a regular grid over the param space on the UNTRANSFORMED scale, but not necessarily the transformed scale.

generateDesign will NOT work if there are dependencies over multiple levels of parameters and the dependency is only given with respect to the “previous” parameter. A current workaround is to state all dependencies on all parameters involved. (We are working on it.)

### Usage

```
generateGridDesign(par.set, resolution, trafo = FALSE)
```

### Arguments

par.set	<a href="#">ParamSet</a> Parameter set.
resolution	(integer) Resolution of the grid for each numeric/integer parameter in par.set. For vector parameters, it is the resolution per dimension. Either pass one resolution for all parameters, or a named vector.
trafo	(logical(1)) Transform all parameters by using their respective transformation functions. Default is FALSE.

### Value

[data.frame](#). Columns are named by the ids of the parameters. If the par.set argument contains a vector parameter, its corresponding column names in the design are the parameter id concatenated with 1 to dimension of the vector. The result will have an `logical(1)` attribute “trafo”, which is set to the value of argument trafo.

### Examples

```
ps = makeParamSet(
  makeNumericParam("x1", lower = -2, upper = 1),
  makeNumericParam("x2", lower = -2, upper = 2, trafo = function(x) x^2)
)
generateGridDesign(ps, resolution = c(x1 = 4, x2 = 5), trafo = TRUE)
```

---

generateRandomDesign *Generates a random design for a parameter set.*

---

### Description

The following types of columns are created:

numeric(vector)	numeric
integer(vector)	integer
discrete(vector)	factor (names of values = levels)
logical(vector)	logical

If you want to convert these, look at `BBmisc::convertDataFrameCols()`. For discrete vectors the levels and their order will be preserved, even if not all levels are present.

The algorithm simply calls `sampleValues()` and arranges the result in a `data.frame`.

Parameters are trafoed (potentially, depending on the setting of argument `trafo`); dependent parameters whose constraints are unsatisfied are set to NA entries.

`generateRandomDesign` will NOT work if there are dependencies over multiple levels of parameters and the dependency is only given with respect to the “previous” parameter. A current workaround is to state all dependencies on all parameters involved. (We are working on it.)

Note that if you have trafo attached to your params, the complete creation of the design (except for the detection of invalid parameters w.r.t to their requires setting) takes place on the UNTRANSFORMED scale. So this function samples from a uniform density over the param space on the UNTRANSFORMED scale, but not necessarily the transformed scale.

### Usage

```
generateRandomDesign(n = 10L, par.set, trafo = FALSE)
```

### Arguments

n	(integer(1)) Number of samples in design. Default is 10.
par.set	<a href="#">ParamSet</a> Parameter set.
trafo	(logical(1)) Transform all parameters by using their respective transformation functions. Default is FALSE.

### Value

`data.frame`. Columns are named by the ids of the parameters. If the `par.set` argument contains a vector parameter, its corresponding column names in the design are the parameter id concatenated with 1 to dimension of the vector. The result will have an `logical(1)` attribute “trafo”, which is set to the value of argument `trafo`.

---

getDefaults	<i>Return defaults of parameters in parameter set.</i>
-------------	--

---

### Description

Return defaults of single parameters or parameters in a parameter set or a list of parameters.

### Usage

```
getDefaults(obj, include.null = FALSE, dict = NULL)
```

### Arguments

obj	( <a href="#">Param()</a>   <a href="#">ParamSet()</a>   list) Parameter, parameter set or list of parameters, whose defaults should be extracted. In case the default values contain expressions, they will be evaluated using the provided dictionary (dict).
include.null	(logical(1)) Include NULL entries for parameters without default values in the result list? Note that this can be slightly dangerous as NULL might be used as default value for other parameters. Default is FALSE.
dict	(environment   list   NULL) Environment or list which will be used for evaluating the variables of expressions within a parameter, parameter set or list of parameters. The default is NULL.

### Value

named list. Named (and in case of a [ParamSet\(\)](#), in the same order). Parameters without defaults are not present in the list.

### Examples

```
ps1 = makeParamSet(
  makeDiscreteParam("x", values = c("a", "b"), default = "a"),
  makeNumericVectorParam("y", len = 2),
  makeIntegerParam("z", default = 99)
)
getDefaults(ps1, include.null = TRUE)

ps2 = makeParamSet(
  makeNumericVectorParam("a", len = expression(k), default = expression(p)),
  makeIntegerParam("b", default = 99),
  makeLogicalParam("c")
)
getDefaults(ps2, dict = list(k = 3, p = 5.4))
```

---

getLower *Get lower / upper bounds and allowed discrete values for parameters.*

---

### Description

getLower and getUpper return a numerical vector of lower and upper bounds, getValues returns a list of possible value sets for discrete parameters.

Parameters for which such bound make no sense - due to their type - are not present in the result.

### Usage

```
getLower(obj, with.nr = FALSE, dict = NULL)
```

```
getUpper(obj, with.nr = FALSE, dict = NULL)
```

```
getValues(obj, dict = NULL)
```

### Arguments

obj	(Param()   ParamSet()   list) Parameter, parameter set or list of parameters, whose boundaries and/or values should be extracted. In case the boundaries or values contain expressions, they will be evaluated using the provided dictionary dict.
with.nr	(logical(1)) Should number from 1 to length be appended to names of vector params? Default is FALSE.
dict	(environment   list   NULL) Environment or list which will be used for evaluating the variables of expressions within a parameter, parameter set or list of parameters. The default is NULL.

### Value

vector | list. Named by parameter ids.

### Examples

```
ps = makeParamSet(
  makeNumericParam("u"),
  makeDiscreteParam("v", values = c("a", "b")),
  makeIntegerParam("w", lower = expression(ceiling(p / 3)), upper = 2),
  makeDiscreteParam("x", values = 1:2),
  makeNumericVectorParam("y", len = 2, lower = c(0, 10), upper = c(1, 11)),
  keys = "p"
)
getLower(ps, dict = list(p = 7))
getUpper(ps)
```

```

ps = makeParamSet(
  makeNumericParam("u"),
  makeDiscreteParam("w", values = list(a = list(), b = NULL))
)
getValues(ps)

par.vals = list(
  u = makeNumericParam("u"),
  v = makeIntegerParam("v", lower = 1, upper = 2),
  w = makeDiscreteParam("w", values = 1:2),
  x = makeNumericVectorParam("x", len = 2, lower = c(3, 1), upper = expression(n))
)
getLower(par.vals)
getUpper(par.vals, dict = list(n = 12))

```

---

getOptPathBestIndex    *Get index of the best element from optimization path.*

---

## Description

Get index of the best element from optimization path.

## Usage

```

getOptPathBestIndex(
  op,
  y.name = op$y.names[1],
  dob = op$env$dob,
  eol = op$env$eol,
  ties = "last"
)

```

## Arguments

op	<a href="#">OptPath</a> Optimization path.
y.name	(character(1)) Name of target value to decide which element is best. Default is y.names[1].
dob	<a href="#">integer</a> Vector of date-of-birth values to further subset the result. Only elements with a date-of-birth included in dob are selected. Default is all.
eol	<a href="#">integer</a> Vector of end-of-life values to further subset the result. Only elements with an end-of-life included in eol are selected. Default is all.

`ties` (character(1))  
 How should ties be broken when more than one optimal element is found? “all”: return all indices, “first”: return first optimal element in path, “last”: return last optimal element in path, “random”: return random optimal element in path. Default is “last”.

### Value

`integer` Index or indices into path. See `ties`.

### See Also

Other `optpath`: `OptPath`, `addOptPathEl()`, `getOptPathCol()`, `getOptPathCols()`, `getOptPathDOB()`, `getOptPathEOL()`, `getOptPathEl()`, `getOptPathErrorMessage()`, `getOptPathExecTimes()`, `getOptPathLength()`, `getOptPathParetoFront()`, `getOptPathX()`, `getOptPathY()`, `setOptPathElDOB()`, `setOptPathElEOL()`

### Examples

```
ps = makeParamSet(makeNumericParam("x"))
op = makeOptPathDF(par.set = ps, y.names = "y", minimize = TRUE)
addOptPathEl(op, x = list(x = 1), y = 5)
addOptPathEl(op, x = list(x = 2), y = 3)
addOptPathEl(op, x = list(x = 3), y = 9)
addOptPathEl(op, x = list(x = 4), y = 3)
as.data.frame(op)
getOptPathBestIndex(op)
getOptPathBestIndex(op, ties = "first")
```

---

<code>getOptPathCol</code>	<i>Get column from the optimization path.</i>
----------------------------	---

---

### Description

Get column from the optimization path.

### Usage

```
getOptPathCol(op, name, dob, eol)
```

### Arguments

<code>op</code>	<code>OptPath</code>	Optimization path.
<code>name</code>	(character(1))	Name of the column.
<code>dob</code>	<code>integer</code>	Vector of date-of-birth values to further subset the result. Only elements with a date-of-birth included in <code>dob</code> are selected. Default is all.

`eol` [integer](#)  
 Vector of end-of-life values to further subset the result. Only elements with an end-of-life included in `eol` are selected. Default is all.

**Value**

Single column as a vector.

