

Package ‘HIPPO’

March 30, 2021

Type Package

Title Heterogeneity-Induced Pre-Processing tOol

Version 1.2.0

Description For scRNA-seq data, it selects features and clusters the cells simultaneously for single-cell UMI data. It has a novel feature selection method using the zero inflation instead of gene variance, and computationally faster than other existing methods since it only relies on PCA+Kmeans rather than graph-clustering or consensus clustering.

License GPL (>=2)

Depends R (>= 3.6.0)

Encoding UTF-8

LazyData true

Suggests knitr, rmarkdown

VignetteBuilder knitr

URL <https://github.com/tk382/HIPPO>

BugReports <https://github.com/tk382/HIPPO/issues>

Imports ggplot2, graphics, stats, reshape2, gridExtra, Rtsne, umap, dplyr, rlang, magrittr, irlba, Matrix, SingleCellExperiment, ggrepel

RoxygenNote 7.1.0

biocViews Sequencing, SingleCell, GeneExpression, DifferentialExpression, Clustering

git_url <https://git.bioconductor.org/packages/HIPPO>

git_branch RELEASE_3_12

git_last_commit 90c3d90

git_last_commit_date 2020-10-27

Date/Publication 2021-03-29

Author Tae Kim [aut, cre],
Mengjie Chen [aut]

Maintainer Tae Kim <tk382@uchicago.edu>

R topics documented:

| | |
|-------------------------------------|-----------|
| ensg_hgnc | 2 |
| get_data_from_sce | 3 |
| get_hippo | 3 |
| get_hippo_diffexp | 4 |
| hippo | 4 |
| hippo_diagnostic_plot | 5 |
| hippo_diffexp | 5 |
| hippo_dimension_reduction | 6 |
| hippo_feature_heatmap | 7 |
| hippo_pca_plot | 8 |
| hippo_tsne_plot | 8 |
| hippo_umap_plot | 9 |
| nb_prob_zero | 10 |
| pois_prob_zero | 10 |
| preprocess_heterogeneous | 11 |
| preprocess_homogeneous | 11 |
| toydata | 12 |
| zero_proportion_plot | 12 |
| zinb_prob_zero | 13 |
| %>% | 13 |
| Index | 14 |

ensg_hgnc

A reference data frame that matches ENSG IDs to HGNC symbols

Description

A reference data frame that matches ENSG IDs to HGNC symbols

Usage

```
ensg_hgnc
```

Format

A data frame with 46606 rows and 2 columns

ensg Ensembl ENSG IDs

hgnc HGNC symbols

Source

<http://www.biomart.org/>

get_data_from_sce *Access data from SCE object*

Description

Access data from SCE object

Usage

```
get_data_from_sce(sce)
```

Arguments

sce SingleCellExperiment object

Value

count matrix

Examples

```
data(toydata)
X = get_data_from_sce(toydata)
```

get_hippo *Access hippo object from SingleCellExperiment object.*

Description

Access hippo object from SingleCellExperiment object.

Usage

```
get_hippo(sce)
```

Arguments

sce SingleCellExperiment object

Value

hippo object embedded in SingleCellExperiment object

Examples

```
data(toydata)
set.seed(20200321)
toydata = hippo(toydata,K = 10,z_threshold = 1,outlier_proportion = 0.01)
hippo_object = get_hippo(toydata)
```

`get_hippo_diffexp` *Return hippo_diffexp object*

Description

Return hippo_diffexp object

Usage

```
get_hippo_diffexp(sce, k = 1)
```

Arguments

| | |
|------------------|--|
| <code>sce</code> | SingleCellExperiment object with hippo |
| <code>k</code> | integer round of result of interest |

Value

data frame of differential expression test

Examples

```
data(toydata)
set.seed(20200321)
toydata = hippo(toydata,K = 10,z_threshold = 1,outlier_proportion = 0.01)
toydata = hippo_diffexp(toydata)
result1 = get_hippo_diffexp(toydata)
```

`hippo` *HIPPO's hierarchical clustering*

Description

HIPPO's hierarchical clustering

Usage

```
hippo(sce, K = 20, z_threshold = 2, outlier_proportion = 0.001, verbose = TRUE)
```

