**Package ‘scAnnotatR’**

**Type**  
Package

**Title**  
Pretrained learning models for cell type prediction on single cell RNA-sequencing data

**Version**  
1.8.0

**Description**  
The package comprises a set of pretrained machine learning models to predict basic immune cell types. This enables all users to quickly get a first annotation of the cell types present in their dataset without requiring prior knowledge. scAnnotatR also allows users to train their own models to predict new cell types based on specific research needs.

**License**  
MIT + file LICENSE

**Encoding**  
UTF-8

**biocViews**  
SingleCell, Transcriptomics, GeneExpression, SupportVectorMachine, Classification, Software

**Imports**  
dplyr, ggplot2, caret, ROCR, pROC, data.tree, methods, stats, e1071, ape, kernlab, AnnotationHub, utils

**Suggests**  
knitr, rmarkdown, scRNAseq, testthat

**VignetteBuilder**  
knitr

**Depends**  
R (>= 4.1), Seurat, SingleCellExperiment, SummarizedExperiment

**LazyData**  
true

**RoxygenNote**  
7.2.3

**URL**  
https://github.com/grisslab/scAnnotatR

**BugReports**  
https://github.com/grisslab/scAnnotatR/issues/new

**git_url**  
https://git.bioconductor.org/packages/scAnnotatR

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RELEASE_3_18

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**Repository**  
Bioconductor 3.18

**Date/Publication**  
2024-03-06
**Description**

Returns the caret model of the scAnnotatR object

**Usage**

caret_model(classifier)

**Arguments**

classifier scAnnotatR object

**Value**

Classifier is the object returned by caret SVM learning process. More information about the caret package: https://topepo.github.io/caret/
Examples

data("tirosh_mel80_example")
selected_marker_genes_B = c("CD19", "MS4A1", "CD79A")
set.seed(123)
classifier_b <- train_classifier(train_obj = tirosh_mel80_example,
assay = 'RNA', slot = 'counts', marker_genes = selected_marker_genes_B,
cell_type = "B cells", tag_slot = 'active.ident')
caret_model(classifier_b)

cell_type(classifier_b)

data("tirosh_mel80_example")
selected_marker_genes_B = c("CD19", "MS4A1", "CD79A")
set.seed(123)
classifier_b <- train_classifier(train_obj = tirosh_mel80_example,
assay = 'RNA', slot = 'counts', marker_genes = selected_marker_genes_B,
cell_type = "B cells", tag_slot = 'active.ident')
caret_model(classifier_b)

cell_type(classifier_b) <- value

Description

Returns the cell type for the given classifier.

Usage

cell_type(classifier)

## S4 replacement method for signature 'scAnnotatR'
cell_type(classifier) <- value

Arguments

classifier scAnnotatR object. The object is returned from the train_classifier function.
value the new cell type

Value

cell type of object
scAnnotatR object with the new cell type

Examples

data("tirosh_mel80_example")
selected_marker_genes_B = c("CD19", "MS4A1", "CD79A")
set.seed(123)
classifier_b <- train_classifier(train_obj = tirosh_mel80_example,
assay = 'RNA', slot = 'counts', marker_genes = selected_marker_genes_B,
cell_type = "B cells", tag_slot = 'active.ident')
caret_model(classifier_b)

