

# Package ‘Giotto’

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**Title** Spatial single-cell transcriptomics toolbox.

**Version** 0.3.5

**Description** Toolbox to process, analyze and visualize spatial single-cell expression data.

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**Encoding** UTF-8

**LazyData** true

**URL** <https://rubd.github.io/Giotto/>, <https://github.com/RubD/Giotto>

**BugReports** <https://github.com/RubD/Giotto/issues>

**RoxygenNote** 7.1.0

**Depends** data.table (>= 1.12.2),  
ggplot2 (>= 3.1.1),  
base (>= 3.5.1),  
utils (>= 3.5.1),  
R (>= 3.5.1)

**Imports** Matrix,  
magick,  
matrixStats (>= 0.55.0),  
uwot (>= 0.0.0.9010),  
cowplot (>= 0.9.4),  
grDevices,  
RColorBrewer (>= 1.1-2),  
dbscan (>= 1.1-3),  
ggalluvial (>= 0.9.1),  
scales (>= 1.0.0),  
ComplexHeatmap (>= 1.20.0),  
qvalue (>= 2.14.1),  
lfa (>= 1.12.0),  
igraph (>= 1.2.4.1),  
irlba,  
plotly,  
reticulate (>= 1.14),  
magrittr,  
limma,  
ggdendro,  
smfishHmrf,  
devtools,

reshape2,  
 ggraph,  
 Rcpp,  
 Rfast,  
 Rtsne ( $\geq 0.15$ ),  
 rlang ( $\geq 0.4.3$ ),  
 R.utils,  
 fitdistrplus,  
 deldir

**Suggests** knitr,  
 rmarkdown,  
 MAST,  
 scan ( $\geq 1.10.1$ ),  
 png,  
 FactoMineR,  
 tiff,  
 biomaRt,  
 trendsceek,  
 multinet ( $\geq 3.0.2$ ),  
 RTriangle ( $\geq 1.6-0.10$ )

**biocViews**

**VignetteBuilder** knitr

**LinkingTo** Rcpp,  
 RcppArmadillo

**Remotes** lambdamoses/smfishhmr-r

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---

|                    |                           |
|--------------------|---------------------------|
| adapt_aspect_ratio | <i>adapt_aspect_ratio</i> |
|--------------------|---------------------------|

---

**Description**

adapt the aspect ratio after inserting cross section mesh grid lines

**Usage**

```
adapt_aspect_ratio(  
  current_ratio,  
  cell_locations,  
  sdimx = NULL,  
  sdimy = NULL,  
  sdimz = NULL,  
  mesh_obj = NULL  
)
```

---

|                    |                           |
|--------------------|---------------------------|
| addCellIntMetadata | <i>addCellIntMetadata</i> |
|--------------------|---------------------------|

---

**Description**

Creates an additional metadata column with information about interacting and non-interacting cell types of the selected cell-cell interaction.

**Usage**

```
addCellIntMetadata(  
  gobject,  
  spatial_network = "spatial_network",  
  cluster_column,  
  cell_interaction,  
  name = "select_int",  
  return_gobject = TRUE  
)
```

**Arguments**

|                               |                                  |
|-------------------------------|----------------------------------|
| <code>gobject</code>          | giotto object                    |
| <code>spatial_network</code>  | name of spatial network to use   |
| <code>cluster_column</code>   | column of cell types             |
| <code>cell_interaction</code> | cell-cell interaction to use     |
| <code>name</code>             | name for the new metadata column |
| <code>return_gobject</code>   | return an updated giotto object  |

**Details**

This function will create an additional metadata column which selects interacting cell types for a specific cell-cell interaction. For example, if you want to color interacting astrocytes and oligodendrocytes it will create a new metadata column with the values "select\_astrocytes", "select\_oligodendrocytes", "other\_astrocytes", "other\_oligodendrocytes" and "other". Where "other" is all other cell types found within the selected cell type column.

**Value**

Giotto object

**Examples**

```
addCellIntMetadata(gobject)
```

---

|                              |                        |
|------------------------------|------------------------|
| <code>addCellMetadata</code> | <i>addCellMetadata</i> |
|------------------------------|------------------------|

---

**Description**

adds cell metadata to the giotto object

**Usage**

```
addCellMetadata(
  gobject,
  new_metadata,
  vector_name = NULL,
  by_column = FALSE,
  column_cell_ID = NULL
)
```

**Arguments**

|                             |   |
|-----------------------------|---|
| <code>gobject</code>        | giotto object   |
| <code>new_metadata</code>   | new cell metadata to use (data.table, data.frame, ...)              |
| <code>vector_name</code>    | (optional) custom name if you provide a single vector               |
| <code>by_column</code>      | merge metadata based on cell_ID column in pDataDT (default = FALSE) |
| <code>column_cell_ID</code> | column name of new metadata to use if by_ID = TRUE                  |

## Details

You can add additional cell metadata in two manners:

- 1. Provide a data.table or data.frame with cell annotations in the same order as the cell\_ID column in pDataDT(gobject)
- 2. Provide a data.table or data.frame with cell annotations and specify which column contains the cell IDs, these cell IDs need to match with the cell\_ID column in pDataDT(gobject)

## Value

giotto object

## Examples

```
addCellMetadata(gobject)
```

---

|                   |                          |
|-------------------|--------------------------|
| addCellStatistics | <i>addCellStatistics</i> |
|-------------------|--------------------------|

---

## Description

adds cells statistics to the giotto object

## Usage

```
addCellStatistics(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  detection_threshold = 0,
  return_gobject = TRUE
)
```

## Arguments

```
gobject          giotto object
expression_values expression values to use
detection_threshold detection threshold to consider a gene detected
return_gobject   boolean: return giotto object (default = TRUE)
```

## Details

This function will add the following statistics to cell metadata:

- nr\_genes: Denotes in how many genes are detected per cell
- perc\_genes: Denotes what percentage of genes is detected per cell
- total\_expr: Shows the total sum of gene expression per cell

**Value**

giotto object if return\_gobject = TRUE

**Examples**

```
addCellStatistics(gobject)
```

---

|                 |                        |
|-----------------|------------------------|
| addGeneMetadata | <i>addGeneMetadata</i> |
|-----------------|------------------------|

---

**Description**

adds gene metadata to the giotto object

**Usage**

```
addGeneMetadata(gobject, new_metadata, by_column = F, column_gene_ID = NULL)
```

**Arguments**

|                |  |
|----------------|--|
| gobject        | giotto object  |
| new_metadata   | new metadata to use                                    |
| by_column      | merge metadata based on gene_ID column in fDataDT      |
| column_cell_ID | column name of new metadata to use if by_column = TRUE |

