Package 'uSORT'

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Title uSORT: A self-refining ordering pipeline for gene selection

Version 1.38.0

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Description This package is designed to uncover the intrinsic cell progression path from single-cell RNA-seq data. It incorporates data pre-processing, preliminary PCA gene selection, preliminary cell ordering, feature selection, refined cell ordering, and post-analysis interpretation and visualization.

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autoSPIN *A wrapper function for autoSPIN sorting method*

Description

A wrapper function for autoSPIN method which implements optimized local refinement using the selected SPIN sorting method, i.e. STS or Neighborhood.

Usage

```
autoSPIN(data, data_type = c("linear", "cyclical"),
  sorting_method = c("STS", "neighborhood"), alpha = 0.2, sigma_width = 1,
  no_randomization = 20, window_perc_range = c(0.1, 0.9),
  window_size_incre_perct = 0.05)
```

Arguments

`data`	An log2 transformed expresssion matrix containing n-rows of cells and m-cols of genes.
`data_type`	A character string indicating the type of progression, i.e. 'linear' (strictly linear) or 'cyclical' (cyclically linear).
`sorting_method`	A character string indicating the choice of SPIN sorting method, i.e. 'STS' (Side-to-Side) or 'Neighborhood'.
`alpha`	A fraction value denoting the size of locality used for calculating the summed local variance.
`sigma_width`	An integer number denoting the degree of spread of the gaussian distribution which is used for computing weight matrix for Neighborhood sorting method.
`no_randomization`	An integer number indicating the number of repeated sorting, each of which uses randomly selected initial cell position.
`window_perc_range`	A fraction value indicating the range of window size to be examined during local refinement.
`window_size_incre_perct`	A fraction value indicating the step size at each iteration for incrementing window size.

Value

A data frame containing single column of ordered sample IDs.

Examples

```
set.seed(15)
da <- iris[sample(150, 150, replace = FALSE), ]
rownames(da) <- paste0('spl_',seq(1,nrow(da)))
d <- da[,1:4]
dl <- da[,5,drop=FALSE]
res <- autoSPIN(data = d)
dl <- dl[match(res$SampleID,rownames(dl)),]
annot <- data.frame(id = seq(1,nrow(res)), label=dl, stringsAsFactors = FALSE)
#ggplot(annot, aes(x=id, y=id, colour = label)) + geom_point() + theme_bw()
```

`clusterGenes1` *A modified monocle's function*

Description

A modified monocle's function for 'compareModels' which identifies and removes genes whose reduced_models is better than full_models in term of likelihood

Usage

```
clusterGenes1(expr_matrix, krange, method = function(x) {     as.dist((1 -
  cor(t(x)))/2) }, ...)
```

Arguments

`expr_matrix`	Expression matrix.
`krange`	krange.
`method`	method function.
`...`	Other parameters.

Value

test_res a dataframe containing status of modeling and adjusted p-value

Author(s)

MaiChan Lau

compareModels1 *A modified monocle's function*

Description

A modified monocle's function for 'compareModels' which identifies and removes genes whose reduced_models is better than full_models in term of likelihood

Usage

```
compareModels1(full_models, reduced_models)
```

Arguments

full_models	a Monocle's vgam full model
reduced_models	a Monocle's vgam reduced/ null model

Value

test_res a dataframe containing status of modeling and adjusted p-value

Author(s)

MaiChan Lau

differentialGeneTest1 *differential gene test*

Description

modified from FludigmSC pacakge

Usage

```
differentialGeneTest1(cds,
  fullModelFormulaStr = "expression~sm.ns(Pseudotime, df=3)",
  reducedModelFormulaStr = "expression~1", cores = 1)
```

Arguments

cds	Input object.
fullModelFormulaStr	Full model formula.
reducedModelFormulaStr	Reduced model formula.
cores	Number of cores will be used.

Value

test results

`diff_test_helper1` *A modified monocle's helper function*

Description

A modified monocle's function for 'diff_test_helper1' which includes more attempts on finding models and also compute max. magnitude change in expression values predicted by GLM model

Usage

```
diff_test_helper1(x, fullModelFormulaStr, reducedModelFormulaStr,
  expressionFamily, lowerDetectionLimit = 0.1, type_ordering = "linear")
```

Arguments

`x`	an expression data
`fullModelFormulaStr`	a Monocle's model structure
`reducedModelFormulaStr`	a Monocle's model structure
`expressionFamily`	a Monocle's family character
`lowerDetectionLimit`	a threshold value
`type_ordering`	a character indicating the type of underlying cell progression, i.e. linear or circular

Value

test_res a dataframe containing status of modeling and adjusted p-value

Author(s)

MaiChan Lau

`distance.function` *A distance function A distance function computes cell-to-cell distance matrix.*

Description

A distance function A distance function computes cell-to-cell distance matrix.

