Package ‘mlr3pipelines’

December 10, 2019

Title Preprocessing Operators and Pipelines for ‘mlr3’

Version 0.1.2

Description Dataflow programming toolkit that enriches ‘mlr3’ with a diverse set of pipelining operators (‘PipeOps’) that can be composed into graphs. Operations exist for data preprocessing, model fitting, and ensemble learning. Graphs can themselves be treated as ‘mlr3’ ‘Learners’ and can therefore be resampled, benchmarked, and tuned.

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URL https://mlr3pipelines.mlr-org.com,
https://github.com/mlr-org/mlr3pipelines

BugReports https://github.com/mlr-org/mlr3pipelines/issues

Depends R (>= 3.1.0)

Imports backports, checkmate, data.table, digest, mlr3 (>= 0.1.4), mlr3misc (>= 0.1.4), paradox, R6, withr

Suggests ggplot2, glmnet, igraph, knitr, lme4, mlbench, mlr3filters (>= 0.1.1), mlr3learners, mlr3measures, nloptr, rmarkdown, rpart, testthat, visNetwork, bestNormalize, fastICA, kernlab, smotefamily, evaluate

VignetteBuilder knitr

ByteCompile true

Encoding UTF-8

LazyData true

NeedsCompilation no

RoxygenNote 7.0.2

topics documented:

'R' 'PipeOpEncodeImpact.R' 'PipeOpEncodeLmer.R'
'PipeOpFeatureUnion.R' 'PipeOpFilter.R' 'PipeOpFixFactors.R'
'PipeOpHistBin.R' 'PipeOpICA.R' 'PipeOpImpute.R'
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'PipeOpYeoJohnson.R' 'Selector.R' 'assert_graph.R'
'greplicate.R' 'gunion.R' 'operators.R' 'po.R' 'reexports.R'
'typecheck.R' 'zzz.R'

Author  Martin Binder [aut, cre],
Florian Pfisterer [aut] (<https://orcid.org/0000-0001-8867-762X>),
Bernd Bischl [aut] (<https://orcid.org/0000-0001-6002-6980>),
Michel Lang [aut] (<https://orcid.org/0000-0001-9754-0393>),
Susanne Dandl [aut]

Maintainer  Martin Binder <mlr.developer@mb706.com>

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Description

Dataflow programming toolkit that enriches ‘mlr3’ with a diverse set of pipelining operators (‘PipeOps’) that can be composed into graphs. Operations exist for data preprocessing, model fitting, and ensemble learning. Graphs can themselves be treated as ‘mlr3’ ‘Learners’ and can therefore be resampled, benchmarked, and tuned.

Author(s)

Maintainer: Martin Binder <mlr.developer@mb706.com>

Authors:

- Florian Pfisterer <pfistererf@googlemail.com> (ORCID)
- Bernd Bischl <bernd_bischl@gmx.net> (ORCID)
- Michel Lang <michellang@gmail.com> (ORCID)
- Susanne Dandl <dandl.susanne@googlemail.com>

See Also

Useful links:

- https://mlr3pipelines.mlr-org.com
- https://github.com/mlr-org/mlr3pipelines
- Report bugs at https://github.com/mlr-org/mlr3pipelines/issues

Description

Add a class hierarchy to the class hierarchy cache. This is necessary whenever an S3 class’s class hierarchy is important when inferring compatibility between types.

Usage

add_class_hierarchy_cache(hierarchy)
assert_graph

Description

Function that checks that a given object is a Graph and throws an error if not.

Usage

assert_graph(x)

Arguments

x (any)

Object to check.

Value

Graph invisible(x)

See Also

Other Graph operators: %>>%, as_graph(), as_pipeop(), assert_pipeop(), greplicate(), gunion()
**assert_pipeop**

*Assertion for mlr3pipeline PipeOp*

**Description**

Function that checks that a given object is a PipeOp and throws an error if not.

**Usage**

```r
assert_pipeop(x)
```

**Arguments**

- `x` *(any)*
  
  Object to check.

**Value**

```r
PipeOp invisible(x)
```

**See Also**

Other Graph operators: `%>>%`, `as_graph()`, `as_pipeop()`, `assert_graph()`, `greplicate()`, `gunion()`

---

**as_graph**

*Conversion to mlr3pipeline Graph*

**Description**

The argument is turned into a Graph if possible. If `clone` is TRUE, a deep copy is made if the incoming object is a Graph to ensure the resulting object is a different reference from the incoming object.

`as_graph()` is an S3 method and can therefore be implemented by other packages that may add objects that can naturally be converted to Graphs.

By default, `as_graph()` tries to

- apply `gunion()` to `x` if it is a list, which recursively applies `as_graph()` to all list elements first
- create a Graph with only one element if `x` is a PipeOp or can be converted to one using `as_pipeop()`.

**Usage**

```r
as_graph(x, clone = FALSE)
```
as_pipeop

Arguments

x (any)
Object to convert.

clonelogical(1))
Whether to return a (deep copied) clone if x is a Graph.

Value

Graph x or a deep clone of it.

See Also

Other Graph operators: %>>%, as_pipeop(), assert_graph(), assert_pipeop(), greplicate(), gunion()
branch  

Branch Between Alternative Paths

Description

Create a multiplexed graph.

Usage

branch(..., .graphs = NULL, .prefix_branchops = "", .prefix_paths = FALSE)

Arguments

...  
Multiple graphs, possibly named. They all must have exactly one output. If any of the arguments are named, then all must have unique names.

.graphs  ([list of Graph]): Named list of Graphs, additionally to the graphs given in ....

.prefix_branchops  ([character(1)]): Optional id prefix to prepend to PipeOpBranch and PipeOpUnbranch id. Their resulting IDs will be ".[.prefix_branchops]branch" and ".[.prefix_branchops]unbranch". Default is ".".

.prefix_paths  ([logical(1) | character(1)]): Whether to add prefixes to graph IDs when performing gunion. Can be helpful to avoid ID clashes in resulting graph. Default FALSE. If this is TRUE, the prefixes are taken from the names of the input arguments if present or "poX" where X counts up. If this is a character(1), it is a prefix that is added to the PipeOp IDs additionally to the input argument list.

Examples

library("mlr3")

po_pca = po("pca")
po_nop = po("nop")

branches = branch(pca = po_pca, nothing = po_nop)
# gives the same as
branches = c("pca", "nothing")
po("branch", branches) %>>%
  gunion(list(po_pca, po_nop)) %>>%
  po("unbranch", branches)

branch(pca = po_pca, nothing = po_nop,
  .prefix_branchops = "br_", .prefix_paths = "xy_")
# gives the same as
po("branch", branches, id = "br_branch") %>>%
  gunion(list(xy_pca = po_pca, xy_nothing = po_nop)) %>>%
  po("unbranch", branches, id = "br_unbranch")
filter_noop

Remove NO_OPs from a List

Description
Remove all NO_OP elements from a list.

Usage
filter_noop(x)

Arguments
x list
List to filter.

Value
list: The input list, with all NO_OP elements removed.

See Also
Other Path Branching: NO_OP, is_noop(), mlr_pipeops_branch, mlr_pipeops_unbranch

Graph

A Graph is a representation of a machine learning pipeline graph. It can be trained, and subsequently used for prediction.

A Graph is most useful when used together with Learner objects encapsulated as PipeOpLearner. In this case, the Graph produces Prediction data during its $predict() phase and can be used as a Learner itself (using the GraphLearner wrapper). However, the Graph can also be used without Learner objects to simply perform preprocessing of data, and, in principle, does not even need to handle data at all but can be used for general processes with dependency structure (although the PipeOps for this would need to be written).

Format
R6Class Graph

Construction
Graph$new()
Internals

A `Graph` is made up of a list of `PipeOps`, and a `data.table` of edges. Both for training and prediction, the `Graph` performs topological sorting of the `PipeOps` and executes their respective `$train()` or `$predict()` functions in order, moving the `PipeOp` results along the edges as input to other `PipeOps`.

Fields

- `pipeops` :: named list of `PipeOp`
  Contains all `PipeOps` in the `Graph`, named by the `PipeOp`'s $ids.

- `edges` :: `data.table` with columns `src_id` (character), `src_channel` (character), `dst_id` (character), `dst_channel` (character)
  Table of connections between the `PipeOps`. A `data.table` src_id and dst_id are $ids of `PipeOps` that must be present in the $pipeops list. src_channel and dst_channel must respectively be $output and $input channel names of the respective `PipeOps`.

- `is_trained` :: logical(1)
  Is the `Graph`, i.e. are all of its `PipeOps`, trained, and can the `Graph` be used for prediction?

- `lhs` :: character
  Ids of the 'left-hand-side' `PipeOps` that have some unconnected input channels and therefore act as `Graph` input layer.

- `rhs` :: character
  Ids of the 'right-hand-side' `PipeOps` that have some unconnected output channels and therefore act as `Graph` output layer.

- `input` :: `data.table` with columns `name` (character), `train` (character), `predict` (character), `op.id` (character), `channel.name` (character)
  Input channels of the `Graph`. For each channel lists the name, input type during training, input type during prediction, `PipeOp` $id of the `PipeOp` the channel pertains to, and channel name as the `PipeOp` knows it.

- `output` :: `data.table` with columns `name` (character), `train` (character), `predict` (character), `op.id` (character), `channel.name` (character)
  Output channels of the `Graph`. For each channel lists the name, output type during training, output type during prediction, `PipeOp` $id of the `PipeOp` the channel pertains to, and channel name as the `PipeOp` knows it.

- `packages` :: character
  Set of all required packages for the various methods in the `Graph`, a set union of all required packages of all contained `PipeOp` objects.

- `state` :: named list
  Get / Set the $state of each of the members of `PipeOp`.

- `param_set` :: `ParamSet`
  Parameters and parameter constraints. Parameter values are in $param_set$values. These are the union of $param_sets of all `PipeOps` in the `Graph`. Parameter names as seen by the `Graph` have the naming scheme `<PipeOp$id>.<PipeOp original parameter name>`. Changing $param_set$values also propagates the changes directly to the contained `PipeOp` objects and is an alternative to changing a `PipeOps` $param_set$values directly.
Graph

- **hash**: character(1)
  Stores a checksum calculated on the Graph configuration, which includes all PipeOp hashes (and therefore their $param_set$ values) and a hash of $edges$.

- **keep_results**: logical(1)
  Whether to store intermediate results in the PipeOp's $.result slot, mostly for debugging purposes. Default FALSE.

**Methods**

- **ids(sorted = FALSE)**
  (logical(1)) -> character
  Get IDs of all PipeOps. This is in order that PipeOps were added if sorted is FALSE, and topologically sorted if sorted is TRUE.

- **add_pipeop(op)**
  (PipeOp | Learner | Filter | ... ) -> self
  Mutates Graph by adding a PipeOp to the Graph. This does not add any edges, so the new PipeOp will not be connected within the Graph at first.
  Instead of supplying a PipeOp directly, an object that can naturally be converted to a PipeOp can also be supplied, e.g. a Learner or a Filter; see as_pipeop().

- **add_edge(src_id, dst_id, src_channel = NULL, dst_channel = NULL)**
  (character(1), character(1), character(1)|numeric(1)|NULL, character(1)|numeric(1)|NULL) -> self
  Add an edge from PipeOp src_id, and its channel src_channel (identified by its name or number as listed in the PipeOp's $output), to PipeOp dst_id's channel dst_channel (identified by its name or number as listed in the PipeOp's $input). If source or destination PipeOp have only one input / output channel and src_channel / dst_channel are therefore unambiguous, they can be omitted (i.e. left as NULL).

- **plot(html)**
  (logical(1)) -> NULL
  Plot the Graph, using either the igraph package (for html = FALSE, default) or the visNetwork package for html = TRUE producing a htmlWidget. The htmlWidget can be rescaled using visOptions.

- **print()**
  () -> NULL
  Print a representation of the Graph on the console. Output is a table with one row for each contained PipeOp and columns ID ($id of PipeOp), State (short representation of $state of PipeOp), sccssors (PipeOps that take their input directly from the PipeOp on this line), and prdcssors (the PipeOps that produce the data that is read as input by the PipeOp on this line).

- **set_names(old,new)**
  (character, character) -> self
  Rename PipeOps: Change ID of each PipeOp as identified by old to the corresponding item in new. This should be used instead of changing a PipeOp's $id value directly!

- **train(input, single_input = TRUE)**
  (any, logical(1)) -> named list
  Train Graph by traversing the Graphs' edges and calling all the PipeOp's $train methods in turn. Return a named list of outputs for each unconnected PipeOp out-channel, named according to the Graph's $output name column. During training, the $state member of each
PipeOps will be set and the $is_trained slot of the Graph (and each individual PipeOp) will consequently be set to TRUE.

If single_input is TRUE, the input value will be sent to each unconnected PipeOp’s input channel (as listed in the Graph’s $input). Typically, input should be a Task, although this is dependent on the PipeOps in the Graph. If single_input is FALSE, then input should be a list with the same length as the Graph’s $input table has rows; each list item will be sent to a corresponding input channel of the Graph. If input is a named list, names must correspond to input channel names ($input$name) and inputs will be sent to the channels by name; otherwise they will be sent to the channels in order in which they are listed in $input.

- predict(input, single_input = TRUE)
  (any, logical(1)) -> list of any
  Predict with the Graph by calling all the PipeOp’s $train methods. Input and output, as well as the function of the single_input argument, are analogous to $train().

See Also

Other mlr3pipelines backend related: PipeOpTaskPreprocSimple, PipeOpTaskPreproc, PipeOp, mlr_pipes

Examples

library("mlr3")

  g = Graph$new()
  add_pipeop(PipeOpScale$new(id = "scale"))
  add_pipeop(PipeOpPCA$new(id = "pca"))
  add_edge("scale", "pca")
  g$input
  g$output

  task = tsk("iris")
  trained = g$train(task)
  trained[[1]]$data()

  task$filter(1:10)
  predicted = g$predict(task)
  predicted[[1]]$data()

---

greplicate Create Disjoint Graph Union of Copies of a Graph

Description

Create a new Graph containing n copies of the input Graph/PipeOp. To avoid ID collisions, PipeOp IDs are suffixed with _i where i ranges from 1 to n.

Usage

greplicate(graph, n)
gunion

Arguments

- **graph** (Graph) Graph to replicate.
- **n** integer(1) Number of copies to create.

Value

Graph containing n copies of input graph.

See Also

Other Graph operators: %>>%, as_graph(), as_pipeop(), assert_graph(), assert_pipeop(), gunion()
\textbf{is_noop} \hspace{1cm} \textit{Test for NO_OP}

\textbf{Description}

Test whether a given object is a \texttt{NO_OP}.

\textbf{Usage}

\begin{verbatim}
is_noop(x)
\end{verbatim}

\textbf{Arguments}

\begin{itemize}
  \item \texttt{x} \hspace{1cm} \texttt{any}
  \hspace{1cm} Object to test.
\end{itemize}

\textbf{Value}

\begin{verbatim}
logical(1): Whether x is a NO_OP.
\end{verbatim}

\textbf{See Also}

Other Path Branching: \texttt{NO_OP, filter_noop()}, \texttt{mlr_pipeops_branch, mlr_pipeops_unbranch}

\textbf{mlr_learners_avg} \hspace{1cm} \textit{Optimized Weighted Average of Features for Classification and Regression}

\textbf{Description}

Computes a weighted average of inputs. Used in the context of computing weighted averages of predictions.

Predictions are averaged using weights (in order of appearance in the data) which are optimized using nonlinear optimization from the package “nloptr” for a measure provided in \texttt{measure} (defaults to \texttt{classif.acc} for \texttt{LearnerClassifAvg} and \texttt{regr.mse} for \texttt{LearnerRegrAvg}). Learned weights can be obtained from \texttt{$model$}. Using non-linear optimization is implemented in the SuperLearner \texttt{R} package. For a more detailed analysis the reader is referred to \textit{LeDell, 2015: Scalable Ensemble Learning and Computationally Efficient Variance Estimation}.

\textbf{Usage}

\begin{verbatim}
mlr_learners_classif.avg
\end{verbatim}

\begin{verbatim}
mlr_learners_regr.avg
\end{verbatim}
**mlr_learners_graph**

**Format**

*R6Class* object inheriting from `mlr3::LearnerClassif/mlr3::Learner`.

**Parameter Set**

- **measure**: character(1) | Measure
  Measure to optimized weights for. The Measure is either obtained from `mlr_measures` or directly supplied. Defaults to `classif.acc` for `LearnerClassifAvg` and `regr.mse` for `LearnerRegrAvg`.

- **algorithm**: character(1)
  Several nonlinear optimization methods from `nloptr` are available. See `nloptr::nloptr.print.options()` for a list of possible options. Note that we only allow for derivative free local or global algorithms, i.e. NLOPT_(G|L)N_.