Arguments

| | |
|---------------------------------|---|
| <code>sce</code> | SingleCellExperiment object |
| <code>K</code> | number of clusters to ultimately get |
| <code>z_threshold</code> | numeric > 0 as a z-value threshold for selecting the features |
| <code>outlier_proportion</code> | numeric between 0 and 1, a cut-off so that when the proportion of important features reach this number, the clustering terminates |
| <code>verbose</code> | if set to TRUE, it shows progress of the algorithm |

Value

a list of clustering result for each level of $k=1, 2, \dots K$.

Examples

```
data(toydata)
toydata = hippo(toydata, K = 10, z_threshold = 1, outlier_proportion = 0.01)
```

hippo_diagnostic_plot *Conduct feature selection by computing test statistics for each gene*

Description

Conduct feature selection by computing test statistics for each gene

Usage

```
hippo_diagnostic_plot(sce, show_outliers = FALSE, zvalue_thresh = 10)
```

Arguments

sce SingleCellExperiment object with count matrix
show_outliers boolean to indicate whether to circle the outliers with given zvalue_thresh
zvalue_thresh a numeric v for defining outliers

Value

a diagnostic plot that shows genes with zero inflation

Examples

```
data(toydata)
hippo_diagnostic_plot(toydata, show_outliers=TRUE, zvalue_thresh = 2)
```

hippo_diffexp *HIPPO's differential expression*

Description

HIPPO's differential expression

Usage

```
hippo_diffexp(
  sce,
  top.n = 5,
  switch_to_hgnc = FALSE,
  ref = NA,
  k = NA,
  plottitle = ""
)
```

Arguments

| | |
|----------------|---|
| sce | SingleCellExperiment object with hippo |
| top.n | number of markers to return |
| switch_to_hgnc | if the current gene names are ensemble ids, and would like to switch to hgnc |
| ref | a data frame with columns 'hgnc' and 'ensg' to match each other, only required when switch_to_hgnc is set to TRUE |
| k | number of rounds of clustering that you'd like to see result. Default is 1 to K |
| plottitle | title of the resulting plot |

Value

list of differential expression result

Examples

```
data(toydata)
set.seed(20200321)
toydata = hippo(toydata,K = 10,z_threshold = 1,outlier_proportion = 0.01)
result = hippo_diffexp(toydata)
```

hippo_dimension_reduction

compute t-SNE or umap of each round of HIPPO

Description

compute t-SNE or umap of each round of HIPPO

Usage

```
hippo_dimension_reduction(
  sce,
  method = c("umap", "tsne"),
  perplexity = 30,
  featurelevel = 1
)
```

Arguments

| | |
|--------------|--|
| sce | SingleCellExperiment object with hippo object in it. |
| method | a string that determines the method for dimension reduction: either 'umap' or 'tsne' |
| perplexity | numeric perplexity parameter for Rtsne function |
| featurelevel | the round of clustering that you will extract features to reduce the dimension |

Value

a data frame of dimension reduction result for each k in 1, ..., K

Examples

```
data(toydata)
set.seed(20200321)
set.seed(20200321)
toydata = hippo(toydata,K = 10,z_threshold = 1,outlier_proportion = 0.01)
toydata = hippo_dimension_reduction(toydata, method="tsne")
hippo_tsne_plot(toydata)
```

hippo_feature_heatmap *HIPPO's feature heatmap*

Description

HIPPO's feature heatmap

Usage

```
hippo_feature_heatmap(  
  sce,  
  switch_to_hgnc = FALSE,  
  ref = NA,  
  top.n = 50,  
  kk = 2,  
  plottitle = ""  
)
```

Arguments

| | |
|----------------|---|
| sce | SingleCellExperiment object with hippo |
| switch_to_hgnc | if the current gene names are ensemble ids, and would like to switch to hgnc |
| ref | a data frame with columns 'hgnc' and 'ensg' to match each other, only required when switch_to_hgnc is set to TRUE |
| top.n | number of markers to return |
| kk | integer for the round of clustering that you'd like to see result. Default is 2 |
| plottitle | title for the plot |

