Package 'SpatialCPie'

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Title Cluster analysis of Spatial Transcriptomics data

Version 1.28.0

Description SpatialCPie is an R package designed to facilitate cluster evaluation for spatial transcriptomics data by providing intuitive visualizations that display the relationships between clusters in order to guide the user during cluster identification and other downstream applications.
The package is built around a shiny ``gadget'' to allow the exploration of the data with multiple plots in parallel and an interactive UI. The user can easily toggle between different cluster resolutions in order to choose the most appropriate visual cues.

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`SpatialCPie-package` *SpatialCPie: Cluster analysis of Spatial Transcriptomics data*

Description

SpatialCPie is an R package designed to facilitate cluster evaluation for spatial transcriptomics data by providing intuitive visualizations that display the relationships between clusters in order to guide the user during cluster identification and other downstream applications. The package is built around a shiny "gadget" to allow the exploration of the data with multiple plots in parallel and an interactive UI. The user can easily toggle between different cluster resolutions in order to choose the most appropriate visual cues.

Author(s)

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.arrayPlot *Array pie plot*

Description

Array pie plot

Usage

```
.arrayPlot(scores, coordinates, counts = NULL, image = NULL,
  scoreMultiplier = 1, spotScale = 1, spotOpacity = 1,
  numTopGenes = 5)
```

Arguments

scores	data.frame with cluster scores for each spot containing the columns "spot", "name", and "score".
coordinates	data.frame with rownames matching those in scores and columns "x" and "y" specifying the plotting position of each observation.
image	a grid.grob to use as background to the plots.
scoreMultiplier	log multiplication factor applied to the score vector.
spotScale	pie chart size.
spotOpacity	pie chart opacity.

Value

ggplot object of the pie plot.

.clusterGraph *Cluster graph*

Description

Cluster graph

Usage

```
.clusterGraph(assignments, clusterMeans, featureName,
  transitionProportions = "To", transitionLabels = FALSE,
  transitionThreshold = 0, numTopFeatures = 10)
```

Arguments

assignments	data.frame with columns "name", "resolution", and "cluster".
clusterMeans	data.frame with columns "name", "resolution", "cluster", featureName, and "mean".
featureName	character with the name of the clustered feature.
transitionProportions	how to compute the transition proportions. Possible values are: • "From": based on the total number of assignments in the lower-resolution cluster • "To": based on the total number of assignments in the higher-resolution cluster
transitionLabels	logical specifying whether to show edge labels.
transitionThreshold	hide edges with transition proportions below this threshold.
numTopFeatures	integer specifying the number of features to show in the hover tooltips.

Value

ggplot object of the cluster graph.

.computeClusterColors *Compute cluster colors*

Description

Computes colors so that dissimilar clusters are far away in color space.

Usage

```
.computeClusterColors(clusterMeans)
```

Arguments

clusterMeans	matrix of size (n, K) representing the n feature means for each of the K clusters.

Value

vector of cluster colors.

.likeness *Likeness score*

Description

Likeness score

Usage

```
.likeness(d, c = 1)
```

Arguments

d	distance vector.
c	log multiplier.

Value

vector of scores.

.logsumexp *Logsumexp*

Description

Adapted from https://stat.ethz.ch/pipermail/r-help/2011-February/269205.html

Usage

```
.logsumexp(xs)
```

Arguments

xs	input vector

Value

log of summed exponentials

.makeApp *SpatialCPie App*

Description

SpatialCPie App

Usage

```
.makeApp(image, ...)
```

Arguments

image	background image.
...	arguments passed to .preprocessData.

Value

SpatialCPie shinyApp object.

.makeServer *SpatialCPie server*

Description

SpatialCPie server

Usage

```
.makeServer(assignments, clusterMeans, counts, scores, colors, image,
  coordinates, featureName)
```

Arguments

assignments	data.frame with cluster assignments containing the columns "unit" (name of the observational unit; either a gene name or a spot name), "resolution", "cluster", and "name" (a unique identifier of the (resolution, cluster) pair).
clusterMeans	data.frame with columns "name", "resolution", "cluster", featureName, and "mean".
scores	data.frame with cluster scores for each spot in each resolution containing the columns "spot", "resolution", "cluster", "name", and "score".
colors	vector of colors for each cluster. Names should match the "name" columns of the assignments and scores.
image	background image for the array plots, passed to grid.raster.
coordinates	data.frame with rownames matching the names in scores and columns "x" and "y" specifying the plotting position of each observation.
featureName	character with the name of the clustered feature.

Value

server function, to be passed to shinyApp.

.makeUI *SpatialCPie UI*

Description

SpatialCPie UI

Usage

```
.makeUI()
```

Value

SpatialCPie UI, to be passed to shinyApp.

.maximizeOverlap *Maximize overlap*

Description

Maximize overlap

Usage

```
.maximizeOverlap(xss)
```

Arguments

xss	list of lists of labels.