Usage

```
distance.function(expr, method = c("Euclidean", "Correlation", "eJaccard",
  "none"))
```

Arguments

`expr`	An expresssion matrix containing n-rows of cells and m-cols of genes.
`method`	A character string indicating the distance function.

Value

A matrix containing n-by-n cell distance.

`driving_force_gene_selection` *A feature/ gene selection function*

Description

A feature/ gene selection function (1) removes sparsely expressed genes, (2) identifies differentially expressed genes based on preliminary cell ordering, (3) removes highly dispersed genes from the identified DEGs, (4) further picks genes which are expected to have large expression difference on the 2 extreme ends of preliminary cell ordering

Usage

```
driving_force_gene_selection(cds, scattering.cutoff.prob = 0.75,
  driving.force.cutoff = NULL, qval_cutoff = 0.05, min_expr = 0.1,
  data_type = c("linear", "cyclical"), nCores = 1)
```

Arguments

cds	a Monocle's CellDataSet object
scattering.cutoff.prob	probability used for removing largely dispersed genes
driving.force.cutoff	a value used for removing genes which do not change much along cell progress along cell progress path
qval_cutoff	a user-defined adjusted p-value below which genes are retained
min_expr	the minimum expression value
data_type	a character indicating the type of underlying cell progression, i.e. linear or cyclical.
nCores	Number of cores to use.

Value

integer

Author(s)

MaiChan Lau

Examples

```
dir <- system.file('extdata', package='uSORT')
file <- list.files(dir, pattern='.txt$', full=TRUE)
#exprs <- uSORT_preProcess(exprs_file = file)
#exp_raw <- t(exprs$exprs_raw)
#exp_trimmed <- t(exprs$exprs_log_trimed)
#cds <- uSORT:::EXP_to_CellDataSet(exp_trimmed, exp_raw)
#driver_genes <- driving_force_gene_selection(cds = cds)
```

---

elbow_detection *A elbow detection function*

Description

A elbow detection function detects the elbow/knee of a given vector of values. Values will be sorted descendingly before detection, and the ID of those values above the elbow will be returned.

Usage

```
elbow_detection(scores, if_plot = FALSE)
```

Arguments

scores	A vector of numeric scores.
if_plot	Boolean determine if plot the results.

Value

a vector of selected elements IDs

Examples

```
scores <- c(10, 9 ,8, 6, 3, 2, 1, 0.1)
elbow_detection(scores, if_plot = TRUE)
```

EXP_to_CellDataSet *A function for constructing a Monocle's CellDataSet object from an expression matrix*

Description

A function for constructing a Monocle's CellDataSet object from an expression matrix

Usage

```
EXP_to_CellDataSet(log2_exp = NULL, expression_data_raw = NULL, lod = 1)
```

Arguments

log2_exp	An log2 transformed expresssion matrix containing n-rows of cells and m-cols of genes.
expression_data_raw	A data frame containing raw expression values, with rownames of cells and colnames of genes.
lod	A value of limit of detection in the unit of TPM/CPM/RPKM.

Value

A CellDataSet object.

---

fluidigmSC_analyzeGeneDetection *A gene detection function*

Description

A gene detection function computes the fraction of genes detected in each cell, reproduced from FluidigmSC package.

Usage

```
fluidigmSC_analyzeGeneDetection(expression_data, threshold = 1)
```

Arguments

expression_data	A data frame containing raw expression values, with rownames of genes and colnames of cells.
threshold	A limit of detection in the unit of TPM/CPM/RPMK.

Value

A data frame containing a column of number of genes detected, and a column of the corresponding percentage of gene detection, rownames of cells.

---

fluidigmSC_identifyExpOutliers

An outlier detection function

Description

An outlier detection function identifies cells with median expression below that of the bulk, reproduced from FluidigmSC package.

Usage

```
fluidigmSC_identifyExpOutliers(log2ex_data, expression_data_raw, threshold,
  step, fine_step, num_fine_test, pct_goodsample_threshold = 0.5,
  quantile_threshold = 0.95, low_quantile_threshold = 0.25,
  min_gene_number = 25, lod)
```

Arguments

log2ex_data	A data frame containing log2 tranformed expression values, with rownames of genes and colnames of cells.
expression_data_raw	A data frame containing raw expression values, with rownames of genes and colnames of cells.
threshold	A value in raw expression used as the starting threshold value.
step	An integer number indicating the increment of threshold value at each iteration.
fine_step	An integer number indicating the increment of threshold value at each iteration, at the refining stage.
num_fine_test	An integer number indicating the number of iteration of the refining stage.
pct_goodsample_threshold	A fraction value indicating the minimum percentage of samples on which the representative genes are detectable.
quantile_threshold	A probability of gene detection rate above which a sample is considered as good sample.