**See Also**

Other optpath: [OptPath](#), [addOptPathEl\(\)](#), [getOptPathBestIndex\(\)](#), [getOptPathCols\(\)](#), [getOptPathDOB\(\)](#), [getOptPathEOL\(\)](#), [getOptPathEl\(\)](#), [getOptPathErrorMessages\(\)](#), [getOptPathExecTimes\(\)](#), [getOptPathLength\(\)](#), [getOptPathParetoFront\(\)](#), [getOptPathX\(\)](#), [getOptPathY\(\)](#), [setOptPathEIDOB\(\)](#), [setOptPathELEOL\(\)](#)

---

<code>getOptPathCols</code>	<i>Get columns from the optimization path.</i>
-----------------------------	--

---

**Description**

Get columns from the optimization path.

**Usage**

```
getOptPathCols(op, names, dob, eol, row.names = NULL)
```

**Arguments**

`op` [OptPath](#)  
 Optimization path.

`names` [character](#)  
 Names of the columns.

`dob` [integer](#)  
 Vector of date-of-birth values to further subset the result. Only elements with a date-of-birth included in `dob` are selected. Default is all.

`eol` [integer](#)  
 Vector of end-of-life values to further subset the result. Only elements with an end-of-life included in `eol` are selected. Default is all.

`row.names` [character](#)  
 Row names for result. Default is none.

**Value**

[data.frame](#).

**See Also**

Other optpath: [OptPath](#), [addOptPathEl\(\)](#), [getOptPathBestIndex\(\)](#), [getOptPathCol\(\)](#), [getOptPathDOB\(\)](#), [getOptPathEOL\(\)](#), [getOptPathEl\(\)](#), [getOptPathErrorMessages\(\)](#), [getOptPathExecTimes\(\)](#), [getOptPathLength\(\)](#), [getOptPathParetoFront\(\)](#), [getOptPathX\(\)](#), [getOptPathY\(\)](#), [setOptPathEIDOB\(\)](#), [setOptPathEIEOL\(\)](#)

---

getOptPathDOB

*Get date-of-birth vector from the optimization path.*

---

**Description**

Get date-of-birth vector from the optimization path.

**Usage**

```
getOptPathDOB(op, dob, eol)
```

**Arguments**

op	<a href="#">OptPath</a> Optimization path.
dob	<a href="#">integer</a> Vector of date-of-birth values to further subset the result. Only elements with a date-of-birth included in dob are selected. Default is all.
eol	<a href="#">integer</a> Vector of end-of-life values to further subset the result. Only elements with an end-of-life included in eol are selected. Default is all.

**Value**

[integer](#).

**See Also**

Other optpath: [OptPath](#), [addOptPathEl\(\)](#), [getOptPathBestIndex\(\)](#), [getOptPathCol\(\)](#), [getOptPathCols\(\)](#), [getOptPathEOL\(\)](#), [getOptPathEl\(\)](#), [getOptPathErrorMessages\(\)](#), [getOptPathExecTimes\(\)](#), [getOptPathLength\(\)](#), [getOptPathParetoFront\(\)](#), [getOptPathX\(\)](#), [getOptPathY\(\)](#), [setOptPathEIDOB\(\)](#), [setOptPathEIEOL\(\)](#)



---

getOptPathEl	<i>Get an element from the optimization path.</i>
--------------	---

---

### Description

Dependent parameters whose requirements are not satisfied are represented by a scalar NA in the elements of x of the return value.

### Usage

```
getOptPathEl(op, index)
```

### Arguments

op	<a href="#">OptPath</a> Optimization path.
index	(integer(1)) Index of element.

### Value

List with elements x (named list), y (named numeric), dob integer(1), eol integer(1). The elements error.message (character(1)), exec.time (numeric(1)) and extra (named list) are there if the respective options in [OptPath\(\)](#) are enabled.

### See Also

Other optpath: [OptPath](#), [addOptPathEl\(\)](#), [getOptPathBestIndex\(\)](#), [getOptPathCol\(\)](#), [getOptPathCols\(\)](#), [getOptPathDOB\(\)](#), [getOptPathEOL\(\)](#), [getOptPathErrorMessages\(\)](#), [getOptPathExecTimes\(\)](#), [getOptPathLength\(\)](#), [getOptPathParetoFront\(\)](#), [getOptPathX\(\)](#), [getOptPathY\(\)](#), [setOptPathEIDOB\(\)](#), [setOptPathEIEOL\(\)](#)

---

getOptPathEOL	<i>Get end-of-life vector from the optimization path.</i>
---------------	---

---

### Description

Get end-of-life vector from the optimization path.

### Usage

```
getOptPathEOL(op, dob, eol)
```

**Arguments**

op	<a href="#">OptPath</a> Optimization path.
dob	<a href="#">integer</a> Vector of date-of-birth values to further subset the result. Only elements with a date-of-birth included in dob are selected. Default is all.
eol	<a href="#">integer</a> Vector of end-of-life values to further subset the result. Only elements with an end-of-life included in eol are selected. Default is all.

**Value**

[integer](#).

**See Also**

Other optpath: [OptPath](#), [addOptPathEl\(\)](#), [getOptPathBestIndex\(\)](#), [getOptPathCol\(\)](#), [getOptPathCols\(\)](#), [getOptPathDOB\(\)](#), [getOptPathEl\(\)](#), [getOptPathErrorMessages\(\)](#), [getOptPathExecTimes\(\)](#), [getOptPathLength\(\)](#), [getOptPathParetoFront\(\)](#), [getOptPathX\(\)](#), [getOptPathY\(\)](#), [setOptPathElDOB\(\)](#), [setOptPathElEOL\(\)](#)

---

getOptPathErrorMessages

*Get error-message vector from the optimization path.*

---

**Description**

Get error-message vector from the optimization path.

**Usage**

```
getOptPathErrorMessages(op, dob, eol)
```

**Arguments**

op	<a href="#">OptPath</a> Optimization path.
dob	<a href="#">integer</a> Vector of date-of-birth values to further subset the result. Only elements with a date-of-birth included in dob are selected. Default is all.
eol	<a href="#">integer</a> Vector of end-of-life values to further subset the result. Only elements with an end-of-life included in eol are selected. Default is all.

**Value**

[character](#).

**See Also**

Other optpath: [OptPath](#), [addOptPathEl\(\)](#), [getOptPathBestIndex\(\)](#), [getOptPathCol\(\)](#), [getOptPathCols\(\)](#), [getOptPathDOB\(\)](#), [getOptPathEOL\(\)](#), [getOptPathEl\(\)](#), [getOptPathExecTimes\(\)](#), [getOptPathLength\(\)](#), [getOptPathParetoFront\(\)](#), [getOptPathX\(\)](#), [getOptPathY\(\)](#), [setOptPathElDOB\(\)](#), [setOptPathElEOL\(\)](#)

---

getOptPathExecTimes     *Get exec-time vector from the optimization path.*

---

**Description**

Get exec-time vector from the optimization path.

**Usage**

```
getOptPathExecTimes(op, dob, eol)
```

**Arguments**

op	<a href="#">OptPath</a> Optimization path.
dob	<a href="#">integer</a> Vector of date-of-birth values to further subset the result. Only elements with a date-of-birth included in dob are selected. Default is all.
eol	<a href="#">integer</a> Vector of end-of-life values to further subset the result. Only elements with an end-of-life included in eol are selected. Default is all.

**Value**

[numeric](#).

**See Also**

Other optpath: [OptPath](#), [addOptPathEl\(\)](#), [getOptPathBestIndex\(\)](#), [getOptPathCol\(\)](#), [getOptPathCols\(\)](#), [getOptPathDOB\(\)](#), [getOptPathEOL\(\)](#), [getOptPathEl\(\)](#), [getOptPathErrorMessage\(\)](#), [getOptPathLength\(\)](#), [getOptPathParetoFront\(\)](#), [getOptPathX\(\)](#), [getOptPathY\(\)](#), [setOptPathElDOB\(\)](#), [setOptPathElEOL\(\)](#)

---

getOptPathLength      *Get the length of the optimization path.*

---

### Description

Dependent parameters whose requirements are not satisfied are represented by a scalar NA in the output.

### Usage

```
getOptPathLength(op)
```

### Arguments

op                      [OptPath](#)  
 Optimization path.

### Value

integer(1)

### See Also

Other optpath: [OptPath](#), [addOptPathEl\(\)](#), [getOptPathBestIndex\(\)](#), [getOptPathCol\(\)](#), [getOptPathCols\(\)](#), [getOptPathDOB\(\)](#), [getOptPathEOL\(\)](#), [getOptPathEl\(\)](#), [getOptPathErrorMessage\(\)](#), [getOptPathExecTimes\(\)](#), [getOptPathParetoFront\(\)](#), [getOptPathX\(\)](#), [getOptPathY\(\)](#), [setOptPathElDOB\(\)](#), [setOptPathElEOL\(\)](#)

---

getOptPathParetoFront      *Get indices of pareto front of optimization path.*

---

### Description

Get indices of pareto front of optimization path.

### Usage

```
getOptPathParetoFront(  
  op,  
  y.names = op$y.names,  
  dob = op$env$dob,  
  eol = op$env$eol,  
  index = FALSE  
)
```

**Arguments**

op	<a href="#">OptPath</a> Optimization path.
y.names	<a href="#">character</a> Names of performance measures to construct pareto front for. Default is all performance measures.
dob	<a href="#">integer</a> Vector of date-of-birth values to further subset the result. Only elements with a date-of-birth included in dob are selected. Default is all.
eol	<a href="#">integer</a> Vector of end-of-life values to further subset the result. Only elements with an end-of-life included in eol are selected. Default is all.
index	(logical(1)) Return indices into path of front or y-matrix of nondominated points? Default is FALSE.