Value

xss, relabeled so as to maximize the overlap between labels in consecutive label lists.

`.preprocessData` *Preprocess data*

Description

Preprocesses input data for `.makeServer`.

Usage

```
.preprocessData(counts, margin, resolutions, assignmentFunction,
  coordinates = NULL)
```

Arguments

`counts`	count matrix. `rownames` should correspond to genes and `colnames` should correspond to spot coordinates.
`margin`	which margin of the count matrix to cluster. Valid values are `c("spot", "sample", "gene", "feature")`.
`resolutions`	vector of resolutions to cluster.
`assignmentFunction`	function to compute cluster assignments. The function should have the following signature: integer (number of clusters) -> (m, n) feature matrix -> m-length vector (cluster assignment of each data point).
`coordinates`	optional `data.frame` with pixel coordinates for each spot. `rownames` should correspond to the `colnames` of `counts` and the columns `x` and `y` should specify the pixel coordinates of the spots.

Value

list with the following elements:

- `$assignments`: tidy assignments
- `$means`: cluster means
- `$scores`: cluster scores for each spot in each resolution
- `$colors`: cluster colors
- `$coordinates`: spot coordinates, either from `coordinates` or parsed from `assignments`
- `$featureName`: name of the clustered feature (the "opposite" of `margin`)

.SVGBarplot *SVG barplot*

Description

SVG barplot

Usage

```
.SVGBarplot(xs)
```

Arguments

xs	named vector with observations

Value

character SVG barplot

.tidyAssignments *Tidy assignments*

Description

Tidy assignments

Usage

```
.tidyAssignments(assignments)
```

Arguments

assignments	list of assignment vectors.

Value

a data.frame containing the assignments, with the data relabeled so that the overlap between consecutive assignment vectors is maximized. Additionally, a "root" resolution is added.

.zscore *Z-score*

Description

Z-score

Usage

```
.zscore(xs)
```

Arguments

xs	vector of observations

Value

xs, z-normalized. if all elements of xs are equal, a vector of zeros will be returned instead.

parseSpotFile *Parse spot detector output*

Description

Parses the output from the ST spot detector tool for use with SpatialCPie.

Usage

```
parseSpotFile(file)
```

Arguments

file	spot file

Value

data.frame with columns "x" and "y" specifying the pixel coordinates of each spot

Examples

```
## Create spot file
data <- rbind(
    c(7, 18, 7.00, 18.07, 563.2, 947.0),
    c(8, 11, 8.00, 11.04, 612.5, 627.7)
)
filename <- tempfile()
write.table(
    data,
    file = filename,
    sep = "\t",
    quote = FALSE,
    col.names = c("x", "y", "new_x", "new_y", "pixel_x", "pixel_y")
)

## Parse spot file
parseSpotFile(filename)

## Delete spot file
unlink(filename)
```

`runCPie` *Run SpatialCPie*

Description

Runs the SpatialCPie gadget.

Usage

```
runCPie(counts, image = NULL, spotCoordinates = NULL,
  margin = "spot", resolutions = 2:4,
  assignmentFunction = function(k, x) kmeans(x, centers = k)$cluster,
  view = NULL)
```

Arguments

`counts`	gene count matrix or a `SummarizedExperiment-class` object containing count values.
`image`	image to be used as background to the plot.
`spotCoordinates`	`data.frame` with pixel coordinates. The rows should correspond to the columns (spatial areas) in the count file.
`margin`	which margin to cluster.
`resolutions`	`numeric` vector specifying the clustering resolutions.
`assignmentFunction`	function to compute cluster assignments.
`view`	`viewer` object.

Value

a list with the following items:

- "clusters": Cluster assignments (may differ from assignments)
- "clusterGraph": The cluster tree ggplot object
- "arrayPlot": The pie plot ggplot objects

Examples

```
if (interactive()) {
    options(device.ask.default = FALSE)

    ## Set up coordinate system
    coordinates <- as.matrix(expand.grid(1:10, 1:10))

    ## Generate data set with three distinct genes generated by three
    ## distinct cell types
    profiles <- diag(rep(1, 3)) + runif(9)
    centers <- cbind(c(5, 2), c(2, 8), c(8, 2))
    mixes <- apply(coordinates, 1, function(x) {
        x <- exp(-colSums((centers - x) ^ 2) / 50)
        x / sum(x)
    })
    means <- 100 * profiles %*% mixes
    counts <- matrix(rpois(prod(dim(means)), means), nrow = nrow(profiles))
    colnames(counts) <- apply(
        coordinates,
        1,
        function(x) do.call(paste, c(as.list(x), list(sep = "x")))
    )
    rownames(counts) <- paste("gene", 1:nrow(counts))

    ## Run SpatialCPie
    runCPie(counts)
}
```

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