**Details**

You can add additional gene metadata in two manners: 1. Provide a data.table or data.frame with gene annotations in the same order as the gene\_ID column in fDataDT(gobject) 2. Provide a data.table or data.frame with gene annotations and specify which column contains the gene IDs, these gene IDs need to match with the gene\_ID column in fDataDT(gobject)

**Value**

giotto object

**Examples**

```
addGeneMetadata(gobject)
```

---

|              |                     |
|--------------|---------------------|
| addGenesPerc | <i>addGenesPerc</i> |
|--------------|---------------------|

---

**Description**

calculates the total percentage of (normalized) counts for a subset of selected genes

**Usage**

```
addGenesPerc(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  genes = NULL,
  vector_name = "gene_perc",
  return_gobject = TRUE
)
```

**Arguments**

|                   |  |
|-------------------|--|
| gobject           | giotto object                                  |
| expression_values | expression values to use                       |
| genes             | vector of selected genes                       |
| vector_name       | column name as seen in pDataDT()               |
| return_gobject    | boolean: return giotto object (default = TRUE) |

**Value**

giotto object if return\_gobject = TRUE, else a vector with

**Examples**

```
addGenesPerc(gobject)
```

---

|                   |                          |
|-------------------|--------------------------|
| addGeneStatistics | <i>addGeneStatistics</i> |
|-------------------|--------------------------|

---

**Description**

adds gene statistics to the giotto object

**Usage**

```
addGeneStatistics(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  detection_threshold = 0,
  return_gobject = TRUE
)
```

**Arguments**

`gobject`                giotto object  
`expression_values`        expression values to use  
`detection_threshold`      detection threshold to consider a gene detected  
`return_gobject`    boolean: return giotto object (default = TRUE)

**Details**

This function will add the following statistics to gene metadata:

- `nr_cells`: Denotes in how many cells the gene is detected
- `per_cells`: Denotes in what percentage of cells the gene is detected
- `total_expr`: Shows the total sum of gene expression in all cells
- `mean_expr`: Average gene expression in all cells
- `mean_expr_det`: Average gene expression in cells with detectable levels of the gene

**Value**

giotto object if `return_gobject = TRUE`

**Examples**

```
addGeneStatistics(gobject)
```

---

`addGiottoImage`
`addGiottoImage`


---

**Description**

Adds giotto image objects to your giotto object

**Usage**

```
addGiottoImage(gobject, images)
```

**Arguments**

`gobject`                giotto object  
`images`                list of giotto image objects, see [createGiottoImage](#)

**Value**

an updated Giotto object with access to the list of images

**Examples**

```
addGiottoImage(mg_object)
```

---

|                          |                                 |
|--------------------------|---------------------------------|
| addGiottoImageToSpatPlot | <i>addGiottoImageToSpatPlot</i> |
|--------------------------|---------------------------------|

---

**Description**

Add a giotto image to a spatial ggplot object post creation

**Usage**

```
addGiottoImageToSpatPlot(spatpl = NULL, gimage = NULL)
```

**Arguments**

- spatpl            a spatial ggplot object
- gimage           a giotto image, see [createGiottoImage](#)

**Value**

an updated spatial ggplot object

**Examples**

```
addGiottoImageToSpatPlot(mg_object)
```

---

|         |                |
|---------|----------------|
| addHMRF | <i>addHMRF</i> |
|---------|----------------|

---

**Description**

Add selected results from doHMRF to the giotto object

**Usage**

```
addHMRF(gobject, HMRFoutput, k = NULL, betas_to_add = NULL, hmrf_name = NULL)
```

**Arguments**

- gobject            giotto object
- HMRFoutput        HMRF output from doHMRF()
- k                  number of domains
- betas\_to\_add      results from different betas that you want to add
- name              specify a custom name

**Details**

Description ...

**Value**

giotto object

**Examples**

```
addHMRf(gobject)
```

---

|                  |                         |
|------------------|-------------------------|
| addNetworkLayout | <i>addNetworkLayout</i> |
|------------------|-------------------------|

---

**Description**

Add a network layout for a selected nearest neighbor network

**Usage**

```
addNetworkLayout(
  gobject,
  nn_network_to_use = "sNN",
  network_name = "sNN.pca",
  layout_type = c("drl"),
  options_list = NULL,
  layout_name = "layout",
  return_gobject = TRUE
)
```

**Arguments**

|                   |  |
|-------------------|--|
| gobject           | giotto object                                  |
| nn_network_to_use | kNN or sNN                                     |
| network_name      | name of NN network to be used                  |
| layout_type       | layout algorithm to use                        |
| options_list      | list of options for selected layout            |
| layout_name       | name for layout                                |
| return_gobject    | boolean: return giotto object (default = TRUE) |

**Details**

This function creates layout coordinates based on the provided kNN or sNN. Currently only the force-directed graph layout "drl", see [layout\\_with\\_drl](#), is implemented. This provides an alternative to tSNE or UMAP based visualizations.

**Value**

giotto object with updated layout for selected NN network

**Examples**

```
addNetworkLayout(gobject)
```



---

|               |                      |
|---------------|----------------------|
| addStatistics | <i>addStatistics</i> |
|---------------|----------------------|

---

## Description

adds genes and cells statistics to the giotto object

## Usage

```
addStatistics(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  detection_threshold = 0,
  return_gobject = TRUE
)
```

## Arguments

`gobject`                giotto object

`expression_values`                expression values to use

`detection_threshold`                detection threshold to consider a gene detected

`return_gobject`    boolean: return giotto object (default = TRUE)

## Details

See [addGeneStatistics](#) and [addCellStatistics](#)

## Value

giotto object if `return_gobject = TRUE`, else a list with results

## Examples

```
addStatistics(gobject)
```

---

|                    |                           |
|--------------------|---------------------------|
| adjustGiottoMatrix | <i>adjustGiottoMatrix</i> |
|--------------------|---------------------------|

---

## Description

normalize and/or scale expresion values of Giotto object

**Usage**

```
adjustGiottoMatrix(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  batch_columns = NULL,
  covariate_columns = NULL,
  return_gobject = TRUE,
  update_slot = c("custom")
)
```

**Arguments**

|                                |   |
|--------------------------------|---|
| <code>gobject</code>           | giotto object   |
| <code>expression_values</code> | expression values to use                                  |
| <code>batch_columns</code>     | metadata columns that represent different batch (max = 2) |
| <code>covariate_columns</code> | metadata columns that represent covariates to regress out |
| <code>return_gobject</code>    | boolean: return giotto object (default = TRUE)            |
| <code>update_slot</code>       | expression slot that will be updated (default = custom)   |

**Details**

This function implements the [limma::removeBatchEffect](#) function to remove known batch effects and to adjust expression values according to provided covariates.