data("tirosh_mel80_example")
selected_marker_genes_B = c("CD19", "MS4A1", "CD79A")
set.seed(123)
classifier_b <- train_classifier(train_obj = tirosh_mel80_example,
checkObjectValidity

```r
cell_type <- Setter for cell_type. Change cell type of a classifier

description
Setter for cell_type. Change cell type of a classifier

usage

cell_type(classifier) <- value

arguments

classifier: the classifier whose cell type will be changed
value: the new cell type

value
the classifier with the new cell type

checkObjectValidity Internal functions of scAnnotatR package

description
Check if a scAnnotatR object is valid

Train a classifier for a new cell type If cell type has a parent, only available for scAnnotatR object as parent cell classifying model.

Train a classifier for a new cell type If cell type has a parent, only available for scAnnotatR object as parent cell classifying model.

Train a classifier for a new cell type from expression matrix and tag If cell type has a parent, only available for scAnnotatR object as parent cell classifying model.

Preprocess Seurat object to produce expression matrix, tag, parent cell tag.

Preprocess Seurat object to produce expression matrix, tag, parent cell tag.

Testing process when test object is of type Seurat
Testing process when test object is of type SCE
Testing process from matrix and tag
This function ensures that parent classifiers are also selected.
Usage

checkObjectValidity(object)
checkCellTypeValidity(cell_type)
checkMarkerGenesValidity(marker_genes)
checkParentValidity(parent)
checkPThresValidity(p_thres)
checkCaretModelValidity(caret_model)
parent(classifier) <- value

## S4 replacement method for signature 'scAnnotatR'
parent(classifier) <- value

caret_model(classifier) <- value

## S4 replacement method for signature 'scAnnotatR'
caret_model(classifier) <- value

marker_genes(classifier) <- value

## S4 replacement method for signature 'scAnnotatR'
marker_genes(classifier) <- value

train_classifier_seurat(
  train_obj,
  cell_type,
  marker_genes,
  parent_cell = NA_character_,
  parent_classifier = NULL,
  path_to_models = "default",
  zscore = TRUE,
  seurat_tag_slot,
  seurat_parent_tag_slot = "predicted_cell_type",
  seurat_assay,
  seurat_slot,
  ambiguous_chars
)

train_classifier_sce(
  train_obj,
  cell_type,
  marker_genes,
  parent_cell = NA_character_,
checkObjectValidity

parent_classifier = NULL,
path_to_models = "default",
zscore = TRUE,
sce_tag_slot,
sce_parent_tag_slot = "predicted_cell_type",
sce_assay,
ambiguous_chars = NULL
)

train_classifier_from_mat(
  mat,
  tag,
  cell_type,
  marker_genes,
  parent_tag,
  parent_cell,
  parent_classifier,
  path_to_models,
  zscore,
  ambiguous_chars = NULL
)

preprocess_seurat_object(
  seurat_obj,
  seurat_assay,
  seurat_slot,
  seurat_tag_slot,
  seurat_parent_tag_slot
)

preprocess_sce_object(sce_obj, sce_assay, sce_tag_slot, sce_parent_tag_slot)

test_classifier_seurat(
  test_obj,
  classifier,
  target_cell_type = NULL,
  parent_classifier = NULL,
  path_to_models = "default",
  zscore = TRUE,
  seurat_tag_slot,
  seurat_parent_tag_slot = "predicted_cell_type",
  seurat_assay,
  seurat_slot,
  ambiguous_chars = NULL
)

test_classifier_sce(
  test_obj,
checkObjectValidity

classifier,
target_cell_type = NULL,
parent_classifier = NULL,
path_to_models = "default",
zscore = TRUE,
sce_tag_slot,
sce_parent_tag_slot = "predicted_cell_type",
sce_assay,
ambiguous_chars = NULL
)

test_classifier_from_mat(
  mat,
tag,
classifier,
parent_tag,
target_cell_type,
parent_classifier,
path_to_models,
zscore,
ambiguous_chars = NULL
)

classify_cells_seurat(
  classify_obj,
classifiers = NULL,
cell_types = "all",
chunk_size = 5000,
path_to_models = "default",
ignore_ambiguous_result = FALSE,
cluster_slot,
seurat_assay,
seurat_slot
)

classify_cells_sce(
  classify_obj,
classifiers = NULL,
cell_types = "all",
chunk_size = 5000,
path_to_models = "default",
ignore_ambiguous_result = FALSE,
sce_assay,
cluster_slot = NULL
)

balance_dataset(mat, tag)
checkObjectValidity

train_func(mat, tag)
transform_to_zscore(mat)
subset_models(model_list, model_names)
select_marker_genes(mat, marker_genes)
check_parent_child_coherence(
    mat,
    tag,
    pos_parent,
    parent_cell,
    cell_type,
    target_cell_type
)
filter_cells(mat, tag, ambiguous_chars = NULL)
construct_tag_vect(tag, cell_type)
process_parent_classifier(
    mat,
    parent_tag,
    parent_cell_type,
    parent_classifier,
    path_to_models,
    zscore
)
make_prediction(mat, classifier, pred_cells, ignore_ambiguous_result = TRUE)
simplify_prediction(meta.data, full_pred, classifiers)