**Methods**

- **LearnerClassifAvg$new**, id = "classif.avg")
  (chr) -> self
  Constructor.

- **LearnerRegrAvg$new**, id = "regr.avg")
  (chr) -> self
  Constructor.

**See Also**

Other Learners: `mlr_learners_graph`

Other Ensembles: `PipeOpEnsemble`, `mlr_pipeops_classifavg`, `mlr_pipeops_regravg`

---

**mlr_learners_graph**

*GraphLearner*

**Description**

A Learner that encapsulates a Graph to be used in mlr3 resampling and benchmarks.

The Graph must return a single Prediction on its $predict() call. The result of the $train() call is discarded, only the internal state changes during training are used.

**Format**

*R6Class* object inheriting from `mlr3::Learner`.

**See Also**

Other Learners: `mlr_learners_avg`
Description

A simple Dictionary storing objects of class PipeOp. Each PipeOp has an associated help page, see mlr_pipeops_[id].

Format

R6Class object inheriting from mlr3misc::Dictionary.

Fields

Fields inherited from Dictionary, as well as:

- metainf :: environment
  Environment that stores the metainf argument of the $add() method. Only for internal use.

Methods

Methods inherited from Dictionary, as well as:

- add(key, value, metainf = NULL)
  (character(1), R6ClassGenerator, NULL | list)
  Adds constructor value to the dictionary with key key, potentially overwriting a previously stored item. If metainf is not NULL (the default), it must be a list of arguments that will be given to the value constructor (i.e. value$new()) when it needs to be constructed for as.data.table PipeOp listing.

S3 methods

- as.data.table(dict)
  Dictionary -> data.table::data.table
  Returns a data.table with columns key (character), packages (character), input.num (integer), output.num (integer), input.type.train (character), input.type.predict (character), output.type.train (character), output.type.predict (character).

See Also

Other mlr3pipelines backend related: Graph, PipeOpTaskPreprocSimple, PipeOpTaskPreproc, PipeOp

mlr_pipeops_boxcox

```r
mlr_pipeops$get("learner", lrn("classif.rpart"))
```

# equivalent:
```r
po("learner", learner = lrn("classif.rpart"))
```

# all PipeOps currently in the dictionary:
```r
as.data.table(mlr_pipeops)[, c("key", "input.num", "output.num", "packages")]
```

---

**Description**

Conducts a Box-Cox transformation on numeric features. The lambda parameter of the transformation is estimated during training and used for both training and prediction transformation. See `bestNormalize::boxcox()` for details.

**Format**


**Construction**

```r
PipeOpBoxCox$new(id = "boxcox", param_vals = list())
```

- **id** :: character(1)
  Identifier of resulting object, default "boxcox".

- **param_vals** :: named list
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default `list()`.

**Input and Output Channels**

Input and output channels are inherited from `PipeOpTaskPreproc`.

The output is the input `Task` with all affected numeric features replaced by their transformed versions.
State

The $state is a named list with the $state elements inherited from PipeOpTaskPreproc, as well as a list of class boxcox for each column, which is transformed.

Parameters

The parameters are the parameters inherited from PipeOpTaskPreproc, as well as:

- **standardize** :: logical(1)
  Whether to center and scale the transformed values to attempt a standard normal distribution. For details see boxcox().
- **eps** :: numeric(1)
  Tolerance parameter to identify if lambda parameter is equal to zero. For details see boxcox().
- **lower** :: numeric(1)
  Lower value for estimation of lambda parameter. For details see boxcox().
- **upper** :: numeric(1)
  Upper value for estimation of lambda parameter. For details see boxcox().

Internals

Uses the bestNormalize::boxcox function.

Methods


See Also


Examples

```r
library("mlr3")

task = tsk("iris")
pop = po("boxcox")

(task$data())
(pop$train(list(task))[1])$data()
```
Description

Perform alternative path branching: PipeOpBranch has multiple output channels that connect to different paths in a Graph. At any time, only one of these paths will be taken for execution. At the end of the different paths, the PipeOpUnbranch PipeOp must be used to indicate the end of alternative paths.

Not to be confused with PipeOpCopy, the naming scheme is a bit unfortunate.

Format

R6Class object inheriting from PipeOp.

Construction

PipeOpBranch$new(options, id = "branch", param_vals = list())

- options :: numeric(1) | character
  If options is an integer number, it determines the number of output channels / options that are created, named output1...output<n>. The $selection parameter will then be a ParamInt.
  If options is a character, it determines the names of channels directly. The $selection parameter will then be a ParamFct.
- id :: character(1)
  Identifier of resulting object, default "branch".
- param_vals :: named list
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default list().

Input and Output

PipeOpBranch has one input channel named "input", taking any input ("*") both during training and prediction.

PipeOpBranch has multiple output channels depending on the options construction argument, named "output1", "output2", ... if options is numeric, and named after each options value if options is a character. All output channels produce the object given as input ("*") or NO_OP, both during training and prediction.

State

The $state is left empty (list()).
Parameters

- selection :: numeric(1) | character(1)
  Selection of branching path to take. Is a ParamInt if the options parameter during construction was a numeric(1), and ranges from 1 to options. Is a ParamFct if the options parameter was a character and its possible values are the options values. Initialized to either 1 (if the options construction argument is numeric(1)) or the first element of options (if it is character).

Internals

Alternative path branching is handled by the PipeOp backend. To indicate that a path should not be taken, PipeOpBranch returns the NO_OP object on its output channel. The PipeOp handles each NO_OP input by automatically returning a NO_OP output without calling $train_internal() or $predict_internal(), until PipeOpUnbranch is reached. PipeOpUnbranch will then take multiple inputs, all except one of which must be a NO_OP, and forward the only non-NO_OP object on its output.

Fields

Only fields inherited from PipeOp.

Methods

Only methods inherited from PipeOp.

See Also


Other Path Branching: NO_OP, filter_noop(), is_noop(), mlr_pipeops_unbranch

Examples

library("mlr3")

pca = po("pca")
nop = po("nop")
choices = c("pca", "nothing")
gr = po("branch", choices) %>>%
gunion(list(pca, nop)) %>>%
po("unbranch", choices)
mlr_pipeops_chunk

```r
gr$param_set$values$branch.selection = "pca"
gr$train(tsk("iris"))

gr$param_set$values$branch.selection = "nothing"
gr$train(tsk("iris"))
```

---

**Description**

Chunks its input into `outnum` chunks. Creates `outnum` Tasks during training, and simply passes on the input during `outnum` times during prediction.

**Format**

*R6Class* object inheriting from `PipeOp`.

**Construction**

```r
PipeOpChunk$new(outnum, id = "chunk", param_vals = list())
```

- `outnum`:: numeric(1)
  Number of output channels, and therefore number of chunks created.
- `id`:: character(1)
  Identifier of resulting object, default "chunk".
- `param_vals`:: named list
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default list().

**Input and Output**

`PipeOpChunk` has one input channel named "input", taking a Task both during training and prediction.

`PipeOpChunk` has multiple output channels depending on the options construction argument, named "output1", "output2", ... All output channels produce (respectively disjoint, random) subsets of the input Task during training, and pass on the original Task during prediction.

**State**

The `$state` is left empty (list()).

**Parameters**

- `shuffle`:: logical(1)
  Should the data be shuffled before chunking? Initialized to TRUE.
mlr_pipeops_classbalancing

**Internals**

Uses the `mlr3misc::chunk_vector()` function.

**Fields**

Only fields inherited from PipeOp.

**Methods**

Only methods inherited from PipeOp.

**See Also**


**Examples**

```r
library("mlr3")

task = tsk("wine")
opc = mlr_pipeops$get("chunk", 2)

# watch the row number: 89 during training (task is chunked)...
opc$train(list(task))

# ... 178 during predict (task is copied)
opc$predict(list(task))
```

---

mlr_pipeops_classbalancing

*PipeOpClassBalancing*

**Description**

Both undersamples a Task to keep only a fraction of the rows of the majority class, as well as oversamples (repeats data points) rows of the minority class.

Sampling happens only during training phase. Class-balancing a Task by sampling may be beneficial for classification with imbalanced training data.
**Format**

*R6Class* object inheriting from *PipeOpTaskPreproc/PipeOp*.

**Construction**

PipeOpClassBalancing$new(id = "classbalancing", param_vals = list())

- id :: character(1) Identifier of the resulting object, default "classbalancing"
- param_vals :: named list
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default list().

**Input and Output Channels**

Input and output channels are inherited from *PipeOpTaskPreproc*. Instead of a *Task*, a *TaskClassif* is used as input and output during training and prediction.

The output during training is the input *Task* with added or removed rows to balance target classes. The output during prediction is the unchanged input.

**State**

The $state is a named list with the $state elements inherited from *PipeOpTaskPreproc*.

**Parameters**

The parameters are the parameters inherited from *PipeOpTaskPreproc*; however, the affect_columns parameter is *not* present. Further parameters are:

- ratio :: numeric(1)
  Ratio of number of rows of classes to keep, relative to the $reference value. Initialized to 1.
- reference :: numeric(1)
  What the $ratio value is measured against. Can be "all" (mean instance count of all classes), "major" (instance count of class with most instances), "minor" (instance count of class with fewest instances), "nonmajor" (average instance count of all classes except the major one), "nonminor" (average instance count of all classes except the minor one), and "one" ($ratio determines the number of instances to have, per class). Initialized to "all".
- adjust :: numeric(1)
  Which classes to up / downsample. Can be "all" (up and downsample all to match required instance count), "major", "minor", "nonmajor", "nonminor" (see respective values for $reference), "upsample" (only upsample), and "downsample". Initialized to "all".
- shuffle :: logical(1)
  Whether to shuffle the result. Otherwise, the resulting task will have the original items that were not removed in downsampling in-order, followed by all newly sampled items ordered by target class. Initialized to TRUE.
Internals

Up / downsampling happens as follows: At first, a "target class count" is calculated, by taking the mean class count of all classes indicated by the reference parameter (e.g. if reference is "nonmajor": the mean class count of all classes that are not the "major" class, i.e. the class with the most samples) and multiplying this with the value of the ratio parameter. If reference is "one", then the "target class count" is just the value of ratio (i.e. 1 * ratio).

Then for each class that is referenced by the adjust parameter (e.g. if adjust is "nonminor": each class that is not the class with the fewest samples), PipeOpClassBalancing either throws out samples (downsampling), or adds additional rows that are equal to randomly chosen samples (upsampling), until the number of samples for these classes equals the "target class count".

Uses task$filter() to remove rows. When identical rows are added during upsampling, then the task$row_roles$use can not be used to duplicate rows because of [inaudible]; instead the task$rbind() function is used, and a new data.table is attached that contains all rows that are being duplicated exactly as many times as they are being added.

Fields


Methods


See Also


Examples

```r
library("mlr3")

task = tsk("spam")
opb = po("classbalancing")

# target class counts
table(task$truth())

# double the instances in the minority class (spam)
opb$param_set$values = list(ratio = 2, reference = "minor")
```
mlr_pipeops_classifavg

adjust = "minor", shuffle = FALSE)
result = opb$train(list(task))[[1L]]
table(result$truth())

# up or downsample all classes until exactly 20 per class remain
opb$param_set$values = list(ratio = 20, reference = "one",
   adjust = "all", shuffle = FALSE)
result = opb$train(list(task))[[1]]
table(result$truth())

---

mlr_pipeops_classifavg

PipeOpClassifAvg

Description

Perform (weighted) majority vote prediction from classification Predictions by connecting PipeOpClassifAvg to multiple PipeOpLearner outputs.

If the incoming Learner's $predict_type is set to "response", the prediction obtained is also a "response" prediction with each instance predicted to the prediction from incoming Learners with the highest total weight. If the Learner's $predict_type is set to "prob", the prediction obtained is also a "prob" type prediction with the probability predicted to be a weighted average of incoming predictions.

All incoming Learner's $predict_type must agree.

Weights can be set as a parameter; if none are provided, defaults to equal weights for each prediction. Defaults to equal weights for each model.

Format

R6Class inheriting from PipeOpEnsemble/PipeOp.

Construction

PipeOpClassifAvg$new(innum = 0, id = "classifavg", param_vals = list())

• innum :: numeric(1)
  Determines the number of input channels. If innum is 0 (default), a vararg input channel is created that can take an arbitrary number of inputs.
• id :: character(1) Identifier of the resulting object, default "classifavg".
• param_vals :: named list
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default list().

Input and Output Channels

Input and output channels are inherited from PipeOpEnsemble. Instead of a Prediction, a PredictionClassif is used as input and output during prediction.
State

The $state is left empty (list()).

Parameters

The parameters are the parameters inherited from the PipeOpEnsemble.

Internals

Inherits from PipeOpEnsemble by implementing the private$weighted_avg_predictions() method.

Fields


Methods


See Also


Other Ensembles: PipeOpEnsemble, mlr_learners_avg, mlr_pipeops_regravg

Examples

library("mlr3")

# Simple Bagging
gr = greplicate(n = 5,
    po("subsample") %>>%
    po("learner", lrn("classif.rpart"))
) %>>%
po("classifavg")

mlr3::resample(tsk("iris"), GraphLearner$new(gr), rsmp("holdout"))
Description

Adds a class weight column to the Task that different Learners may be able to use for sample weighting. Sample weights are added to each sample according to the target class.

Only binary classification tasks are supported.

Caution: when constructed naively without parameter, the weights are all set to 1. The minor_weight parameter must be adjusted for this PipeOp to be useful.

Format

R6Class object inheriting from PipeOpTaskPreproc/PipeOp.

Construction

PipeOpClassWeights$new(id = "classweights", param_vals = list())

- id :: character(1) Identifier of the resulting object, default "classweights"
- param_vals :: named list
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default list().

Input and Output Channels

Input and output channels are inherited from PipeOpTaskPreproc. Instead of a Task, a TaskClassif is used as input and output during training and prediction.

The output during training is the input Task with added weights column according to target class.

The output during prediction is the unchanged input.

State

The $state is a named list with the $state elements inherited from PipeOpTaskPreproc.

Parameters

The parameters are the parameters inherited from PipeOpTaskPreproc; however, the affect_columns parameter is not present. Further parameters are:

- minor_weight :: numeric(1)
  Weight given to samples of the minor class. Major class samples have weight 1. Initialized to 1.
Internals

Introduces, or overwrites, the "weights" column in the Task. However, the Learner method needs to respect weights for this to have an effect.

The newly introduced column is named .WEIGHTS; there will be a naming conflict if this column already exists and is not a weight column itself.

Fields


Methods


See Also


Examples

library("mlr3")

  task = tsk("spam")
  opb = po("classweights")

  # task weights
  task$weights

  # double the instances in the minority class (spam)
  opb$param_set$values$minor_weight = 2
  result = opb$train(list(task))[[1L]]
  result$weights
Description

Applies a function to each column of a task. Use the affect_columns parameter inherited from PipeOpTaskPreproc to limit the columns this function should be applied to. This can be used for simple parameter transformations or type conversions (e.g. as.numeric).

The same function is applied during training and prediction. One important relationship for machine learning preprocessing is that during the prediction phase, the preprocessing on each data row should be independent of other rows. Therefore, the applicator function should always return a vector / list where each result component only depends on the corresponding input component and not on other components. As a rule of thumb, if the function f generates output different from Vectorize(f), it is not a function that should be used for applicator.

Format

R6Class object inheriting from PipeOpTaskPreproc/PipeOp.

Construction

PipeOpColApply$new(id = "colapply", param_vals = list())

- id:: character(1)
  Identifier of resulting object, default "colapply".
- param_vals:: named list
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default list().

Input and Output Channels

Input and output channels are inherited from PipeOpTaskPreproc.

The output is the input Task with features changed according to the applicator parameter.

State

The $state is a named list with the $state elements inherited from PipeOpTaskPreproc, as well as:

- emptydt :: data.table
  An empty data.table with columns of names and types from output features after training. This is used to produce a correct type conversion during prediction, even when the input has zero length and applicator is therefore not called.
Parameters

The parameters are the parameters inherited from PipeOpTaskPreproc, as well as:

- `applicator` :: function
  Function to apply to each column of the task. The return value must have the same length as the input, i.e. vectorize over the input. A typical example would be `as.numeric`. Use `Vectorize` to create a vectorizing function from any function that ordinarily only takes one element input.
  The `applicator` is not called during prediction if the input task has no rows; instead the types of affected features are changed to the result types of the `applicator` call during training. Initialized to the `identity()`-function.

Internals

PipeOpColApply can not inherit from PipeOpTaskPreprocSimple, because if `applicator` is given and the prediction data has 0 rows, then the resulting data.table does not know what the column types should be. Column type conformity between training and prediction is enforced by simply saving a copy of an empty data.table in the $state$emptydt slot.