**Value**

giotto object

**Examples**

```
adjustGiottoMatrix(gobject)
```

---

aes\_string2

*aes\_string2*

---

**Description**

makes sure aes\_string can also be used with names that start with numeric values

**Usage**

```
aes_string2(...)
```

---

```
all_plots_save_function
    all_plots_save_function
```

---

## Description

Function to automatically save plots to directory of interest

## Usage

```
all_plots_save_function(
  gobject,
  plot_object,
  save_dir = NULL,
  save_folder = NULL,
  save_name = NULL,
  default_save_name = "giotto_plot",
  save_format = NULL,
  show_saved_plot = F,
  ncol = 1,
  nrow = 1,
  scale = 1,
  base_width = NULL,
  base_height = NULL,
  base_aspect_ratio = NULL,
  units = NULL,
  dpi = NULL,
  limitsize = TRUE,
  ...
)
```

## Arguments

|                   |                                   |
|-------------------|-----------------------------------|
| gobject           | giotto object                     |
| plot_object       | object to plot                    |
| save_dir          | directory to save to              |
| save_folder       | folder in save_dir to save to     |
| save_name         | name of plot                      |
| save_format       | format (e.g. png, tiff, pdf, ...) |
| show_saved_plot   | load & display the saved plot     |
| ncol              | number of columns                 |
| nrow              | number of rows                    |
| scale             | scale                             |
| base_width        | width                             |
| base_height       | height                            |
| base_aspect_ratio | aspect ratio                      |

|           |  |
|-----------|--|
| units     | units  |
| dpi       | Plot resolution  |
| limitsize | When TRUE (the default), ggsave will not save images larger than 50x50 inches, to prevent the common error of specifying dimensions in pixels. |
| ...       | additional parameters to ggplot_save_function or general_save_function   |

**See Also**

[general\\_save\\_function](#)

**Examples**

```
all_plots_save_function(gobject)
```

---

|                |                       |
|----------------|-----------------------|
| annotateGiotto | <i>annotateGiotto</i> |
|----------------|-----------------------|

---

**Description**

Converts cluster results into provided annotation.

**Usage**

```
annotateGiotto(
  gobject,
  annotation_vector = NULL,
  cluster_column = NULL,
  name = "cell_types"
)
```

**Arguments**

|                   |   |
|-------------------|---|
| gobject           | giotto object                                 |
| annotation_vector | named annotation vector (names = cluster ids) |
| cluster_column    | cluster column to convert to annotation names |
| name              | new name for annotation column                |

**Details**

You need to specify which (cluster) column you want to annotate and you need to provide an annotation vector like this:

- 1. identify the cell type of each cluster
- 2. create a vector of these cell types, e.g. `cell_types = c('T-cell', 'B-cell', 'Stromal')`
- 3. provide original cluster names to previous vector, e.g. `names(cell_types) = c(2, 1, 3)`

**Value**

giotto object

## Examples

```
annotateGiotto(gobject)
```

---

```
annotateSpatialNetwork
      annotateSpatialNetwork
```

---

## Description

Annotate spatial network with cell metadata information.

## Usage

```
annotateSpatialNetwork(
  gobject,
  spatial_network_name = "Delaunay_network",
  cluster_column,
  create_full_network = F
)
```

## Arguments

```
gobject          giotto object
spatial_network_name
                  name of spatial network to use
cluster_column  name of column to use for clusters
create_full_network
                  convert from reduced to full network representation
```

## Value

annotated network in data.table format

## Examples

```
annotateSpatialNetwork(gobject)
```

---

```
annotate_spatlocs_with_spatgrid_2D
      annotate_spatlocs_with_spatgrid_2D
```

---

## Description

annotate spatial locations with 2D spatial grid information

## Usage

```
annotate_spatlocs_with_spatgrid_2D(spatloc, spatgrid)
```

**Arguments**

|          |   |
|----------|---|
| spatloc  | spatial_locs slot from giotto object          |
| spatgrid | selected spatial_grid slot from giotto object |

**Value**

annotated spatial location data.table

**Examples**

```
annotate_spatlocs_with_spatgrid_2D()
```

---

```
annotate_spatlocs_with_spatgrid_3D  
      annotate_spatlocs_with_spatgrid_3D
```

---

**Description**

annotate spatial locations with 3D spatial grid information

**Usage**

```
annotate_spatlocs_with_spatgrid_3D(spatloc, spatgrid)
```

**Arguments**

|          |   |
|----------|---|
| spatloc  | spatial_locs slot from giotto object          |
| spatgrid | selected spatial_grid slot from giotto object |

**Value**

annotated spatial location data.table

**Examples**

```
annotate_spatlocs_with_spatgrid_3D()
```

---

```
average_gene_gene_expression_in_groups
      average_gene_gene_expression_in_groups
```

---

**Description**

calculate average expression per cluster

**Usage**

```
average_gene_gene_expression_in_groups(
  gobject,
  cluster_column = "cell_types",
  gene_set_1,
  gene_set_2
)
```

**Arguments**

|                |   |
|----------------|---|
| gobject        | giotto object to use                      |
| cluster_column | cluster column with cell type information |
| gene_set_1     | first specific gene set from gene pairs   |
| gene_set_2     | second specific gene set from gene pairs  |

**Details**

Details will follow soon.

**Value**

data.table with average expression scores for each cluster

**Examples**

```
average_gene_gene_expression_in_groups(gobject)
```

---

|          |                 |
|----------|-----------------|
| binSpect | <i>binSpect</i> |
|----------|-----------------|

---

**Description**

Previously: binGetSpatialGenes. BinSpect (Binary Spatial Extraction of genes) is a fast computational method that identifies genes with a spatially coherent expression pattern.