`low_quantile_threshold`
: A probability of average gene expression value below which a sample is taken as an outlier.

`min_gene_number`
: An integer indicating the minimum size of representative genes.

`lod`
: A value of limit of detection in the unit of TPM/CPM/RPKM.

Value

A vector of character stating the IDs of outlier cells.

`fluidigmSC_isElementIgnoreCase` *A gene finding function*

Description

A gene finding function looking for genes in the target set x from the source set y, reproduced from FluidigmSC package.

Usage

```
fluidigmSC_isElementIgnoreCase(x, y, ignore_case = TRUE)
```

Arguments

`x`
: A vector of characters representing gene names (target genes).

`y`
: A vector of characters representing gene names (source genes).

`ignore_case`
: Boolean, if TRUE ignores letter case.

Value

A vector of characters representing gene names.

fluidigmSC_readLinearExp

An expression reading function

Description

An expression reading function which imports expression data from .txt file, and then computes log2 transformed data, reproduced from FluidigmSC package.

Usage

```
fluidigmSC_readLinearExp(exp_file = TRUE, lod = 1)
```

Arguments

exp_file	Input file name in txt format, with rownames of cells and colnames of genes.
lod	A value of limit of detection in the unit of TPM/CPM/RPKM. It will be used as the starting value for outlier cell detection and the basis for removing scarce genes.

Value

A list containing expression_data_raw(data frame), log2ex_data(data frame), and log2ex_avg_data(data frame).

fluidigmSC_removeGenesByLinearExpForAllType

A gene trimming function

Description

A gene trimming function removes genes whose average expression value is below the log2(threshold), and also present in at least 10

Usage

```
fluidigmSC_removeGenesByLinearExpForAllType(log2ex_data, log2ex_avg_data,
  threshold)
```

Arguments

log2ex_data	A data frame containing log2 tranformed expression values, with rownames of genes and colnames of cells.
log2ex_avg_data	A data frame containing log2 tranformed average expression values for individual gene.
threshold	A limit of detection in the unit of TPM/CPM/RPMK.

Value

A vector of character containing gene names of those passed the filtering.

`fluidigmSC_removeGenesByLinearExpForAllType_log2` *A gene trimming function*

Description

A gene trimming function removes genes whose average expression value is below the log2(threshold); reproduced from FluidigmSC package.

Usage

```
fluidigmSC_removeGenesByLinearExpForAllType_log2(log2ex_data, threshold)
```

Arguments

`log2ex_data`	A data frame containing log2 tranformed expression values, with rownames of genes and colnames of cells.
`threshold`	A limit of detection in the unit of TPM/CPM/RPMK.

Value

A vector of character containing gene names of those passed the filtering.

`monocle_wrapper` *A wrapper function for Monocle sorting method*

Description

A wrapper function for Monocle sorting method

Usage

```
monocle_wrapper(log2_exp, expression_data_raw, lod = 1)
```

Arguments

`log2_exp`	An log2 transformed expresssion matrix containing n-rows of cells and m-cols of genes.
`expression_data_raw`	A data frame containing raw expression values, with rownames of cells and colnames of genes.
`lod`	A value of limit of detection in the unit of TPM/CPM/RPKM.

Value

A data frame containing single column of ordered sample IDs.

Examples

```
set.seed(15)
da <- iris[sample(150, 150, replace = FALSE), ]
rownames(da) <- paste0('spl_',seq(1,nrow(da)))
d <- da[,1:4]
dl <- da[,5,drop=FALSE]
#res <- monocle_wrapper(log2_exp = d, expression_data_raw = d)
#dl <- dl[match(res,rownames(dl)),]
#annot <- data.frame(id = seq(1,length(res)), label=dl, stringsAsFactors = FALSE)
#ggplot(annot, aes(x=id, y=id, colour = label)) + geom_point() + theme_bw()
```

---

neighborhood_sorting *A sorting function using the Neighborhood algorithm*

Description

A sorting function using the Neighborhood algorithm

Usage

```
neighborhood_sorting(d, weights_mat = NULL, max_iter = 100)
```

Arguments

d	A matrix containing n-by-n cell distance.
weights_mat	A weight matrix of size n-by-n.
max_iter	An integer number indicating the maximum number of iteration if sorting does not converge.

Value

A list containing `ordering`(a vector of re-ordered sequence) and `cost`(a numeric value).

neighborhood_sortingcost

A cost computation function for Neighborhood algorithm

Description

A cost computation function for Neighborhood algorithm

Usage

```
neighborhood_sortingcost(expr = NULL, sigma_width = 1,
  method = c("Euclidean", "Correlation", "eJaccard", "none"))
```

Arguments

expr	An expresssion matrix containing n-rows of cells and m-cols of genes.
sigma_width	An integer number determining the degree of spread of the gaussian distribution which is used for computing weight matrix for Neighborhood sorting method.
method	A character string indicating the distance function.

