Package ‘TSCAN’

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Type Package

Title TSCAN: Tools for Single-Cell ANalysis

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Description TSCAN enables users to easily construct and tune pseudotemporal cell ordering as well as analyzing differentially expressed genes. TSCAN comes with a user-friendly GUI written in shiny. More features will come in the future.

License GPL(>=2)

Imports ggplot2, shiny, plyr, grid, fastICA, igraph, combinat, mgcv, mclust, gplots

VignetteBuilder knitr

Suggests knitr

Depends R(>= 2.10.0)

biocViews GeneExpression, Visualization, GUI

NeedsCompilation no

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Description
testing differentially expressed genes

Usage
difftest(data, TSCANorder, df = 3)

Arguments
data The raw single_cell data, which is a numeric matrix or data.frame. Rows represent genes/features and columns represent single cells.
TSCANorder The TSCAN ordering generated by function TSCANorder.
df Numeric value specifying the degree of freedom used in the GAM model.

Details
This function tests whether a gene is significantly expressed given pseudotime ordering. Likelihood ratio test is performed to compare a generalized additive model (GAM) with a constant fit to get the p-values. The p-values are adjusted for multiple testing by fdr.

Value
Data frame containing pvalues and qvalues of testing differentially expression.

Author(s)
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Examples
data(lpsdata)
procdata <- preprocess(lpsdata)
lpsorder <- TSCANorder(exprmclust(procdata))
difftval <- difftest(procdata,lpsorder)
#Selected differentially expressed genes under qvalue cutoff of 0.05
row.names(difftval)[difftval$qval < 0.05]
Description

Perform model-based clustering on expression values

Usage

exprmclust(data, clusternum = 2:9, modelNames = "VVV", reduce = T)

Arguments

data The raw single_cell data, which is a numeric matrix or data.frame. Rows represent genes/features and columns represent single cells.
clusternum An integer vector specifying all possible cluster numbers. The best cluster number will be picked using BIC. The minimum value should be two other
modelNames model to be used in model-based clustering. By default "ellipsoidal, varying volume, shape, and orientation" is used.
reduce Whether to perform the PCA on the expression data.

Details

By default, this function first uses principal component analysis (PCA) to reduce dimensionality of original data. It then performs model-based clustering on the transformed expression values. A minimum-spanning-tree is constructed to link the cluster centers. The clustering results will be used for TSCAN ordering.

Value

if more than one cluster detected, a list containing

• pcareduceres Numeric matrix containing the transformed expression values after PCA.
• MSTtree igraph object which is the result of constructing MST.
• clusterid A named vector specifying which cluster the cells belong to.
• clucenter Numeric matrix of the cluster centers.

if only one cluster detected, a list containing

• pcareduceres Numeric matrix containing the transformed expression values after PCA.

Author(s)

Zhicheng Ji, Hongkai Ji <zji4@zji4.edu>

References

Examples

```r
data(lpsdata)
procdata <- preprocess(lpsdata)
exprmclust(procdata)
```

**lpsdata**

*Single-cell RNA-seq data for BMDC cells before and after LPS stimulation*

**Description**

The dataset contains 16776 rows and 131 columns. Each row represents a gene and each column represents a single cell. This dataset is a subset of single-cell RNA-seq data provided by GEO GSE48968. Only unstimulated cells and cells after 6h of LPS stimulation are retained for the purpose of demonstration. Genes which have raw expression values of greater than zero in at least one cell are retained. For the original dataset please refer to GSE48968 on GEO (http://www.ncbi.nlm.nih.gov/geo/query/acc.cgi?acc=GSE48968).

**Format**

A matrix with 16776 rows and 131 variables

**Source**


**References**


**orderscore**

**Description**

Calculate pseudotemporal ordering scores for orders

**Usage**

```r
orderscore(subpopulation, orders)
```

**Arguments**

- **subpopulation**: Data frame with two columns. First column: cell names. Second column: subpopulation codes.
- **orders**: A list with various length containing pseudotime orderings.
plotmclust

Details

This function calculates pseudotemporal ordering scores (POS) based on the sub-population information and order information given by users. Cells should come from at least two cell sub-populations. These sub-population should be coded as 0,1,2,...

Value

a numeric vector of calculated POS.

Author(s)

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Examples

data(lpsdata)
procdata <- preprocess(lpsdata)
subpopulation <- data.frame(cell = colnames(procdata), sub = ifelse(grepl("Unstimulated", colnames(procdata)), 0, 1), stringsAsFactors = FALSE)
lpsmclust <- exprmclust(procdata)
#Comparing default TSCAN ordering and tuned TSCAN ordering
order1 <- TSCANorder(lpsmclust)
order2 <- TSCANorder(lpsmclust, c(1,2,3))
orders <- list(order1, order2)
orderscore(subpopulation, orders)

plotmclust

Description

Plot the model-based clustering results

Usage

plotmclust(mclustobj, x = 1, y = 2, MSTorder = NULL, show_tree = T, show_cell_names = T, cell_name_size = 3, markerexpr = NULL)

Arguments

mclustobj The exact output of exprmclust function.
x The column of data after dimension reduction to be plotted on the horizontal axis.
y The column of data after dimension reduction to be plotted on the vertical axis.
MSTorder The arbitrary order of cluster to be shown on the plot.
show_tree Whether to show the links between cells connected in the minimum spanning tree.
show_cell_names Whether to draw the name of each cell in the plot.
cell_name_size The size of cell name labels if show_cell_names is TRUE.
markerexpr The gene expression used to define the size of nodes.
Details

This function will plot the gene expression data after dimension reduction and show the clustering results.