verify_parent(mat, classifier, meta.data)
test_performance(mat, classifier, tag)
classify_clust(clusts, most_probable_cell_type)
download_data_file(verbos = FALSE)

Arguments

object The request classifier to check.
cell_type name of cell type
marker_genes list of selected marker genes
parent Classifier parent to check.
checkObjectValidity

p_thres       Classifier probability threshold to check.
caret_model   Classifier to check.
classifier    classifier
value         the new classifier
train_obj     SCE object
parent_cell   name of parent cell type
parent_classifier

\textit{scAnnotatR} object corresponding to classification model for the parent cell type
path_to_models  path to databases, or by default
zscore        boolean indicating the transformation of gene expression in object to zscore or not

seurat_tag_slot
\begin{small}
\text{string, name of annotation slot indicating cell tag/label in the testing object. Strings indicating cell types are expected in this slot. Expected values are string (A-Z, a-z, 0-9, no special character accepted) or binary/logical, 0/"no"/F/FALSE: not being new cell type, 1/"yes"/T/TRUE: being new cell type.}
\end{small}

\textit{seurat_parent_tag_slot}
\begin{small}
\text{string, name of tag slot in cell meta data indicating pre-assigned/predicted parent cell type. Default field is "predicted_cell_type". The slot must contain only string values.}
\end{small}

seurat_assay   name of assay to use in Seurat object
seurat_slot    type of expression data to use in Seurat object. Some available types are: "counts", "data" and "scale.data".
ambiguous_chars
\begin{small}
\text{Vector of character (sequences) that if contained within a cell type mark this cell type as being ambiguous. If NULL default values are used. Characters with a meaning in REGEX must be enclosed by \\.[.]. F.e. \\[^[+]. Default value is \\("/\,"\."\."\."\."\."\."\."\[+]\."\[\]."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\."\.”}
\end{small}

sce_tag_slot
\begin{small}
\text{string, name of annotation slot indicating cell tag/label in the testing object. Strings indicating cell types are expected in this slot. Expected values are string (A-Z, a-z, 0-9, no special character accepted) or binary/logical, 0/"no"/F/FALSE: not being new cell type, 1/"yes"/T/TRUE: being new cell type.}
\end{small}

sce_parent_tag_slot
\begin{small}
\text{string, name of tag slot in cell meta data indicating pre-assigned/predicted parent cell type. Default field is "predicted_cell_type". The slot must contain only string values.}
\end{small}

sce_assay   name of assay to use in SCE object
mat         expression matrix
tag          tag of data
parent_tag  vector, named list indicating pre-assigned/predicted parent cell type
seurat_obj  Seurat object
sce_obj     Seurat object
test_obj    SCE object used for testing
checkObjectValidity

target_cell_type
  alternative cell types (in case of testing classifier)
classify_obj
  the SCE object containing cells to be classified
classifiers
  classifiers
cell_types
  list of cell types containing models to be used for classification, only applicable if the models have been saved to package.
chunk_size
  size of data chunks to be predicted separately. This option is recommended for large datasets to reduce running time. Default value at 5000, because smaller datasets can be predicted rapidly.
ignore_ambiguous_result
  whether ignore ambiguous result
cluster_slot
  name of slot in meta data containing cluster information, in case users want to have additional cluster-level prediction
model_list
  A list of models
model_names
  The names of the models to retain
pos_parent
  a vector indicating parent classifier prediction
parent_cell_type
  name of parent cell type
pred_cells
  a whole prediction for all cells
meta.data
  object meta data
full_pred
  full prediction
clusts
  cluster info
most_probable_cell_type
  predicted cell type
verbose
  logical indicating downloading the file or not

Value

TRUE if the classifier is valid or the reason why it is not
TRUE if the cell type is valid or the reason why it is not.
TRUE if the marker_genes is valid or the reason why it is not.
TRUE if the parent is valid or the reason why it is not.
TRUE if the p_thres is valid or the reason why it is not.
TRUE if the classifier is valid or the reason why it is not.
the classifier with the new parent.
scAnnotatR object with the new parent
the classifier with the new core caret model.
scAnnotatR object with the new trained classifier.
the classifier with the new marker genes
scAnnotatR object with the new marker genes.
sca
classify_cells

