

# Package ‘netSmooth’

November 28, 2021

**Type** Package

**Title** Network smoothing for scRNAseq

**Version** 1.14.0

**Description** netSmooth is an R package for network smoothing of single cell RNA sequencing data. Using bio networks such as protein-protein interactions as priors for gene co-expression, netsmooth improves cell type identification from noisy, sparse scRNAseq data.

**biocViews** Network, GraphAndNetwork, SingleCell, RNASeq, GeneExpression, Sequencing, Transcriptomics, Normalization, Preprocessing, Clustering, DimensionReduction

**URL** <https://github.com/BIMSBbioinfo/netSmooth>

**BugReports** <https://github.com/BIMSBbioinfo/netSmooth/issues>

**License** GPL-3

**Encoding** UTF-8

**LazyData** true

**Depends** R (>= 3.5), scater (>= 1.15.11), clusterExperiment (>= 2.1.6)

**Imports** entropy, SummarizedExperiment, SingleCellExperiment, Matrix, cluster, data.table, stats, methods, DelayedArray, HDF5Array (>= 1.15.13)

**Suggests** knitr, testthat, Rtsne, biomaRt, igraph, STRINGdb, NMI, pheatmap, ggplot2, BiocStyle, rmarkdown, BiocParallel, uwot

**VignetteBuilder** knitr

**RoxygenNote** 7.0.2

**git\_url** <https://git.bioconductor.org/packages/netSmooth>

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human.ppi	<i>Human Protein-Protein interaction graph</i>
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**Description**

An adjacency matrix of the 10 percent highest confidence interactions between human proteins on STRINGdb.

**Usage**

```
human.ppi
```

**Format**

A square matrix where  $A_{ij}=1$  if gene  $i$  interacts with gene  $j$

**Details**

See the script in ‘system.file(package="netSmooth", "data-raw", "make\_ppi\_from\_string.R)” for full details of how this object was made.

**Source**

<http://www.string-db.org/>

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`mouse.ppi`*Mouse Protein-Protein interaction graph*

---

**Description**

An adjacency matrix of the 10 percent highest confidence interactions between mouse proteins on STRINGdb.

**Usage**`mouse.ppi`**Format**

A square matrix where  $A_{ij}=1$  if gene  $i$  interacts with gene  $j$

**Details**

See the script in `'system.file(package="netSmooth", "data-raw", "make_ppi_from_string.R")'` for full details of how this object was made.

**Source**

<http://www.string-db.org/>

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`netSmooth,matrix-method`*Perform network smoothing of gene expression or other omics data*

---

**Description**

Perform network smoothing of gene expression or other omics data

**Usage**

```
## S4 method for signature 'matrix'
netSmooth(
  x,
  adjMatrix,
  alpha = "auto",
  normalizeAdjMatrix = c("rows", "columns"),
  autoAlphaMethod = c("robustness", "entropy"),
  autoAlphaRange = 0.1 * (seq_len(9)),
  autoAlphaDimReduceFlavor = "auto",
  is.counts = TRUE,
  bpparam = BiocParallel::SerialParam(),
```

```

    ...
)

## S4 method for signature 'SummarizedExperiment'
netSmooth(x, ...)

## S4 method for signature 'SingleCellExperiment'
netSmooth(x, ...)

## S4 method for signature 'Matrix'
netSmooth(
  x,
  adjMatrix,
  alpha = "auto",
  normalizeAdjMatrix = c("rows", "columns"),
  autoAlphaMethod = c("robustness", "entropy"),
  autoAlphaRange = 0.1 * (seq_len(9)),
  autoAlphaDimReduceFlavor = "auto",
  is.counts = TRUE,
  bpparam = BiocParallel::SerialParam(),
  ...
)

## S4 method for signature 'DelayedMatrix'
netSmooth(
  x,
  adjMatrix,
  alpha = "auto",
  normalizeAdjMatrix = c("rows", "columns"),
  autoAlphaMethod = c("robustness", "entropy"),
  autoAlphaRange = 0.1 * (seq_len(9)),
  autoAlphaDimReduceFlavor = "auto",
  is.counts = TRUE,
  bpparam = BiocParallel::SerialParam(),
  filepath = NULL,
  ...
)