## Usage

```
binSpect(
  gobject,
  bin_method = c("kmeans", "rank"),
  expression_values = c("normalized", "scaled", "custom"),
  subset_genes = NULL,
  spatial_network_name = "Delaunay_network",
  nstart = 3,
  iter_max = 10,
  percentage_rank = 30,
  do_fisher_test = TRUE,
  calc_hub = FALSE,
  hub_min_int = 3,
  get_av_expr = TRUE,
  get_high_expr = TRUE,
  do_parallel = TRUE,
  cores = NA,
  verbose = T
)
```

## Arguments

|                                   |  |
|-----------------------------------|--|
| <code>gobject</code>              | giotto object  |
| <code>bin_method</code>           | method to binarize gene expression                                     |
| <code>expression_values</code>    | expression values to use   |
| <code>subset_genes</code>         | only select a subset of genes to test                                  |
| <code>spatial_network_name</code> | name of spatial network to use (default = 'spatial_network')           |
| <code>nstart</code>               | kmeans: nstart parameter   |
| <code>iter_max</code>             | kmeans: iter.max parameter   |
| <code>percentage_rank</code>      | percentage of top cells for binarization                               |
| <code>do_fisher_test</code>       | perform fisher test  |
| <code>calc_hub</code>             | calculate the number of hub cells                                      |
| <code>hub_min_int</code>          | minimum number of cell-cell interactions for a hub cell                |
| <code>get_av_expr</code>          | calculate the average expression per gene of the high expressing cells |
| <code>get_high_expr</code>        | calculate the number of high expressing cells per gene                 |
| <code>do_parallel</code>          | run calculations in parallel with mclapply                             |
| <code>cores</code>                | number of cores to use if <code>do_parallel = TRUE</code>              |
| <code>verbose</code>              | be verbose   |

## Details

We provide two ways to identify spatial genes based on gene expression binarization. Both methods are identical except for how binarization is performed.

- 1. binarize: Each gene is binarized (0 or 1) in each cell with **kmeans** (k = 2) or based on **rank** percentile



- 2. network: All cells are connected through a spatial network based on the physical coordinates
- 3. contingency table: A contingency table is calculated based on all edges of neighboring cells and the binarized expression (0-0, 0-1, 1-0 or 1-1)
- 4. For each gene an odds-ratio (OR) and fisher.test (optional) is calculated

Other statistics are provided (optional):

- Number of cells with high expression (binary = 1)
- Average expression of each gene within high expressing cells
- Number of hub cells, these are high expressing cells that have a user defined number of high expressing neighbors

By selecting a subset of likely spatial genes (e.g. soft thresholding highly variable genes) or using multiple cores can accelerate the speed.

### Value

data.table with results (see details)

### Examples

```
binSpect(gobject)
```

---

calculateHVG

*calculateHVG*

---

### Description

compute highly variable genes

### Usage

```
calculateHVG(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  method = c("cov_groups", "cov_loess"),
  reverse_log_scale = FALSE,
  logbase = 2,
  expression_threshold = 0,
  nr_expression_groups = 20,
  zscore_threshold = 1.5,
  HVGname = "hvg",
  difference_in_cov = 0.1,
  show_plot = NA,
  return_plot = NA,
  save_plot = NA,
  save_param = list(),
  default_save_name = "HVGplot",
  return_gobject = TRUE
)
```

**Arguments**

|                                   |  |
|-----------------------------------|--|
| <code>gobject</code>              | giotto object  |
| <code>expression_values</code>    | expression values to use   |
| <code>method</code>               | method to calculate highly variable genes  |
| <code>reverse_log_scale</code>    | reverse log-scale of expression values (default = FALSE)   |
| <code>logbase</code>              | if <code>reverse_log_scale</code> is TRUE, which log base was used?                                  |
| <code>expression_threshold</code> | expression threshold to consider a gene detected   |
| <code>nr_expression_groups</code> | number of expression groups for <code>cov_groups</code>  |
| <code>zscore_threshold</code>     | zscore to select hvg for <code>cov_groups</code>   |
| <code>HVGname</code>              | name for highly variable genes in cell metadata  |
| <code>difference_in_cov</code>    | minimum difference in coefficient of variance required   |
| <code>show_plot</code>            | show plot  |
| <code>return_plot</code>          | return ggplot object   |
| <code>save_plot</code>            | directly save the plot [boolean]   |
| <code>save_param</code>           | list of saving parameters from <a href="#">all_plots_save_function</a>                               |
| <code>default_save_name</code>    | default save name for saving, don't change, change <code>save_name</code> in <code>save_param</code> |
| <code>return_gobject</code>       | boolean: return giotto object (default = TRUE)   |

**Details**

Currently we provide 2 ways to calculate highly variable genes: **1. high coeff of variance (COV) within groups:**

First genes are binned (*nr\_expression\_groups*) into average expression groups and the COV for each gene is converted into a z-score within each bin. Genes with a z-score higher than the threshold (*zscore\_threshold*) are considered highly variable.

**2. high COV based on loess regression prediction:**

A predicted COV is calculated for each gene using loess regression (COV~log(mean expression)) Genes that show a higher than predicted COV (*difference\_in\_cov*) are considered highly variable.

**Value**

giotto object highly variable genes appended to gene metadata (fDataDT)

**Examples**

```
calculateHVG(gobject)
```

---

|                    |                           |
|--------------------|---------------------------|
| calculateMetaTable | <i>calculateMetaTable</i> |
|--------------------|---------------------------|

---

**Description**

calculates the average gene expression for one or more (combined) annotation columns.

**Usage**

```
calculateMetaTable(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  metadata_cols = NULL,
  selected_genes = NULL
)
```

**Arguments**

gobject            giotto object  
 expression\_values            expression values to use  
 metadata\_cols    annotation columns found in pDataDT(gobject)  
 selected\_genes   subset of genes to use

**Value**

data.table with average expression values for each gene per (combined) annotation

**Examples**

```
calculateMetaTable(gobject)
```

---

|                         |                                |
|-------------------------|--------------------------------|
| calculateMetaTableCells | <i>calculateMetaTableCells</i> |
|-------------------------|--------------------------------|

---

**Description**

calculates the average metadata values for one or more (combined) annotation columns.