**Value**

matrix | integer. Either matrix (with named columns) of points of front in objective space or indices into path for front.

**See Also**

Other optpath: [OptPath](#), [addOptPathEl\(\)](#), [getOptPathBestIndex\(\)](#), [getOptPathCol\(\)](#), [getOptPathCols\(\)](#), [getOptPathDOB\(\)](#), [getOptPathEOL\(\)](#), [getOptPathEl\(\)](#), [getOptPathErrorMessage\(\)](#), [getOptPathExecTimes\(\)](#), [getOptPathLength\(\)](#), [getOptPathX\(\)](#), [getOptPathY\(\)](#), [setOptPathElDOB\(\)](#), [setOptPathElEOL\(\)](#)

**Examples**

```
ps = makeParamSet(makeNumericParam("x"))
op = makeOptPathDF(par.set = ps, y.names = c("y1", "y2"), minimize = c(TRUE, TRUE))
addOptPathEl(op, x = list(x = 1), y = c(5, 3))
addOptPathEl(op, x = list(x = 2), y = c(2, 4))
addOptPathEl(op, x = list(x = 3), y = c(9, 4))
addOptPathEl(op, x = list(x = 4), y = c(4, 9))
as.data.frame(op)
getOptPathParetoFront(op)
getOptPathParetoFront(op, index = TRUE)
```

---

getOptPathX	<i>Get data.frame of input points (X-space) referring to the param set from the optimization path.</i>
-------------	--

---

**Description**

Get data.frame of input points (X-space) referring to the param set from the optimization path.

**Usage**

```
getOptPathX(op, dob, eol)
```

**Arguments**

op	<a href="#">OptPath</a> Optimization path.
dob	<a href="#">integer</a> Vector of date-of-birth values to further subset the result. Only elements with a date-of-birth included in dob are selected. Default is all.
eol	<a href="#">integer</a> Vector of end-of-life values to further subset the result. Only elements with an end-of-life included in eol are selected. Default is all.

**Value**

[data.frame](#).

**See Also**

Other optpath: [OptPath](#), [addOptPathEl\(\)](#), [getOptPathBestIndex\(\)](#), [getOptPathCol\(\)](#), [getOptPathCols\(\)](#), [getOptPathDOB\(\)](#), [getOptPathEOL\(\)](#), [getOptPathEl\(\)](#), [getOptPathErrorMessages\(\)](#), [getOptPathExecTimes\(\)](#), [getOptPathLength\(\)](#), [getOptPathParetoFront\(\)](#), [getOptPathY\(\)](#), [setOptPathEIDOB\(\)](#), [setOptPathEIEOL\(\)](#)

---

getOptPathY

*Get y-vector or y-matrix from the optimization path.*

---

**Description**

Get y-vector or y-matrix from the optimization path.

**Usage**

```
getOptPathY(op, names, dob, eol, drop = TRUE)
```

**Arguments**

op	<a href="#">OptPath</a> Optimization path.
names	<a href="#">character</a> Names of performance measure. Default is all performance measures in path.
dob	<a href="#">integer</a> Vector of date-of-birth values to further subset the result. Only elements with a date-of-birth included in dob are selected. Default is all.

eol	<a href="#">integer</a> Vector of end-of-life values to further subset the result. Only elements with an end-of-life included in eol are selected. Default is all.
drop	(logical(1)) Return vector instead of matrix when only one y-column was selected? Default is TRUE.

**Value**

(numeric | matrix). The columns of the matrix are always named.

**See Also**

Other optpath: [OptPath](#), [addOptPathEl\(\)](#), [getOptPathBestIndex\(\)](#), [getOptPathCol\(\)](#), [getOptPathCols\(\)](#), [getOptPathDOB\(\)](#), [getOptPathEOL\(\)](#), [getOptPathEl\(\)](#), [getOptPathErrorMessages\(\)](#), [getOptPathExecTimes\(\)](#), [getOptPathLength\(\)](#), [getOptPathParetoFront\(\)](#), [getOptPathX\(\)](#), [setOptPathEIDOB\(\)](#), [setOptPathEIEOL\(\)](#)

---

getParamIds

*Return ids of parameters in parameter set.*

---

**Description**

Useful if vectors are included.

**Usage**

```
getParamIds(par, repeated = FALSE, with.nr = FALSE)
```

**Arguments**

par	( <a href="#">Param</a>   <a href="#">ParamSet</a> ) Parameter or parameter set.
repeated	(logical(1)) Should ids be repeated length-times if parameter is a vector? Default is FALSE.
with.nr	(logical(1)) Should number from 1 to length be appended to id if repeated is TRUE? Otherwise ignored. Default is FALSE.

**Value**

[character](#).

**Examples**

```
ps = makeParamSet(
  makeNumericParam("u"),
  makeIntegerVectorParam("v", len = 2)
)
getParamIds(ps)
getParamIds(ps, repeated = TRUE)
getParamIds(ps, repeated = TRUE, with.nr = TRUE)
```

---

getParamLengths	<i>Return lengths of single parameters or parameters in parameter set.</i>
-----------------	--

---

**Description**

Useful for vector parameters.

**Usage**

```
getParamLengths(par, dict = NULL)
```

**Arguments**

par	( <a href="#">Param</a>   <a href="#">ParamSet</a> ) Parameter or parameter set.
dict	(environment   <a href="#">list</a>   NULL) Environment or list which will be used for evaluating the variables of expressions within a parameter, parameter set or list of parameters. The default is NULL.

**Value**

(integer). Named and in the same order as the input for [ParamSet\(\)](#) input.

**Examples**

```
ps = makeParamSet(
  makeNumericParam("u"),
  makeIntegerParam("v", lower = 1, upper = 2),
  makeDiscreteParam("w", values = 1:2),
  makeDiscreteVectorParam("x", len = 2, values = c("a", "b"))
)
getParamLengths(ps)
# the length of the vector x is 2, for all other single value parameters the length is 1.

par = makeNumericVectorParam("x", len = expression(k), lower = 0)
getParamLengths(par, dict = list(k = 4))
```



---

getParamNr	<i>Return number of parameters in set.</i>
------------	--

---

**Description**

Either number of parameters or sum over parameter lengths.

**Usage**

```
getParamNr(par.set, devectorize = FALSE)
```

**Arguments**

par.set	<a href="#">ParamSet</a> Parameter set.
devectorize	(logical(1)) Sum over length of vector parameters? Default is FALSE.

**Value**

[integer](#).

**Examples**

```
ps = makeParamSet(
  makeNumericParam("u"),
  makeDiscreteVectorParam("x", len = 2, values = c("a", "b"))
)
getParamNr(ps)
getParamNr(ps, devectorize = TRUE)
```

---

getParamSet	<i>Get parameter set.</i>
-------------	---------------------------

---

**Description**

getParamSet is a generic and can be called to extract the ParamSet from different objects.

**Usage**

```
getParamSet(x)
```

**Arguments**

x	(object) Object to extract the ParamSet from.
---	--

**Value**

ParamHelpers::ParamSet()

---

getParamTypeCounts      *Returns information on the number of parameters of a each type.*

---

**Description**

Returns information on the number of parameters of a each type.

**Usage**

```
getParamTypeCounts(par.set)
```

**Arguments**

par.set      [ParamSet](#)  
Parameter set.

**Value**

[list](#) Named list which contains for each supported parameter type the number of parameters of this type in the given ParamSet.

---

getParamTypes      *Returns type information for a parameter set.*

---

**Description**

Returns type information for a parameter set.

**Usage**

```
getParamTypes(
  par.set,
  df.cols = FALSE,
  df.discretes.as.factor = TRUE,
  use.names = FALSE,
  with.nr = TRUE
)
```

**Arguments**

par.set	<a href="#">ParamSet</a> Parameter set.
df.cols	(logical(1)) If FALSE simply return the parameter types in the set, i.e., par\$type. If TRUE, convert types so they correspond to R types of a data.frame where values of this set might be stored. This also results in replication of output types for vector parameters. Default is FALSE.
df.discretes.as.factor	(logical(1)) If df.cols is TRUE: Should type for discrete params be factor or character? Default is TRUE.
use.names	(logical(1)) Name the result vector? Default is FALSE.
with.nr	(logical(1)) Should number from 1 to length be appended to name? Only used if use.names and df.cols are TRUE. Default is TRUE.

**Value**

[character](#).

---

getRequirements	<i>Return all require-expressions of a param set.</i>
-----------------	---

---

**Description**

Returns all requires-objects of a param set as a list.

**Usage**

```
getRequirements(par.set, remove.null = TRUE)
```

**Arguments**

par.set	<a href="#">ParamSet</a> Parameter set.
remove.null	(logical(1)) If not set, params without a requires-setting will result in a NULL element in the returned list, otherwise they are removed. Default is TRUE.

**Value**

xnamed list. Named list of require-call-objects, lengths corresponds to number of params (potentially only the subset with requires-field), named with with param ids.

---

getTypeStrings	<i>Get parameter type-strings.</i>
----------------	------------------------------------

---

**Description**

Returns type strings used in param\$type for certain groups of parameters.