Value

list of differential expression result

Examples

```
data(toydata)
set.seed(20200321)
toydata = hippo(toydata,K = 10,z_threshold = 1,outlier_proportion = 0.01)
hippo_feature_heatmap(toydata)
```

hippo_pca_plot *visualize each round of hippo through t-SNE*

Description

visualize each round of hippo through t-SNE

Usage

```
hippo_pca_plot(sce, k = NA, pointsize = 0.5, pointalpha = 0.5, plottitle = "")
```

Arguments

| | |
|------------|---|
| sce | SingleCellExperiment object with hippo and t-SNE result in it |
| k | number of rounds of clustering that you'd like to see result. Default is 1 to K |
| pointsize | size of the point for the plot (default 0.5) |
| pointalpha | transparency level of points for the plot (default 0.5) |
| plottitle | title for the ggplot |

Value

ggplot for pca in each round

Examples

```
data(toydata)
set.seed(20200321)
toydata = hippo(toydata, K = 10, z_threshold = 1)
hippo_pca_plot(toydata, k = 2:3)
```

hippo_tsne_plot *visualize each round of hippo through t-SNE*

Description

visualize each round of hippo through t-SNE

Usage

```
hippo_tsne_plot(sce, k = NA, pointsize = 0.5, pointalpha = 0.5, plottitle = "")
```

Arguments

| | |
|------------|---|
| sce | SingleCellExperiment object with hippo and t-SNE result in it |
| k | number of rounds of clustering that you'd like to see result. Default is 1 to K |
| pointsize | size of the point for the plot (default 0.5) |
| pointalpha | transparency level of points for the plot (default 0.5) |
| plottitle | title for the ggplot output |

Value

ggplot object for t-SNE in each round

Examples

```
data(toydata)
set.seed(20200321)
toydata = hippo(toydata,K = 10,z_threshold = 1,outlier_proportion = 0.01)
toydata = hippo_dimension_reduction(toydata, method="tsne")
hippo_tsne_plot(toydata)
```

| | |
|-----------------|---|
| hippo_umap_plot | <i>visualize each round of hippo through UMAP</i> |
|-----------------|---|

Description

visualize each round of hippo through UMAP

Usage

```
hippo_umap_plot(sce, k = NA, pointsize = 0.5, pointalpha = 0.5, plottitle = "")
```

Arguments

| | |
|------------|---|
| sce | SingleCellExperiment object with hippo and UMAP result in it |
| k | number of rounds of clustering that you'd like to see result. Default is 1 to K |
| pointsize | size of the point for the plot (default 0.5) |
| pointalpha | transparency level of points for the plot (default 0.5) |
| plottitle | title of the resulting plot |

Value

ggplot object for umap in each round

Examples

```
data(toydata)
set.seed(20200321)
toydata = hippo(toydata,K = 10,z_threshold = 1,outlier_proportion = 0.01)
toydata = hippo_dimension_reduction(toydata, method="umap")
hippo_umap_plot(toydata)
```

| | |
|--------------|---|
| nb_prob_zero | <i>Expected zero proportion under Negative Binomial</i> |
|--------------|---|

Description

Expected zero proportion under Negative Binomial

Usage

```
nb_prob_zero(lambda, theta)
```

Arguments

| | |
|--------|--|
| lambda | numeric vector of means of negative binomial |
| theta | numeric vector of the dispersion parameter for negative binomial, 0 if poisson |

Value

numeric vector of expected zero proportion under Negative Binomial

Examples

```
nb_prob_zero(3, 1.1)
```

| | |
|----------------|---|
| pois_prob_zero | <i>Expected zero proportion under Poisson</i> |
|----------------|---|

Description

Expected zero proportion under Poisson

Usage

```
pois_prob_zero(lambda)
```

Arguments

| | |
|--------|------------------------------------|
| lambda | numeric vector of means of Poisson |
|--------|------------------------------------|

Value

numeric vector of expected proportion of zeros for each lambda

Examples

```
pois_prob_zero(3)
```

```
preprocess_heterogeneous
```

Preprocess UMI data without cell label so that each row contains information about each gene

Description

Preprocess UMI data without cell label so that each row contains information about each gene

Usage

```
preprocess_heterogeneous(X)
```

Arguments

X a matrix object with counts data

Value

data frame with one row for each gene.