**Description**

Classify cells from multiple models

**scAnnotatR** object
caret trained model

a list containing: expression matrix of size n x m, n: genes, m: cells; a vector indicating cell type, and a vector containing parent cell type.

result of testing process in form of a list, including predicted values, prediction accuracy at a probability threshold, and roc curve information.

model performance statistics

the input object with new slots in cells meta data New slots are: predicted_cell_type, most_probable_cell_type, slots in form of [cell_type]_p, [cell_type]_class, and clust_pred (if cluster_slot was provided).

a list of balanced count matrix and corresponding tags of balanced count matrix

the classification model (caret object)

row wise center-scaled count matrix

The list containing the selected models

filtered matrix

list of adjusted tag

filtered matrix and corresponding tag

a binary vector for cell tag

list of cells which are positive to parent classifier

prediction

simplified prediction

applicable matrix

classifier performance

model list object
classify_cells

classify_cells(
    classify_obj,
    assay,
    slot = NULL,
    classifiers = NULL,
    cell_types = "all",
    chunk_size = 5000,
    path_to_models = "default",
    ignore_ambiguous_result = FALSE,
    cluster_slot = "clusters"
)

Arguments

classify_obj the object containing cells to be classified
assay name of assay to use in classify_object
slot type of expression data to use in classify_object. For Seurat object, some available types are: "counts", "data" and "scale.data".
classifiers list of classification models. The model is obtained from train_classifier function or available in current working space. Users may test the model using test_classifier before using this function. If classifiers contain classifiers for sub cell types, classifiers for parent cell type must be indicated first in order to be applied before children classifiers. If classifiers is NULL, the method will use all classifiers in database.
cell_types list of cell types containing models to be used for classification, only applicable if the models have been saved to package.
chunk_size size of data chunks to be predicted separately. This option is recommended for large datasets to reduce running time. Default value at 5000, because smaller datasets can be predicted rapidly.
pay_to_models path to the folder containing the list of models. As default value, the pretrained models in the package will be used. If user has trained new models, indicate the folder containing the new_models.rda file.
ignore_ambiguous_result return all ambiguous predictions (multiple cell types) to empty When this parameter turns to TRUE, most probably predicted cell types will be ignored.
cluster_slot name of slot in meta data containing cluster information, in case users want to have additional cluster-level prediction

Value

the input object with new slots in cells meta data New slots are: predicted_cell_type, most_probable_cell_type, slots in form of [cell_type]_p, [cell_type]_class, and clust_pred (if cluster_slot was provided).
delete_model

Examples

# load small example dataset
data("tirosh_mel80_example")

# train one classifier for one cell type, for ex, B cell
# define genes to use to classify this cell type
selected_marker_genes_B = c("CD19", "MS4A1", "CD79A")

# train the classifier
set.seed(123)
classifier_b <- train_classifier(train_obj = tirosh_mel80_example,
assay = 'RNA', slot = 'counts', marker_genes = selected_marker_genes_B,
cell_type = "b cells", tag_slot = 'active.ident')

# do the same thing with other cell types, for example, T cells
selected_marker_genes_T = c("CD4", "CD8A", "CD8B")
set.seed(123)
classifier_t <- train_classifier(train_obj = tirosh_mel80_example,
assay = 'RNA', slot = 'counts', marker_genes = selected_marker_genes_T,
cell_type = "T cells", tag_slot = 'active.ident')

# create a list of classifiers
classifier_ls <- list(classifier_b, classifier_t)

# classify cells with list of classifiers
seurat.obj <- classify_cells(classify_obj = tirosh_mel80_example,
assay = 'RNA', slot = 'counts', classifiers = classifier_ls)

description

Delete model/branch from package

Usage

delete_model(cell_type, path_to_models = tempdir())

Arguments

cell_type string indicating the cell type of which the model will be removed from package
Attention: deletion of a parent model will also delete all of child model.

path_to_models path to the folder containing the list of models in which the to-be-deleted model is.

Value

no return value, but the model is deleted from database
Examples