**Usage**

```
getTypeStringsAll()
getTypeStringsNumeric(include.int = TRUE)
getTypeStringsNumericStrict()
getTypeStringsInteger()
getTypeStringsCharacter()
getTypeStringsDiscrete(include.logical = TRUE)
getTypeStringsLogical()
```

**Arguments**

include.int	(logical(1)) Are integers also considered to be numeric? Default is TRUE.
include.logical	(logical(1)) Are logicals also considered to be discrete? Default is TRUE.

**Value**

character.

---

hasExpression	<i>Check if parameter values contain expressions.</i>
---------------	---

---

**Description**

Checks if a parameter, parameter set or list of parameters contain expressions.

**Usage**

```
hasExpression(obj)
```

**Arguments**

obj            ([Param\(\)](#) | [ParamHelpers::ParamSet\(\)](#) | list)  
Parameter, parameter set or list of parameters.

**Value**

logical(1).

**Examples**

```
ps1 = makeParamSet(
  makeNumericParam("x", lower = 1, upper = 2),
  makeNumericParam("y", lower = 1, upper = 10)
)

ps2 = makeParamSet(
  makeNumericLearnerParam("x", lower = 1, upper = 2),
  makeNumericLearnerParam("y", lower = 1, upper = expression(p))
)

hasExpression(ps1)
hasExpression(ps2)
```

---

**hasFiniteBoxConstraints**

*Checks if a parameter or each parameter of a parameter set has ONLY finite lower and upper bounds.*

---

**Description**

Checks if a parameter or each parameter of a parameter set has ONLY finite lower and upper bounds.

**Usage**

```
hasFiniteBoxConstraints(par, dict = NULL)
```

**Arguments**

par            ([Param](#) | [ParamSet](#))  
Parameter or parameter set.

dict            (environment | [list](#) | NULL)  
Environment or list which will be used for evaluating the variables of expressions within a parameter, parameter set or list of parameters. The default is NULL.

**Value**

logical(1)

---

hasForbidden	<i>Check parameter set for forbidden region.</i>
--------------	--

---

**Description**

Check parameter set for forbidden region.

**Usage**

```
hasForbidden(par.set)
```

**Arguments**

par.set	<a href="#">ParamSet</a> Parameter set.
---------	--

**Value**

```
logical(1).
```

---

hasRequires	<i>Check parameter / parameter set for requirements / dependencies.</i>
-------------	---

---

**Description**

TRUE iff the parameter has any requirements or any parameter in the set has requirements.

**Usage**

```
hasRequires(par)
```

**Arguments**

par	<a href="#">(Param   ParamSet)</a> Parameter or parameter set.
-----	---

**Value**

```
logical(1).
```

---

hasTrafo	<i>Check parameter / parameter set for trafos.</i>
----------	--

---

**Description**

TRUE iff the parameter has any trafos or any parameter in the set has trafos.

**Usage**

hasTrafo(par)

**Arguments**

par	( <a href="#">Param</a>   <a href="#">ParamSet</a> ) Parameter or parameter set.
-----	---

**Value**

logical(1).

---

hasType	<i>Check whether parameter set contains a certain type.</i>
---------	---

---

**Description**

TRUE if the parameter set contains at least one parameter of the mentioned type x. Type x always subsumes x and x-vector.

**Usage**

hasDiscrete(par.set, include.logical = TRUE)

hasInteger(par.set)

hasLogical(par.set)

hasCharacter(par.set)

hasNumeric(par.set, include.int = TRUE)

**Arguments**

par.set	<a href="#">ParamSet</a> Parameter set.
include.logical	(logical(1)) Are logicals also considered to be discrete? Default is TRUE.
include.int	(logical(1)) Are integers also considered to be numeric? Default is TRUE.

**Value**

logical(1)

---

isEmpty	<i>Check whether parameter set is empty.</i>
---------	--

---

**Description**

Check whether parameter set is empty.

**Usage**

```
isEmpty(par.set)
```

**Arguments**

par.set	(ParamSet()) Parameter set.
---------	--------------------------------

**Value**

logical(1).

---

isFeasible	<i>Check if parameter value is valid.</i>
------------	---

---

**Description**

Check if a parameter value satisfies the constraints of the parameter description. This includes the requires expressions and the forbidden expression, if par is a [ParamSet\(\)](#). If requires is not satisfied, the parameter value must be set to scalar NA to be still feasible, a single scalar even in a case of a vector parameter. If the result is FALSE the attribute "warning" is attached which gives the reason for the negative result.

If the parameter has cnames, these are also checked.



**Usage**

```
isFeasible(par, x, use.defaults = FALSE, filter = FALSE)
```

**Arguments**

par	(Param   ParamSet) Parameter or parameter set.
x	(any) Single value to check against the Param or ParamSet. For a ParamSet x must be a list. x has to contain the untransformed values. If the list is named, it is possible to only pass a subset of parameters defined in the ParamSet() par. In that case, only conditions regarding the passed parameters are checked. (Note that this might not work if one of the passed params has a requires setting which refers to an unpassed param.)
use.defaults	(logical(1)) Whether defaults of the Param()/ParamSet() should be used if no values are supplied. If the defaults have requirements that are not met by x it will be feasible nonetheless. Default is FALSE.
filter	(logical(1)) Whether the ParamSet() should be reduced to the space of the given Param Values. Note that in case of use.defaults = TRUE the filtering will be conducted after the insertion of the default values. Default is FALSE.

**Value**

logical(1).

**Examples**

```
p = makeNumericParam("x", lower = -1, upper = 1)
isFeasible(p, 0) # True
isFeasible(p, 2) # False, out of bounds
isFeasible(p, "a") # False, wrong type
# now for parameter sets
ps = makeParamSet(
  makeNumericParam("x", lower = -1, upper = 1),
  makeDiscreteParam("y", values = c("a", "b"))
)
isFeasible(ps, list(0, "a")) # True
isFeasible(ps, list("a", 0)) # False, wrong order
```

---

isForbidden

*Check whether parameter setting lies in forbidden region of parameter set.*

---

**Description**

Parameter sets without a forbidden region always return FALSE.

**Usage**

```
isForbidden(par.set, x)
```

**Arguments**

par.set	<a href="#">ParamSet</a> Parameter set.
x	(named list) Parameter setting to check.

**Value**

```
logical(1).
```

---

isRequiresOk	<i>Check if parameter requirements are met.</i>
--------------	---

---

**Description**

Check if a parameter value satisfies the requirements of the parameter description. This only checks the requires expressions.

**Usage**

```
isRequiresOk(par.set, par.vals, ids = names(par.vals), use.defaults = TRUE)
```

**Arguments**

par.set	<a href="#">ParamSet</a> Parameter set.
par.vals	(list()) List of parameter settings.
ids	(character()) ids of the param.vals to check. Default is names(par.vals).
use.defaults	(logical()) Some requirements rely on default values of the par.set. Default is TRUE, which means that if the value is not present in par.vals the default value will be considered.

**Value**

```
logical(1)
```

---

isSpecialValue	<i>Is a given value in the list of special values for a param?</i>
----------------	--

---

**Description**

See title.

**Usage**

```
isSpecialValue(par, x)
```

**Arguments**

par	<a href="#">Param</a> Parameter.
x	(any) Single value to check.

**Value**

```
logical(1).
```

---

isType	<i>Check parameter / parameter set contain ONLY a certain type.</i>
--------	---

---

**Description**

An empty param set is considered to be of all types.

**Usage**

```
isNumeric(par, include.int = TRUE)  
isDiscrete(par, include.logical = TRUE)  
isInteger(par)  
isLogical(par)  
isCharacter(par)
```

**Arguments**

par	(Param   ParamSet) Parameter or parameter set.
include.int	(logical(1)) Are integers also considered to be numeric? Default is TRUE.
include.logical	(logical(1)) Are logicals also considered to be discrete? Default is TRUE.

**Value**

(logical(1))

---

isTypeString	<i>Check if type string is of certain type.</i>
--------------	---

---

**Description**

TRUE iff the type string is a certain type, e.g. isIntegerTypeString checks if we have “integer” or “integervector”, and isVectorTypeString check if we have “\*vector”.

**Usage**

```
isNumericTypeString(type, include.int = TRUE)
isIntegerTypeString(type)
isCharacterTypeString(type)
isDiscreteTypeString(type, include.logical = TRUE)
isLogicalTypeString(type)
isVectorTypeString(type)
```

**Arguments**

type	(character(1)) Type string.
include.int	(logical(1)) Are integers also considered to be numeric? Default is TRUE.
include.logical	(logical(1)) Are logicals also considered to be discrete? Default is TRUE.

**Value**

(logical(1))

---

`isVector`*Check parameter / parameter set for vector params.*

---

**Description**

TRUE if the parameter is a vector parameter or all parameters in the set are vector parameters.

**Usage**`isVector(par)`**Arguments**

`par` ([Param](#) | [ParamSet](#))  
Parameter or parameter set.

**Value**

logical(1).

---

`LearnerParam`*Create a description object for a parameter of a machine learning algorithm.*

---

**Description**

This specializes [Param\(\)](#) by adding a few more attributes, like a default value, whether it refers to a training or a predict function, etc. Note that you can set `length` to NA

The S3 class is a [Param\(\)](#) which additionally stores these elements:

**when** character(1) See argument of same name.

See the note in [Param\(\)](#) about being able to pass expressions to certain arguments.