Value

A ggplot2 object.

Author(s)

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Examples

```r
data(lpsdata)
procdata <- preprocess(lpsdata)
lpsmclust <- exprmclust(procdata)
plotmclust(lpsmclust)
```

Description

preprocess the raw single-cell data

Usage

```r
preprocess(data, clusternum = NULL, takelog = TRUE, logbase = 2,
pseudocount = 1, minexpr_value = 1, minexpr_percent = 0.5,
cvcutoff = 1)
```

Arguments

- `data`: The raw single_cell data, which is a numeric matrix or data.frame. Rows represent genes/features and columns represent single cells.
- `clusternum`: The number of clusters for doing cluster, typically 5 percent of number of all genes. The clustering will be done after all the transformation and trimming. If NULL no clustering will be performed.
- `takelog`: Logical value indicating whether to take logarithm
- `logbase`: Numeric value specifying base of logarithm
- `pseudocount`: Numeric value to be added to the raw data when taking logarithm
- `minexpr_value`: Numeric value specifying the minimum cutoff of log transformed (if takelog is TRUE) value
- `minexpr_percent`: Numeric value specifying the lowest percentage of highly expressed cells (expression value bigger than minexpr_value) for the genes/features to be retained.
- `cvcutoff`: Numeric value specifying the minimum value of coefficient of variance for the genes/features to be retained.
**Details**

This function first takes logarithm of the raw data and then filters out genes/features in which too many cells are low expressed. It also filters out genes/features with low coefficient of variance which indicates the genes/features does not contain much information. The default setting will first take log2 of the raw data after adding a pseudocount of 1. Then genes/features in which at least half of cells have expression values are greater than 1 and the coefficients of variance across all cells are at least 1 are retained.

**Value**

Matrix or data frame with the same format as the input dataset.

**Author(s)**

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**Examples**

```r
data(lpsdata)
prodata <- preprocess(lpsdata)
```

**Description**

plot expression values of individual genes against pseudotime axis

**Usage**

```r
singlegeneplot(geneexpr, TSCANorder, cell_size = 2)
```

**Arguments**

- `geneexpr`: The gene expression values. Names should agree with the pseudotime information.
- `TSCANorder`: The output of function `TSCANorder`.
- `cell_size`: Size of cells in the plot.

**Details**

This function plots the expression values of individual genes against given pseudotime

**Value**

ggplot2 object.

**Author(s)**

Zhicheng Ji, Hongkai Ji <zji4@zji4.edu>
Examples

data(lpsdata)
procdata <- preprocess(lpsdata)
lpsmclust <- exprmclust(procdata)
lpsorder <- TSCANorder(lpsmclust, orderonly=FALSE, flip=TRUE)
# Choose STAT1 gene expression to plot
STAT2expr <- log2(lpsdata["STAT2",]+1)
singlegeneplot(STAT2expr, lpsorder)

TSCAN: Tools for Single-Cell Analysis

Description

This package provides essential tools used in analyzing data from single-cell experiments.

Details

TSCAN enables users to easily construct and tune pseudotemporal cell ordering as well as analyzing differentially expressed genes. TSCAN comes with a user-friendly GUI written in shiny. More functions will come in the future.

TSCANorder

Description

Construct TSCAN order after exprmclust

Usage

TSCANorder(mclustobj, MSTorder = NULL, orderonly = T, flip = F,
listbranch = F)

Arguments

mclustobj The exact output of the exprmclust function.
MSTorder A numeric vector specifying the order of clusters.
orderonly Only return the ordering. State or pseudotime information will not be returned
flip whether to flip the ordering
listbranch whether to list the ordering results of all possible branches

Details

This function takes the exact output of exprmclust function and construct TSCAN order by mapping all cells onto the path that connects cluster centers. Users can also specify their own path.
TSCANui

Value

if orderonly = F, a vector of ordered cell names. if orderonly = T, a data frame of ordered cell names, cell states and pseudotime.

Author(s)

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Examples

data(lpsdata)
procdata <- preprocess(lpsdata)
lpsmclust <- exprmclust(procdata)
TSCANorder(lpsmclust)

Description

Launch the TSCAN user interface in local machine

Usage

TSCANui()

Details

This function will automatically launch the TSCAN user interface in a web browser. The user interface provides many powerful functions which is not available by command line programming. It also provides a much easier and more convenient way to quickly explore single cell data and construct pseudotime analysis. The user interface can also be accessed by http://zhiji.shinyapps.io/TSCAN. Neither R nor any packages are required in this online version. However, it is highly recommended that the user interface be launched locally for faster running speed.

Author(s)

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Examples

## Not run:
TSCANui()

## End(Not run)
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