```r
# load small example dataset
data("tiroshe_mel80_example")

# train a classifier
set.seed(123)
selected_marker_genes_T = c("CD4", "CD8A", "CD8B")
classifier_t <- train_classifier(train_obj = tiroshe_mel80_example,
                               assay = 'RNA', slot = 'counts', marker_genes = selected_marker_genes_T,
                               cell_type = "t cells", tag_slot = 'active.ident')

# save a classifier to system
save_new_model(new_model = classifier_t, path_to_models = tempdir(),
               include.default = FALSE)

# delete classifier from system
delete_model("t cells", path_to_models = tempdir())
```

---

### load_models

 Load classifiers from databases

**Description**

Load classifiers from databases

**Usage**

```r
load_models(path_to_models)
```

**Arguments**

- `path_to_models`  path to databases, or by default

**Value**

list of classifiers

---

### marker_genes

**Description**

Returns the set of marker genes for the given classifier.

**Usage**

```r
marker_genes(classifier)
```
parent

Arguments

classifier  scAnnotatR object

Value

Applied marker genes of object

Examples

data("tirosh_mel80_example")
selected_marker_genes_B = c("CD19", "MS4A1", "CD79A")
set.seed(123)
classifier_b <- train_classifier(train_obj = tirosh_mel80_example,
assay = 'RNA', slot = 'counts', marker_genes = selected_marker_genes_B,
cell_type = "B cells", tag_slot = 'active.ident')
marker_genes(classifier_b)

data("tirosh_mel80_example")
selected_marker_genes_B = c("CD19", "MS4A1", "CD79A")
set.seed(123)
classifier_b <- train_classifier(train_obj = tirosh_mel80_example,
assay = 'RNA', slot = 'counts', marker_genes = selected_marker_genes_B,
cell_type = "B cells", tag_slot = 'active.ident')
parent(classifier_b)
plant_tree

Description
Plant tree from list of models

Usage
plant_tree(path_to_models = "default")

Arguments
path_to_models  list of models. If not provided, list of default pretrained models in the package will be used.

Value
tree structure and plot of tree

Examples
# to create the tree of classifiers
# (in this example, based on default classifiers)
plant_tree()

plot_roc_curve

Description
Plot roc curve

Usage
plot_roc_curve(test_result)

Arguments
test_result  result of test_classifier function

Value
ggplot2 roc curve
### Examples

```r
# load small example dataset
data("tirosh_mel80_example")

# train a classifier, for ex: B cell
selected_marker_genes_B = c("CD19", "MS4A1", "CD79A")
set.seed(123)
classifier_b <- train_classifier(train_obj = tirosh_mel80_example,
assay = 'RNA', slot = 'counts', marker_genes = selected_marker_genes_B,
cell_type = "b cells", tag_slot = 'active.ident')

classifier_b_test <- test_classifier(classifier = classifier_b,
test_obj = tirosh_mel80_example, assay = 'RNA', slot = 'counts',
tag_slot = 'active.ident', target_cell_type = c("B cell"))

# run plot curve on the test result
roc_curve <- plot_roc_curve(test_result = classifier_b_test)
```

---

### Description

Returns the probability threshold for the given classifier.

### Usage

```r
p_thres(classifier)
```

```
## S4 replacement method for signature 'scAnnotatR'
p_thres(classifier) <- value
```

### Arguments

- `classifier`: scAnnotatR object. The object is returned from the train_classifier function.
- `value`: the new threshold

### Value

Predicting probability threshold of object

scAnnotatR object with the new threshold.
Examples

```r
data("tirosh_mel80_example")
selected_marker_genes_B = c("CD19", "MS4A1", "CD79A")
set.seed(123)
classifier_b <- train_classifier(train_obj = tirosh_mel80_example,
assay = 'RNA', slot = 'counts', marker_genes = selected_marker_genes_B,
cell_type = "B cells", tag_slot = 'active.ident')
p_thres(classifier_b)
```