**Usage**

```
makeNumericLearnerParam(  
  id,  
  lower = -Inf,  
  upper = Inf,  
  allow.inf = FALSE,  
  default,  
  when = "train",  
  requires = NULL,  
  tunable = TRUE,  
  special.vals = list()  
)  
  
makeNumericVectorLearnerParam(  
  id,  
  len = as.integer(NA),  
  lower = -Inf,  
  upper = Inf,  
  allow.inf = FALSE,  
  default,  
  when = "train",  
  requires = NULL,  
  tunable = TRUE,  
  special.vals = list()  
)  
  
makeIntegerLearnerParam(  
  id,  
  lower = -Inf,  
  upper = Inf,  
  default,  
  when = "train",  
  requires = NULL,  
  tunable = TRUE,  
  special.vals = list()  
)  
  
makeIntegerVectorLearnerParam(  
  id,  
  len = as.integer(NA),  
  lower = -Inf,  
  upper = Inf,  
  default,  
  when = "train",  
  requires = NULL,  
  tunable = TRUE,  
  special.vals = list()  
)
```

```
makeDiscreteLearnerParam(  
  id,  
  values,  
  default,  
  when = "train",  
  requires = NULL,  
  tunable = TRUE,  
  special.vals = list()  
)  
  
makeDiscreteVectorLearnerParam(  
  id,  
  len = as.integer(NA),  
  values,  
  default,  
  when = "train",  
  requires = NULL,  
  tunable = TRUE,  
  special.vals = list()  
)  
  
makeLogicalLearnerParam(  
  id,  
  default,  
  when = "train",  
  requires = NULL,  
  tunable = TRUE,  
  special.vals = list()  
)  
  
makeLogicalVectorLearnerParam(  
  id,  
  len = as.integer(NA),  
  default,  
  when = "train",  
  requires = NULL,  
  tunable = TRUE,  
  special.vals = list()  
)  
  
makeUntypedLearnerParam(  
  id,  
  default,  
  when = "train",  
  requires = NULL,  
  tunable = TRUE,  
  special.vals = list()  
)
```

```

)

makeFunctionLearnerParam(
  id,
  default,
  when = "train",
  requires = NULL,
  tunable = TRUE,
  special.vals = list()
)

```

### Arguments

id	(character(1)) Name of parameter.
lower	(numeric   expression) Lower bounds. A single value of length 1 is automatically replicated to len for vector parameters. If len = NA you can only pass length-1 scalars. Default is -Inf.
upper	(numeric   expression) Upper bounds. A single value of length 1 is automatically replicated to len for vector parameters. If len = NA you can only pass length-1 scalars. Default is Inf.
allow.inf	(logical(1)) Allow infinite values for numeric and numericvector params to be feasible settings. Default is FALSE.
default	(any concrete value   expression) Default value used in learner. Note: When this is a discrete parameter make sure to use a VALUE here, not the NAME of the value. If this argument is missing, it means no default value is available.
when	(character(1)) Specifies when parameter is used in the learner: "train", "predict" or "both". Default is "train".
requires	(NULL   call   expression) States requirements on other parameters' values, so that setting this parameter only makes sense if its requirements are satisfied (dependent parameter). Can be an object created either with expression or quote, the former type is auto-converted into the later. Only really useful if the parameter is included in a (ParamSet()). Default is NULL which means no requirements.
tunable	(logical(1)) Is this parameter tunable? Defining a parameter to be not-tunable allows to mark arguments like, e.g., "verbose" or other purely technical stuff. Note that this flag is most likely not respected by optimizing procedures unless stated otherwise. Default is TRUE (except for untyped, function, character and characterVector) which means it is tunable.



special.vals	(list()) A list of special values the parameter can except which are outside of the defined range. Default is an empty list.
len	(integer(1)) Length of vector parameter. Can be set to NA to define a vector with unspecified length.
values	(vector   list   expression) Possible discrete values. Instead of using a vector of atomic values, you are also allowed to pass a list of quite “complex” R objects, which are used as discrete choices. If you do the latter, the elements must be uniquely named, so that the names can be used as internal representations for the choice.

**Value**

`LearnerParam()`.

---

listToDfOneRow	<i>Convert a list to a data.frame with one row</i>
----------------	--

---

**Description**

Convert a list of vectors or scalars to a `data.frame` with only one row. Names of the columns correspond to the names of elements in the list. If a vector is one list element it is spread over multiple columns and named sequentially, e.g. `a = c(5, 7)` becomes `data.frame(a1 = 5, a2 = 7)`.

**Usage**

```
listToDfOneRow(l)
```

**Arguments**

l	(list) of atomic values of vectors.
---	--

**Value**

(`data.frame`) with only one row, containing the list elements.

---

makeParamSet	<i>Construct a parameter set.</i>
--------------	-----------------------------------

---

### Description

makeParamSet: Construct from a bunch of parameters.

Multiple sets can be concatenated with c.

The constructed S3 class is simply a list that contains the element pars. pars is a list of the passed parameters, named by their ids.

If keys are provided it will automatically be checked whether all expressions within the provided parameters only contain arguments that are a subset of keys.

### Usage

```
makeParamSet(..., params = NULL, forbidden = NULL, keys = NULL)
```

```
makeNumericParamSet(id = "x", len, lower = -Inf, upper = Inf, vector = TRUE)
```

### Arguments

...	( <a href="#">Param()</a> ) Parameters.
params	(list of <a href="#">Param()</a> ) List of parameters, alternative way instead of using ...
forbidden	(NULL   R expression) States forbidden region of parameter set via an expression. Every setting which satisfies this expression is considered to be infeasible. This makes it possible to exclude more complex region of the parameter space than through simple constraints or requires-conditions (although these should be always used when possible). If parameters have associated trafos, the forbidden region must always be specified on the original scale and not the transformed one. Default is NULL which means no forbidden region.
keys	<a href="#">character</a> Character vector with keys (names) of feasible variable names which will be provided via a dictionary/hash later. Default is NULL.
id	( <a href="#">character(1)</a> ) Name of parameter.
len	( <a href="#">integer(1)</a> ) Length of vector.
lower	( <a href="#">numeric</a> ) Lower bound. Default is -Inf.
upper	<a href="#">numeric</a> Upper bound. Default is Inf.

vector (logical(1))  
Should a NumericVectorParam be used instead of n NumericParam objects?  
Default is TRUE.

### Value

[ParamSet\(\)](#) | [LearnerParamSet](#). If all parameters of the ParamSet are learner parameters, the output will inherit the class [LearnerParamSet](#).

### Examples

```
makeParamSet(
  makeNumericParam("u", lower = 1),
  makeIntegerParam("v", lower = 1, upper = 2),
  makeDiscreteParam("w", values = 1:2),
  makeLogicalParam("x"),
  makeDiscreteVectorParam("y", len = 2, values = c("a", "b"))
)
makeParamSet(
  makeNumericParam("u", lower = expression(ceiling(n))),
  makeIntegerParam("v", lower = expression(floor(n)), upper = 2),
  keys = c("p", "n")
)
makeParamSet(
  makeNumericParam("min", lower = 0, upper = 0.8),
  makeNumericParam("max", lower = 0.2, upper = 1),
  forbidden = expression(min > max)
)
```

---

OptPath

*Create optimization path.*

---

### Description

Optimizers can iteratively log their evaluated points into this object. Can be converted into a `data.frame` with `as.data.frame(x, discret.es.as.factor = TRUE / FALSE)`.

A optimization path has a number of path elements, where each element consists of: the value of the decision variables at this point, the values of the performance measures at this point, the date-of-birth (dob) of this point, the end-of-life (eol) of this point and possibly an error message. See also [addOptPathEl\(\)](#).

For discrete parameters always the name of the value is stored as a character. When you retrieve an element with [getOptPathEl\(\)](#), this name is converted to the actual discrete value.

If parameters have associated transformation you are free to decide whether you want to add `x` values before or after transformation, see argument `add.transformed.x` and [trafoOptPath\(\)](#).

The S3 class is a list which stores at least these elements:

**par.set** [ParamSet\(\)](#) See argument of same name.

**y.names** *character* See argument of same name.

**minimize** *logical* See argument of same name.

**add.transformed.x** *logical(1)* See argument of same name.

**env** *environment* Environment which stores the optimization path. Contents depend on implementation.

## Usage

```
makeOptPathDF(
  par.set,
  y.names,
  minimize,
  add.transformed.x = FALSE,
  include.error.message = FALSE,
  include.exec.time = FALSE,
  include.extra = FALSE
)
```

## Arguments

<code>par.set</code>	<a href="#">ParamSet</a> Parameter set.
<code>y.names</code>	( <i>character</i> ) Names of performance measures that are optimized or logged.
<code>minimize</code>	( <i>logical</i> ) Which of the performance measures in <code>y.names</code> should be minimized? Vector of booleans in the same order as <code>y.names</code> .
<code>add.transformed.x</code>	( <i>logical(1)</i> ) If some parameters have associated transformations, are you going to add <code>x</code> values after they have been transformed? Default is <code>FALSE</code> .
<code>include.error.message</code>	( <i>logical(1)</i> ) Should it be possible to include an error message string (or <code>NA</code> if no error occurred) into the path for each evaluation? This is useful if you have complex, long running objective evaluations that might fail. Default is <code>FALSE</code> .
<code>include.exec.time</code>	( <i>logical(1)</i> ) Should it be possible to include execution time of evaluations into the path for each evaluation? Note that execution time could also be entered in <code>y.names</code> as a direct performance measure. If you use this option here, time is regarded as an extra measurement you might be curious about. Default is <code>FALSE</code> .
<code>include.extra</code>	( <i>logical(1)</i> ) Should it be possible to include extra info into the path for each evaluation? Default is <code>FALSE</code> .