Value

A numeric value of sorting cost.

Examples

```
set.seed(15)
da <- iris[sample(150, 150, replace = FALSE), ]
d <- da[,1:4]
randomOrdering_cost <- neighborhood_sortingcost(d, method= 'Euclidean')
randomOrdering_cost

da <- iris
d <- da[,1:4]
properOrdering_cost <- neighborhood_sortingcost(d, method= 'Euclidean')
properOrdering_cost
```

neighborhood_sorting_wrapper

A wrapper function for Neighborhood sorting.

Description

A wrapper function for Neighborhood sorting as proposed in [Tsafrir et al. 2005].

Usage

```
neighborhood_sorting_wrapper(expr, sigma_width = 1, no_randomization = 10)
```

Arguments

expr	An expresssion matrix containing n-rows of cells and m-cols of genes.
sigma_width	An integer number determining the degree of spread of the gaussian distribution which is used for computing weight matrix for Neighborhood sorting method.
no_randomization	An integer number indicating the number of repeated sorting, each of which uses a randomaly selected initial cell ordering.

Value

A list containing `permutated.expr`(data frame) and `best.cost`(a numeric value).

---

pca_gene_selection *Gene selection using PCA technique*

Description

Gene selection using PCA technique

Usage

```
pca_gene_selection(data)
```

Arguments

data	A matrix of data.frame with row.name of cells, and col.name of genes

Value

a vector of the names of selected genes.

Examples

```
dir <- system.file('extdata', package='uSORT')
file <- list.files(dir, pattern='.txt$', full=TRUE)
exprs <- uSORT_preProcess(exprs_file = file)
exp_trimmed <- t(exprs$exprs_log_trimed)
PCA_selected_genes <- pca_gene_selection(exp_trimmed)
```

Rwanderlust *R inplementation of wanderlust*

Description

R inplementation of wanderlust

Usage

```
Rwanderlust(data, s, l = 15, k = 15, num_graphs = 1,
  num_waypoints = 250, waypoints_seed = 123, flock_waypoints = 2,
  metric = "euclidean", voting_scheme = "exponential",
  band_sample = FALSE, partial_order = NULL, verbose = TRUE)
```

Arguments

data	Input data matrix.
s	Starting point ID.
l	l nearest neighbours.
k	k nearest neighbours, k < l.
num_graphs	Number of repreated graphs.
num_waypoints	Number of waypoints to guide the trajectory detection.
waypoints_seed	The seed for reproducing the results.
flock_waypoints	The number of times for flocking the waypoints, default is 2.
metric	Distance calculation metric for nearest neighbour detection.
voting_scheme	The scheme of voting.
band_sample	Boolean, if band the sample
partial_order	default NULL
verbose	Boolean, if print the details

Value

a list containing Trajectory, Order, Waypoints

Author(s)

Hao Chen

Examples

```
set.seed(15)
shuffled_iris <- iris[sample(150, 150, replace = FALSE), ]
data <- shuffled_iris[,1:4]
data_label <- shuffled_iris[,5]
wishbone <- Rwanderlust(data = data, num_waypoints = 100, waypoints_seed = 2)
pd1 <- data.frame(id = wishbone$Trajectory, label=data_label, stringsAsFactors = FALSE)
pd2 <- data.frame(id = seq_along(row.names(data)), label=data_label, stringsAsFactors = FALSE)
#ggplot(pd1, aes(x=id, y=id, colour = label)) + geom_point() + theme_bw()
#ggplot(pd2, aes(x=id, y=id, colour = label)) + geom_point() + theme_bw()
```

---

scattering_quantification_per_gene

An expression scattering measurement function

Description

An expression scattering measurement function computes the level of scattering for individual genes along the cell ordering

Usage

```
scattering_quantification_per_gene(CDS = NULL)
```

Arguments

CDS	a Monocle's CellDataSet object

Value

integer

Author(s)

MaiChan Lau

---

sorting_method_parameter_GUI

GUI for sorting method paramters

Description

The parameters appeared on GUI are based on input method, this function is called by uSORT_parameters_GUI. For internal use only.

Usage

```
sorting_method_parameter_GUI(method = c("autoSPIN", "sWanderlust", "monocle",
  "Wanderlust", "SPIN", "none"))
```

Arguments

method	method name.

Value

a list of parameters.

Author(s)

Hao Chen

SPIN *A wrapper function for SPIN sorting method*

Description

A wrapper function for SPIN method provides a R version of SPIN [Tsafrir et al. 2005].