```r
data("tirosh_mel80_example")
selected_marker_genes_B = c("CD19", "MS4A1", "CD79A")
set.seed(123)
classifier_b <- train_classifier(train_obj = tirosh_mel80_example,
assay = 'RNA', slot = 'counts', marker_genes = selected_marker_genes_B,
cell_type = "B cells", tag_slot = 'active.ident')
classifier_b_test <- test_classifier(classifier = classifier_b,
test_obj = tirosh_mel80_example, assay = 'RNA', slot = 'counts',
tag_slot = 'active.ident')
# assign a new threshold probability for prediction
p_thres(classifier_b) <- 0.4
```

---

**p_thres<-**

*Setter for predicting probability threshold*

**Description**

Setter for predicting probability threshold

**Usage**

```
p_thres(classifier) <- value
```

**Arguments**

- `classifier` the classifier whose predicting probability threshold will be changed
- `value` the new threshold

**Value**

classifier with the new threshold.
**save_new_model**

Save a model to the package

**Description**

Save a model to the package

**Usage**

```
save_new_model(new_model, include.default = TRUE, path_to_models = tempdir())
```

**Arguments**

- `new_model` new model to be added into the classification tree
- `include.default` whether include the default models of the package in the list of new trained models or not. If users further want to classify cells, they can only use default pretrained model list or their new model list. Including default models in new trained models helps users using both of them once. In addition, default pretrained models of the package cannot be changed or removed. This can be done with the new trained model list.
- `path_to_models` path to the folder containing the list of new models.

**Value**

no return value, but the model is now saved to database

**Examples**

```r
# load small example dataset
data("tirosh_mel80_example")

# train classifier
selected_marker_genes_T = c("CD4", "CD8A", "CD8B")
set.seed(123)
classifier_t <- train_classifier(train_obj = tirosh_mel80_example,
assay = 'RNA', slot = 'counts', marker_genes = selected_marker_genes_T,
cell_type = "t cells", tag_slot = 'active.ident')

# save the trained classifier to system
# test classifier can be used before this step
# Note: We do not include the default models here to runtime of the example
save_new_model(new_model = classifier_t, path_to_models = tempdir(),
                  include.default = FALSE)

# verify if new model has been saved
print(names(load(file.path(tempdir(), "new_models.rda"))))
delete_model("t cells")
```
Description

This class is returned by the `train_classifier` function. Generally, scAnnotatR objects are never created directly.

Usage

```r
scAnnotatR(cell_type, caret_model, marker_genes, p_thres, parent)
```

Arguments

- `cell_type` character. Name of the cell type.
- `caret_model` list. Trained model returned by caret train function.
- `marker_genes` vector/character containing marker genes used for the training.
- `p_thres` numeric. Probability threshold for the cell type to be assigned for a cell.
- `parent` character. Parent cell type.

Value

A scAnnotatR object.

Slots

- `cell_type` character. Name of the cell type.
- `caret_model` list. Trained model returned by caret train function.
- `marker_genes` vector/character containing marker genes used for the training.
- `p_thres` numeric. Probability threshold for the cell type to be assigned for a cell.
- `parent` character. Parent cell type.

Examples

```r
# load small example dataset
data("tirosh_mel80_example")

# train a classifier, for ex: B cell
selected_marker_genes_B = c("CD19", "MS4A1", "CD79A")
set.seed(123)
classifier_b <- train_classifier(train_obj = tirosh_mel80_example,
assay = 'RNA', slot = 'counts', marker_genes = selected_marker_genes_B,
cell_type = "B cells", tag_slot = 'active.ident')