Fields


Methods


See Also


Examples

```r
library("mlr3")

task = tsk("iris")
poca = po("colapply", applicator = as.character)
poca$train(list(task))[[1]] # types are converted

# function that does not vectorize
```
```r
f = function(x) {
  # we could use 'ifelse' here, but that is not the point
  if (x > 1) {
    "a"
  } else {
    "b"
  }
}
poca$param_set$values$applicator = Vectorize(f)
poca$train(list(task))[[1]]$data()

# only affect Petal.* columns:
poca$param_set$values$affect_columns = selector_grep("^Petal")
poca$train(list(task))[[1]]$data()
```

---

**mlr.pipeops-collapsefactors**

*PipeOpCollapseFactors*

**Description**

Collapses factors of type factor, ordered: Collapses the rarest factors in the training samples, until `target_level_count` levels remain. Levels that have prevalence above `noCollapseAbovePrevalence` are retained, however. For factor variables, these are collapsed to the next larger level, for ordered variables, rare variables are collapsed to the neighbouring class, whichever has fewer samples.

Levels not seen during training are not touched during prediction; Therefore it is useful to combine this with the *PipeOpFixFactors*.

**Format**

*R6Class* object inheriting from *PipeOpTaskPreprocSimple/PipeOpTaskPreproc/PipeOp*.

**Construction**

```r
PipeOpCollapseFactors$new(id = "collapsefactors", param_vals = list())
```

- **id**: character(1)
  
  Identifier of resulting object, default "collapsefactors".

- **param_vals**: named list
  
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default list().

**Input and Output Channels**

Input and output channels are inherited from *PipeOpTaskPreproc*.

The output is the input *Task* with rare affected factor and ordered feature levels collapsed.
State

The state is a named list with the state elements inherited from PipeOpTaskPreproc, as well as:

- **collapse_map**: named list of named list of character
  List of factor level maps. For each factor, collapse_map contains a named list that indicates what levels of the input task get mapped to what levels of the output task. If collapse_map has an entry feat_1 with an entry a = c("x", "y"), it means that levels "x" and "y" get collapsed to level "a" in feature "feat_1".

Parameters

The parameters are the parameters inherited from PipeOpTaskPreproc, as well as:

- **no_collapse_above_prevalence**: numeric(1)
  Fraction of samples below which factor levels get collapsed. Default is 1, which causes all levels to be collapsed until target_level_count remain.

- **target_level_count**: integer(1)
  Number of levels to retain. Default is 2.

Internals

Makes use of the fact that levels(fact_var) = list(target1 = c("source1", "source2"), target2 = "source2") causes renaming of level "source1" and "source2" both to "target1", and also "source2" to "target2".

Methods


See Also


Examples

library("mlr3")
Description

Copies its input outnum times. This PipeOp usually not needed, because copying happens automatically when one PipeOp is followed by multiple different PipeOps. However, when constructing big Graphs using the %>>%-operator, PipeOpCopy can be helpful to specify which PipeOp gets connected to which.

Format

R6Class object inheriting from PipeOp.

Construction

PipeOpEnsemble$new(outnum, id = "copy", param_vals = list())

• outnum :: numeric(1)
  Number of output channels, and therefore number of copies being made.
• id :: character(1)
  Identifier of resulting object, default "copy".
• param_vals :: named list
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default list().

Input and Output Channels

PipeOpCopy has one input channel named "input", taking any input ("*") both during training and prediction.

PipeOpCopy has multiple output channels depending on the outnum construction argument, named "output1", "output2", ... All output channels produce the object given as input ("*").

State

The $state is left empty (list()).

Parameters

PipeOpCopy has no parameters.

Internals

Note that copies are not clones, but only reference copies. This affects R6-objects: If R6 objects are copied using PipeOpCopy, they must be cloned before
Fields

Only fields inherited from PipeOp.

Methods

Only methods inherited from PipeOp.

See Also


Other Placeholder Pipeops: mlr_pipeops_nop

Examples

# The following copies the output of 'scale' automatically to both 'pca' and 'nop'
po("scale") %>>%
gunion(list(
  po("pca"),
  po("nop")
))

# The following would not work: the '%>>%' operator does not know which output to connect to which input
# > gunion(list("scale", "select")
# > >>%
# > gunion(list("pca", "nop")
# > >>%)

# Instead, the 'copy' operator makes clear which output gets copied.
gunion(list("scale") %>>% mlr_pipeops$get("copy", outnum = 2),
  po("select")
)) %>>%
gunion(list(
  po("pca"),
  po("select")
))

mlr_pipeops_encode

```r
po("nop"),
po("imputemean")
```

---

**Description**

Encodes columns of type factor, character and ordered.

Possible encodings are "one-hot" encoding, as well as encoding according to `stats::contr.helmert()`, `stats::contr.poly()`, `stats::contr.sum()` and `stats::contr.treatment()`. Newly created columns are named via pattern column-name.[x] where x is the respective factor level for "one-hot" and "treatment" encoding, and an integer sequence otherwise.

Use the `PipeOpTaskPreproc` $affect_columns functionality to only encode a subset of columns, or only encode columns of a certain type.

**Format**


**Construction**

PipeOpEncode$new(id = "encode", param_vals = list())

- `id`: character(1)
  Identifier of resulting object, default "encode".
- `param_vals`: named list
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default list().

**Input and Output Channels**

Input and output channels are inherited from `PipeOpTaskPreproc`.

The output is the input *Task* with all affected factor, character or ordered parameters encoded according to the method parameter.

**State**

The $state is a named list with the $state elements inherited from `PipeOpTaskPreproc`, as well as:

- `contrasts`: named list of matrix
  List of contrast matrices, one for each affected discrete feature. The rows of each matrix correspond to (training task) levels, the the columns to the new columns that replace the old discrete feature. See `stats::contrasts`.
Parameters

The parameters are the parameters inherited from `PipeOpTaskPreproc`, as well as:

- **method**: character(1)
  Initialized to "one-hot". One of:
  - "one-hot": create a new column for each factor level.
  - "treatment": create $n-1$ columns leaving out the first factor level of each factor variable (see `stats::contr.treatment()`).
  - "helmert": create columns according to Helmert contrasts (see `stats::contr.helmert()`).
  - "poly": create columns with contrasts based on orthogonal polynomials (see `stats::contr.poly()`).
  - "sum": create columns with contrasts summing to zero, (see `stats::contr.sum()`).

Internals

Uses the `stats::contrasts` functions. This is relatively inefficient for features with a large number of levels.

Methods


See Also


Examples

```r
library("mlr3")

data = data.table::data.table(x = factor(letters[1:3]), y = factor(letters[1:3]))
task = TaskClassif$new("task", data, "x")
poe = po("encode")

# poe is initialized with encoding: "one-hot"
poe$train(list(task))[[1]]$data()

# other kinds of encoding:
poe$param_set$values$method = "treatment"
```
Conditional Target Value Impact Encoding

Description

Encodes columns of type factor, character and ordered.

Impact coding for classification Tasks converts factor levels of each (factorial) column to the difference between each target level’s conditional log-likelihood given this level, and the target level’s global log-likelihood.

Impact coding for regression Tasks converts factor levels of each (factorial) column to the difference between the target’s conditional mean given this level, and the target’s global mean.

Treats new levels during prediction like missing values.

Format


Construction

PipeOpEncodeImpact$new(id = "encodeimpact", param_vals = list())

- id:: character(1)
  Identifier of resulting object, default "encodeimpact".
- param_vals:: named list
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default list().

Input and Output Channels

Input and output channels are inherited from PipeOpTaskPreproc.

The output is the input Task with all affected factor, character or ordered parameters encoded.
State

The state is a named list with the state elements inherited from PipeOpTaskPreproc, as well as:

- **impact** :: a named list
  A list with an element for each affected feature:
  For regression each element is a single column matrix of impact values for each level of that feature.
  For classification, it is a list with an element for each feature level, which is a vector giving the impact of this feature level on each outcome level.

Parameters

- **smoothing** :: numeric(1)
  A finite positive value used for smoothing. Mostly relevant for classification Tasks if a factor does not coincide with a target factor level (and would otherwise give an infinite logit value).
  Initialized to $1e^{-4}$.
- **impute_zero** :: logical(1)
  If TRUE, impute missing values as impact 0; otherwise the respective impact is coded as NA. Default FALSE.

Internals

Uses laplace smoothing, mostly to avoid infinite values for classification Task.

Methods


See Also


Examples

```r
library("mlr3")
poe = po("encodeimpact")

task = TaskClassif$new("task",
```
Impact Encoding with Random Intercept Models

Description

Encodes columns of type factor, character and ordered. 

PipeOpEncodeLmer() converts factor levels of each factorial column to the estimated coefficients of a simple random intercept model. Models are fitted with the glmer function of the lme4 package and are of the type target ~ 1 + (1 | factor). If the task is a regression task, the numeric target variable is used as dependent variable and the factor is used for grouping. If the task is a classification task, the target variable is used as dependent variable and the factor is used for grouping. If the target variable is multiclass, for each level of the multiclass target variable, binary "one vs. rest" models are fitted.

For training, multiple models can be estimated in a cross-validation scheme to ensure that the same factor level does not always result in identical values in the converted numerical feature. For prediction, a global model (which was fitted on all observations during training) is used for each factor. New factor levels are converted to the value of the intercept coefficient of the global model for prediction. NAs are ignored by the CPO.

Use the PipeOpTaskPreproc $affect_columns functionality to only encode a subset of columns, or only encode columns of a certain type.

Format


Construction

PipeOpEncodeLmer$new(id = "encodelmer", param_vals = list())

- id:: character(1)
  Identifier of resulting object, default "encodelmer".
- param_vals:: named list
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default list().
Input and Output Channels

Input and output channels are inherited from PipeOpTaskPreproc.

The output is the input Task with all affected factor, character or ordered parameters encoded according to the method parameter.

State

The $state is a named list with the $state elements inherited from PipeOpTaskPreproc, as well as:

- target_levels :: character
  Levels of the target columns.
- control :: a named list
  List of coefficients learned via glmer

Parameters

- fast_optim :: logical(1)
  Initialized to TRUE. If “fast_optim” is TRUE (default), a faster (up to 50 percent) optimizer from the nloptr package is used when fitting the lmer models. This uses additional stopping criteria which can give suboptimal results.

Internals

Uses the lme4::glmer. This is relatively inefficient for features with a large number of levels.

Methods


See Also


Examples

library("mlr3")
poe = po("encodelmer")
```r
task = TaskClassif$new("task",
data.table::data.table(
    x = factor(c("a", "a", "a", "b", "b")),
y = factor(c("a", "a", "b", "b", "b")),
"x")
poe$train(list(task))[[1]]$data()
poe$state
```

---

**mlr_pipeops_featureunion**

**PipeOpFeatureUnion**

**Description**

Aggregates features from all input tasks by `cbind()`ing them together into a single Task. DataBackend primary keys and Task targets have to be equal across all Tasks. Only the target column(s) of the first Task are kept.

If `assert_targets_equal` is TRUE then target column names are compared and an error is thrown if they differ across inputs.

**Format**

*R6Class* object inheriting from *PipeOp*.

**Construction**

PipeOpFeatureUnion$new(innum = 0, id = "featureunion", param_vals = list(), assert_targets_equal = TRUE)

- **innum**: numeric(1) | character
  Determines the number of input channels. If `innum` is 0 (default), a vararg input channel is created that can take an arbitrary number of inputs. If `innum` is a character vector, the number of input channels is the length of `innum`, and the columns of the result are prefixed with the values.

- **id**: character(1) Identifier of the resulting object, default "featureunion".

- **param_vals**: named list
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default list().

- **assert_targets_equal**: logical(1)
  If `assert_targets_equal` is TRUE (Default), task target column names are checked for agreement. Disagreeing target column names are usually a bug, so this should often be left at the default.
Input and Output Channels

PipeOpFeatureUnion has multiple input channels depending on the innum construction argument, named "input1", "input2", ..., if innum is nonzero; if innum is 0, there is only one vararg input channel named "...". All input channels take a Task both during training and prediction.

PipeOpFeatureUnion has one output channel named "output", producing a Task both during training and prediction.

The output is a Task constructed by cbind()ing all features from all input Tasks, both during training and prediction.

State

The $state is left empty (list()).

Parameters

PipeOpFeatureUnion has no Parameters.

Internals

PipeOpFeatureUnion uses the Task cbind() method to bind the input values beyond the first input to the first Task. This means if the Tasks are database-backed, all of them except the first will be fetched into R memory for this. This behaviour may change in the future.

Fields

Only fields inherited from PipeOp.

Methods

Only methods inherited from PipeOp.

See Also

Examples

```r
library("mlr3")

task = tsk("iris")
gr = gunion(list(
    po("nop"),
    po("pca")
)) %>>% po("featureunion")

gr$train(task)

po = po("featureunion", innum = c("a", "b"))

po$train(list(task, task))
```

---

### mlr_pipeops_filter  
**PipeOpFilter**

#### Description

Feature filtering using a `mlr3filters::Filter` object, see the `mlr3filters` package.  
If a `Filter` can only operate on a subset of columns based on column type, then only these features are considered and filtered. `nfeat` and `frac` will count for the features of the type that the `Filter` can operate on; this means e.g. that setting `nfeat` to 0 will only remove features of the type that the `Filter` can work with.

#### Format


#### Construction

`PipeOpFilter$new(filter, id = filter$id, param_vals = list())`

- **filter** :: `Filter`
  
  `Filter` used for feature filtering.

- **id** :: character(1) Identifier of the resulting object, defaulting to the id of the `Filter` being used.

- **param_vals** :: named list
  
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default `list()`.

#### Input and Output Channels

Input and output channels are inherited from `PipeOpTaskPreproc`.

The output is the input `Task` with features removed that were filtered out.
State

The $state is a named list with the $state elements inherited from PipeOpTaskPreproc, as well as:

- **scores**: named numeric
  Scores calculated for all features of the training Task which are being used as cutoff for feature filtering. If frac or nfeat is given, the underlying Filter may choose to not calculate scores for all features that are given. This only includes features on which the Filter can operate; e.g. if the Filter can only operate on numeric features, then scores for factorial features will not be given.

- **features**: character
  Names of features that are being kept. Features of types that the Filter can not operate on are always being kept.

Parameters

The parameters are the parameters inherited from the PipeOpTaskPreproc, as well as the parameters of the Filter used by this object. Besides, parameters introduced are:

- **filter.nfeat**: numeric(1)
  Number of features to select. Mutually exclusive with frac and cutoff.

- **filter.frac**: numeric(1)
  Fraction of features to keep. Mutually exclusive with nfeat and cutoff.

- **filter.cutoff**: numeric(1)
  Minimum value of filter heuristic for which to keep features. Mutually exclusive with nfeat and frac.

Note that at least one of filter.nfeat, filter.frac, or filter.cutoff must be given.

Internals

This does not use the $select_cols feature of PipeOpTaskPreproc to select only features compatible with the Filter; instead the whole Task is used by $get_state() and subset internally.

Fields

Fields inherited from PipeOpTaskPreproc, as well as:

- **filter**: Filter
  Filter that is being used for feature filtering. Do not use this slot to get to the feature filtering scores after training; instead, use $state$scores. Read-only.

Methods

See Also


Examples

library("mlr3")
library("mlr3filters")

# setup PipeOpFilter to keep the 5 most important
# features of the spam task w.r.t. their AUC

task = tsk("spam")
filter = flt("auc")
po = po("filter", filter = filter)
po$param_set
po$param_set$values$filter.nfeat = 5

# filter the task
filtered_task = po$train(list(task))[[1]]

# filtered task + extracted AUC scores
filtered_task$feature_names
head(po$state$scores, 10)

# feature selection embedded in a 3-fold cross validation
# keep 30% of features based on their AUC score

task = tsk("spam")
gr = po("filter", filter = flt("auc"), filter.frac = 0.5) %>%
  po("learner", lrn("classif.rpart"))
learner = GraphLearner$new(gr)
rr = resample(task, learner, rsmp("holdout"), store_models = TRUE)
rr$learners[[1]]$model$auc$scores
Description

Fixes factors of type factor, ordered: Makes sure the factor levels during prediction are the same as during training; possibly dropping empty training factor levels before.

Note this may introduce missing values during prediction if unseen factor levels are found.

Format


Construction

PipeOpFixFactors$new(id = "fixfactors", param_vals = list())

- id:: character(1)
  Identifier of resulting object, default "fixfactors".
- param_vals:: named list
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default list().

Input and Output Channels

Input and output channels are inherited from PipeOpTaskPreproc.

The output is the input Task with all affected factor and ordered feature levels fixed.

State

The $state is a named list with the $state elements inherited from PipeOpTaskPreproc, as well as:

- levels:: named list of character
  List of factor levels of each affected factor or ordered feature that will be fixed.