```

### Arguments

<code>x</code>	matrix or <code>SummarizedExperiment</code>
<code>adjMatrix</code>	adjacency matrix of gene network to use
<code>alpha</code>	numeric in $[0,1]$ or 'auto'. if 'auto', the optimal value for alpha will be automatically chosen among the values specified in 'autoAlphaRange', using the strategy specified in 'autoAlphaMethod'
<code>normalizeAdjMatrix</code>	how to normalize the adjacency matrix possible values are 'rows' (in-degree) and 'columns' (out-degree)

autoAlphaMethod	if 'robustness', pick alpha that gives the highest proportion of samples in robust clusters if 'entropy', pick alpha that gives highest Shannon entropy in 2D PCA embedding
autoAlphaRange	if 'alpha='optimal'', search these values for the best alpha
autoAlphaDimReduceFlavor	algorithm for dimensionality reduction that will be used to pick the optimal value for alpha. Either the 2D embedding to calculate the Shannon entropy for (if 'autoAlphaMethod='entropy''), or the dimensionality reduction algorithm to be used in robust clustering (if 'autoAlphamethod='robustness'')
is.counts	logical: is the assay count data
bpparam	instance of bpparam, for parallel computation with the 'alpha='auto'' option. See the BiocParallel manual.
...	arguments passed on to 'robustClusters' if using the robustness criterion for optimizing alpha
filepath	String: Path to location where hdf5 output file is supposed to be saved. Will be ignored when regular matrices or SummarizedExperiment are used as input.

**Value**

network-smoothed gene expression matrix or SummarizedExperiment object

**Examples**

```
x <- matrix(rnbinom(12000, size=1, prob = .1), ncol=60)
rownames(x) <- paste0('gene', seq_len(dim(x)[1]))

adj_matrix <- matrix(as.numeric(rnorm(200*200)>.8), ncol=200)
rownames(adj_matrix) <- colnames(adj_matrix) <- paste0('gene', seq_len(dim(x)[1]))
x.smoothed <- netSmooth(x, adj_matrix, alpha=0.5)
```

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pickDimReduction,matrix-method

*Pick the dimensionality reduction method for a dataset that gives the 2D embedding with the highest entropy*

---

**Description**

Pick the dimensionality reduction method for a dataset that gives the 2D embedding with the highest entropy

**Usage**

```
## S4 method for signature 'matrix'
pickDimReduction(x, flavors = c("pca", "tsne", "umap"), is.counts = TRUE)

## S4 method for signature 'SummarizedExperiment'
pickDimReduction(x)

## S4 method for signature 'Matrix'
pickDimReduction(x, flavors = c("pca", "tsne", "umap"), is.counts = TRUE)

## S4 method for signature 'DelayedMatrix'
pickDimReduction(x, flavors = c("pca", "tsne", "umap"), is.counts = TRUE)
```

**Arguments**

x	matrix or SummarizedExperiment object [GENES x SAMPLES]
flavors	list of dimensionality reduction algorithms to try. Currently the options are "pca", "tsne" and "umap"
is.counts	logical: is exprs count data

**Value**

name of dimensionality reduction method that gives the highest 2d entropy

**Examples**

```
x <- matrix(rnbinom(60000, size=1, prob = .1), ncol=100)
pickDimReduction(x)
```

---

robustClusters, SummarizedExperiment-method

*Perform robust clustering on dataset, and calculate the proportion of samples in robust clusters*

---

**Description**

Perform robust clustering on dataset, and calculate the proportion of samples in robust clusters

**Usage**

```
## S4 method for signature 'SummarizedExperiment'
robustClusters(x, dimReduceFlavor = "auto", is.counts = TRUE, ...)

## S4 method for signature 'matrix'
robustClusters(x, ...)
```

**Arguments**

`x` matrix or SummarizedExperiment object

`dimReduceFlavor` algorithm for dimensionality reduction step of clustering procedure. May be 'pca', 'tsne', 'dm', 'umap' or 'auto', which uses shannon entropy to pick the algorithm.

`is.counts` logical: is the data counts

`...` arguments passed on to 'clusterExperimentWorkflow'

**Value**

list(clusters, proportion.robust)

**Examples**

```
data("smallscRNAseq")
robustClusters(smallscRNAseq, dimReduceFlavor='pca')
```

---

smallPPI *A small human Protein-Protein interaction graph for use in examples.*

---

**Description**

Contains a synthetic PPI of human genes.

**Usage**

```
smallPPI
```

**Format**

An object of class `matrix` with 611 rows and 611 columns.

---

smallscRNAseq *A small single cell RNA-seq dataset for use in examples.*

---

**Description**

Contains scRNAseq profiles of human blastomeres.

**Usage**

```
smallscRNAseq
```

**Format**

SingleCellExperiment

**Source**

<https://www.ncbi.nlm.nih.gov/geo/query/acc.cgi?acc=GSE44183>



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