Usage

```
SPIN(data, sorting_method = c("STS", "neighborhood"), sigma_width = 1)
```

Arguments

data	An log2 transformed expresssion matrix containing n-rows of cells and m-cols of genes.
sorting_method	A character string indicating the choice of sorting method, i.e. 'STS' (Side-to-Side) or 'Neighborhood'.
sigma_width	An integer number determining the degree of spread of the gaussian distribution which is used for computing weight matrix for Neighborhood sorting method.

Value

A data frame containing single column of ordered sample IDs.

Examples

```
set.seed(15)
da <- iris[sample(150, 150, replace = FALSE), ]
rownames(da) <- paste0('spl_',seq(1,nrow(da)))
d <- da[,1:4]
dl <- da[,5,drop=FALSE]
res <- SPIN(data = d)
dl <- dl[match(res$SampleID,rownames(dl)),]
annot <- data.frame(id = seq(1,nrow(res)), label=dl, stringsAsFactors = FALSE)
#ggplot(annot, aes(x=id, y=id, colour = label)) + geom_point() + theme_bw()
```

`STS_sorting` *A sorting function using the Side-to-Side (STS) algorithm*

Description

A sorting function using the Side-to-Side (STS) algorithm

Usage

```
STS_sorting(d, max_iter = 10)
```

Arguments

`d`	A matrix containing n-by-n cell distance.
`max_iter`	An integer number indicating the maximum number of iteration if sorting does not converge.

Value

A list containing `ordering`(a vector of re-ordered sequence) and `cost`(a numeric value).

`STS_sortingcost` *A cost computation function for Side-to-Side (STS) algorithm*

Description

A cost computation function for Side-to-Side (STS) algorithm

Usage

```
STS_sortingcost(expr = NULL, method = c("Euclidean", "Correlation",
  "eJaccard", "none"))
```

Arguments

expr	An expresssion matrix containing n-rows of cells and m-cols of genes.
method	A character string indicating the distance function.

Value

A numeric value of sorting cost.

Examples

```
set.seed(15)
da <- iris[sample(150, 150, replace = FALSE), ]
d <- da[,1:4]
randomOrdering_cost <- STS_sortingcost(d, method= 'Euclidean')
randomOrdering_cost

da <- iris
d <- da[,1:4]
properOrdering_cost <- STS_sortingcost(d, method= 'Euclidean')
properOrdering_cost
```

STS_sorting_wrapper *A wrapper function for Side-to-Side (STS) sorting.*

Description

A wrapper function for Side-to-Side (STS) sorting as proposed in [Tsafrir et al. 2005].

Usage

```
STS_sorting_wrapper(expr, no_randomization = 10)
```

Arguments

expr	An expresssion matrix containing n-rows of cells and m-cols of genes.
no_randomization	An integer number indicating the number of repeated sorting, each of which uses a randomaly selected initial cell ordering.

Value

A list containing `permutated.expr`(data frame) and `best.cost`(a numeric value).

summed_local_variance *A summed local variance function*

Description

A summed local variance function

Usage

```
summed_local_variance(expr = NULL, alpha = NULL, data_type = "linear")
```

Arguments

expr	An expresssion matrix containing n-rows of cells and m-cols of genes.
alpha	A fraction value indicating the size of window for local variance measurement.
data_type	A character string indicating the type of progression, i.e. 'linear' (strictly linear) or 'cyclical' (cyclically linear).

Value

A numeric value of the summed local variance.

summed_local_variance_cyclical *A summed local variance function for cyclical linear data type*

Description

A summed local variance function for cyclical linear data type

Usage

```
summed_local_variance_cyclical(d, alpha = 0.3)
```

Arguments

d	A cell-to-cell distance matrix.
alpha	A fraction value indicating the size of window for local variance measurement.

Value

A numeric value of the summed local variance.

summed_local_variance_linear *A summed local variance function for strictly linear data type*

Description

A summed local variance function for strictly linear data type

Usage

```
summed_local_variance_linear(d, alpha = 0.3)
```

Arguments

d	A cell-to-cell distance matrix.
alpha	A fraction value indicating the size of window for local variance measurement.

Value

A numeric value of the summed local variance.

sWanderlust *sWanderlust*

Description

autoSPIN guided wanderlust. Specifically, we use autoSPIN to help find the starting point for wanderlust.

Usage

```
sWanderlust(data, data_type = c("linear", "cyclical"),
  SPIN_option = c("STS", "neighborhood"), alpha = 0.2, sigma_width = 1,
  diffusionmap_components = 4, l = 15, k = 15, num_waypoints = 150,
  flock_waypoints = 2, waypoints_seed = 2711)
```

Arguments

data	data Input data matrix.
data_type	The data type which guides the autoSPIN sorting, including linear, cyclical.
SPIN_option	SPIN contains two options including STS(default), neighborhood.
alpha	alpha parameter for autoSPIN, default is 0.2.
sigma_width	Sigma width parameter for SPIN, default is 1.