Parameters

The parameters are the parameters inherited from PipeOpTaskPreproc, as well as:

- droplevels:: logical(1)
  Whether to drop empty factor levels of the training task. Default TRUE

Internals

Changes factor levels of columns and attaches them with a new data.table backend and the virtual cbind() backend.

Methods

**mlr_pipeops_histbin**  

**See Also**


---

**Examples**

```r
library("mlr3")
```

---

**Description**

Splits numeric features into equally spaced bins. See `graphics::hist()` for details.

**Format**


**Construction**

```r
PipeOpHistBin$new(id = "histbin", param_vals = list())
```

- `id`:: character(1)
  
  Identifier of resulting object, default "histbin".

- `param_vals`:: named list
  
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default `list()`.

**Input and Output Channels**

Input and output channels are inherited from `PipeOpTaskPreproc`.

The output is the input `Task` with all affected numeric features replaced by their binned versions.
**State**

The $state is a named list with the $state elements inherited from PipeOpTaskPreproc, as well as:

- **bins**: list
  List of intervals representing the bins for each numeric feature.

**Parameters**

The parameters are the parameters inherited from PipeOpTaskPreproc, as well as:

- **bins**: character(1) | numeric | function
  Either a character(1) string naming an algorithm to compute the number of cells, a numeric(1) giving the number of breaks for the histogram, a vector numeric giving the breakpoints between the histogram cells, or a function to compute the vector of breakpoints or to compute the number of cells. Default is algorithm "Sturges" (see grDevices::nclass.Sturges()). For details see hist().

**Internals**

Uses the graphics::hist function.

**Methods**


**See Also**


**Examples**

```r
library("mlr3")

task = tsk("iris")
pop = po("histbin")

task$data()

pop$train(list(task))[[1]]$data()

pop$state
```
Description

Extracts statistically independent components from data. Only affects numerical features. See fastICA::fastICA for details.

Format

R6Class object inheriting from PipeOpTaskPreproc/PipeOp.

Construction

PipeOpICA$new(id = "ica", param_vals = list())

- id:: character(1)
  Identifier of resulting object, default "ica".
- param_vals:: named list
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default list().

Input and Output Channels

Input and output channels are inherited from PipeOpTaskPreproc.

The output is the input Task with all affected numeric parameters replaced by independent components.

State

The $state is a named list with the $state elements inherited from PipeOpTaskPreproc, as well as the elements of the function fastICA::fastICA(), with the exception of the $X and $S slots. These are in particular:

- K:: matrix
  Matrix that projects data onto the first n.comp principal components. See fastICA().
- W:: matrix
  Estimated un-mixing matrix. See fastICA().
- A:: matrix
  Estimated mixing matrix. See fastICA().
- center:: numeric
  The mean of each numeric feature during training.
Parameters

The parameters are the parameters inherited from PipeOpTaskPreproc, as well as the following parameters based on fastICA():

- **n.comp**: numeric(1)
  Number of components to extract. Default is NULL, which sets it to the number of available numeric columns.
- **alg.typ**: character(1)
  Algorithm type. One of “parallel” (default) or “deflation”.
- **fun**: character(1)
  One of “logcosh” (default) or “exp”.
- **alpha**: numeric(1)
  In range [1, 2]. Used for negentropy calculation when fun is “logcosh”. Default is 1.0.
- **method**: character(1)
  Internal calculation method. “C” (default) or “R”. See fastICA().
- **row.norm**: logical(1)
  Logical value indicating whether rows should be standardized beforehand. Default is FALSE.
- **maxit**: numeric(1)
  Maximum number of iterations. Default is 200.
- **tol**: numeric(1)
  Tolerance for convergence, default is 1e-4.
- **verbose**: logical(1)
  Logical value indicating the level of output during the run of the algorithm. Default is FALSE.
- **w.init**: matrix
  Initial un-mixing matrix. See fastICA(). Default is NULL.

Internals

Uses the fastICA() function.

Methods


See Also

mlr_pipeops_imputehist

Examples

library("mlr3")

task = tsk("iris")
pop = po("ica")

task$data()
pop$train(list(task)[[1]]$data)

pop$state

mlr_pipeops_imputehist

PipeOpImputeHist

Description

Impute numerical features by histogram.

Format

R6Class object inheriting from PipeOpImpute/PipeOp.

Construction

PipeOpImputeHist$new(id = "imputehist", param_vals = list())

- id:: character(1)
  Identifier of resulting object, default "imputehist".
- param_vals:: named list
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default list().

Input and Output Channels

Input and output channels are inherited from PipeOpImputeHist.

The output is the input Task with all affected numeric features missing values imputed by (column-wise) histogram.

State

The $state is a named list with the $state elements inherited from PipeOpImpute.

The $state$model is a named list of lists containing elements $counts and $breaks.

Parameters

The parameters are the parameters inherited from PipeOpImpute.
mlr_pipeops_imputemean

Internals

Uses the `graphics::hist()` function. Features that are entirely NA are imputed as 0.

Methods

Only methods inherited from PipeOpImpute/PipeOp.

See Also


Other Imputation PipeOps: PipeOpImpute, mlr_pipes_imputemean, mlr_pipes_imputemedian, mlr_pipes_imputenewlvl, mlr_pipes_imputesample

Examples

```r
library("mlr3")

task = tsk("pima")
task$missings()

po = po("imputehist")
new_task = po$train(list(task = task))[[1]]
new_task$missings()

po$state$model
```

mlr_pipes_imputemean

PipeOpImputeMean

Description

Impute numerical features by their mean.

Format

`R6Class` object inheriting from `PipeOpImpute/PipeOp`.
Construction

PipeOpImputeMean$new(id = "imputemean", param_vals = list())

- \texttt{id} :: character(1)
  Identifier of resulting object, default "imputemean".
- \texttt{param_vals} :: named list
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default list().

Input and Output Channels

Input and output channels are inherited from \texttt{PipeOpImputeMean}.

The output is the input \texttt{Task} with all affected numeric features missing values imputed by (column-wise) mean.

State

The $state is a named list with the $state elements inherited from \texttt{PipeOpImpute}.

The $state$model is a named list of \texttt{numeric(1)} indicating the mean of the respective feature.

Parameters

The parameters are the parameters inherited from \texttt{PipeOpImpute}.

Internals

Uses the mean() function. Features that are entirely NA are imputed as 0.

Methods

Only methods inherited from \texttt{PipeOpImpute/PipeOp}.

See Also


Other Imputation PipeOps: \texttt{PipeOpImpute}, \texttt{mlr_pipeopsImputeHist}, \texttt{mlr_pipeopsImputemedian}, \texttt{mlr_pipeopsImputenewlvl}, \texttt{mlr_pipeopsImputesample}
Examples

```r
library("mlr3")

task = tsk("pima")
task$missings()

po = po("imputemean")
new_task = po$train(list(task = task))[[1]]
new_task$missings()

po$state$model
```

---

**mlr_pipeops_imputemedian**

*PipeOpImputeMedian*

**Description**

Impute numerical features by their median.

**Format**

*R6Class* object inheriting from *PipeOpImpute/PipeOp*.

**Construction**

```r
PipeOpImputeMedian$new(id = "imputemedian", param_vals = list())
```

- **id**: character(1)
  - Identifier of resulting object, default "imputemedian".
- **param_vals**: named list
  - List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default list().

**Input and Output Channels**

Input and output channels are inherited from *PipeOpImputeMedian*.

The output is the input *Task* with all affected numeric features missing values imputed by (column-wise) median.

**State**

The $state is a named list with the $state elements inherited from *PipeOpImpute*.

The $state$model is a named list of numeric(1) indicating the median of the respective feature.

**Parameters**

The parameters are the parameters inherited from *PipeOpImpute*.
Internals

Uses the `stats::median()` function. Features that are entirely NA are imputed as 0.

Methods

Only methods inherited from `PipeOpImpute/PipeOp`.

See Also


Other Imputation PipeOps: `PipeOpImpute, mlr_pipeops_imputehist, mlr_pipeops_imputemean, mlr_pipeops_imputenewlvl, mlr_pipeops_imputesample`

Examples

```r
library("mlr3")

task = tsk("pima")
task$missings()

po = po("imputemedian")
new_task = po$train(list(task = task))[[1]]
new_task$missings()

po$state$model
```

Description

Impute factorial features by adding a new feature.

Format

`R6Class` object inheriting from `PipeOpImpute/PipeOp`. 
Construction

PipeOpImputeNewlvl$new(id = "imputenewlvl", param_vals = list())

- id:: character(1)
  Identifier of resulting object, default "imputenewlvl".
- param_vals:: named list
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default list().

Input and Output Channels

Input and output channels are inherited from PipeOpImputeNewlvl.

The output is the input Task with all affected factorial features missing values imputed by a new level.

State

The $state is a named list with the $state elements inherited from PipeOpImpute.

The $state$model contains only NULL elements.

Parameters

The parameters are the parameters inherited from PipeOpImpute.

Internals

Adds an explicit new level() to factor and ordered features, but not to character features.

Methods

Only methods inherited from PipeOpImpute/PipeOp.

See Also


Other Imputation PipeOps: PipeOpImpute, mlr_pipeops_imputehist, mlr_pipeops_imputemean, mlr_pipeops_imputemedian, mlr_pipeops_imputesample
Examples

```r
library("mlr3")

task = tsk("pima")
task$missings()

po = po("imputenewlvl")
new_task = po$train(list(task = task))[[1]]
new_task$missings()
```

Description

Impute features by sampling from non-missing training data.

Format

*R6Class* object inheriting from *PipeOpImpute/PipeOp*.

Construction

`PipeOpImputeSample$new(id = "imputesample", param_vals = list())`

- **id**:: character(1)
  Identifier of resulting object, default "imputesample".

- **param_vals**:: named list
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default list().

Input and Output Channels

Input and output channels are inherited from *PipeOpImputeSample*.

The output is the input Task with all affected numeric features missing values imputed by values sampled (column-wise) from training data.

State

The $state is a named list with the $state elements inherited from *PipeOpImpute*.

The $state$model is a named list of training data with missings removed.

Parameters

The parameters are the parameters inherited from *PipeOpImpute*. 
Internals

Uses the `sample()` function. Features that are entirely NA are imputed as the values given by `vector()` of their type.

Methods

Only methods inherited from `PipeOpImpute/PipeOp`.

See Also


Other Imputation PipeOps: `PipeOpImpute, mlr_pipeops_imputehist, mlr_pipeops_imputemean, mlr_pipeops_imputemedian, mlr_pipeops_imputenewlvl`

Examples

```r
library("mlr3")

task = tsk("pima")
task$missings()

po = po("imputesample")
new_task = po$train(list(task = task))[[1]]
new_task$missings()
```

---

**mlr_pipeops_kernelpca**  
**PipeOpKernelPCA**

Description

Extracts kernel principle components from data. Only affects numerical features. See `kernlab::kpca` for details.

Format

`R6Class` object inheriting from `PipeOpTaskPreproc/PipeOp`.
mlr_pipeops_kernelpca

Construction

PipeOpKernelPCA$new(id = "kernelpca", param_vals = list())

- id :: character(1)
  Identifier of resulting object, default "kernelpca".

- param_vals :: named list
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default list().

Input and Output Channels

Input and output channels are inherited from PipeOpTaskPreproc.

The output is the input Task with all affected numeric parameters replaced by their principal components.

State

The $state is a named list with the $state elements inherited from PipeOpTaskPreproc, as well as the returned S4 object of the function kernlab::kpca().

The @rotated slot of the "kpca" object is overwritten with an empty matrix for memory efficiency.

The slots of the S4 object can be accessed by accessor function. See kernlab::kpca.

Parameters

The parameters are the parameters inherited from PipeOpTaskPreproc, as well as:

- kernel :: character(1)
  The standard deviations of the principal components. See kpca().

- kpar :: list
  List of hyper-parameters that are used with the kernel function. See kpca().

- features :: numeric(1)
  Number of principal components to return. Default 0 means that all principal components are returned. See kpca().

- th :: numeric(1)
  The value of eigenvalue under which principal components are ignored. Default is 0.0001. See kpca().

- na.action :: function
  Function to specify NA action. Default is na.omit. See kpca().

Internals

Uses the kpca() function.

Methods

See Also


Examples

library("mlr3")

task = tsk("iris")
pop = po("kernelpca", features = 3) # only keep top 3 components

task$data()
pop$train(list(task))[[1]]$data()

mlr_pipeops_learner PipeOpLearner

Description

Wraps an mlr3::Learner into a PipeOp.

Inherits the $param_set (and therefore $param_set$values) from the Learner it is constructed from. Using PipeOpLearner, it is possible to embed mlr3::Learners into Graphs, which themselves can be turned into Learners using GraphLearner. This way, preprocessing and ensemble methods can be included into a machine learning pipeline which can then be handled as singular object for resampling, benchmarking and tuning.

Format

R6Class object inheriting from PipeOp.

Construction

PipeOpLearner$new(learner, id = if (is.character(learner)) learner else learner$id, param_vals = list())

- learner :: Learner | character(1) Learner to wrap, or a string identifying a Learner in the mlr3::mlr_learners Dictionary.
- id :: character(1) Identifier of the resulting object, defaulting to the id of the Learner being wrapped.
Input and Output Channels

PipeOpLearner has one input channel named "input", taking a Task specific to the Learner type given to learner during construction; both during training and prediction.

PipeOpLearner has one output channel named "output", producing NULL during training and a Prediction subclass during prediction; this subclass is specific to the Learner type given to learner during construction.

The output during prediction is the Prediction on the prediction input data, produced by the Learner trained on the training input data.

State

The $state is set to the $state slot of the Learner object. It is a named list with members:

- model :: any
  Model created by the Learner’s $train_internal() function.

- train_log :: data.table with columns class (character), msg (character)
  Errors logged during training.

- train_time :: numeric(1)
  Training time, in seconds.

- predict_log :: NULL | data.table with columns class (character), msg (character)
  Errors logged during prediction.

- predict_time :: NULL | numeric(1) Prediction time, in seconds.

Parameters

The parameters are exactly the parameters of the Learner wrapped by this object.

Internals

The $state is currently not updated by prediction, so the $state$predict_log and $state$predict_time will always be NULL.

Fields

Fields inherited from PipeOp, as well as:

- learner :: Learner
  Learner that is being wrapped. Read-only.

Methods

Methods inherited from PipeOp.
See Also

Other Meta PipeOps: mlr_pipeops

Examples

library("mlr3")

task = tsk("iris")
learner = lrn("classif.rpart", cp = 0.1)
lrn_po = mlr_pipeops$get("learner", learner)

lrn_po$train(list(task))
lrn_po$predict(list(task))
Format

R6Class object inheriting from PipeOpTaskPreproc/PipeOp.

Construction

PipeOpLearnerCV$new(learner, id = if (is.character(learner)) learner else learner$id, param_vals = list())

• learner :: Learner
  Learner to use for cross validation / prediction, or a string identifying a Learner in the mlr3::mlr_learners Dictionary.

• id :: character(1) Identifier of the resulting object, defaulting to the id of the Learner being wrapped.

• param_vals :: named list
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default list().

Input and Output Channels

PipeOpLearnerCV has one input channel named "input", taking a Task specific to the Learner type given to learner during construction; both during training and prediction.

PipeOpLearnerCV has one output channel named "output", producing a Task specific to the Learner type given to learner during construction; both during training and prediction.

The output is a task with the same target as the input task, with features replaced by predictions made by the Learner. During training, this prediction is the out-of-sample prediction made by resample, during prediction, this is the ordinary prediction made on the data by a Learner trained on the training phase data.

State

The $state is set to the $state slot of the Learner object, together with the $state elements inherited from the PipeOpTaskPreproc. It is a named list with the inherited members, as well as:

• model :: any
  Model created by the Learner’s $train_internal() function.

• train_log :: data.table with columns class (character), msg (character)
  Errors logged during training.

• train_time :: numeric(1)
  Training time, in seconds.

• predict_log :: NULL | data.table with columns class (character), msg (character)
  Errors logged during prediction.

• predict_time :: NULL | numeric(1) Prediction time, in seconds.

Parameters

The parameters are the parameters inherited from the PipeOpTaskPreproc, as well as the parameters of the Learner wrapped by this object. Besides that, parameters introduced are:
• resampling.method :: character(1)
  Which resampling method do we want to use. Currently only supports "cv".
• resampling.folds :: numeric(1)
  Number of cross validation folds. Initialized to 3.
• keep_response :: logical(1)
  Only effective during "prob" prediction: Whether to keep response values, if available. Initialized to FALSE.

Internals

The $state is currently not updated by prediction, so the $state$predict_log and $state$predict_time will always be NULL.

Fields

Fields inherited from PipeOpTaskPreproc/PipeOp, as well as:

• learner :: Learner
  Learner that is being wrapped. Read-only.