Examples

```
data(toydata)
df = preprocess_heterogeneous(get_data_from_sce(toydata))
```

```
preprocess_homogeneous
```

Preprocess UMI data with inferred or known labels

Description

Preprocess UMI data with inferred or known labels

Usage

```
preprocess_homogeneous(sce, label)
```

Arguments

sce SingleCellExperiment object with counts data
label a numeric or character vector of inferred or known label

Value

data frame with one row for each gene.

Examples

```
data(toydata)
labels = SingleCellExperiment::colData(toydata)$phenoid
df = preprocess_homogeneous(toydata, label = labels)
```

 toydata

A sample single cell sequencing data subsetted from Zheng2017

Description

A sample single cell sequencing data subsetted from Zheng2017

Usage

```
toydata
```

Format

Single Cell experiment object with 10,000 genes and 100 cells

Source

<https://www.nature.com/articles/ncomms14049>

 zero_proportion_plot

visualize each round of hippo through zero proportion plot

Description

visualize each round of hippo through zero proportion plot

Usage

```
zero_proportion_plot(
  sce,
  switch_to_hgnc = FALSE,
  ref = NA,
  k = NA,
  plottitle = "",
  top.n = 5,
  pointsize = 0.5,
  pointalpha = 0.5,
  textsize = 3
)
```

Arguments

| | |
|----------------|---|
| sce | SingleCellExperiment object with hippo element in it |
| switch_to_hgnc | boolean argument to indicate whether to change the gene names from ENSG IDs to HGNC symbols |
| ref | a data frame with hgnc column and ensg column |
| k | select rounds of clustering that you would like to see result. Default is 1 to K |
| plottitle | Title of your plot output |

| | |
|------------|--|
| top.n | number of top genes to show the name |
| pointsize | size of the ggplot point |
| pointalpha | transparency level of the ggplot point |
| textsize | text size of the resulting plot |

Value

a ggplot object that shows the zero proportions for each round

Examples

```
data(toydata)
set.seed(20200321)
toydata = hippo(toydata, K = 10, z_threshold = 1, outlier_proportion = 0.01)
data(ensg_hgnc)
zero_proportion_plot(toydata, switch_to_hgnc = TRUE, ref = ensg_hgnc)
```

| | |
|----------------|---|
| zinb_prob_zero | <i>Expected zero proportion under Negative Binomial</i> |
|----------------|---|

Description

Expected zero proportion under Negative Binomial

Usage

```
zinb_prob_zero(lambda, theta, pi)
```

Arguments

| | |
|--------|--|
| lambda | gene mean |
| theta | dispersion parameter, 0 if zero-inflated poisson |
| pi | zero inflation, 0 if negative binomial |

Value

Expected zero proportion under Zero-Inflated Negative Binomial

Examples

```
zinb_prob_zero(3, 1.1, 0.1)
```

| | |
|-----|---|
| %>% | <i>re-export magrittr pipe operator</i> |
|-----|---|

Description

re-export magrittr pipe operator

Index

* datasets

ensg_hgnc, [2](#)

toydata, [12](#)

%>%, [13](#)

ensg_hgnc, [2](#)

get_data_from_sce, [3](#)

get_hippo, [3](#)

get_hippo_diffexp, [4](#)

hippo, [4](#)

hippo_diagnostic_plot, [5](#)

hippo_diffexp, [5](#)

hippo_dimension_reduction, [6](#)

hippo_feature_heatmap, [7](#)

hippo_pca_plot, [8](#)

hippo_tsne_plot, [8](#)

hippo_umap_plot, [9](#)

nb_prob_zero, [10](#)

pois_prob_zero, [10](#)

preprocess_heterogeneous, [11](#)

preprocess_homogeneous, [11](#)

toydata, [12](#)

zero_proportion_plot, [12](#)

zinb_prob_zero, [13](#)