`diffusionmap_components`
: Number of components from diffusion map used for wanderlust analysis, default is 4.

`l`
: Number of nearest neighbors, default is 15.

`k`
: Number of nearest neighbors for repeating graphs, default is 15, should be less than or equal to l.

`num_waypoints`
: Number of waypoint used for wanderlust, default is 150.

`flock_waypoints`
: The number of times for flocking the waypoints, default is 2.

`waypoints_seed`
: The seed for reproducing the results.

Value

a vector of the sorted oder.

Author(s)

Hao Chen

Examples

```
set.seed(15)
shuffled_iris <- iris[sample(150, 150, replace = FALSE), ]
data <- shuffled_iris[,1:4]
data_label <- shuffled_iris[,5]
wishbone <- sWanderlust(data = data, num_waypoints = 100)
```

`trajectory_landmarks` *determining initial trajectory and landmarks*

Description

determining initial trajectory and landmarks

Usage

```
trajectory_landmarks(knn, data, s, partial_order = NULL, waypoints = 250,
  waypoints_seed = 123, metric = "euclidean", flock_waypoints = 2,
  band_sample = FALSE)
```

Arguments

`knn`
: A sparse matrix of knn.

`data`
: data.

`s`
: The ID of starting point.

`partial_order`
: A vector of IDs specified as recommended waypoints, NULL to ignore.

waypoints	Either the number of waypoints, or specify the waypoint IDs.
waypoints_seed	Random sampling seed, for reproducible results.
metric	Distance calculation metric for nearest neighbour detection.
flock_waypoints	Iteration of using nearest points around waypoint to adjust its position.
band_sample	if give more chance to nearest neighbours of starting point in randomly waypoints selection.

Value

a list

---

uSORT *uSORT: A self-refining ordering pipeline for gene selection*

Description

This package is designed to uncover the intrinsic cell progression path from single-cell RNA-seq data.

The main function of uSORT-pacakge which provides a workflow of sorting scRNA-seq data.

Usage

```
uSORT(exprs_file, log_transform = TRUE, remove_outliers = TRUE,
  preliminary_sorting_method = c("autoSPIN", "sWanderlust", "monocle",
  "Wanderlust", "SPIN", "none"), refine_sorting_method = c("autoSPIN",
  "sWanderlust", "monocle", "Wanderlust", "SPIN", "none"),
  project_name = "uSORT", result_directory = getwd(), nCores = 1,
  save_results = TRUE, reproduce_seed = 1234,
  scattering_cutoff_prob = 0.75, driving_force_cutoff = NULL,
  qval_cutoff_featureSelection = 0.05, pre_data_type = c("linear",
  "cyclical"), pre_SPIN_option = c("STS", "neighborhood"),
  pre_SPIN_sigma_width = 1, pre_autoSPIN_alpha = 0.2,
  pre_autoSPIN_randomization = 20, pre_wanderlust_start_cell = NULL,
  pre_wanderlust_dfmap_components = 4, pre_wanderlust_l = 15,
  pre_wanderlust_num_waypoints = 150, pre_wanderlust_waypoints_seed = 2711,
  pre_wanderlust_flock_waypoints = 2, ref_data_type = c("linear",
  "cyclical"), ref_SPIN_option = c("STS", "neighborhood"),
  ref_SPIN_sigma_width = 1, ref_autoSPIN_alpha = 0.2,
  ref_autoSPIN_randomization = 20, ref_wanderlust_start_cell = NULL,
  ref_wanderlust_dfmap_components = 4, ref_wanderlust_l = 15,
  ref_wanderlust_num_waypoints = 150, ref_wanderlust_flock_waypoints = 2,
  ref_wanderlust_waypoints_seed = 2711)
```

Arguments

exprs_file	Input file name in txt format, with rownames of cells and colnames of genes.
log_transform	Boolean, if log transform the data.
remove_outliers	Boolean, if remove the outliers.
preliminary_sorting_method	Method name for preliminary sorting, including autoSPIN, sWanderlust, monocle, Wanderlust, SPIN, or none.
refine_sorting_method	Method name for refined sorting, including autoSPIN, sWanderlust, monocle, Wanderlust, SPIN, or none.
project_name	A character name as the prefix of the saved result file.
result_directory	The directory indicating where to save the results.
nCores	Number of cores that will be employed for drive gene selection (parallel computing), default is 1.
save_results	Boolean determining if save the results.
reproduce_seed	A seed used for reproducing the result.
scattering_cutoff_prob	Scattering cutoff value probability for gene selection, default 0.75.
driving_force_cutoff	Driving force cutoff value for gene selection, default NULL(automatically).
qval_cutoff_featureSelection	Q value cutoff for gene selection, default 0.05.
pre_data_type	The data type which guides the autoSPIN sorting, including linear, cyclical.
pre_SPIN_option	SPIN contains two options including STS(default), neighborhood.
pre_SPIN_sigma_width	Sigma width parameter for SPIN, default is 1.
pre_autoSPIN_alpha	alpha parameter for autoSPIN, default is 0.2.
pre_autoSPIN_randomization	Number of randomizations for autoSPIN, default is 20.
pre_wanderlust_start_cell	The name of starting cell for wanderlust, default is the first cell from the data.
pre_wanderlust_dfmap_components	Number of components from diffusion map used for wanderlust analysis, default is 4.
pre_wanderlust_l	Number of nearest neighbors used for wanderlust, default is 15.
pre_wanderlust_num_waypoints	Number of waypoint used for wanderlust, default is 150.
pre_wanderlust_waypoints_seed	The seed for reproducing the wanderlust results.