classifier_b
```
Description

Show object

Usage

## S4 method for signature 'scAnnotatR'
show(object)

Arguments

object scAnnotatR object

Value

print to console information about the object

Examples

data("tirosh_mel80_example")
selected_marker_genes_B = c("CD19", "MS4A1", "CD79A")
set.seed(123)
classifier_b <- train_classifier(train_obj = tirosh_mel80_example,
assay = 'RNA', slot = 'counts', marker_genes = selected_marker_genes_B,
cell_type = "B cells", tag_slot = 'active.ident')
classifier_b

data("tirosh_mel80_example")
selected_marker_genes_B = c("CD19", "MS4A1", "CD79A")
set.seed(123)
classifier_b <- train_classifier(train_obj = tirosh_mel80_example,
assay = 'RNA', slot = 'counts', marker_genes = selected_marker_genes_B,
cell_type = "B cells", tag_slot = 'active.ident')
classifier_b

test.classifier Testing process.

Description

Testing process.
test_classifier

Usage

test_classifier(
  classifier,
  test_obj,
  assay,
  slot = NULL,
  tag_slot,
  target_cell_type = NULL,
  parent_classifier = NULL,
  parent_tag_slot = "predicted_cell_type",
  path_to_models = "default",
  zscore = TRUE,
  ambiguous_chars = NULL
)

## S4 method for signature 'scAnnotatR'

test_classifier(
  classifier,
  test_obj,
  assay,
  slot = NULL,
  tag_slot,
  target_cell_type = NULL,
  parent_classifier = NULL,
  parent_tag_slot = "predicted_cell_type",
  path_to_models = "default",
  zscore = TRUE,
  ambiguous_chars = NULL
)

Arguments

classifier scAnnotatR classification model

test_obj object that can be used for testing

assay name of assay to use in test_object

slot type of expression data to use in test_object. For Seurat object, some available types are: "counts", "data" and "scale.data". Ignore this if test_obj is SingleCellExperiment object.

tag_slot string, name of annotation slot indicating cell tag/label in the testing object. Strings indicating cell types are expected in this slot. Expected values are string (A-Z, a-z, 0-9, no special character accepted) or binary/logical, 0/"no"/F/FALSE: not being new cell type, 1/"yes"/T/TRUE: being new cell type.

target_cell_type vector indicating other cell types than cell labels that can be considered as the main cell type in classifier, for example, c("plasma cell", "b cell", "b cells", "activating b cell"). Default as NULL.
parent_classifier

`scAnnotatR` object corresponding to classification model for the parent cell type

parent_tag_slot

string, name of tag slot in cell meta data indicating pre-assigned/predicted parent cell type. Default field is "predicted_cell_type". The slot must contain only string values.

path_to_models

path to the folder containing the list of models. As default, the pretrained models in the package will be used. If user has trained new models, indicate the folder containing the new_models.rda file.

zscore

boolean, whether gene expression is transformed to zscore

ambiguous_chars

List of characters to indicate ambiguous cells. For more details see `filter_cells`.

Value

result of testing process in form of a list, including predicted values, prediction accuracy at a probability threshold, and roc curve information.

Note

Only one cell type is expected for each cell. Ambiguous cell type, such as: "T cells/NK cells/ILC", will be ignored. Subtypes used in testing model for parent cell types can be indicated as parent cell type, or can be indicated in target_cell_type. For example, when testing for B cells, plasma cells can be annotated as B cells, or target_cell_type is set c("plasma cells").

Examples

```r
# load small example dataset
data("tirosh_mel80_example")

# train the classifier
selected_marker_genes_B = c("CD19", "MS4A1", "CD79A")
set.seed(123)
classifier_b <- train_classifier(train_obj = tirosh_mel80_example, assay = 'RNA', slot = 'counts', marker_genes = selected_marker_genes_B, cell_type = "b cells", tag_slot = 'active.ident')

classifier_b_test <- test_classifier(classifier = classifier_b, test_obj = tirosh_mel80_example, assay = 'RNA', slot = 'counts', tag_slot = 'active.ident', target_cell_type = c("B cell"))
classifier_b_test
```
**tirosh_mel80_example**  
*A Seurat Object Sample*

**Description**  
An example Seurat object shipped with the package as an example data. The expression data was originally from the dataset GSE72056, with samples corresponding to patient CY80. The Seurat object was then adapted to be used in scAnnotatR.

**Usage**
`tirosh_mel80_example`

**Format**
a Seurat object

**Author(s)**
Itay Tirosh, 2016-04-05

**Source**
WEIZMANN INSTITUTE OF SCIENCE

---

**train_classifier**  
*Train cell type classifier*

**Description**
Train a classifier for a new cell type. If cell type has a parent, only available for scAnnotatR object as parent cell classifying model.

**Usage**
```
train_classifier(
    train_obj,
    assay,
    slot = NULL,
    cell_type,
    marker_genes,
    tag_slot,
    parent_cell = NA_character_,
    parent_tag_slot = "predicted_cell_type",
    parent_classifier = NULL,
    path_to_models = "default",
)```
train_classifier

zscore = TRUE,
ambiguous_chars = NULL
)