**Usage**

```
calculateMetaTableCells(
  gobject,
  value_cols = NULL,
  metadata_cols = NULL,
  spat_enr_names = NULL
)
```

**Arguments**

|                             |   |
|-----------------------------|---|
| <code>gobject</code>        | giotto object   |
| <code>value_cols</code>     | metadata or enrichment value columns to use               |
| <code>metadata_cols</code>  | annotation columns found in <code>pDataDT(gobject)</code> |
| <code>spat_enr_names</code> | which spatial enrichment results to include               |

**Value**

data.table with average metadata values per (combined) annotation

**Examples**

```
calculateMetaTableCells(gobject)
```

---

```
calculate_distance_and_weight
      calculate_distance_and_weight
```

---

**Description**

`calculate_distance_and_weight`

**Usage**

```
calculate_distance_and_weight(
  networkDT,
  sdimx = "sdimx",
  sdimy = "sdimy",
  sdimz = "sdimz",
  d2_or_d3 = c(2, 3)
)
```

---

```
cellProximityBarplot  cellProximityBarplot
```

---

**Description**

Create barplot from cell-cell proximity scores

**Usage**

```
cellProximityBarplot(  
  gobject,  
  CPscore,  
  min_orig_ints = 5,  
  min_sim_ints = 5,  
  p_val = 0.05,  
  show_plot = NA,  
  return_plot = NA,  
  save_plot = NA,  
  save_param = list(),  
  default_save_name = "cellProximityBarplot"  
)
```

**Arguments**

|                                |  |
|--------------------------------|--|
| <code>gobject</code>           | giotto object  |
| <code>CPscore</code>           | CPscore, output from <code>cellProximityEnrichment()</code>  |
| <code>min_orig_ints</code>     | filter on minimum original cell-cell interactions  |
| <code>min_sim_ints</code>      | filter on minimum simulated cell-cell interactions   |
| <code>p_val</code>             | p-value  |
| <code>show_plot</code>         | show plot  |
| <code>return_plot</code>       | return ggplot object   |
| <code>save_plot</code>         | directly save the plot [boolean]   |
| <code>save_param</code>        | list of saving parameters from <a href="#">all_plots_save_function</a>                               |
| <code>default_save_name</code> | default save name for saving, don't change, change <code>save_name</code> in <code>save_param</code> |

**Details**

This function creates a barplot that shows the spatial proximity enrichment or depletion of cell type pairs.

**Value**

ggplot barplot

**Examples**

```
cellProximityBarplot(CPscore)
```

---

```
cellProximityEnrichment
      cellProximityEnrichment
```

---

## Description

Compute cell-cell interaction enrichment (observed vs expected)

## Usage

```
cellProximityEnrichment(
  gobject,
  spatial_network_name = "Delaunay_network",
  cluster_column,
  number_of_simulations = 1000,
  adjust_method = c("none", "fdr", "bonferroni", "BH", "holm", "hochberg", "hommel",
    "BY")
)
```

## Arguments

```
gobject          giotto object
spatial_network_name
                  name of spatial network to use
cluster_column  name of column to use for clusters
number_of_simulations
                  number of simulations to create expected observations
```

## Details

Spatial proximity enrichment or depletion between pairs of cell types is calculated by calculating the observed over the expected frequency of cell-cell proximity interactions. The expected frequency is the average frequency calculated from a number of spatial network simulations. Each individual simulation is obtained by reshuffling the cell type labels of each node (cell) in the spatial network.

## Value

List of cell Proximity scores (CPscores) in data.table format. The first data.table (raw\_sim\_table) shows the raw observations of both the original and simulated networks. The second data.table (enrichm\_res) shows the enrichment results.

## Examples

```
cellProximityEnrichment(gobject)
```

---

cellProximityHeatmap    *cellProximityHeatmap*


---

## Description

Create heatmap from cell-cell proximity scores

## Usage

```
cellProximityHeatmap(
  gobject,
  CPscore,
  scale = T,
  order_cell_types = T,
  color_breaks = NULL,
  color_names = NULL,
  show_plot = NA,
  return_plot = NA,
  save_plot = NA,
  save_param = list(),
  default_save_name = "cellProximityHeatmap"
)
```

## Arguments

|                                |  |
|--------------------------------|--|
| <code>gobject</code>           | giotto object  |
| <code>CPscore</code>           | CPscore, output from <code>cellProximityEnrichment()</code>  |
| <code>scale</code>             | scale cell-cell proximity interaction scores   |
| <code>order_cell_types</code>  | order cell types based on enrichment correlation   |
| <code>color_breaks</code>      | numerical vector of length 3 to represent min, mean and maximum                                      |
| <code>color_names</code>       | character color vector of length 3   |
| <code>show_plot</code>         | show plot  |
| <code>return_plot</code>       | return ggplot object   |
| <code>save_plot</code>         | directly save the plot [boolean]   |
| <code>save_param</code>        | list of saving parameters from <a href="#">all_plots_save_function</a>                               |
| <code>default_save_name</code> | default save name for saving, don't change, change <code>save_name</code> in <code>save_param</code> |

## Details

This function creates a heatmap that shows the spatial proximity enrichment or depletion of cell type pairs.

## Value

ggplot heatmap

**Examples**

```
cellProximityHeatmap(CPscore)
```

---

```
cellProximityNetwork    cellProximityNetwork
```

---

**Description**

Create network from cell-cell proximity scores

**Usage**

```
cellProximityNetwork(
  gobject,
  CPscore,
  remove_self_edges = FALSE,
  self_loop_strength = 0.1,
  color_depletion = "lightgreen",
  color_enrichment = "red",
  rescale_edge_weights = TRUE,
  edge_weight_range_depletion = c(0.1, 1),
  edge_weight_range_enrichment = c(1, 5),
  layout = c("Fruchterman", "DrL", "Kamada-Kawai"),
  only_show_enrichment_edges = F,
  edge_width_range = c(0.1, 2),
  node_size = 4,
  node_text_size = 6,
  show_plot = NA,
  return_plot = NA,
  save_plot = NA,
  save_param = list(),
  default_save_name = "cellProximityNetwork"
)
```

**Arguments**

|  |   |
|--|---|
| <code>gobject</code>                     | giotto object   |
| <code>CPscore</code>                     | CPscore, output from <code>cellProximityEnrichment()</code>   |
| <code>remove_self_edges</code>           | remove enrichment/depletion edges with itself                 |
| <code>self_loop_strength</code>          | size of self-loops  |
| <code>color_depletion</code>             | color for depleted cell-cell interactions                     |
| <code>color_enrichment</code>            | color for enriched cell-cell interactions                     |
| <code>rescale_edge_weights</code>        | rescale edge weights (boolean)                                |
| <code>edge_weight_range_depletion</code> | numerical vector of length 2 to rescale depleted edge weights |



|                              |  |
|------------------------------|--|
| edge_weight_range_enrichment | numerical vector of length 2 to rescale enriched edge weights              |
| layout                       | layout algorithm to use to draw nodes and edges                            |
| only_show_enrichment_edges   | show only the enriched pairwise scores                                     |
| edge_width_range             | range of edge width  |
| node_size                    | size of nodes  |
| node_text_size               | size of node labels  |
| show_plot                    | show plot  |
| return_plot                  | return ggplot object   |
| save_plot                    | directly save the plot [boolean]   |
| save_param                   | list of saving parameters from <a href="#">all_plots_save_function</a>     |
| default_save_name            | default save name for saving, don't change, change save_name in save_param |

### Details

This function creates a network that shows the spatial proximity enrichment or depletion of cell type pairs.