**See Also**

Other optpath: [addOptPathEl\(\)](#), [getOptPathBestIndex\(\)](#), [getOptPathCol\(\)](#), [getOptPathCols\(\)](#), [getOptPathDOB\(\)](#), [getOptPathEOL\(\)](#), [getOptPathEl\(\)](#), [getOptPathErrorMessages\(\)](#), [getOptPathExecTimes\(\)](#), [getOptPathLength\(\)](#), [getOptPathParetoFront\(\)](#), [getOptPathX\(\)](#), [getOptPathY\(\)](#), [setOptPathEIDOB\(\)](#), [setOptPathEIEOL\(\)](#)

---

 Param

---

*Create a description object for a parameter.*


---

**Description**

For each parameter type a special constructor function is available, see below.

For the following arguments you can also pass an expression instead of a concrete value: `default`, `len`, `lower`, `upper`, `values`. These expressions can depend on arbitrary symbols, which are later filled in / substituted from a dictionary, in order to produce a concrete value, see [evaluateParamExpressions\(\)](#). So this enables data / context dependent settings, which is sometimes useful.

The S3 class is a list which stores these elements:

**id** (character(1)) See argument of same name.

**type** (character(1)) Data type of parameter. For all type string see [\(getTypeStringsAll\(\)\)](#)

**len** (integer(1) | expression) See argument of same name.

**lower** (numeric | expression) See argument of same name. Length of this vector is `len`.

**upper** (numeric | expression) See argument of same name. Length of this vector is `len`.

**values** (list | expression) Discrete values, always stored as a named list.

**cnames** (character) See argument of same name.

**allow.inf** (logical(1)) See argument of same name.

**trafo** (NULL | function(x)) See argument of same name.

**requires** (NULL | expression) See argument of same name.

**default** (any concrete value | expression) See argument of same name.

**has.default** (logical(1)) Extra flag to really be able to check whether the user passed a default, to avoid troubles with NULL and NA.

**tunable** (logical(1)) See argument of same name.

**special.vals** (list) See argument of same name.

**Usage**

```
makeNumericParam(
  id,
  lower = -Inf,
  upper = Inf,
  allow.inf = FALSE,
  default,
```

```
    trafo = NULL,  
    requires = NULL,  
    tunable = TRUE,  
    special.vals = list()  
  )
```

```
makeNumericVectorParam(  
  id,  
  len,  
  lower = -Inf,  
  upper = Inf,  
  cnames = NULL,  
  allow.inf = FALSE,  
  default,  
  trafo = NULL,  
  requires = NULL,  
  tunable = TRUE,  
  special.vals = list()  
)
```

```
makeIntegerParam(  
  id,  
  lower = -Inf,  
  upper = Inf,  
  default,  
  trafo = NULL,  
  requires = NULL,  
  tunable = TRUE,  
  special.vals = list()  
)
```

```
makeIntegerVectorParam(  
  id,  
  len,  
  lower = -Inf,  
  upper = Inf,  
  cnames = NULL,  
  default,  
  trafo = NULL,  
  requires = NULL,  
  tunable = TRUE,  
  special.vals = list()  
)
```

```
makeLogicalParam(  
  id,  
  default,  
  requires = NULL,
```

```
    tunable = TRUE,  
    special.vals = list()  
  )
```

```
makeLogicalVectorParam(  
  id,  
  len,  
  cnames = NULL,  
  default,  
  requires = NULL,  
  tunable = TRUE,  
  special.vals = list()  
)
```

```
makeDiscreteParam(  
  id,  
  values,  
  trafo = NULL,  
  default,  
  requires = NULL,  
  tunable = TRUE,  
  special.vals = list()  
)
```

```
makeDiscreteVectorParam(  
  id,  
  len,  
  values,  
  trafo = NULL,  
  default,  
  requires = NULL,  
  tunable = TRUE,  
  special.vals = list()  
)
```

```
makeFunctionParam(  
  id,  
  default = default,  
  requires = NULL,  
  special.vals = list()  
)
```

```
makeUntypedParam(  
  id,  
  default,  
  requires = NULL,  
  tunable = TRUE,  
  special.vals = list()  
)
```

```

)

makeCharacterParam(id, default, requires = NULL, special.vals = list())

makeCharacterVectorParam(
  id,
  len,
  cnames = NULL,
  default,
  requires = NULL,
  special.vals = list()
)

```

### Arguments

id	(character(1)) Name of parameter.
lower	(numeric   expression) Lower bounds. A single value of length 1 is automatically replicated to len for vector parameters. If len = NA you can only pass length-1 scalars. Default is -Inf.
upper	(numeric   expression) Upper bounds. A single value of length 1 is automatically replicated to len for vector parameters. If len = NA you can only pass length-1 scalars. Default is Inf.
allow.inf	(logical(1)) Allow infinite values for numeric and numericvector params to be feasible settings. Default is FALSE.
default	(any concrete value   expression) Default value used in learner. Note: When this is a discrete parameter make sure to use a VALUE here, not the NAME of the value. If this argument is missing, it means no default value is available.
trafo	(NULL   function(x)) Function to transform parameter. It should be applied to the parameter value before it is, e.g., passed to a corresponding objective function. Function must accept a parameter value as the first argument and return a transformed one. Default is NULL which means no transformation.
requires	(NULL   call   expression) States requirements on other parameters' values, so that setting this parameter only makes sense if its requirements are satisfied (dependent parameter). Can be an object created either with expression or quote, the former type is auto-converted into the later. Only really useful if the parameter is included in a (ParamSet()). Default is NULL which means no requirements.
tunable	(logical(1)) Is this parameter tunable? Defining a parameter to be not-tunable allows to mark arguments like, e.g., "verbose" or other purely technical stuff. Note that this flag is most likely not respected by optimizing procedures unless stated



	otherwise. Default is TRUE (except for untyped, function, character and characterVector) which means it is tunable.
special.vals	(list()) A list of special values the parameter can except which are outside of the defined range. Default is an empty list.
len	(integer(1)   expression) Length of vector parameter.
cnames	(character) Component names for vector params (except discrete). Every function in this package that creates vector values for such a param, will name that vector with cnames.
values	(vector   list   expression) Possible discrete values. Instead of using a vector of atomic values, you are also allowed to pass a list of quite “complex” R objects, which are used as discrete choices. If you do the latter, the elements must be uniquely named, so that the names can be used as internal representations for the choice.

**Value**

[Param()].

**Examples**

```
makeNumericParam("x", lower = -1, upper = 1)
makeNumericVectorParam("x", len = 2)
makeDiscreteParam("y", values = c("a", "b"))
makeCharacterParam("z")
```

---

paramValueToString      *Convert a value to a string.*

---

**Description**

Useful helper for logging. For discrete parameter values always the name of the discrete value is used.

**Usage**

```
paramValueToString(par, x, show.missing.values = FALSE, num.format = "%.3g")
```

**Arguments**

par	(Param   ParamSet) Parameter or parameter set.
x	(any) Value for parameter or value for parameter set. In the latter case it must be named list. For discrete parameters their values must be used, not their names.

```

show.missing.values
    (logical(1))
    Display "NA" for parameters, which have no setting, because their requirements
    are not satisfied (dependent parameters), instead of displaying nothing? Default
    is FALSE.

num.format
    (character(1))
    Number format for output of numeric parameters. See the details section of the
    manual for base::sprintf() for details.

```

**Value**

```
character(1).
```

**Examples**

```

p = makeNumericParam("x")
paramValueToString(p, 1)
paramValueToString(p, 1.2345)
paramValueToString(p, 0.000039)
paramValueToString(p, 8.13402, num.format = "%.2F")

p = makeIntegerVectorParam("x", len = 2)
paramValueToString(p, c(1L, 2L))

p = makeLogicalParam("x")
paramValueToString(p, TRUE)

p = makeDiscreteParam("x", values = list(a = NULL, b = 2))
paramValueToString(p, NULL)

ps = makeParamSet(
  makeNumericVectorParam("x", len = 2L),
  makeDiscreteParam("y", values = list(a = NULL, b = 2))
)
paramValueToString(ps, list(x = c(1, 2), y = NULL))

```

---

plotEAF

*Plots attainment functions for data stored in multiple OptPaths.*


---

**Description**

Can be used to plot OptPaths where information for bi-objective evaluation was logged for repeated runs of different algorithmic runs. Pretty directly calls `eaf::eafplot()`.

**Usage**

```
plotEAF(opt.paths, xlim = NULL, ylim = NULL, ...)
```

**Arguments**

opt.paths	(list)	List of list of OptPath objects. First index is the algorithm / major variation in the experiment, second index is the index of the replicated run.
xlim	(numeric(2))	The x limits (x1, x2) of the plot.
ylim	(numeric(2))	The y limits (y1, y2) of the plot.
...	(any)	Passed on to <code>eaf::eafplot()</code> .

**Value**

`data.frame` Invisibly returns the data passed to `eaf::eafplot()`.

**Note**

We changed the defaults of `eaf::eafplot()` in the following way: The axis are labeled by `y.` names, colors are set to our favorite grey values and linetypes changed, too. With our colors / linetypes default it is possible to distinguish 6 different algorithms. But this can again be overwritten by the user.