Methods


See Also

Other Meta PipeOps: mlr_pipeops_learner

Examples

library("mlr3")

  task = tsk("iris")
  learner = lrn("classif.rpart")

  lrncv_po = po("learner_cv", learner)
  lrncv_po$learner$predict_type = "response"

  nop = mlr_pipeops$get("nop")

  graph = gunion(list(
    lrncv_po,
    nop
  )) %>>% po("featureunion")

  graph$train(task)

  graph$pipeops$classif.rpart$learner$predict_type = "prob"

  graph$train(task)
mlr_pipeops_missind

PipeOpMissInd

Description

Add missing indicator columns ("dummy columns") to the Task. Drops original features; should probably be used in combination with PipeOpFeatureUnion and imputation PipeOps (see examples).

Format


Construction

PipeOpMissInd$new(id = "missind", param_vals = list())

• id :: character(1) Identifier of the resulting object, defaulting to "missind".
• param_vals :: named list
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default list().

State

$state is a named list with the $state elements inherited from PipeOpTaskPreproc, as well as:

• indicand_cols :: character
  Names of columns for which indicator columns are added. If the which parameter is "all", this is just the names of all features, otherwise it is the names of all features that had missing values during training.

Parameters

The parameters are the parameters inherited from the PipeOpTaskPreproc, as well as:

• which :: character(1)
  Determines for which features the indicator columns are added. Can either be “missing_train” (default), adding indicator columns for each feature that actually has missing values, or "all", adding indicator columns for all features.
• type :: character(1)
  Determines the type of the newly created columns. Can be one of "numeric", "factor" (default), "logical".
Internals

This PipeOp should cover most cases where "dummy columns" or "missing indicators" are desired. Some edge cases:

- If imputation for factorial features is performed and only numeric features should gain missing indicators, the affect_columns parameter can be set to selector_type("numeric").
- If missing indicators should only be added for features that have more than a fraction of missing values, the PipeOpRemoveConstants can be used with affect_columns = selector_grep("^missing_") and ratio = x.

Fields


Methods


See Also


Examples

library("mlr3")

task = tsk("pima")$select(c("insulin", "triceps"))
sum(complete.cases(task$data()))
task$missings()
tail(task$data())

po = po("missind")
new_task = po$train(list(task))[[1]]
tail(new_task$data())

# proper imputation + missing indicators

impgraph = list(
po("imputesample"),
Po("missind") %>>% Po("featureunion")

tail(impgraph$train(task)[[1]]$data())

---

**PipeOpModelMatrix**

**Description**

Transforms columns using a given formula using the `stats::model.matrix()` function.

**Format**


**Construction**

PipeOpModelMatrix$new(id = "modelmatrix", param_vals = list())

- **id**: `character(1)`
  - Identifier of resulting object, default "modelmatrix".
- **param_vals**: `named list`
  - List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default list().

**Input and Output Channels**

Input and output channels are inherited from `PipeOpTaskPreproc`.

The output is the input Task with transformed columns according to the used formula.

**State**

The $state is a named list with the $state elements inherited from `PipeOpTaskPreproc`.

**Parameters**

The parameters are the parameters inherited from `PipeOpTaskPreproc`, as well as:

- **formula**: `formula`
  - Formula to use. Higher order interactions can be created using constructs like `~. ^ 2`. By default, an (Intercept) column of all 1s is created, which can be avoided by adding `0 +` to the term. See `model.matrix()`.

**Internals**

Uses the `model.matrix()` function.
Methods


See Also


Examples

library("mlr3")

task = tsk("iris")
pop = po("modelmatrix", formula = ~ . ^ 2)

task$data()
pop$param_set$values$formula = ~ 0 + . ^ 2
pop$train(list(task))[[1]]$data()

Description

Adds features according to expressions given as formulas that may depend on values of other features. This can add new features, or can change existing features.

Format

Construction

PipeOpMutate$new(id = "mutate", param_vals = list())

- id :: character(1)
  Identifier of resulting object, default "mutate".
- param_vals :: named list
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default list().

Input and Output Channels

Input and output channels are inherited from PipeOpTaskPreproc.

The output is the input Task with added and/or mutated features according to the mutation parameter.

State

The $state is a named list with the $state elements inherited from PipeOpTaskPreproc.

Parameters

The parameters are the parameters inherited from PipeOpTaskPreproc, as well as:

- mutation :: named list of formula
  Expressions for new features to create (or present features to change), in the form of formula. Each element of the list is a formula with the name of the element naming the feature to create or change, and the formula expression determining the result. This expression may reference other features, as well as variables visible at the creation of the formula (see examples). Initialized to list().
- delete_originals :: logical(1)
  Whether to delete original features. Even when this is FALSE, present features may still be overwritten. Initialized to FALSE.

Internals

A formula created using the ~ operator always contains a reference to the environment in which the formula is created. This makes it possible to use variables in the ~-expressions that both reference either column names or variable names.

Fields


Methods

See Also


Examples

library("mlr3")

pom = po("mutate")
pom$param_set$values$mutation = list(
  Sepal.Area = ~ Sepal.Width * Sepal.Length,
  Petal.Area = ~ Petal.Width * Petal.Length
)

pom$train(list(tsk("iris")))[[1]]$data()

mlr_pipeops_nop  \hspace{1cm} PipeOpNOP

Description

Simply pushes the input forward. Can be useful during Graph construction using the >>-operator to specify which PipeOp gets connected to which.

Format

R6Class object inheriting from PipeOp.

Construction

PipeOpNOP$new(id = "nop", param_vals = list())

- id:: character(1)
  Identifier of resulting object, default "nop".
- param_vals:: named list
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default list().
**Input and Output Channels**

PipeOpNOP has one input channel named "input", taking any input ("*") both during training and prediction.

PipeOpNOP has one output channel named "output", producing the object given as input ("*") without changes.

**State**

The $state is left empty (list()).

**Parameters**

PipeOpNOP has no parameters.

**Internals**

PipeOpNOP is a useful "default" stand-in for a PipeOp/Graph that does nothing.

**Fields**

Only fields inherited from PipeOp.

**Methods**

Only methods inherited from PipeOp.

**See Also**


Other Placeholder Pipeops: mldr_pipeops_copy

**Examples**

library("mlr3")
	nop = po("nop")
	nop$train(list(1))
# use `gunion` and `%>>%` to create a "bypass"
# next to "pca"
gr = gunion(list(
    po("pca"),
    nop
  )) %>>% po("featureunion")

gr$train(tsk("iris"))[[1]]$data()

---

### mlr_pipeops_pca

#### PipeOpPCA

**Description**

Extracts principle components from data. Only affects numerical features. See `stats::prcomp()` for details.

**Format**

`R6Class` object inheriting from `PipeOpTaskPreproc/PipeOp`.

**Construction**

`PipeOpPCA$new(id = "pca", param_vals = list())`

- `id`: character(1)
  Identifier of resulting object, default "pca".
- `param_vals`: named list
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default list().

**Input and Output Channels**

Input and output channels are inherited from `PipeOpTaskPreproc`.

The output is the input `Task` with all affected numeric features replaced by their principal components.

**State**

The $state is a named list with the $state elements inherited from `PipeOpTaskPreproc`, as well as the elements of the class `stats::prcomp`, with the exception of the $x slot. These are in particular:

- `sdev`: numeric
  The standard deviations of the principal components.
- `rotation`: matrix
  The matrix of variable loadings.
- `center`: numeric|logical(1)
  The centering used, or FALSE.
- `scale`: numeric|logical(1)
  The scaling used, or FALSE.
Parameters

The parameters are the parameters inherited from `PipeOpTaskPreproc`, as well as:

- `center` :: logical(1)
  Indicating whether the features should be centered. Default is FALSE. See `prcomp()`.
- `scale` :: logical(1)
  Whether to scale features to unit variance before analysis. Default is FALSE, but scaling is advisable. See `prcomp()`.
- `rank` :: integer(1)
  Maximal number of principal components to be used. Default is NULL: use all components. See `prcomp()`.

Internals

Uses the `prcomp()` function.

Methods


See Also


Examples

```r
library("mlr3")

task = tsk("iris")
pop = po("pca")

# Call the PipeOp

# A task has been loaded, but nothing has been trained on it yet.
# By calling the PipeOp, it will return a trained task.

# It is important to notice that the object returned from the PipeOp is a task.
# It can be inspected in the same way as an original task.

# A trained task is a task which has been processed (pre-processed).

# The training set can be accessed, and should be trained on:

# [...]#1$data()

# The problem state is set, but nothing is trained.

pop$state
```
Description

Splits numeric features into quantile bins.

Format


Construction

PipeOpQuantileBin$new(id = "quantilebin", param_vals = list())

• id :: character(1)
  Identifier of resulting object, default "quantilebin".
• param_vals :: named list
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default list().

Input and Output Channels

Input and output channels are inherited from PipeOpTaskPreproc.

The output is the input Task with all affected numeric features replaced by their binned versions.

State

The $state is a named list with the $state elements inherited from PipeOpTaskPreproc, as well as:

• bins :: list
  List of intervals representing the bins for each numeric feature.

Parameters

The parameters are the parameters inherited from PipeOpTaskPreproc, as well as:

• numsplits :: numeric(1)
  Number of bins to create. Default is 2.

Internals

Uses the stats::quantile function.

Methods

See Also


Examples

```r
library("mlr3")

task = tsk("iris")
pop = po("quantilebin")

# apply the quantile binning on the iris dataset
# and then apply the regravg pipe operator
# to predict the response
# The resulting "response" prediction is a weighted average of the incoming "response" predictions.
# "se" prediction is currently not aggregated but discarded if present.
# Weights can be set as a parameter; if none are provided, defaults to equal weights for each prediction.
# Defaults to equal weights for each model.

mlr_pipeops_regravg PipeOpRegrAvg

### Description

Perform (weighted) prediction averaging from regression Predictions by connecting PipeOpRegrAvg to multiple PipeOpLearner outputs.

The resulting "response" prediction is a weighted average of the incoming "response" predictions. "se" prediction is currently not aggregated but discarded if present.

Weights can be set as a parameter; if none are provided, defaults to equal weights for each prediction. Defaults to equal weights for each model.

### Format

R6Class inheriting from PipeOpEnsemble/PipeOp.

### Construction

PipeOpRegrAvg$new(innum = 0, id = "regravg", param_vals = list())

- innum :: numeric(1)
  Determines the number of input channels. If innum is 0 (default), a vararg input channel is created that can take an arbitrary number of inputs.
mlr.pipeops.regravg

- **id**: character(1) Identifier of the resulting object, default "regravg".
- **param_vals**: named list
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default list().

**Input and Output Channels**

Input and output channels are inherited from `PipeOpEnsemble`. Instead of a `Prediction`, a `PredictionRegr` is used as input and output during prediction.

**State**

The `$state` is left empty (list()).

**Parameters**

The parameters are the parameters inherited from the `PipeOpEnsemble`.

**Internals**

Inherits from `PipeOpEnsemble` by implementing the private `$weighted_avg_predictions()` method.

**Fields**


**Methods**


**See Also**


Other Ensembles: `PipeOpEnsemble, mlr.learners_avg, mlr.pipeops.classifavg`
Examples

library("mlr3")

# Simple Bagging
gr = greplicate(n = 5,
  po("subsample") %>>% 
  po("learner", lrn("classif.rpart"))) %>>%
  po("classifavg")

resample(tsk("iris"), GraphLearner$new(gr), rsmp("holdout"))

mlr_pipeops_removeconstants

PipeOpRemoveConstants

Description

Remove constant features from a mlr3::Task. For each feature, calculates the ratio of features which
differ from their mode value. All features which a ratio below a settable threshold are removed
from the task. Missing values can be ignored or treated as a regular value distinct from non-missing
values.

Format


Construction

PipeOpRemoveConstants$new(id = "removeconstants")

- id :: character(1) Identifier of the resulting object, defaulting to "removeconstants".
- param_vals :: named list
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise
  be set during construction. Default list().

State

$state is a named list with the $state elements inherited from PipeOpTaskPreproc, as well as:

- features :: character
  Names of features that are being kept. Features of types that the Filter can not operate on
  are always being kept.
Parameters

The parameters are the parameters inherited from the `PipeOpTaskPreproc`, as well as:

- **ratio**: numeric(1)
  Ratio of values which must be different from the mode value in order to keep a feature in the task. Default is 0, which means only constant features with exactly one observed level are removed.
- **rel_tol**: numeric(1)
  Relative tolerance within which to consider a numeric feature constant. Set to 0 to disregard relative tolerance. Default is 1e-8.
- **abs_tol**: numeric(1)
  Absolute tolerance within which to consider a numeric feature constant. Set to 0 to disregard absolute tolerance. Default is 1e-8.
- **na_ignore**: logical(1)
  If TRUE, the ratio is calculated after removing all missing values first. Default is FALSE.

Fields


Methods


See Also


Examples

```r
library("mlr3")
data = data.table::data.table(y = runif(10), a = 1:10, b = rep(1, 10), c = rep(1:2, each = 5))
task = TaskRegr$new("example", data, target = "y")
po = po("removeconstants")
po$train(list(task = task))[[1]]$data()
po$state
```
mlr_pipeops_scale

PipeOpScale

Description

Centers all numeric features to mean = 0 (if center parameter is TRUE) and scales them by dividing them by their root-mean-square (if scale parameter is TRUE).

The root-mean-square here is defined as $\sqrt{\frac{\sum(x^2)}{(\text{length}(x)-1)}}$. If the center parameter is TRUE, this corresponds to the sd().

Format

R6Class object inheriting from PipeOpTaskPreproc/PipeOp.

Construction

PipeOpScale$new(id = "scale", param_vals = list())

- id :: character(1)
  Identifier of resulting object, default "scale".

- param_vals :: named list
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default list().

Input and Output Channels

Input and output channels are inherited from PipeOpTaskPreproc.

The output is the input Task with all affected numeric parameters centered and/or scaled.

State

The $state is a named list with the $state elements inherited from PipeOpTaskPreproc, as well as:

- center :: numeric
  The mean of each numeric feature during training, or 0 if center is FALSE. Will be subtracted during the predict phase.

- scale :: numeric
  The root mean square, defined as $\sqrt{\frac{\sum(x^2)}{(\text{length}(x)-1)}}$, of each feature during training, or 1 if scale is FALSE. During predict phase, features are divided by this. This is 1 for features that are constant during training if center is TRUE, to avoid division-by-zero.
Parameters

The parameters are the parameters inherited from PipeOpTaskPreproc, as well as:

- **center** :: `logical(1)`
  Whether to center features, i.e. subtract their mean() from them. Default TRUE.

- **scale** :: `logical(1)`
  Whether to scale features, i.e. divide them by \( \sqrt{\text{sum}(x^2)/(\text{length}(x)-1)} \). Default TRUE.

Internals

Uses the `scale()` function.

Methods


See Also


Examples

library("mlr3")

  task = tsk("iris")
  pos = po("scale")

  pos$train(list(task))[[1]]$data()

  one_line_of_iris = task$filter(13)

  one_line_of_iris$data()

  pos$predict(list(one_line_of_iris))[[1]]$data()
Description
Scales the numeric data columns so their maximum absolute value is \texttt{maxabs}, if possible. \texttt{NA}, \texttt{Inf} are ignored, and features that are constant 0 are not scaled.

Format
\texttt{R6Class} object inheriting from \texttt{PipeOpTaskPreprocSimple/PipeOpTaskPreproc/PipeOp}.

Construction
\texttt{PipeOpScaleMaxAbs$new(id = "scalemaxabs", param_vals = list())}

\begin{itemize}
  \item \texttt{id}:: character(1)
      Identifier of resulting object, default "scalemaxabs".
  \item \texttt{param_vals}:: named list
      List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default \texttt{list()}.
\end{itemize}

Input and Output Channels
Input and output channels are inherited from \texttt{PipeOpTaskPreproc}.
The output is the input \texttt{Task} with scaled numeric features.

State
The $state is a named list with the $state elements inherited from \texttt{PipeOpTaskPreproc}, as well as the maximum absolute values of each numeric feature.

Parameters
The parameters are the parameters inherited from \texttt{PipeOpTaskPreproc}, as well as:

\begin{itemize}
  \item \texttt{maxabs}:: numeric(1)
      The maximum absolute value for each column after transformation. Default is 1.
\end{itemize}

Methods
Only methods inherited from \texttt{PipeOpTaskPreprocSimple/PipeOpTaskPreproc/PipeOp}. 

\texttt{mlr_pipeops_scalemaxabs}

\texttt{PipeOpScaleMaxAbs}
See Also


Examples

```r
library("mlr3")

task = tsk("iris")
pop = po("scalemaxabs")

