

Package ‘scBSP’

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Title A Fast Tool for Single-Cell Spatially Variable Genes
Identifications on Large-Scale Data

Description Identifying spatially variable genes is critical in linking molecular cell functions with tissue phenotypes. This package utilizes a granularity-based dimension-agnostic tool, single-cell big-small patch (scBSP), implementing sparse matrix operation and KD tree methods for distance calculation, for the identification of spatially variable genes on large-scale data. The detailed description of this method is available at Wang, J. and Li, J. et al. 2023 (Wang, J. and Li, J. (2023), <[doi:10.1038/s41467-023-43256-5](https://doi.org/10.1038/s41467-023-43256-5)>).

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Encoding UTF-8

Imports Matrix, sparseMatrixStats, fitdistrplus, RANN, spam

Suggests knitr, rmarkdown

RoxygenNote 7.3.2

NeedsCompilation no

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Contents

CombinePvalues	2
LoadSpatial	3
scBSP	3
SpFilter	4
Index	6

`CombinePvalues`*Combine p-values across multiple samples from scBSP*

Description

Given the results from multiple samples with gene names and p-values, this function merges them by gene and computes a combined p-value for each gene. Fisher's method or Stouffer's method can be used.

Usage

```
CombinePvalues(list_of_pvalues, method = c("fisher", "stouffer"))
```

Arguments

`list_of_pvalues` A list of data.frames, each with columns: GeneNames, P_values.

`method` Combination method. One of "fisher" (default) or "stouffer".

Value

A data.frame with columns:

- GeneNames
- Number_Samples: number of datasets contributing to this gene
- Calibrated_P_values: the combined p-value

Examples

```
df1 <- data.frame(GeneNames = c("A","B","C"),  
                 P_values = c(0.01, 0.20, 0.03))  
df2 <- data.frame(GeneNames = c("A","C","D"),  
                 P_values = c(0.04, 0.10, 0.50))  
df3 <- data.frame(GeneNames = c("B","C","E"),  
                 P_values = c(0.05, 0.02, 0.80))  
  
CombinePvalues(list(df1, df2, df3), method = "fisher")
```

LoadSpatial	<i>Loading data from a Seurat object or a data frame.</i>
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Description

A function to load and filter data from a Seurat object or a data frame.

Usage

```
LoadSpatial(InputData, Dimension = 2)
```

Arguments

InputData	A Seurat spatial object or a $M \times (D + N)$ data matrix representing the D -dimensional coordinates and expressions of N genes on M spots. The coordinates should be placed at the first D columns
Dimension	The dimension of coordinates

Value

A list of two data frame:

Coords	A $M \times D$ matrix representing D -dimensional coordinates for M spots
ExpMatrix	A sparse, $N \times M$ expression matrix in dgCMatrix class with N genes and M spots

scBSP	<i>A Granularity-Based Approach to identify Spatially Variable Genes</i>
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Description

This function is designed to identify spatially variable genes through a granularity-based approach.

Usage

```
scBSP(Coords, ExpMat_Sp, D_1 = 1.0, D_2 = 3.0,
      Exp_Norm = TRUE, Coords_Norm_Method = c("Sliced", "Overall", "None"),
      K_NN = 100, treetype = "kd")
```

Arguments

Coords	A $M \times D$ matrix representing D -dimensional coordinates for M spots
ExpMat_Sp	A sparse, $N \times M$ expression matrix in dgCMatrix class with N genes and M spots
D_1	Size of the small patch
D_2	Size of the big patch
Exp_Norm	A Boolean value indicating whether the expression matrix should be normalized
Coords_Norm_Method	Normalization method for the coordinates matrix, which can be "None", "Sliced", or "Overall".
K_NN	The maximum number of nearest neighbours to compute.
treetype	Character vector specifying the standard 'kd' tree or a 'bd' (box-decomposition, AMNSW98) tree which may perform better for larger point sets.

Details

This function utilizes a $M \times D$ matrix (Coords) representing D -dimensional coordinates with M spots and a sparse, $N \times M$ expression matrix (ExpMat_Sp) with N genes and M spots.

Value

A data frame with the name of genes and corresponding p-values.

Examples

```
Coords <- expand.grid(1:100,1:100, 1:3)
RandFunc <- function(n) floor(10 * stats::rbeta(n, 1, 5))
Raw_Exp <- Matrix::rsparsematrix(nrow = 10^4, ncol = 3*10^4, density = 0.0001, rand.x = RandFunc)
Filtered_ExpMat <- SpFilter(Raw_Exp)
rownames(Filtered_ExpMat) <- paste0("Gene_", 1:nrow(Filtered_ExpMat))
P_values <- scBSP(Coords, Filtered_ExpMat)
```

SpFilter

A function for filtering low expressed genes

Description

A function for filtering low expressed genes

Usage

```
SpFilter(ExpMat_Sp, Threshold = 5)
```

Arguments

ExpMat_Sp	A sparse, N x M expression matrix in dgCMatrix class with N genes and M spots
Threshold	A threshold set to filter out genes with a total read count below this specified value

Value

A sparse expression matrix in dgCMatrix class

Examples

```
# create a sparse expression matrix
Raw_ExpMat <- Matrix::rsparsematrix(nrow = 10000, ncol = 2000,
density = 0.01, rand.x = function(n) rpois(n, 15))
Filtered_ExpMat <- SpFilter(Raw_ExpMat)
```

Index

CombinePvalues, [2](#)

LoadSpatial, [3](#)

scBSP, [3](#)

SpFilter, [4](#)