---

plotOptPath	<i>Plot method for optimization paths.</i>
-------------	--

---

**Description**

Plot method for every type of optimization path, containing any numbers and types of variables. For every iteration up to 4 types of plots can be generated: One plot for the distribution of points in X and Y space respectively and plots for the trend of specified X variables, Y variables and extra measures over the time.

**Usage**

```
plotOptPath(
  op,
  iters,
  pause = TRUE,
  xlim = list(),
  ylim = list(),
  title = "Optimization Path Plots",
  ...
)
```

**Arguments**

op	(OptPath) Optimization path.
iters	(integer   NULL) Vector of iterations which should be plotted one after another. If NULL, which is the default, only the last iteration is plotted. Iteration 0 plots all elements with dob = 0. Note that the plots for iteration i contains all observations alive in iteration i.
pause	(logical(1)) Should the process be paused after each iteration? Default is TRUE.
xlim	<a href="#">list</a> X axis limits for the plots. Must be a named list, so you can specify the axis limits for every plot. Every element of the list must be a numeric vector of length 2. Available names for elements are: XSpace - limits for the X-Space plot YSpace - limits for the Y-Space plot Default is an empty list - in this case limits are automatically set. Note: For some plots it is not meaningful to set limits, in this case the set limits are ignored. Note: We do not support setting lims for the over.time.plots. We think, in nearly every case the ggplot defaults are fine, and the very rare case you have to set them, you can you can extract the plots and add your own limits.
ylim	<a href="#">list</a> Y axis limits for the plots. Must be a named list, so you can specify the axis limits for every plot. Every element of the list must be a numeric vector of length 2. Available names for elements are: XSpace - limits for the X-Space plot YSpace - limits for the Y-Space plot Default is an empty list - in this case limits are automatically set. Note: For some plots it is not meaningful to set limits, in this case the set limits are ignored. Note: We do not support setting lims for the over.time.plots. We think, in nearly every case the ggplot defaults are fine, and the very rare case you have to set them, you can you can extract the plots and add your own limits.
title	(character(1)) Main title for the arranged plots, default is Optimization Path Plots.
...	Additional parameters for <a href="#">renderOptPathPlot()</a> .

---

plotYTraces

*Plots Y traces of multiple optimization paths*


---

**Description**

Plot function for [renderYTraces\(\)](#)

**Usage**

```
plotYTraces(opt.paths, over.time = "dob")
```

**Arguments**

opt.paths	<a href="#">list</a> List of OptPath objects
over.time	<a href="#">character</a> Should the traces be plotted versus the iteration number or the cumulated execution time? For the later, the opt.path has to contain a extra column names exec.time. Possible values are dob and exec.time, default is dob.

**Value**

[NULL](#)

---

removeMissingValues     *Removes all scalar NAs from a parameter setting list.*

---

**Description**

Removes all scalar NAs from a parameter setting list.

**Usage**

```
removeMissingValues(x)
```

**Arguments**

x	<a href="#">list</a> List of parameter values.
---	---

**Value**

[list.](#)

---

renderOptPathPlot     *Function for plotting optimization paths.*

---

**Description**

Same as [plotOptPath\(\)](#), but renders the plots for just 1 iteration and returns a list of plots instead of printing the plot. Useful, if you want to extract single plots or to edit the ggplots by yourself.

**Usage**

```
renderOptPathPlot(
  op,
  iter,
  x.over.time,
  y.over.time,
  contour.name = NULL,
  xlim = list(),
  ylim = list(),
  alpha = TRUE,
  log = NULL,
  colours = c("red", "blue", "green", "orange"),
  size.points = 3,
  size.lines = 1.5,
  impute.scale = 1,
  impute.value = "missing",
  scale = "std",
  ggplot.theme = ggplot2::theme(legend.position = "top"),
  marked = NULL,
  subset.obs,
  subset.vars,
  subset.targets,
  short.x.names,
  short.y.names,
  short.rest.names
)
```

**Arguments**

op	<a href="#">OptPath</a> Optimization path.
iter	(integer(1)) Selected iteration of x to render plots for.
x.over.time	(list   NULL) List of vectors of x-variables, either specified via name or id. If specified via names, also extra measurements from the opt.path can be selected. Maximum length for each vector is 5. For each list-element a line-plot iteration versus variable is generated. If the vector has length > 2 only mean values per iteration are plotted as lines, if vector has length 1 every point is plotted. Default is to plot all variables into as few plots as possible. Note that discrete variables are converted to numeric, if specified in the same vector with numerics. Moreover, if more than 1 point per iteration exists, mean values are calculated. This is also done for factor variables! We recommend you to specify this argument in a useful way.
y.over.time	(list   NULL) List of vectors of y-variables, either specified via name or id. If specified via names, also extra measurements from the opt.path can be selected. Maximum

length for each vector is 5. For each list-element a line-plot iteration versus variable is generated. If the vector has length > 2 only mean values per iteration are plotted as lines, if vector has length 1 every point is plotted. Default is to plot all variables into as few plots as possible. Note that discrete variables are converted to numeric, if specified in the same vector with numerics. Moreover, if more than 1 point per iteration exists, mean values are calculated. This is also done for factor variables! We recommend you to specify this argument in a useful way.

contour.name	(character(1)   NULL) It is possible to overlay the XSpace plot with an contour plot. This is only possible, if the XSpace has exact 2 numeric and 0 discrete variable. Consider subsetting your variables to use this feature! contour.name is the name of the target variable that will be used for the contour lines. Default is to use the first target variable, if it is possible to add contour lines.
xlim	<a href="#">list</a> X axis limits for the plots. Must be a named list, so you can specify the axis limits for every plot. Every element of the list must be a numeric vector of length 2. Available names for elements are: XSpace - limits for the X-Space plot YSpace - limits for the Y-Space plot Default is an empty list - in this case limits are automatically set. Note: For some plots it is not meaningful to set limits, in this case the set limits are ignored. Note: We do not support setting lims for the over.time.plots. We think, in nearly every case the ggplot defaults are fine, and the very rare case you have to set them, you can you can extract the plots and add your own limits.
ylim	<a href="#">list</a> Y axis limits for the plots. Must be a named list, so you can specify the axis limits for every plot. Every element of the list must be a numeric vector of length 2. Available names for elements are: XSpace - limits for the X-Space plot YSpace - limits for the Y-Space plot Default is an empty list - in this case limits are automatically set. Note: For some plots it is not meaningful to set limits, in this case the set limits are ignored. Note: We do not support setting lims for the over.time.plots. We think, in nearly every case the ggplot defaults are fine, and the very rare case you have to set them, you can you can extract the plots and add your own limits.
alpha	(logical(1)) Activates or deactivates the alpha fading for the plots. Default is TRUE.
log	<a href="#">character</a> Vector of variable names. All of this variable logarithmized in every plot. Default is NULL - no logarithm is applied. Note that, if an variable has only negative value, it is multiplied with -1. For variables with both positive and negative values you have to do your own data preprocessing.
colours	(character(4)) Colours of the points/lines for the four point types init, seq, prob and marked. Default is red for init, blue for seq, green for prob and orange for marked.
size.points	(numeric(4)   NULL) Size of points in the plot, default is 3.

size.lines	(numeric(4)   NULL) Size of lines in the plots, default is 1.5.
impute.scale	(numeric(1)) Numeric missing values will be replaced by $\text{max} + \text{impute.scale} * (\text{max} - \text{min})$ . Default is 1.
impute.value	(character(1)) Factor missing values will be replaced by impute.value. Default is missing.
scale	(character(1)) Parameter scale from the function <code>GGally::ggparcoord()</code> which is used for the multiD-case. Default is std.
ggplot.theme	Theme for the ggplots. Can be generated by <code>ggplot2::theme()</code> . Default is <code>ggplot2::theme(legend.position = "top")</code> .
marked	(integer   character(1)   NULL) "best" or indices of points that should be marked in the plots. If marked = "best" the best point for single crit optimization respectively the pareto front for multi crit optimization is marked. Default is NULL (no points are marked).
subset.obs	<b>integer</b> Vector of indices to subset of observations to be plotted, default is all observations. All indices must be available in the opt.path. But, to enable subsetting over multiple iterations, not all indices must be available in the current iteration. Indices not available in the current iteration will be ignored. Default is all observations.
subset.vars	(integer   character) Subset of variables (x-variables) to be plotted. Either vector of indices or names. Default is all variables.
subset.targets	(integer   character) Subset of target variables (y-variables) to be plotted. Either vector of indices or names. Default is all variables
short.x.names	<b>character</b> Short names for x variables that are used as axis labels. Note you can only give shortnames for variables you are using in subset.vars
short.y.names	<b>character</b> Short names for y variables that are used as axis labels. Note you can only give shortnames for variables you are using in subset.targets
short.rest.names	<b>character</b> Short names for rest variables that are used as axis labels. Note you can only give shortnames for variables you are used in x.over.time or y.over.time.

### Value

List of plots. List has up to elements: plot.x: Plot for XSpace. If both X and Y are 1D, Plot for both plot.y: Plot for YSpace. If both X and Y are 1D, NULL. plot.x.over.time: List of plots for x over time. Can also be NULL. plot.y.over.time: List of plots for y over time. Can also be NULL.



---

renderYTraces	<i>Plots Y traces of multiple optimization paths</i>
---------------	--

---

### Description

Can be used for only single-objective optimization paths. Useful to compare runs of different algorithms on the same optimization problem. You can add your own ggplot layers to the resulting plot object.