# Apply the PipeOp to the task
task$data()
pop$train(list(task))[[1]]$data()

# Get the state of the PipeOp
pop$state
```

---

### Description

Linearly transforms numeric data columns so they are between `lower` and `upper`. The formula for this is $x' = a + x \times b$, where $b$ is $(upper - lower) / (max(x) - min(x))$ and $a$ is $-min(x) \times b + lower$.

### Format


### Construction

```r
PipeOpScaleRange$new(id = "scalerange", param_vals = list())
```

- **id**: character(1)
  
  Identifier of resulting object, default "scalerange".

- **param_vals**: named list
  
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default list().
Input and Output Channels

Input and output channels are inherited from PipeOpTaskPreproc. The output is the input Task with scaled numeric features.

State

The $state is a named list with the $state elements inherited from PipeOpTaskPreproc, as well as the two transformation parameters $a$ and $b$ for each numeric feature.

Parameters

The parameters are the parameters inherited from PipeOpTaskPreproc, as well as:

- **lower**: numeric(1)
  Target value of smallest item of input data. Default is 0.
- **upper**: numeric(1)
  Target value of greatest item of input data. Default is 1.

Methods


See Also


Examples

```r
library("mlr3")

task = tsk("iris")
pop = po("scalerange", param_vals = list(lower = -1, upper = 1))

task$data()
pop$train(list(task))[[1]]$data()

pop$state
```
Description

Removes features from Task depending on a Selector function: The selector parameter gives the features to keep. See Selector for selectors that are provided and how to write custom Selectors.

Format


Construction

PipeOpSelect$new(id = "select", param_vals = list())

• id :: character(1)
  Identifier of resulting object, default "select".
• param_vals :: named list
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default list().

Input and Output Channels

Input and output channels are inherited from PipeOpTaskPreproc.

The output is the input Task with features removed that were not selected by the Selector/function in selector.

State

The $state is a named list with the $state elements inherited from PipeOpTaskPreproc, as well as:

• selection :: character
  A vector of all feature names that are kept (i.e. not dropped) in the Task. Initialized to selector_all()

Parameters

• selector :: function|Selector
  Selector function, takes a Task as argument and returns a character of features to keep. See Selector for example functions. Defaults to selector_all().

Internals

Uses task$select().
mlr_pipeops_smote

Fields


Methods


See Also


Other Selectors: Selector

Examples

library("mlr3")

task = tsk("boston_housing")
pos = po("select")

pos$param_set$values$selector = selector_all()
pos$param_set$values$selector = selector_type("factor")
pos$param_set$values$selector = selector_invert(selector_type("factor"))
pos$param_set$values$selector = selector_grep("^r")

mlr_pipeops_smote  PipeOpSmote
Description
Generates a more balanced data set by creating synthetic instances of the minority class using the SMOTE algorithm. The algorithm samples for each minority instance a new data point based on the K nearest neighbors of that data point. It can only be applied to tasks with numeric features. See smotefamily::SMOTE for details.

Format
R6Class object inheriting from PipeOpTaskPreproc/PipeOp.

Construction
PipeOpSmote$new(id = "smote", param_vals = list())

- id:: character(1)
  Identifier of resulting object, default "smote".
- param_vals:: named list
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default list().

Input and Output Channels
Input and output channels are inherited from PipeOpTaskPreproc.
The output during training is the input Task with added synthetic rows for the minority class. The output during prediction is the unchanged input.

State
The $state is a named list with the $state elements inherited from PipeOpTaskPreproc.

Parameters
The parameters are the parameters inherited from PipeOpTaskPreproc, as well as:

- K:: numeric(1)
  The number of nearest neighbors used for sampling new values. See SMOTE().
- dup_size:: numeric
  Desired times of synthetic minority instances over the original number of majority instances. See SMOTE().

Internals
For details see:
SMOTE: Synthetic minority oversampling technique.
Journal of Artificial Intelligence Research. 16, 321-357.

Fields
Methods


See Also


Examples

library("mlr3")

# Create example task
data = smotefamily::sample_generator(1000, ratio = 0.80)
data$result = factor(data$result)
task = TaskClassif$new(id = "example", backend = data, target = "result")
task$data()
table(task$data()$result)

# Generate synthetic data for minority class
pop = po("smote")
smotedata = pop$train(list(task))[[1]]$data()
table(smotedata$result)

```
mlr_pipeops_spatialsign

PipeOpSpatialSign

Description

Normalizes the data row-wise. This is a natural generalization of the "sign" function to higher dimensions.

Format

Construction

PipeOpSpatialSign$new(id = "spatialsign", param_vals = list())

- id:: character(1)
  Identifier of resulting object, default "spatialsign".
- param_vals:: named list
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default list().

Input and Output Channels

Input and output channels are inherited from PipeOpTaskPreproc.

The output is the input Task with all affected numeric features replaced by their normalized versions.

State

The $state is a named list with the $state elements inherited from PipeOpTaskPreproc.

Parameters

The parameters are the parameters inherited from PipeOpTaskPreproc, as well as:

- length:: numeric(1)
  Length to scale rows to. Default is 1.
- norm:: numeric(1)
  Norm to use. Rows are scaled to \(\text{sum}(x^{\text{norm}})^{(1/\text{norm})} = \text{length}\) for finite norm, or to \(\text{max}(\text{abs}(x)) = \text{length}\) if norm is Inf. Default is 2.

Methods


See Also

mlr_pipeops_subsample

Examples

```r
library("mlr3")

task = tsk("iris")

task$data()

pop = po("spatialsign")

pop$train(list(task))[[1]]$data()
```

---

Description

Subsamples a Task to use a fraction of the rows.

Sampling happens only during training phase. Subsampling a Task may be beneficial for training time at possibly (depending on original Task size) negligible cost of predictive performance.

Format

R6Class object inheriting from PipeOpTaskPreproc/PipeOp.

Construction

```r
PipeOpSubsample$new(id = "classbalancing", param vals = list())
```

- **id**:: character(1) Identifier of the resulting object, default "subsample"
- **param_vals**:: named list
  
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default list().

Input and Output Channels

Input and output channels are inherited from PipeOpTaskPreproc.

The output during training is the input Task with added or removed rows according to the sampling. The output during prediction is the unchanged input.

State

The $state is a named list with the $state elements inherited from PipeOpTaskPreproc.
Parameters

The parameters are the parameters inherited from PipeOpTaskPreproc; however, the affect_columns parameter is not present. Further parameters are:

- **frac** :: numeric(1)
  Fraction of rows in the Task to keep. May only be greater than 1 if replace is TRUE. Initialized to \((1 - \exp(-1)) \approx 0.6321\).
- **stratify** :: logical(1)
  Should the subsamples be stratified by target? Initialized to FALSE. May only be TRUE for TaskClassif input.
- **replace** :: logical(1)
  Sample with replacement? Initialized to FALSE.

Internals

Uses task$filter() to remove rows. If replace is TRUE and identical rows are added, then the task$row_roles$use can not be used to duplicate rows because of [inaudible]; instead the task$rowbind() function is used, and a new data.table is attached that contains all rows that are being duplicated exactly as many times as they are being added.

Fields


Methods


See Also


Examples

```r
library("mlr3")

pos = mlr_pipeops$get("subsample")

pos$train(list(tsk("iris")))
```
# simple bagging:
gr = greplicate(pos %>>% mlr_pipeops$get("learner", lrn("classif.rpart")), 5) %>>%
mlr.pipeops$get("classifavg")

mlr.pipeops_unbranch PipeOpUnbranch

Description

Used to bring together different paths created by PipeOpBranch.

Format

R6Class object inheriting from PipeOp.

Construction

PipeOpUnbranch$new(options, id = "unbranch", param_vals = list())

• options :: numeric(1) | character
  If options is 0, a vararg input channel is created that can take any number of inputs. If
  options is a nonzero integer number, it determines the number of input channels / options
  that are created, named input1...input<n>. The If options is a character, it determines the
  names of channels directly. The difference between these three is purely cosmetic if the user
  chooses to produce channel names matching with the corresponding PipeOpBranch. How-
  ever, it is not necessary to have matching names and the vararg option is always viable.

• id :: character(1)
  Identifier of resulting object, default "unbranch".

• param_vals :: named list
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise
  be set during construction. Default list().

Input and Output

PipeOpUnbranch has multiple input channels depending on the options construction argument,
named "input1", "input2", ... if options is a nonzero integer and named after each options
value if options is a character; if options is 0, there is only one vararg input channel named
"...". All input channels take any argument ("*") both during training and prediction.

PipeOpUnbranch has one output channel named "output", producing the only NO_OP object re-
ceived as input ("*"), both during training and prediction.

State

The $state is left empty (list()).
mlr_pipeops_yeojohnson

Parameters

PipeOpUnbranch has no parameters.

Internals

See PipeOpBranch Internals on how alternative path branching works.

Fields

Only fields inherited from PipeOp.

Methods

Only methods inherited from PipeOp.

See Also


Other Path Branching: NO_OP, filter_noop(), is_noop(), mlr_pipeops_branch

Examples

# See PipeOpBranch for a complete branching example
pou = po("unbranch")

pou$train(list(NO_OP, NO_OP, "hello", NO_OP, NO_OP))

mlr_pipeops_yeojohnson

PipeOpYeoJohnson

Description

Conducts a Yeo-Johnson transformation on numeric features. It therefore estimates the optimal value of lambda for the transformation. See bestNormalize::yeojohnson() for details.
Format

R6Class object inheriting from PipeOpTaskPreproc/PipeOp.

Construction

PipeOpYeoJohnson$new(id = "yeojohnson", param_vals = list())

- id:: character(1)
  Identifier of resulting object, default "yeojohnson".
- param_vals:: named list
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default list().

Input and Output Channels

Input and output channels are inherited from PipeOpTaskPreproc.

The output is the input Task with all affected numeric features replaced by their transformed versions.

State

The $state is a named list with the $state elements inherited from PipeOpTaskPreproc, as well as a list of class yeojohnson for each column, which is transformed.

Parameters

The parameters are the parameters inherited from PipeOpTaskPreproc, as well as:

- eps:: numeric(1)
  Tolerance parameter to identify the lambda parameter as zero. For details see yeojohnson().
- standardize:: logical
  Whether to center and scale the transformed values to attempt a standard normal distribution. For details see yeojohnson().
- lower:: numeric(1)
  Lower value for estimation of lambda parameter. For details see yeojohnson().
- upper:: numeric(1)
  Upper value for estimation of lambda parameter. For details see yeojohnson().

Internals

Uses the bestNormalize::yeojohnson function.

Methods

NO_OP

See Also


Examples

library("mlr3")

task = tsk("iris")
pop = po("yeojohnson")

# Apply the no-op pipe operation

pop$train(list(task))[1]$data()

task$data()

pop$state

---

NO_OP  No-Op Sentinel Used for Alternative Branching

Description

Special data type for no-ops. Distinct from NULL for easier debugging and distinction from unintentional NULL returns.

Usage

NO_OP

Format

R6 object.

See Also

Other Path Branching: filter_noop(), is_noop(), mlr_pipeops_branch, mlr_pipeops_unbranch
A PipeOp represents a transformation of a given "input" into a given "output", with two stages: "training" and "prediction". It can be understood as a generalized function that not only has multiple inputs, but also multiple outputs (as well as two stages). The "training" stage is used when training a machine learning pipeline or fitting a statistical model, and the "predicting" stage is then used for making predictions on new data.

To perform training, the $train() function is called which takes inputs and transforms them, while simultaneously storing information in its $state slot. For prediction, the $predict() function is called, where the $state information can be used to influence the transformation of the new data.

A PipeOp is usually used in a Graph object, a representation of a computational graph. It can have multiple input channels—think of these as multiple arguments to a function, for example when averaging different models—, and multiple output channels—a transformation may return different objects, for example different subsets of a Task. The purpose of the Graph is to connect different outputs of some PipeOps to inputs of other PipeOps.

Input and output channel information of a PipeOp is defined in the $input and $output slots; each channel has a name, a required type during training, and a required type during prediction. The $train() and $predict() function are called with a list argument that has one entry for each declared channel (with one exception, see next paragraph). The list is automatically type-checked for each channel against $input and then passed on to the $train_internal() or $predict_internal() functions. There the data is processed and a result list is created. This list is again type-checked for declared output types of each channel. The length and types of the result list is as declared in $output.

A special input channel name is ". . .", which creates a vararg channel that takes arbitrarily many arguments, all of the same type. If the $input table contains an ". . ."-entry, then the input given to $train() and $predict() may be longer than the number of declared input channels.

This class is an abstract base class that all PipeOps being used in a Graph should inherit from, and is not intended to be instantiated.

Format

Abstract R6Class.

Construction

PipeOp$new(id, param_set = ParamSet$new(), param_vals = list(), input, output, packages = character(0))

- id:: character(1)
  Identifier of resulting object. See $id slot.
- param_set:: ParamSet | list of expression
  Parameter space description. This should be created by the subclass and given to super$initialize(). If this is a ParamSet, it is used as the PipeOp's ParamSet directly. Otherwise it must be a list
of expressions e.g. created by `alist()` that evaluate to `ParamSets`. These `ParamSet` are combined using a `ParamSetCollection`.

- **param_vals**: named list
  List of hyperparameter settings, overwriting the hyperparameter settings given in `param_set`. The subclass should have its own `param_vals` parameter and pass it on to `super$initialize()`. Default list `list()`.

- **input**: `data.table` with columns `name` (character), `train` (character), `predict` (character)
  Sets the `input` slot of the resulting object; see description there.

- **output**: `data.table` with columns `name` (character), `train` (character), `predict` (character)
  Sets the `output` slot of the resulting object; see description there.

- **packages**: character
  Set of all required packages for the `PipeOp`'s `$train` and `$predict` methods. See `$packages` slot. Default is character(0).

### Internals

`PipeOp` is an abstract class with abstract functions `$train_internal()` and `$predict_internal()`. To create a functional `PipeOp` class, these two methods must be implemented. Each of these functions receives a named list according to the `PipeOp`'s input channels, and must return a list (names are ignored) with values in the order of output channels in `$output`. The `$train_internal()` and `$predict_internal()` function should not be called by the user; instead, a `$train()` and `$predict()` should be used. The most convenient usage is to add the `PipeOp` to a `Graph` (possibly as singleton in that `Graph`), and using the `Graph`'s `$train()` / `$predict()` methods.

### Fields

- **id**: character
  ID of the `PipeOp`. IDs are user-configurable, and IDs of `PipeOps` must be unique within a `Graph`. IDs of `PipeOps` must not be changed once they are part of a `Graph`, instead the `Graph`'s `$set_names()` method should be used.

- **packages**: character
  Packages required for the `PipeOp`. Functions that are not in base R should still be called using `::` (or explicitly attached using `require()`) in `$train_internal()` and `$predict_internal()`, but packages declared here are checked before any (possibly expensive) processing has started within a `Graph`.

- **param_set**: `ParamSet`
  Parameters and parameter constraints. Parameter values that influence the functioning of `$train` and/or `$predict` are in the `$param_set$values` slot; these are automatically checked against parameter constraints in `$param_set`.

- **state**: any | NULL
  Method-dependent state obtained during training step, and usually required for the prediction step. This is NULL if and only if the `PipeOp` has not been trained. The `state` is the only slot that can be reliably modified during `$train()`, because `$train_internal()` may theoretically be executed in a different R-session (e.g. for parallelization).

- **input**: `data.table` with columns `name` (character), `train` (character), `predict` (character)
  Input channels of `PipeOp`. Column `name` gives the names (and order) of values in the list given
to $train() and $predict(). Column train is the (S3) class that an input object must conform to during training, column predict is the (S3) class that an input object must conform to during prediction. Types are checked by the PipeOp itself and do not need to be checked by $train_internal() / $predict_internal() code.

A special name is "...", which creates a vararg input channel that accepts a variable number of inputs.

- output :: data.table with columns name (character), train (character), predict (character)
  Output channels of PipeOp, in the order in which they will be given in the list returned by $train and $predict functions. Column train is the (S3) class that an output object must conform to during training, column predict is the (S3) class that an output object must conform to during prediction. The PipeOp checks values returned by $train_internal() and $predict_internal() against these types specifications.

- innum :: numeric(1)
  Number of input channels. This equals nrow($input).

- outnum :: numeric(1)
  Number of output channels. This equals nrow($output).

- is_trained :: logical(1)
  Indicate whether the PipeOp was already trained and can therefore be used for prediction.

- hash :: character(1)
  Checksum calculated on the PipeOp, depending on the PipeOp's class and the slots $id and $param_set (and therefore also $param_set$values). If a PipeOp's functionality may change depending on more than these values, it should inherit the $hash active binding and calculate the hash as digest(list(super$hash, <OTHER THINGS>), algo = "xxhash64").

- .result :: list
  If the Graph's $keep_results flag is set to TRUE, then the intermediate Results of $train() and $predict() are saved to this slot, exactly as they are returned by these functions. This is mainly for debugging purposes and done, if requested, by the Graph backend itself; it should not be done explicitly by $train_internal() or $predict_internal().