`pre_wanderlust_flock_waypoints`
: The number of times for flocking the waypoints, default is 2.

`ref_data_type`
: The data type which guides the autoSPIN sorting, including `linear`, `cyclical`.

`ref_SPIN_option`
: SPIN contains two options including `STS`(default), `neighborhood`.

`ref_SPIN_sigma_width`
: Sigma width parameter for SPIN, default is 1.

`ref_autoSPIN_alpha`
: alpha parameter for autoSPIN, default is 0.2.

`ref_autoSPIN_randomization`
: Number of randomizations for autoSPIN, default is 20.

`ref_wanderlust_start_cell`
: The name of starting cell for wanderlust, default is the first cell from the data.

`ref_wanderlust_dfmap_components`
: Number of components from diffusion map used for wanderlust analysis, default is 4.

`ref_wanderlust_l`
: Number of nearest neighbors used for wanderlust, default is 15.

`ref_wanderlust_num_waypoints`
: Number of waypoint used for wanderlust, default is 150

`ref_wanderlust_flock_waypoints`
: The number of times for flocking the waypoints, default is 2.

`ref_wanderlust_waypoints_seed`
: The seed for reproducing the wanderlust results.

Details

This package incorporates data pre-processing, preliminary PCA gene selection, preliminary cell ordering, feature selection, refined cell ordering, and post-analysis interpretation and visualization. The uSORT workflow can be implemented through calling the main function or the GUI. `uSORT`.

Value

results object (a list)

See Also

`uSORT-package`, `uSORT_GUI`

Examples

```
dir <- system.file('extdata', package='uSORT')
file <- list.files(dir, pattern='.txt$', full=TRUE)
#remove the # symbol of the following codes to test
#uSORT_results <- uSORT(exprs_file = file, project_name = "test",
# preliminary_sorting_method = "autoSPIN",
# refine_sorting_method = "sWanderlust",
# save_results = FALSE)
```

uSORT_GUI *The user friendly GUI for* uSORT-package

Description

This GUI provides an easy way for applying the uSORT package.

Usage

```
uSORT_GUI()
```

Value

the GUI for uSORT-package

Author(s)

Hao Chen

References

http://JinmiaoChenLab.github.io/uSORT/

See Also

uSORT-package, uSORT

Examples

```
interactive()
#if(interactive()) uSORT_GUI()  # remove the hash symbol to run
```

uSORT_parameters_GUI *The GUI for inputting paramters for uSORT*

Description

This is a function for generating the GUI for uSORT, it's called by uSORT_GUI. For internal use only.

Usage

```
uSORT_parameters_GUI()
```

Value

a list of parameters.

Author(s)

Hao Chen

`uSORT_preProcess` *A data loading and pre-processing function*

Description

A data loading and pre-processing function which firstly identifies outlier cells and scarcely expressed genes.

Usage

```
uSORT_preProcess(exprs_file, log_transform = TRUE, remove_outliers = TRUE,
  lod = 1)
```

Arguments

`exprs_file`	Input file name in txt format, with rownames of cells and colnames of genes.
`log_transform`	Boolean, if TRUE log transform the data.
`remove_outliers`	Boolean, if TRUE remove the outliers.
`lod`	A value of limit of detection in the unit of TPM/CPM/RPKM. It will be used as the starting value for outlier cell detection and the basis for removing scarce genes.

Value

A list containing `exprs_raw`(data frame) and `exprs_log_trimed`(data.frame).

Examples

```
dir <- system.file('extdata', package='uSORT')
file <- list.files(dir, pattern='.txt$', full=TRUE)
exprs <- uSORT_preProcess(exprs_file = file)
```

uSORT_sorting_wrapper *wrapper of all avaliable sorting methods in uSORT*

Description

Sorting methods include autoSPIN, sWanderlust, monocle, Wanderlust, SPIN. Any of the sorting method can be called directly using this funciton.