### Value

igraph plot

### Examples

```
cellProximityNetwork(CPscore)
```

---

cellProximitySpatPlot *cellProximitySpatPlot*

---

### Description

Visualize 2D cell-cell interactions according to spatial coordinates in ggplot mode

### Usage

```
cellProximitySpatPlot(gobject, ...)
```

### Arguments

|                  |   |
|------------------|---|
| gobject          | giotto object                             |
| interaction_name | cell-cell interaction name                |
| cluster_column   | cluster column with cell clusters         |
| sdimx            | x-axis dimension name (default = 'sdimx') |
| sdimy            | y-axis dimension name (default = 'sdimy') |

|                            |  |
|----------------------------|--|
| cell_color                 | color for cells (see details)  |
| cell_color_code            | named vector with colors   |
| color_as_factor            | convert color column to factor   |
| show_other_cells           | decide if show cells not in network  |
| show_network               | show underlying spatial network  |
| network_color              | color of spatial network   |
| spatial_network_name       | name of spatial network to use   |
| show_grid                  | show spatial grid  |
| grid_color                 | color of spatial grid  |
| spatial_grid_name          | name of spatial grid to use  |
| coord_fix_ratio            | fix ratio between x and y-axis   |
| show_legend                | show legend  |
| point_size_select          | size of selected points  |
| point_select_border_col    | border color of selected points  |
| point_select_border_stroke | stroke size of selected points   |
| point_size_other           | size of other points   |
| point_other_border_col     | border color of other points   |
| point_other_border_stroke  | stroke size of other points  |
| show_plot                  | show plots   |
| return_plot                | return ggplot object   |
| save_plot                  | directly save the plot [boolean]   |
| save_param                 | list of saving parameters from <a href="#">all_plots_save_function</a>     |
| default_save_name          | default save name for saving, don't change, change save_name in save_param |

## Details

Description of parameters.

## Value

ggplot

## See Also

[cellProximitySpatPlot2D](#) and [cellProximitySpatPlot3D](#) for 3D

**Examples**

```
cellProximitySpatPlot(gobject)
```

---

```
cellProximitySpatPlot2D
```

```
cellProximitySpatPlot2D
```

---

**Description**

Visualize 2D cell-cell interactions according to spatial coordinates in ggplot mode

**Usage**

```
cellProximitySpatPlot2D(
  gobject,
  interaction_name = NULL,
  cluster_column = NULL,
  sdimx = "sdimx",
  sdimy = "sdimy",
  cell_color = NULL,
  cell_color_code = NULL,
  color_as_factor = T,
  show_other_cells = F,
  show_network = F,
  show_other_network = F,
  network_color = NULL,
  spatial_network_name = "Delaunay_network",
  show_grid = F,
  grid_color = NULL,
  spatial_grid_name = "spatial_grid",
  coord_fix_ratio = 1,
  show_legend = T,
  point_size_select = 2,
  point_select_border_col = "black",
  point_select_border_stroke = 0.05,
  point_size_other = 1,
  point_alpha_other = 0.3,
  point_other_border_col = "lightgrey",
  point_other_border_stroke = 0.01,
  show_plot = NA,
  return_plot = NA,
  save_plot = NA,
  save_param = list(),
  default_save_name = "cellProximitySpatPlot2D"
)
```

**Arguments**

|                  |                            |
|------------------|----------------------------|
| gobject          | giotto object              |
| interaction_name | cell-cell interaction name |

|                            |  |
|----------------------------|--|
| cluster_column             | cluster column with cell clusters  |
| sdimx                      | x-axis dimension name (default = 'sdimx')                                  |
| sdimy                      | y-axis dimension name (default = 'sdimy')                                  |
| cell_color                 | color for cells (see details)  |
| cell_color_code            | named vector with colors   |
| color_as_factor            | convert color column to factor   |
| show_other_cells           | decide if show cells not in network  |
| show_network               | show underlying spatial network  |
| network_color              | color of spatial network   |
| spatial_network_name       | name of spatial network to use   |
| show_grid                  | show spatial grid  |
| grid_color                 | color of spatial grid  |
| spatial_grid_name          | name of spatial grid to use  |
| coord_fix_ratio            | fix ratio between x and y-axis   |
| show_legend                | show legend  |
| point_size_select          | size of selected points  |
| point_select_border_col    | border color of selected points  |
| point_select_border_stroke | stroke size of selected points   |
| point_size_other           | size of other points   |
| point_other_border_col     | border color of other points   |
| point_other_border_stroke  | stroke size of other points  |
| show_plot                  | show plots   |
| return_plot                | return ggplot object   |
| save_plot                  | directly save the plot [boolean]   |
| save_param                 | list of saving parameters from <a href="#">all_plots_save_function</a>     |
| default_save_name          | default save name for saving, don't change, change save_name in save_param |

## Details

Description of parameters.

## Value

ggplot

**Examples**

```
cellProximitySpatPlot2D(gobject)
```

---

```
cellProximitySpatPlot3D
```

```
cellProximitySpatPlot2D
```

---

**Description**

Visualize 3D cell-cell interactions according to spatial coordinates in plotly mode

**Usage**

```
cellProximitySpatPlot3D(
  gobject,
  interaction_name = NULL,
  cluster_column = NULL,
  sdimx = "sdimx",
  sdimy = "sdimy",
  sdimz = "sdimz",
  cell_color = NULL,
  cell_color_code = NULL,
  color_as_factor = T,
  show_other_cells = T,
  show_network = T,
  show_other_network = F,
  network_color = NULL,
  spatial_network_name = "Delaunay_network",
  show_grid = F,
  grid_color = NULL,
  spatial_grid_name = "spatial_grid",
  show_legend = T,
  point_size_select = 4,
  point_size_other = 2,
  point_alpha_other = 0.5,
  axis_scale = c("cube", "real", "custom"),
  custom_ratio = NULL,
  x_ticks = NULL,
  y_ticks = NULL,
  z_ticks = NULL,
  show_plot = NA,
  return_plot = NA,
  save_plot = NA,
  save_param = list(),
  default_save_name = "cellProximitySpatPlot3D",
  ...
)
```