**Methods**

- train(input)
  (list) -> named list
  Train PipeOp on inputs, transform it to output and store the learned $state. If the PipeOp is already trained, already present $state is overwritten. Input list is typechecked against the $input train column. Return value is a list with as many entries as $output has rows, with each entry named after the $output name column and class according to the $output train column.

- train_internal(input)
  (named list) -> list
  Abstract function that must be implemented by concrete subclasses. $train_internal() is called by $train() after typechecking. It must change the $state value to something non-NULL and return a list of transformed data according to the $output train column. Names of the returned list are ignored.
  The $train_internal() method should not be called by a user; instead, the $train() method should be used which does some checking and possibly type conversion.
PipeOp

- **predict(input)
  (list) -> named list**
  Predict on new data in input, possibly using the stored $state. Input and output are specified by $input and $output in the same way as for $train(), except that the predict column is used for type checking.

- **predict_internal(input)
  (named list) -> list**
  Abstract function that must be implemented by concrete subclasses. $predict_internal() is called by $predict after type checking and works analogously to $train_internal(). Unlike $train_internal(), $predict_internal() should not modify the $PipeOp in any way. Just as $train_internal(), $predict_internal() should not be called by a user; instead, the $predict() method should be used.

- **print()**
  () -> NULL
  Prints the $PipeOps most salient information: $id, $is_trained, $param_set$values, $input and $output.

See Also

Other mlr3pipelines backend related: Graph, PipeOpTaskPreprocSimple, PipeOpTaskPreproc, mlr_pipeops


Examples

```r
# example (bogus) PipeOp that returns the sum of two numbers during $train()
# as well as a letter of the alphabet corresponding to that sum during $predict().

PipeOpSumLetter = R6::R6Class("sumletter",  
  inherit = PipeOp,  # inherit from PipeOp  
  public = list(  
    initialize = function(id = "posum", param_vals = list()) {  
      super$initialize(id, param_vals = param_vals,  
        # declare "input" and "output" during construction here  
        # training takes two 'numeric' and returns a 'numeric';  
        # prediction takes 'NULL' and returns a 'character'.  
        input = data.table::data.table(name = c("input1", "input2"),  
          train = "numeric", predict = "NULL"),  
        output = data.table::data.table(name = "output",  
          train = "numeric", predict = "NULL")  
    })  
)  
```
PipeOpEnsemble

train = "numeric", predict = "character"
)
},

# PipeOp deriving classes must implement train_internal and
# predict_internal; each taking an input list and returning
# a list as output.
train_internal = function(input) {
  sum = input[[1]] + input[[2]]
  self$state = sum
  list(sum)
},
predict_internal = function(input) {
  list(letters[self$state])
}
)
)
posum = PipeOpSumLetter$new()

print(posum)

posum$train(list(1, 2))
# note the name 'output' is the name of the output channel specified
# in the $output data.table.

posum$predict(list(NULL, NULL))

PipeOpEnsemble

Description

Parent class for PipeOps that aggregate predictions. Implements the $train_internal() and $predict_internal() methods necessary for a PipeOp and requires deriving classes to create the private$weighted_avg_predictions() function.

Format

Abstract R6Class inheriting from PipeOp.

Construction

Note: This object is typically constructed via a derived class, e.g. PipeOpClassifAvg or PipeOpRegrAvg.

PipeOpEnsemble$new(innum = 0, id, param_set = ParamSet$new(), param_vals = list(), packages = character(0), prediction_type = "Prediction")

• innum:: numeric(1)
  Determines the number of input channels. If innum is 0 (default), a vararg input channel is created that can take an arbitrary number of inputs.
PipeOpEnsemble

- **id:: character(1)**
  Identifier of the resulting object.

- **param_set:: ParamSet**
  ("Hyper")-Parameters in form of a ParamSet for the resulting PipeOp.

- **param_vals:: named list**
  List of hyperparameter settings, overwriting the hyperparameter settings that would otherwise be set during construction. Default list().

- **packages:: character**
  Set of packages required for this PipeOp. These packages are loaded during $train()$ and $predict()$, but not attached. Default character().

- **prediction_type:: character(1)**
  The predict entry of the $input and $output type specifications. Should be "Prediction" (default) or one of its subclasses, e.g. "PredictionClassif", and correspond to the type accepted by $train_internal()$ and $predict_internal()$.

### Input and Output Channels

PipeOpEnsemble has multiple input channels depending on the innum construction argument, named "input1", "input2", ... if innum is nonzero; if innum is 0, there is only one vararg input channel named "...". All input channels take only NULL during training and take a Prediction during prediction.

PipeOpEnsemble has one output channel named "output", producing NULL during training and a Prediction during prediction.

The output during prediction is in some way a weighted averaged representation of the input.

### State

The $state is left empty (list()).

### Parameters

- **weights:: numeric**
  Relative weights of input predictions. If this has length 1, it is ignored and weighs all inputs equally. Otherwise it must have length equal to the number of connected inputs. Initialized to 1 (equal weights).

### Internals

The commonality of ensemble methods using PipeOpEnsemble is that they take a NULL-input during training and save an empty $state. They can be used following a set of PipeOpLearner PipeOps to perform (possibly weighted) prediction averaging. See e.g. PipeOpClassifAvg and PipeOpRegrAvg which both inherit from this class.

Should it be necessary to use the output of preceding Learners during the "training" phase, then PipeOpEnsemble should not be used. In fact, if training time behaviour of a Learner is important, then one should use a PipeOpLearnerCV instead of a PipeOpLearner, and the ensemble can be created with a Learner encapsulated by a PipeOpLearner. See LearnerClassifAvg and LearnerRegrAvg for examples.
**PipeOpImpute**

### Fields
Only fields inherited from `PipeOp`.

### Methods
Methods inherited from `PipeOp` as well as:

- `weighted_avg_prediction(inputs, weights, row_ids, truth)`
  
  (list of `Prediction`, numeric, integer | character, list) -> `NULL`

  Create `Predictions` that correspond to the weighted average of incoming `Predictions`. This is called by `predict_internal()` with cleaned and sanity-checked values: inputs are guaranteed to fit together, row_ids and truth are guaranteed to be the same as each one in inputs, and weights is guaranteed to have the same length as inputs.

  This method is abstract, it must be implemented by deriving classes.

### See Also

Other Ensembles: `mlr_learners_avg`, `mlr_pipeops_classifavg`, `mlr_pipeops_regravg`

---

**PipeOpImpute**

### Description
Abstract base class for feature imputation.

### Format
Abstract `R6Class` object inheriting from `PipeOp`.

### Construction

`PipeOpImpute$new(id, param_set = ParamSet$new(), param_vals = list(), whole_task_dependent = FALSE, packages = character(0))`

- `id`:: character(1)
  
  Identifier of resulting object. See `$id` slot of `PipeOp`.
PipeOpImpute

- **param_set**: `ParamSet`
  Parameter space description. This should be created by the subclass and given to `super$initialize()`.

- **param_vals**: named list
  List of hyperparameter settings, overwriting the hyperparameter settings given in `param_set`. The subclass should have its own `param_vals` parameter and pass it on to `super$initialize()`. Default list().

- **whole_task_dependent**: logical(1)
  Whether the `context_columns` parameter should be added which lets the user limit the columns that are used for imputation inference. This should generally be `FALSE` if imputation depends only on individual features (e.g. mode imputation), and `TRUE` if imputation depends on other features as well (e.g. kNN-imputation).

- **packages**: character
  Set of all required packages for the `PipeOp`'s `$train` and `$predict` methods. See `$packages` slot. Default is `character(0)`.

- **task_type**: character(1)
  The class of `Task` that should be accepted as input and will be returned as output. This should generally be a character(1) identifying a type of `Task`, e.g. "Task", "TaskClassif" or "TaskRegr" (or another subclass introduced by other packages). Default is "Task".

### Input and Output Channels

`PipeOpImpute` has one input channel named "input", taking a `Task`, or a subclass of `Task` if the `task_type` construction argument is given as such; both during training and prediction.

`PipeOpImpute` has one output channel named "output", producing a `Task`, or a subclass; the `Task` type is the same as for input; both during training and prediction.

The output `Task` is the modified input `Task` with features imputed according to the `Simpute()` function.

### State

The `$state` is a named list; besides members added by inheriting classes, the members are:

- **affect_cols**: character
  Names of features being selected by the `affect_columns` parameter.

- **inference_cols**: character
  Names of features being selected by the `context_columns` parameter.

- **intasklayout**: `data.table`
  Copy of the training `Task`'s `$feature_types` slot. This is used during prediction to ensure that the prediction `Task` has the same features, feature layout, and feature types as during training.

- **outtasklayout**: `data.table`
  Copy of the trained `Task`'s `$feature_types` slot. This is used during prediction to ensure that the `Task` resulting from the prediction operation has the same features, feature layout, and feature types as after training.

- **model**: named list
  Model used for imputation. This is a list named by `Task` features, containing the result of the `$train_imputer()` function for each one.
PipeOpImpute

Parameters

- **affect_columns** :: function | Selector | NULL
  What columns the PipeOpImpute should operate on. The parameter must be a Selector function, which takes a Task as argument and returns a character of features to use. See Selector for example functions. Defaults to NULL, which selects all features.

- **context_columns** :: function | Selector | NULL
  What columns the PipeOpImpute imputation may depend on. This parameter is only present if the constructor is called with the whole_task_dependent argument set to TRUE. The parameter must be a Selector function, which takes a Task as argument and returns a character of features to use. See Selector for example functions. Defaults to NULL, which selects all features.

Internals

PipeOpImpute is an abstract class inheriting from PipeOp that makes implementing imputer PipeOps simple.

Fields

Fields inherited from PipeOp.

Methods

Methods inherited from PipeOp, as well as:

- **select_cols(task)**
  (Task) -> character
  Selects which columns the PipeOp operates on. In contrast to the affect_columns parameter, select_cols is for the inheriting class to determine which columns the operator should function on, e.g. based on feature type, while affect_columns is a way for the user to limit the columns that a PipeOpTaskPreproc should operate on.

- **train_imputer(feature,type,context)**
  (atomic, character(1), data.table) -> any
  Called once for each feature selected by affect_columns to create the model entry to be used for $impute().

- **impute(feature,type,model,context)**
  (atomic, character(1), any, data.table) -> atomic
  Imputes the features. model is the model created by $train_imputer()

See Also

PipeOpTaskPreproc

### Description

Base class for handling most "preprocessing" operations. These are operations that have exactly one Task input and one Task output, and expect the column layout of these Tasks during input and output to be the same.

Users must implement `$train_task()` and `$predict_task()`, which have a Task input and should return that Task. The Task should, if possible, be manipulated in-place, and should not be cloned.

Alternatively, the `$train_dt()` and `$predict_dt()` functions can be implemented, which operate on data.table objects instead. This should generally only be done if all data is in some way altered (e.g. PCA changing all columns to principal components) and not if only a few columns are added or removed (e.g. feature selection) because this should be done at the Task-level with `$train_task()`.

The `$select_cols()` function can be overloaded for `$train_dt()` and `$predict_dt()` to operate only on subsets of the Task's data, e.g. only on numerical columns.

If the `can_subset_cols` argument of the constructor is TRUE (the default), then the hyperparameter `affect_columns` is added, which can limit the columns of the Task that is modified by the PipeOpTaskPreproc using a Selector function. Note this functionality is entirely independent of the `$select_cols()` functionality.

PipeOpTaskPreproc is useful for operations that behave differently during training and prediction. For operations that perform essentially the same operation and only need to perform extra work to build a $state during training, the PipeOpTaskPreprocSimple class can be used instead.

### Format

Abstract R6Class inheriting from PipeOp.

### Construction

PipeOpTaskPreproc$new(id, param_set = ParamSet$new(), param_vals = list(), can_subset_cols = TRUE, packages = character(0), task_type = "Task")

- **id** :: character(1)
  Identifier of resulting object. See `$id` slot of PipeOp.

- **param_set** :: ParamSet
  Parameter space description. This should be created by the subclass and given to super$initialize().
PipeOpTaskPreproc

- **param_vals** :: named list
  List of hyperparameter settings, overwriting the hyperparameter settings given in `param_set`. The subclass should have its own `param_vals` parameter and pass it on to `super$initialize()`. Default `list()`.

- **can_subset_cols** :: logical(1)
  Whether the `affect_columns` parameter should be added which lets the user limit the columns that are modified by the `PipeOpTaskPreproc`. This should generally be `FALSE` if the operation adds or removes rows from the `Task`, and `TRUE` otherwise. Default is `TRUE`.

- **packages** :: character
  Set of all required packages for the `PipeOp`'s `$train` and `$predict` methods. See `$packages` slot. Default is `character(0)`.

- **task_type** :: character(1)
  The class of `Task` that should be accepted as input and will be returned as output. This should generally be a `character(1)` identifying a type of `Task`, e.g. "Task", "TaskClassif" or "TaskRegr" (or another subclass introduced by other packages). Default is "Task".

**Input and Output Channels**

`PipeOpTaskPreproc` has one input channel named "input", taking a `Task`, or a subclass of `Task` if the `task_type` construction argument is given as such; both during training and prediction.

`PipeOpTaskPreproc` has one output channel named "output", producing a `Task`, or a subclass; the `Task` type is the same as for input; both during training and prediction.

The output `Task` is the modified input `Task` according to the overloaded `$train_task()`/$predict_task()` or `$train_dt()`/$predict_dt()` functions.

**State**

The `$state` is a named list; besides members added by inheriting classes, the members are:

- **affect_cols** :: character
  Names of features being selected by the `affect_columns` parameter, if present; names of all present features otherwise.

- **intasklayout** :: `data.table`
  Copy of the training `Task`'s `$feature_types` slot. This is used during prediction to ensure that the prediction `Task` has the same features, feature layout, and feature types as during training.

- **outtasklayout** :: `data.table`
  Copy of the trained `Task`'s `$feature_types` slot. This is used during prediction to ensure that the `Task` resulting from the prediction operation has the same features, feature layout, and feature types as after training.

- **dt_columns** :: character
  Names of features selected by the `$select_cols()` call during training. This is only present if the `$train_dt()` functionality is used, and not present if the `$train_task()` function is overloaded instead.
PipeOpTaskPreproc

Parameters

- affect_columns :: function | Selector | NULL
  What columns the PipeOpTaskPreproc should operate on. This parameter is only present if
  the constructor is called with the can_subset_cols argument set to TRUE (the default).
  The parameter must be a Selector function, which takes a Task as argument and returns a
  character of features to use.
  See Selector for example functions. Defaults to NULL, which selects all features.

Internals

PipeOpTaskPreproc is an abstract class inheriting from PipeOp. It implements the $train_internal() and
$predict_internal() functions. These functions perform checks and go on to call $train_task() and
$predict_task(). A subclass of PipeOpTaskPreproc may implement these functions, or imple-
ment $train_dt() and $predict_dt() instead. This works by having the default implementations of
$train_task() and $predict_task() call $train_dt() and $predict_dt(), respectively.

The affect_columns functionality works by unsetting columns by removing their "col_role" be-
fore processing, and adding them afterwards by setting the col_role to "feature".

Fields

Fields inherited from PipeOp.

Methods

Methods inherited from PipeOp, as well as:

- train_task
  (Task) -> Task
  Called by the PipeOpTaskPreproc's implementation of $train_internal(). Takes a single Task
  as input and modifies it (ideally in-place without cloning) while storing information in the
  $state slot. Note that unlike $train_internal(), the argument is not a list but a singular Task,
  and the return object is also not a list but a singular Task. Also, contrary to $train_internal(),
  the $state being generated must be a list, which the PipeOpTaskPreproc will add additional
  slots to (see Section State). Care should be taken to avoid name collisions between $state
  elements added by $train_task() and PipeOpTaskPreproc.
  By default this function calls the $train_dt() function, but it can be overloaded to perform
  operations on the Task directly.

- predict_task
  (Task) -> Task
  Called by the PipeOpTaskPreproc's implementation of $predict_internal(). Takes a single Task
  as input and modifies it (ideally in-place without cloning) while using information in the
  $state slot. Works analogously to $train_task(). If $predict_task() should only be overloaded
  if $train_task() is overloaded (i.e. $train_dt() is not used).

- train_dt(dt, levels, target)
  (data.table, named list, any) -> data.table | data.frame | matrix
  Train PipeOpTaskPreproc on dt, transform it and store a state in $state. A transformed object
  must be returned that can be converted to a data.table using as.data.table. dt does not
  need to be copied deliberately, it is possible and encouraged to change it in-place.
The levels argument is a named list of factor levels for factorial or character features. The target argument contains the $truth() information of the training Task; its type depends on the Task type being trained on.

