

Package ‘scBio’

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Type Package

Title Single Cell Genomics for Enhancing Cell Composition Inference
from Bulk Genomics Data

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Author Amit Frishberg [aut, cre], Naama Peshes-Yaloz [aut], Irit Gat-Viks [aut]

Maintainer Amit Frishberg <amfrishberg@gmail.com>

URL <https://github.com/amitfrish/scBio>

BugReports <https://github.com/amitfrish/scBio/issues>

Description Cellular population mapping (CPM) a deconvolution algorithm in which single-cell genomics is required in only one or a few samples, where in other samples of the same tissue, only bulk genomics is measured and the underlying fine resolution cellular heterogeneity is inferred.

License GPL-2

Encoding UTF-8

LazyData true

RoxygenNote 7.0.2

biocViews limma

Depends R (>= 2.10)

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BulkFlu	<i>Gene expression profiles of flu and pbs sample.</i>
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Description

A dataset containing the RNA-seq profiles of collaborative-cross (CC) mice 2 days after the infection with either the flu virus or PBS.

Usage

```
BulkFlu
```

Format

A matrix with 1858 rows (genes) and 74 columns (samples).

CPM	<i>The Cellular Population Mapping (CPM) algorithm.</i>
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Description

This function initiates the Cellular Population Mapping (CPM) algorithm - a deconvolution algorithm in which single-cell genomics is required in only one or a few samples, where in other samples of the same tissue, only bulk genomics is measured and the underlying fine resolution cellular heterogeneity is inferred. CPM predicts the abundance of cells (and cell types) ranging monotonically from negative to positive levels. Using a relative framework these values correspond to decrease and increase in cell abundance levels, respectively. On the other hand, in an absolute framework lower values (including negatives) correspond to lower abundances and vice versa. These values are comparable between samples.

Usage

```
CPM(  
  SCData,  
  SCLabels,  
  BulkData,  
  cellSpace,  
  no_cores = NULL,  
  neighborhoodSize = 10,  
  modelSize = 50,  
  minSelection = 5,  
  quantifyTypes = F,  
  typeTransformation = F,  
  calculateCI = F  
)
```

Arguments

SCData	A matrix containing the single-cell RNA-seq data. Each row corresponds to a certain gene and each column to a certain cell. Importantly, CPM relies on many iterative processes and therefore might take a long running time. For extremely large single cell datasets, we suggest to use only a portion of the data, using random sampling of the cells.
SCLabels	A vector containing the labels of each of the cells.
BulkData	A matrix containing heterogenous RNA-seq data for one or more samples. Each row corresponds to a certain gene and each column to a certain sample.
cellSpace	The cell state space corresponding to the single-cell RNA-seq data. It can be a vector for a 1-dim space or a 2D matrix for a two space where each column represents a different dimension. The cell space should incorporate the similarities of cells within cell types. Similarities between cells from different cell types, based on the cell space, are not taken into account in CPM.
no_cores	A number for the amount of cores which will be used for the analysis. The default (NULL) is total number of cores minus 1.
neighborhoodSize	Cell neighborhood size which will be used for the analysis. This should be lower than the number of cells in the smallest cell type. The default is 10.
modelSize	The reference subset size in each iteration of CPM. This should be lower than the total number of cells. The default is 50.
minSelection	The minimum number of times in which each reference cell is selected. Increasing this value might have a large effect on the algorithm's running time. The default is 5.
quantifyTypes	A boolean parameter indicating whether the prediction of cell type quantities is needed. This is recommended only in the case of homogeneity within cell types. Cell types with high inner cellular variability will receive less reliable values. The default is FALSE.
typeTransformation	This parameter will have an effect only if <code>quantifyTypes = TRUE</code> . A boolean parameter indicating whether cell type deconvolution should be provided in fractions. This is done by subtracting all cell types by values of the minimal cell type and dividing in their sum. This is not recommended, since it reduces the comparability between sample. The default is FALSE.
calculateCI	A boolean parameter indicating whether the calculation of confidence intervals is needed. The default is FALSE.

Value

A list including:

predicted	CPM predicted cell abundance matrix. Each row represents a sample and each column a single cell.
cellTypePredictions	CPM predicted cell-type abundance matrix. Each row represents a sample and each column a single cell-type. This is calculated if <code>quantifyTypes = TRUE</code> .

`confIntervals` A matrix containing the confidence interval for each cell and sample. Each row represents a sample and each column a single cell. This is calculated if `calculateCI = TRUE`.

`numOfRuns` The number of deconvolution repeats performed by CPM.

References

Frishberg, A., Peshes-Yaloz, N., Cohn, O., Rosentul, D., Steuerman, Y., Valadarsky, L., Yankovitz, G., Mandelboim, M., Iraqi, F.A., Amit, I. et al. (2019) Cell composition analysis of bulk genomics using single-cell data. *Nature Methods*, 16, 327-332.

Examples

```
data(SCLabels)
data(SCFlu)
data(BulkFlu)
data(SCCellSpace)

# Creating relative bulk data (Influenza infection compared to PBS):
BulkFluReduced = BulkFlu - rowMeans(BulkFlu[,grep("pbs",colnames(BulkFlu))])
BulkFluReduced = BulkFluReduced[,grep("flu",colnames(BulkFluReduced))]

# Running CPM using only a single cell-type:
oneCellTypeIndexes = which(SCLabels == "MPS")
res = CPM(SCData = SCFlu[,oneCellTypeIndexes], SCLabels = SCLabels[oneCellTypeIndexes],
          BulkData = BulkFluReduced, cellSpace = SCCellSpace[oneCellTypeIndexes,], no_cores = 2)

## Not run:

# Running CPM using a variety of cell-types:
res = CPM(SCFlu, SCLabels, BulkFluReduced, SCCellSpace, no_cores = 2)
### Full multi-threading : CPM(SCFlu, SCLabels, BulkFluReduced, SCCellSpace)

## End(Not run)
```

SCCellSpace *Single-cell cell space.*

Description

A dataset containing a 2-dim cell space of all single-cells in the SCFlu dataset.

Usage

```
SCCellSpace
```

Format

A matrix with 349 rows (cells) and 2 columns (dimensions).

SCFlu	<i>Gene expression profiles of lung cells after influenza infection.</i>
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Description

A dataset containing the RNA-seq profiles of lung cells from multiple cell types, taken from two mice 2 days after the infection with either the flu virus or PBS.

Usage

SCFlu

Format

A matrix with 1858 rows (genes) and 349 columns (cells).

SCLabels	<i>Single-cell classification into cell types.</i>
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Description

A dataset containing the classification of each cell in the SCFlu dataset to a specific cell type.

Usage

SCLabels

Format

A vector with 349 values.

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