**Arguments**

|                                   |  |
|-----------------------------------|--|
| <code>gobject</code>              | giotto object  |
| <code>interaction_name</code>     | cell-cell interaction name   |
| <code>cluster_column</code>       | cluster column with cell clusters  |
| <code>sdimx</code>                | x-axis dimension name (default = 'sdimx')                                  |
| <code>sdimy</code>                | y-axis dimension name (default = 'sdimy')                                  |
| <code>sdimz</code>                | z-axis dimension name (default = 'sdimz')                                  |
| <code>cell_color</code>           | color for cells (see details)  |
| <code>cell_color_code</code>      | named vector with colors   |
| <code>color_as_factor</code>      | convert color column to factor   |
| <code>show_other_cells</code>     | decide if show cells not in network  |
| <code>show_network</code>         | show underlying spatial network  |
| <code>network_color</code>        | color of spatial network   |
| <code>spatial_network_name</code> | name of spatial network to use   |
| <code>show_grid</code>            | show spatial grid  |
| <code>grid_color</code>           | color of spatial grid  |
| <code>spatial_grid_name</code>    | name of spatial grid to use  |
| <code>show_legend</code>          | show legend  |
| <code>point_size_select</code>    | size of selected points  |
| <code>point_size_other</code>     | size of other points   |
| <code>show_plot</code>            | show plots   |
| <code>return_plot</code>          | return plotly object   |
| <code>save_plot</code>            | directly save the plot [boolean]   |
| <code>save_param</code>           | list of saving parameters from <a href="#">all_plots_save_function</a>     |
| <code>default_save_name</code>    | default save name for saving, don't change, change save_name in save_param |

**Details**

Description of parameters.

**Value**

plotly

**Examples**

```
cellProximitySpatPlot3D(gobject)
```

---

cellProximityVisPlot    *cellProximityVisPlot*


---

## Description

Visualize cell-cell interactions according to spatial coordinates

## Usage

```
cellProximityVisPlot(
  gobject,
  interaction_name = NULL,
  cluster_column = NULL,
  sdimx = NULL,
  sdimy = NULL,
  sdimz = NULL,
  cell_color = NULL,
  cell_color_code = NULL,
  color_as_factor = T,
  show_other_cells = F,
  show_network = F,
  show_other_network = F,
  network_color = NULL,
  spatial_network_name = "Delaunay_network",
  show_grid = F,
  grid_color = NULL,
  spatial_grid_name = "spatial_grid",
  coord_fix_ratio = 1,
  show_legend = T,
  point_size_select = 2,
  point_select_border_col = "black",
  point_select_border_stroke = 0.05,
  point_size_other = 1,
  point_alpha_other = 0.3,
  point_other_border_col = "lightgrey",
  point_other_border_stroke = 0.01,
  axis_scale = c("cube", "real", "custom"),
  custom_ratio = NULL,
  x_ticks = NULL,
  y_ticks = NULL,
  z_ticks = NULL,
  plot_method = c("ggplot", "plotly"),
  ...
)
```

## Arguments

|                               |                                   |
|-------------------------------|-----------------------------------|
| <code>gobject</code>          | giotto object                     |
| <code>interaction_name</code> | cell-cell interaction name        |
| <code>cluster_column</code>   | cluster column with cell clusters |

|                            |   |
|----------------------------|---|
| sdimx                      | x-axis dimension name (default = 'sdimx') |
| sdimy                      | y-axis dimension name (default = 'sdimy') |
| sdimz                      | z-axis dimension name (default = 'sdimz') |
| cell_color                 | color for cells (see details)             |
| cell_color_code            | named vector with colors                  |
| color_as_factor            | convert color column to factor            |
| show_network               | show underlying spatial network           |
| network_color              | color of spatial network                  |
| spatial_network_name       | name of spatial network to use            |
| show_grid                  | show spatial grid                         |
| grid_color                 | color of spatial grid                     |
| spatial_grid_name          | name of spatial grid to use               |
| coord_fix_ratio            | fix ratio between x and y-axis            |
| show_legend                | show legend                               |
| point_size_select          | size of selected points                   |
| point_select_border_col    | border color of selected points           |
| point_select_border_stroke | stroke size of selected points            |
| point_size_other           | size of other points                      |
| point_other_border_col     | border color of other points              |
| point_other_border_stroke  | stroke size of other points               |

## Details

Description of parameters.

## Value

ggplot or plotly

## Examples

```
cellProximityVisPlot(gobject)
```



---

```
cellProximityVisPlot_2D_ggplot
      cellProximityVisPlot_2D_ggplot
```

---

## Description

Visualize 2D cell-cell interactions according to spatial coordinates in ggplot mode

## Usage

```
cellProximityVisPlot_2D_ggplot(
  gobject,
  interaction_name = NULL,
  cluster_column = NULL,
  sdimx = NULL,
  sdimy = NULL,
  cell_color = NULL,
  cell_color_code = NULL,
  color_as_factor = T,
  show_other_cells = F,
  show_network = F,
  show_other_network = F,
  network_color = NULL,
  spatial_network_name = "Delaunay_network",
  show_grid = F,
  grid_color = NULL,
  spatial_grid_name = "spatial_grid",
  coord_fix_ratio = 1,
  show_legend = T,
  point_size_select = 2,
  point_select_border_col = "black",
  point_select_border_stroke = 0.05,
  point_size_other = 1,
  point_alpha_other = 0.3,
  point_other_border_col = "lightgrey",
  point_other_border_stroke = 0.01,
  ...
)
```

## Arguments

|                               |   |
|-------------------------------|---|
| <code>gobject</code>          | giotto object                             |
| <code>interaction_name</code> | cell-cell interaction name                |
| <code>cluster_column</code>   | cluster column with cell clusters         |
| <code>sdimx</code>            | x-axis dimension name (default = 'sdimx') |
| <code>sdimy</code>            | y-axis dimension name (default = 'sdimy') |
| <code>cell_color</code>       | color for cells (see details)             |
| <code>cell_color_code</code>  | named vector with colors                  |

|                            |                                     |
|----------------------------|-------------------------------------|
| color_as_factor            | convert color column to factor      |
| show_other_cells           | decide if show cells not in network |
| show_network               | show underlying spatial network     |
| network_color              | color of spatial network            |
| spatial_network_name       | name of spatial network to use      |
| show_grid                  | show spatial grid                   |
| grid_color                 | color of spatial grid               |
| spatial_grid_name          | name of spatial grid to use         |
| coord_fix_ratio            | fix ratio between x and y-axis      |
| show_legend                | show legend                         |
| point_size_select          | size of selected points             |
| point_select_border_col    | border color of selected points     |
| point_select_border_stroke | stroke size of selected points      |
| point_size_other           | size of other points                |
| point_other_border_col     | border color of other points        |
| point_other_border_stroke  | stroke size of other points         |

## Details

Description of parameters.