Arguments

train_obj

object that can be used for training the new model. Seurat object or SingleCellExperiment
object is supported. If the training model has parent, parent_tag_slot may have
been indicated. This field would have been filled out automatically if user prece-
dently run classify_cells function. If no (predicted) cell type annotation pro-
vided, the function can be run if 1- parent_cell or 2- parent_classifier is pro-
vided.

assay

name of assay to use in training object.

slot

type of expression data to use in training object, omitted if train_obj is SingleCellExperiment
object.

cell_type

string indicating the name of the subtype This must exactly match cell tag/label
if cell tag/label is a string.

marker_genes

list of marker genes used for the new training model

tag_slot

string, name of slot in cell meta data indicating cell tag/label in the training
object. Strings indicating cell types are expected in this slot. For Seurat object,
default value is "active.ident". Expected values are string (A-Z, a-z, 0-9, no
special character accepted) or binary/logical, 0/"no"/F/FALSE: not being new
cell type, 1/"yes"/T/TRUE: being new cell type.

parent_cell

string indicated the name of the parent cell type, if parent cell type classifier
has already been saved in model database. Adjust path_to_models for exact
database.

parent_tag_slot

string, name of a slot in cell meta data indicating assigned/predicted cell type.
Default is "predicted_cell_type". This slot would have been filled automatically
if user have called classify_cells function. The slot must contain only string
values.

parent_classifier

classification model for the parent cell type

path_to_models

path to the folder containing the model database. As default, the pretrained
models in the package will be used. If user has trained new models, indicate the
folder containing the new_models.rda file.

zscore

whether gene expression in train_obj is transformed to zscore

ambiguous_chars

List of characters to indicate ambiguous cells. For more details see filter_cells.

Value

scAnnotatR object
Note

Only one cell type is expected for each cell in object. Ambiguous cell type, such as: "T cells/NK cells/ILC", will be ignored from training. Subtypes used in training model for parent cell types must be indicated as parent cell type. For example, when training for B cells, plasma cells must be annotated as B cells in order to be used.

Examples

```r
# load small example dataset
data("tirosh_mel80_example")

# this dataset already contains pre-defined cell labels
table(Seurat::Idents(tirosh_mel80_example))

# define genes to use to classify this cell type (B cells in this example)
selected_marker_genes_B = c("CD19", "MS4A1", "CD79A")

# train the classifier, the "cell_type" argument must match
# the cell labels in the data, except upper/lower case
set.seed(123)
classifier_b <- train_classifier(train_obj = tirosh_mel80_example,
assay = "RNA", slot = "counts", marker_genes = selected_marker_genes_B,
cell_type = "b cells", tag_slot = "active.ident")

# classify cell types using B cell classifier,
# a test classifier process may be used before applying the classifier
tirosh_mel80_example <- classify_cells(classify_obj = tirosh_mel80_example,
classifiers = c(classifier_b), assay = "RNA", slot = "counts")

# tag all cells that are plasma cells (random example here)
tirosh_mel80_example[[\'plasma_cell_tag\']]] <- c(rep(1, 80), rep(0, 400))

# set new marker genes for the subtype
p_marker_genes = c("SDC1", "CD19", "CD79A")

# train the classifier, the "B cell" classifier is used as parent.
# This means, only cells already classified as "B cells" will be evaluated.
# the "tag_slot" parameter tells the classifier to use this cell meta data
# for the training process.
set.seed(123)
plasma_classifier <- train_classifier(train_obj = tirosh_mel80_example,
assay = "RNA", slot = "counts", cell_type = "Plasma cell",
marker_genes = p_marker_genes, tag_slot = "plasma_cell_tag",
parent_classifier = classifier_b)
```
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