Usage

```
uSORT_sorting_wrapper(data, data_raw, method = c("autoSPIN", "sWanderlust",
  "monocle", "Wanderlust", "SPIN", "none"), data_type = c("linear",
  "cyclical"), SPIN_option = c("STS", "neighborhood"), SPIN_sigma_width = 1,
  autoSPIN_alpha = 0.2, autoSPIN_randomization = 20,
  wanderlust_start_cell = NULL, wanderlust_dfmap_components = 4,
  wanderlust_l = 15, wanderlust_num_waypoints = 150,
  wanderlust_waypoints_seed = 2711, wanderlust_flock_waypoints = 2)
```

Arguments

data	Input preprocessed data matrix with row.name of cells and col.name of genes.
data_raw	Input raw data matrix with row.name of cells and col.name of genes, for monocle method.
method	The name of the sorting method to use, including autoSPIN, sWanderlust, monocle, Wanderlust, SPIN and none.
data_type	The type of the data, either linear or cyclical.
SPIN_option	The runing option of SPIN, STS or neighborhood.
SPIN_sigma_width	Sigma width for SPIN.
autoSPIN_alpha	alpha for autoSPIN.
autoSPIN_randomization	Number of randomization for autoSPIN.
wanderlust_start_cell	The id of the starting cell for wanderlust.
wanderlust_dfmap_components	The number of components from diffusionmap for wanderlust.
wanderlust_l	The number of nearest neighbors used for wanderlust.
wanderlust_num_waypoints	The number of waypoints for wanderlust.
wanderlust_waypoints_seed	The seed for reproducible analysis.
wanderlust_flock_waypoints	The bumber of flock times for wanderlust.

Value

return the order of sorting results.

Examples

```
dir <- system.file('extdata', package='uSORT')
file <- list.files(dir, pattern='.txt$', full=TRUE)
exprs <- uSORT_preProcess(exprs_file = file)
exp_trimmed <- t(exprs$exprs_log_trimed)
PCA_selected_genes <- pca_gene_selection(exp_trimmed)
exp_PCA_genes <- exp_trimmed[, PCA_selected_genes]
#order <- uSORT_sorting_wrapper(data = exp_PCA_genes, method = 'autoSPIN')
```

---

uSORT_write_results *Resluts parsing for uSORT*

Description

Save result object into a RData file. Save cell to cell distance heatmap for both preliminary and refined results. Creat plot of driver gene profiles on final ordering using heatmap.

Usage

```
uSORT_write_results(uSORT_results, project_name, result_directory)
```

Arguments

uSORT_results	Result object from uSort function, a list.
project_name	A prefix for the saving files.
result_directory	The path where to save the results.

Value

save the results.

Examples

```
dir <- system.file('extdata', package='uSORT')
file <- list.files(dir, pattern='.txt$', full=TRUE)
#remove the # symbol of the following codes to test
#uSORT_results <- uSORT(exprs_file = file,
# project_name = 'test',
# preliminary_sorting_method = 'autoSPIN',
# refine_sorting_method = 'sWanderlust',
# save_results = FALSE)
#uSORT_write_results(uSORT_results,
# project_name = 'test',
# result_directory = getwd())
```

variability_per_gene *A utility function for scattering_quantification_per_gene*

Description

A utility function for scattering_quantification_per_gene which computes the degree of scattering for single gene, whereby the value is computed by summing over the local values of smaller local windows

Usage

```
variability_per_gene(logExp = NULL, min_expr = 0.1,
  window_size_perct = 0.1, nonZeroExpr_perct = 0.1)
```

Arguments

logExp	a log-scale expression vector of a gene
min_expr	a minimum expression value
window_size_perct	a window size (in dispersion level
nonZeroExpr_perct	a minimum amount of cells (in expression, otherwise the associated window will be assigned to 0 disperson value

Value

integer

Author(s)

MaiChan Lau

wanderlust_wrapper *a wrapper of wanderlust for sWanderlust*

Description

a wrapper of wanderlust for sWanderlust

Usage

```
wanderlust_wrapper(data, s, diffusionmap_components = 4, l = 15, k = 15,
  num_graphs = 1, num_waypoints = 150, waypoints_seed = 123,
  flock_waypoints = 2)
```

Arguments

data	Input data matrix.
s	The ID of starting point.
diffusionmap_components	Number of components from diffusion map used for wanderlust analysis, default is 4.
l	Number of nearest neighbors, default is 15.
k	Number of nearest neighbors for repeating graphs, default is 15, should be less than or equal to l.
num_graphs	Number of repreated graphs.
num_waypoints	Number of waypoint used for wanderlust, default is 150.
waypoints_seed	The seed for reproducing the results.
flock_waypoints	The number of times for flocking the waypoints, default is 2.

Value

sorted order.

Author(s)

Hao Chen

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