This method can be overloaded when inheriting from PipeOpTaskPreproc, together with $predict_dt() and optionally $select_cols(); alternatively, $train_task() and $predict_task() can be overloaded.

- **predict_dt(dt,levels)**
  (data.table, named list) -> data.table | data.frame | matrix
  Predict on new data in dt, possibly using the stored $state. A transformed object must be returned that can be converted to a data.table using as.data.table. dt does not need to be copied deliberately, it is possible and encouraged to change it in-place.
  The levels argument is a named list of factor levels for factorial or character features.
  This method can be overloaded when inheriting PipeOpTaskPreproc, together with $train_dt() and optionally $select_cols(); alternatively, $train_task() and $predict_task() can be overloaded.

- **select_cols(task)**
  (Task) -> character
  Selects which columns the PipeOp operates on, if $train_dt() and $predict_dt() are overloaded. This function is not called if $train_task() and $predict_task() are overloaded. In contrast to the affect_columns parameter, select_cols is for the inheriting class to determine which columns the operator should function on, e.g. based on feature type, while affect_columns is a way for the user to limit the columns that a PipeOpTaskPreproc should operate on.
  This method can optionally be overloaded when inheriting PipeOpTaskPreproc, together with $train_dt() and $predict_dt(); alternatively, $train_task() and $predict_task() can be overloaded.
  If this method is not overloaded, it defaults to selecting all columns.

**See Also**

Other mlr3pipelines backend related: Graph, PipeOpTaskPreprocSimple, PipeOp, mlr_pipeops

Description

Base class for handling many "preprocessing" operations that perform essentially the same operation during training and prediction. Instead implementing a $train_task() and a $predict_task() operation, only a $get_state() and a $transform() operation needs to be defined, both of which take one argument: a Task.

Alternatively, analogously to the PipeOpTaskPreproc approach of offering $train_dt()/$predict_dt(), the $get_state_dt() and $transform_dt() functions may be implemented. $get_state must not change its input value in-place and must return something that will be written into $state (which must not be NULL), $transform() should modify its argument in-place; it is called both during training and prediction.

This inherits from PipeOpTaskPreproc and behaves essentially the same.

Format


Construction

PipeOpTaskPreprocSimple$new(id, param_set = ParamSet$new(), param_vals = list(), can_subset_cols = TRUE, packages = character(0), task_type = "Task")

(Construction is identical to PipeOpTaskPreproc.)

- id :: character(1)
  Identifier of resulting object. See $id slot of PipeOp.

- param_set :: ParamSet
  Parameter space description. This should be created by the subclass and given to super$initialize().

- param_vals :: named list
  List of hyperparameter settings, overwriting the hyperparameter settings given in param_set. The subclass should have its own param_vals parameter and pass it on to super$initialize(). Default is list().

- can_subset_cols :: logical(1)
  Whether the affect_columns parameter should be added which lets the user limit the columns that are modified by the PipeOpTaskPreprocSimple. This should generally be FALSE if the operation adds or removes rows from the Task, and TRUE otherwise. Default is TRUE.

- packages :: character
  Set of all required packages for the PipeOp's $train and $predict methods. See $packages slot. Default is character(0).

- task_type :: character(1)
  The class of Task that should be accepted as input and will be returned as output. This should generally be a character(1) identifying a type of Task, e.g. "Task", "TaskClassif" or "TaskRegr" (or another subclass introduced by other packages). Default is "Task".

Input and Output Channels

Input and output channels are inherited from PipeOpTaskPreproc.

The output during training and prediction is the Task, modified by $transform() or $transform_dt().
State

The $state is a named list with the $state elements inherited from PipeOpTaskPreproc.

Parameters

The parameters are the parameters inherited from PipeOpTaskPreproc.

Internals

PipeOpTaskPreprocSimple is an abstract class inheriting from PipeOpTaskPreproc and implementing the $train_task() and $predict_task() functions. A subclass of PipeOpTaskPreprocSimple may implement the functions $get_state() and $transform(), or alternatively the functions $get_state_dt() and $transform_dt() (as well as $select_cols(), in the latter case). This works by having the default implementations of $get_state() and $transform() call $get_state_dt() and $transform_dt().

Fields

Fields inherited from PipeOp.

Methods

Methods inherited from PipeOpTaskPreproc, as well as:

- get_state(task)
  (Task) -> named list
  Store create something that will be stored in $state during training phase of PipeOpTaskPreprocSimple. The state can then influence the $transform() function. Note that $get_state() must return the state, and should not store it in $state. It is not strictly necessary to implement either $get_state() or $get_state_dt(); if they are not implemented, the state will be stored as list(). This method can optionally be overloaded when inheriting from PipeOpTaskPreprocSimple, together with $transform(); alternatively, $get_state_dt() (optional) and $transform_dt() (and possibly $select_cols(), from PipeOpTaskPreproc) can be overloaded.

- transform(task)
  (Task) -> Task
  Predict on new data in task, possibly using the stored $state. task should not be cloned, instead it should be changed in-place. This method is called both during training and prediction phase, and should essentially behave the same independently of phase. (If this is incongruent with the functionality to be implemented, then it should inherit from PipeOpTaskPreproc, not from PipeOpTaskPreprocSimple.)
  This method can be overloaded when inheriting from PipeOpTaskPreprocSimple, optionally with $get_state(); alternatively, $get_state_dt() (optional) and $transform_dt() (and possibly $select_cols(), from PipeOpTaskPreproc) can be overloaded.

- get_state_dt(dt)
  (data.table) -> named list
  Create something that will be stored in $state during training phase of PipeOpTaskPreprocSimple. The state can then influence the $transform_dt() function. Note that $get_state_dt() must return the state, and should not store it in $state. If neither $get_state() nor $get_state_dt() are overloaded, the state will be stored as list(). This method can optionally be overloaded when inheriting from PipeOpTaskPreprocSimple,
together with $transform_dt() (and optionally $select_cols(), from PipeOpTaskPreproc); Alternatively, $get_state() (optional) and $transform() can be overloaded.

- transform_dt(dt)
  (data.table) -> data.table | data.frame | matrix
  Predict on new data in dt, possibly using the stored $state. A transformed object must be returned that can be converted to a data.table using as.data.table. dt does not need to be copied deliberately, it is possible and encouraged to change it in-place. This method is called both during training and prediction phase, and should essentially behave the same independently of phase. (If this is incongruent with the functionality to be implemented, then it should inherit from PipeOpTaskPreproc, not from PipeOpTaskPreprocSimple.) This method can optionally be overloaded when inheriting from PipeOpTaskPreprocSimple, together with $transform_dt() (and optionally $select_cols(), from PipeOpTaskPreproc); Alternatively, $get_state() (optional) and $transform() can be overloaded.

See Also
Other mlr3pipelines backend related: Graph, PipeOpTaskPreproc, PipeOp, mlr_pipeops

---

**po**

**Shorthand PipeOp Constructor**

**Description**

Create

- a PipeOp from mlr_pipeops from given ID
- a PipeOpLearner from a Learner object
- a PipeOpFilter from a Filter object

The object is initialized with given parameters and param_vals.

**Usage**

`po(.obj, ...)`

**Arguments**

- `.obj` [any]
  The object from which to construct a PipeOp. If this is a character(1), it is looked up in the `mlr_pipeops` dictionary. Otherwise, it is converted to a PipeOp.

- `...` any
  Additional parameters to give to constructed object. This may be an argument of the constructor of the PipeOp, in which case it is given to this constructor; or it may be a parameter value, in which case it is given to the param_vals argument of the constructor.
Examples

```r
library("mlr3")

po("learner", lrn("classif.rpart"), cp = 0.3)

po(lrn("classif.rpart"), cp = 0.3)

# is equivalent with:
mlr_pipeops$get("learner", lrn("classif.rpart"),
    param_vals = list(cp = 0.3))
```

Description

Add functions that perform conversion to a desired class.

Whenever a Graph or a PipeOp is called with an object that does not conform to its declared input type, the "autoconvert register" is queried for functions that may turn the object into a desired type.

Usage

```r
register_autoconvert_function(cls, fun, packages = character(0))
```

Arguments

- `cls` character(1) The class that `fun` converts to.
- `fun` function The conversion function. Must take one argument and return an object of class `cls`, or possibly a sub-class as recognized by `are_types_compatible()`.
- `packages` character The packages required to be loaded for `fun` to operate.

Value

NULL.

See Also

Other class hierarchy operations: `add_class_hierarchy_cache()`, `reset_autoconvert_register()`, `reset_class_hierarchy_cache()`

Examples

```r
# This lets mlr3pipelines automatically try to convert a string into
# a 'PipeOp' by querying the ['mlr_pipeops'] ['Dictionary'][mlr3misc::Dictionary].
# This is an example and not necessary, because mlr3pipelines adds it by default.
register_autoconvert_function("PipeOp", function(x) as_pipeop(x), packages = "mlr3pipelines")
```
**reset_autoconvert_register**

*Reset Autoconvert Register*

**Description**

Reset autoconvert register to factory default, thereby undoing any calls to `register_autoconvert_function()` by the user.

**Usage**

```c
reset_autoconvert_register()
```

**Value**

NULL

**See Also**

Other class hierarchy operations: `add_class_hierarchy_cache()`, `register_autoconvert_function()`, `reset_autoconvert_register()`

**reset_class_hierarchy_cache**

*Reset the Class Hierarchy Cache*

**Description**

Reset the class hierarchy cache to factory default, thereby undoing any calls to `add_class_hierarchy_cache()` by the user.

**Usage**

```c
reset_class_hierarchy_cache()
```

**Value**

NULL

**See Also**

Other class hierarchy operations: `add_class_hierarchy_cache()`, `register_autoconvert_function()`, `reset_autoconvert_register()`
## Selector Functions

### Description

A **Selector** function is used by different PipeOps, most prominently **PipeOpSelect** and many PipeOps inheriting from **PipeOpTaskPreproc**, to determine a subset of **Tasks** to operate on.

Even though a **Selector** is a function that can be written itself, it is preferable to use the **Selector** constructors shown here. Each of these can be called with its arguments to create a **Selector**, which can then be given to the **PipeOpSelect** selector parameter, or many **PipeOpTaskPreprocs’ affect_columns** parameter. See there for examples of this usage.

### Usage

- `selector_all()`
- `selector_none()`
- `selector_type(types)`
- `selector_grep(pattern, ignore.case = FALSE, perl = FALSE, fixed = FALSE)`
- `selector_name(feature_names, assert_present = FALSE)`
- `selector_invert(selector)`
- `selector_intersect(selector_x, selector_y)`
- `selector_union(selector_x, selector_y)`
- `selector_setdiff(selector_x, selector_y)`

### Arguments

- **types** (character): Type of feature to select
- **pattern** (character(1)): grep pattern
- **ignore.case** (logical(1)): ignore case
- **perl** (logical(1)): perl regex
- **fixed** (logical(1)): fixed pattern instead of regex
- **feature_names** (character): Select features by exact name match.
assert_present (logical(1))

Throw an error if feature_names are not all present in the task being operated on.

selector (Selector)

Selector to invert.

selector_x (Selector)

First Selector to query.

selector_y (Selector)

Second Selector to query.

Value

function: A Selector function that takes a Task and returns the feature names to be processed.

Functions

- selector_all: selector_all selects all features.
- selector_none: selector_none selects none of the features.
- selector_type: selector_type selects features according to type. Legal types are listed in mlr_reflections$task_feature_types.
- selector_grep: selector_grep selects features with names matching the grep() pattern.
- selector_name: selector_name selects features with names matching exactly the names listed.
- selector_invert: selector_invert inverts a given Selector: It always selects the features that would be dropped by the other Selector, and drops the features that would be kept.
- selector_intersect: selector_intersect selects the intersection of two Selectors: Only features selected by both Selectors are selected in the end.
- selector_union: selector_union selects the union of two Selectors: Features selected by either Selector are selected in the end.
- selector_setdiff: selector_setdiff selects the setdiff of two Selectors: Features selected by selector_x are selected, unless they are also selected by selector_y.

Details

A Selector is a function that has one input argument (commonly named task). The function is called with the Task that a PipeOp is operating on. The return value of the function must be a character vector that is a subset of the feature names present in the Task.

For example, a Selector that selects all columns is

function(task) {
  task$feature_names
}

(this is the selector_all() Selector.) A Selector that selects all columns that have names shorter than four letters would be:
function(task) {
    task$feature_names[
        nchar(task$feature_names) < 4
    ]
}

A Selector that selects only the column "Sepal.Length" (as in the iris task), if present, is

function(task) {
    intersect(task$feature_names, "Sepal.Length")
}

It is preferable to use the Selector construction functions like select_type, select_grep etc. if possible, instead of writing custom Selectors.

See Also

Other Selectors: mlr_pipeops_select

Examples

library("mlr3")

iris_task = tsk("iris")
bh_task = tsk("boston_housing")

sela = selector_all()
sela(iris_task)
sela(bh_task)

self = selector_type("factor")
self(iris_task)
self(bh_task)

selg = selector_grep("a.*i")
selg(iris_task)
selg(bh_task)

selgi = selector_invert(selg)
selgi(iris_task)
selgi(bh_task)

selgf = selector_union(selg, self)
selgf(iris_task)
selgf(bh_task)
PipeOp Composition Operator

Description

This operator "pipes" data from the source \texttt{g1} into the sink \texttt{g2}. Both source and sink can either be a \texttt{Graph} or a \texttt{PipeOp} (or an object that can be automatically converted into a \texttt{Graph} or \texttt{PipeOp}, see \texttt{as_graph()} and \texttt{as_pipeop()}).

\texttt{%>>%} tries to automatically match output channels of \texttt{g1} to input channels of \texttt{g2}; this is only possible if either

- the number of output channels of \texttt{g1} (as given by \texttt{g1$output}) is equal to the number of input channels of \texttt{g2} (as given by \texttt{g2$input}), or
- \texttt{g1} has only one output channel (i.e. \texttt{g1$output} has one line), or
- \texttt{g2} has only one input channel, which is a \texttt{vararg} channel (i.e. \texttt{g2$input} has one line, with name entry "...").

Connections between channels are created in the order in which they occur in \texttt{g1} and \texttt{g2}, respectively: \texttt{g1}'s output channel 1 is connected to \texttt{g2}'s input channel 1, channel 2 to 2 etc.

This operator always created deep copies of its input arguments, so they cannot be modified by reference afterwards. To access individual \texttt{PipeOps} after composition, use the resulting \texttt{Graph}'s \$pipeops list.

Both arguments of \texttt{%>>%} are automatically converted to \texttt{Graphs} using \texttt{as_graph()}; this means that objects on either side may be objects that can be automatically converted to \texttt{PipeOps} (such as \texttt{Learners} or \texttt{Filters}), or that can be converted to \texttt{Graphs}. This means, in particular, lists of \texttt{Graphs}, \texttt{PipeOps} or objects convertible to that, because \texttt{as_graph()} automatically applies \texttt{gunion()} to lists. See examples.

Usage

\texttt{g1} \texttt{%>>%} \texttt{g2}

Arguments

\texttt{g1} \hspace{1em} (\texttt{Graph}|\texttt{PipeOp}|\texttt{Learner}|\texttt{Filter}|\texttt{list}|...)

\texttt{Graph} / \texttt{PipeOp} / object-convertible-to-\texttt{PipeOp} to put in front of \texttt{g2}.

\texttt{g2} \hspace{1em} (\texttt{Graph}|\texttt{PipeOp}|\texttt{Learner}|\texttt{Filter}|\texttt{list}|...)

\texttt{Graph} / \texttt{PipeOp} / object-convertible-to-\texttt{PipeOp} to put after \texttt{g1}.

Value

\texttt{Graph}: the constructed \texttt{Graph}.

See Also

Other Graph operators: \texttt{as_graph()}, \texttt{as_pipeop()}, \texttt{assert_graph()}, \texttt{assert_pipeop()}, \texttt{greplicate()}, \texttt{gunion()}


Examples

```r
o1 = PipeOpScale$new()
o2 = PipeOpPCA$new()
o3 = PipeOpFeatureUnion$new(2)

# The following two are equivalent:
pipe1 = o1 %>>% o2

pipe2 = Graph$new()
  add_pipeop(o1$clone(deep = TRUE))
  add_pipeop(o2$clone(deep = TRUE))
  add_edge(o1$id, o2$id)

# Note automatical gunion() of lists.
# The following three are equivalent:
graph1 = list(o1, o2) %>>% o3

graph2 = gunion(list(o1, o2)) %>>% o3

graph3 = Graph$new()
  add_pipeop(o1$clone(deep = TRUE))
  add_pipeop(o2$clone(deep = TRUE))
  add_pipeop(o3$clone(deep = TRUE))
  add_edge(o1$id, o3$id, dst_channel = 1)
  add_edge(o2$id, o3$id, dst_channel = 2)
```
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