### Usage

```
renderYTraces(opt.paths, over.time = "dob")
```

### Arguments

opt.paths	[ <a href="#">OptPath()</a>   list of <a href="#">OptPath()</a> ] Object(s) to plot.
over.time	<a href="#">character</a> Should the traces be plotted versus the iteration number or the cumulated execution time? For the later, the opt.path has to contain a extra column names exec.time. Possible values are dob and exec.time, default is dob.

### Value

ggplot2 plot object

---

repairPoint	<i>Repairs values of numeric and integer parameters out side of constraints.</i>
-------------	--

---

### Description

Clips values outside of box constraints to bounds.

### Usage

```
repairPoint(par.set, x, warn = FALSE)
```

### Arguments

par.set	<a href="#">ParamSet</a> Parameter set.
x	<a href="#">list</a> List of parameter values. Must be in correct order. Values corresponding to non-numeric/integer types are left unchanged.
warn	( <a href="#">logical(1)</a> ) Boolean indicating whether a warning should be printed each time a value is repaired. Default is FALSE.

**Value**

**list:** List of repaired points.

---

sampleValue	<i>Sample a random value from a parameter or a parameter set uniformly.</i>
-------------	---

---

**Description**

Sample a random value from a parameter or a parameter set uniformly.

Dependent parameters whose requirements are not satisfied are represented by a scalar NA in the output.

**Usage**

```
sampleValue(par, discrete.names = FALSE, trafo = FALSE)
```

**Arguments**

par	( <a href="#">Param</a>   <a href="#">ParamSet</a> ) Parameter or parameter set.
discrete.names	(logical(1)) Should names be sampled for discrete parameters or values instead? Default is FALSE.
trafo	(logical(1)) Transform all parameters by using their respective transformation functions. Default is FALSE.

**Value**

The return type is determined by the type of the parameter. For a set a named list of such values in the correct order is returned.

**Examples**

```
# bounds are necessary here, can't sample with Inf bounds:
u = makeNumericParam("x", lower = 0, upper = 1)
# returns a random number between 0 and 1:
sampleValue(u)

p = makeDiscreteParam("x", values = c("a", "b", "c"))
# can be either "a", "b" or "c"
sampleValue(p)

p = makeIntegerVectorParam("x", len = 2, lower = 1, upper = 5)
# vector of two random integers between 1 and 5:
sampleValue(p)
```

```
ps = makeParamSet(
  makeNumericParam("x", lower = 1, upper = 10),
  makeIntegerParam("y", lower = 1, upper = 10),
  makeDiscreteParam("z", values = 1:2)
)
sampleValue(ps)
```

---

sampleValues	<i>Sample n random values from a parameter or a parameter set uniformly.</i>
--------------	--

---

### Description

Sample n random values from a parameter or a parameter set uniformly.

Dependent parameters whose requirements are not satisfied are represented by a scalar NA in the output.

### Usage

```
sampleValues(par, n, discrete.names = FALSE, trafo = FALSE)
```

### Arguments

par	( <a href="#">Param</a>   <a href="#">ParamSet</a> ) Parameter or parameter set.
n	(integer(1)) Number of values.
discrete.names	(logical(1)) Should names be sampled for discrete parameters or values instead? Default is FALSE.
trafo	(logical(1)) Transform all parameters by using their respective transformation functions. Default is FALSE.

### Value

list. For consistency always a list is returned.

### Examples

```
p = makeIntegerParam("x", lower = -10, upper = 10)
sampleValues(p, 4)
```

```
p = makeNumericParam("x", lower = -10, upper = 10)
sampleValues(p, 4)
```

```

p = makeLogicalParam("x")
sampleValues(p, 4)

ps = makeParamSet(
  makeNumericParam("u", lower = 1, upper = 10),
  makeIntegerParam("v", lower = 1, upper = 10),
  makeDiscreteParam("w", values = 1:2)
)
sampleValues(ps, 2)

```

---

setOptPathEIDOB      *Set the dates of birth of parameter values, in-place.*

---

### Description

Set the dates of birth of parameter values, in-place.

### Usage

```
setOptPathEIDOB(op, index, dob)
```

### Arguments

op	<a href="#">OptPath</a> Optimization path.
index	<a href="#">integer</a> Vector of indices of elements.
dob	<a href="#">integer</a> Dates of birth, single value or same length of index.

### Value

Nothing.

### See Also

Other optpath: [OptPath](#), [addOptPathEl\(\)](#), [getOptPathBestIndex\(\)](#), [getOptPathCol\(\)](#), [getOptPathCols\(\)](#), [getOptPathDOB\(\)](#), [getOptPathEOL\(\)](#), [getOptPathEl\(\)](#), [getOptPathErrorMessage\(\)](#), [getOptPathExecTimes\(\)](#), [getOptPathLength\(\)](#), [getOptPathParetoFront\(\)](#), [getOptPathX\(\)](#), [getOptPathY\(\)](#), [setOptPathELEOL\(\)](#)

---

setOptPathEIEOL	<i>Set the end of life dates of parameter values, in-place.</i>
-----------------	---

---

**Description**

Set the end of life dates of parameter values, in-place.

**Usage**

```
setOptPathEIEOL(op, index, eol)
```

**Arguments**

op	<a href="#">OptPath</a> Optimization path.
index	<a href="#">integer</a> Vector of indices of elements.
eol	<a href="#">integer</a> EOL dates, single value or same length of index.

**Value**

Nothing.

**See Also**

Other optpath: [OptPath](#), [addOptPathEl\(\)](#), [getOptPathBestIndex\(\)](#), [getOptPathCol\(\)](#), [getOptPathCols\(\)](#), [getOptPathDOB\(\)](#), [getOptPathEOL\(\)](#), [getOptPathEl\(\)](#), [getOptPathErrorMessage\(\)](#), [getOptPathExecTimes\(\)](#), [getOptPathLength\(\)](#), [getOptPathParetoFront\(\)](#), [getOptPathX\(\)](#), [getOptPathY\(\)](#), [setOptPathElDOB\(\)](#)

---

setValueCNames	<i>Set components names for vector names</i>
----------------	--

---

**Description**

If param has cnames set component names in a value. Otherwise x is left unchanged.

**Usage**

```
setValueCNames(par, x)
```

**Arguments**

par	<a href="#">(Param   ParamSet)</a> Parameter or parameter set.
x	<a href="#">(any)</a> Param value(s). For a parameter set this must be a list in the correct order.

**Value**

x with changed names.

---

trafoOptPath	<i>Transform optimization path.</i>
--------------	-------------------------------------

---

**Description**

Transform optimization path with associated transformation functions of parameters. Can only be done when x values were added “untransformed”.

**Usage**

```
trafoOptPath(opt.path)
```

**Arguments**

opt.path	[ <a href="#">OptPath()</a> ] Optimization path.
----------	---

**Value**

[[OptPath\(\)](#)].

**Examples**

```
ps = makeParamSet(
  makeIntegerParam("u", trafo = function(x) 2 * x),
  makeNumericVectorParam("v", len = 2, trafo = function(x) x / sum(x)),
  makeDiscreteParam("w", values = c("a", "b"))
)
op = makeOptPathDF(ps, y.names = "y", minimize = TRUE)
addOptPathEl(op, x = list(3, c(2, 4), "a"), y = 0, dob = 1, eol = 1)
addOptPathEl(op, x = list(4, c(5, 3), "b"), y = 2, dob = 5, eol = 7)

as.data.frame(op)
op = trafoOptPath(op)
as.data.frame(op)
```

---

trafoValue	<i>Transform a value.</i>
------------	---------------------------

---

**Description**

Transform a value with associated transformation function(s).

**Usage**

```
trafoValue(par, x)
```

**Arguments**

par	( <a href="#">Param</a>   <a href="#">ParamSet</a> ) Parameter or parameter set.
x	(any) Single value to check. For a parameter set this must be a list. If the list is unnamed (not recommended) it must be in the same order as the param set. If it is named, its names must match the parameter names in the param set.

**Value**

Transformed value.

**Examples**

```
# transform simple parameter:
p = makeNumericParam(id = "x", trafo = function(x) x^2)
trafoValue(p, 2)
# for a parameter set different transformation functions are possible:
ps = makeParamSet(
  makeIntegerParam("u", trafo = function(x) 2 * x),
  makeNumericVectorParam("v", len = 2, trafo = function(x) x / sum(x)),
  makeDiscreteParam("w", values = c("a", "b"))
)
# now the values of "u" and "v" are transformed:
trafoValue(ps, list(3, c(2, 4), "a"))
```

---

updateParVals	<i>Insert par.vals to old ones with meeting requirements</i>
---------------	--

---

**Description**

Update the values of a given parameter setting with a new parameter setting. Settings that do not meet the requirements anymore will be deleted from the first given parameter setting. Default values of the Param Set are respected to check if the new param settings meet the requirements.

**Usage**

```
updateParVals(par.set, old.par.vals, new.par.vals, warn = FALSE)
```

**Arguments**

par.set	<a href="#">ParamSet</a> Parameter set.
old.par.vals	<a href="#">list</a> Param Values to be updated.
new.par.vals	<a href="#">list</a> New Param Values to update the old.par.vals.
warn	<a href="#">logical</a> Whether a warning should be shown, if a param setting from old.par.vals is dropped. Default is FALSE.

**Value**

[list](#).



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