## Value

ggplot

## Examples

```
cellProximityVisPlot_2D_ggplot(gobject)
```

---

```
cellProximityVisPlot_2D_plotly
      cellProximityVisPlot_2D_plotly
```

---

## Description

Visualize 2D cell-cell interactions according to spatial coordinates in plotly mode

## Usage

```
cellProximityVisPlot_2D_plotly(
  gobject,
  interaction_name = NULL,
  cluster_column = NULL,
  sdimx = NULL,
  sdimy = NULL,
  cell_color = NULL,
  cell_color_code = NULL,
  color_as_factor = T,
  show_other_cells = F,
  show_network = F,
  show_other_network = F,
  network_color = NULL,
  spatial_network_name = "Delaunay_network",
  show_grid = F,
  grid_color = NULL,
  spatial_grid_name = "spatial_grid",
  show_legend = T,
  point_size_select = 2,
  point_size_other = 1,
  point_alpha_other = 0.3,
  axis_scale = c("cube", "real", "custom"),
  custom_ratio = NULL,
  x_ticks = NULL,
  y_ticks = NULL,
  ...
)
```

## Arguments

|                               |   |
|-------------------------------|---|
| <code>gobject</code>          | giotto object                             |
| <code>interaction_name</code> | cell-cell interaction name                |
| <code>cluster_column</code>   | cluster column with cell clusters         |
| <code>sdimx</code>            | x-axis dimension name (default = 'sdimx') |
| <code>sdimy</code>            | y-axis dimension name (default = 'sdimy') |
| <code>cell_color</code>       | color for cells (see details)             |
| <code>cell_color_code</code>  | named vector with colors                  |

|                      |                                     |
|----------------------|-------------------------------------|
| color_as_factor      | convert color column to factor      |
| show_other_cells     | decide if show cells not in network |
| show_network         | show underlying spatial network     |
| network_color        | color of spatial network            |
| spatial_network_name | name of spatial network to use      |
| show_grid            | show spatial grid                   |
| grid_color           | color of spatial grid               |
| spatial_grid_name    | name of spatial grid to use         |
| show_legend          | show legend                         |
| point_size_select    | size of selected points             |
| coord_fix_ratio      | fix ratio between x and y-axis      |

**Details**

Description of parameters.

**Value**

plotly

**Examples**

```
cellProximityVisPlot_2D_plotly(gobject)
```

---

```
cellProximityVisPlot_3D_plotly
  cellProximityVisPlot_3D_plotly
```

---

**Description**

Visualize 3D cell-cell interactions according to spatial coordinates in plotly mode

**Usage**

```
cellProximityVisPlot_3D_plotly(
  gobject,
  interaction_name = NULL,
  cluster_column = NULL,
  sdimx = NULL,
  sdimy = NULL,
  sdimz = NULL,
  cell_color = NULL,
  cell_color_code = NULL,
```

```

    color_as_factor = T,
    show_other_cells = F,
    show_network = F,
    show_other_network = F,
    network_color = NULL,
    spatial_network_name = "Delaunay_network",
    show_grid = F,
    grid_color = NULL,
    spatial_grid_name = "spatial_grid",
    show_legend = T,
    point_size_select = 2,
    point_size_other = 1,
    point_alpha_other = 0.5,
    axis_scale = c("cube", "real", "custom"),
    custom_ratio = NULL,
    x_ticks = NULL,
    y_ticks = NULL,
    z_ticks = NULL,
    ...
)

```

### Arguments

|                                   |   |
|-----------------------------------|---|
| <code>gobject</code>              | giotto object                             |
| <code>interaction_name</code>     | cell-cell interaction name                |
| <code>cluster_column</code>       | cluster column with cell clusters         |
| <code>sdimx</code>                | x-axis dimension name (default = 'sdimx') |
| <code>sdimy</code>                | y-axis dimension name (default = 'sdimy') |
| <code>sdimz</code>                | z-axis dimension name (default = 'sdimz') |
| <code>cell_color</code>           | color for cells (see details)             |
| <code>cell_color_code</code>      | named vector with colors                  |
| <code>color_as_factor</code>      | convert color column to factor            |
| <code>show_other_cells</code>     | decide if show cells not in network       |
| <code>show_network</code>         | show underlying spatial network           |
| <code>network_color</code>        | color of spatial network                  |
| <code>spatial_network_name</code> | name of spatial network to use            |
| <code>show_grid</code>            | show spatial grid                         |
| <code>grid_color</code>           | color of spatial grid                     |
| <code>spatial_grid_name</code>    | name of spatial grid to use               |
| <code>show_legend</code>          | show legend                               |
| <code>point_size_select</code>    | size of selected points                   |
| <code>coord_fix_ratio</code>      | fix ratio between x and y-axis            |

**Details**

Description of parameters.

**Value**

plotly

**Examples**

```
cellProximityVisPlot_3D_plotly(gobject)
```

---

changeGiottoInstructions  
*changeGiottoInstructions*

---

**Description**

Function to change one or more instructions from giotto object

**Usage**

```
changeGiottoInstructions(  
  gobject,  
  params = NULL,  
  new_values = NULL,  
  return_gobject = TRUE  
)
```

**Arguments**

|                |                                |
|----------------|--------------------------------|
| gobject        | giotto object                  |
| params         | parameter(s) to change         |
| new_values     | new value(s) for parameter(s)  |
| return_gobject | (boolean) return giotto object |

**Value**

giotto object with one or more changed instructions

**Examples**

```
changeGiottoInstructions()
```

---

|               |                      |
|---------------|----------------------|
| changeImageBg | <i>changeImageBg</i> |
|---------------|----------------------|

---

**Description**

Function to change the background color of a magick image plot to another color

**Usage**

```
changeImageBg(
  mg_object,
  bg_color,
  perc_range = 10,
  new_color = "#FFFFFF",
  new_name = NULL
)
```

**Arguments**

|            |   |
|------------|---|
| mg_object  | magick image or giotto image object                             |
| bg_color   | estimated current background color                              |
| perc_range | range around estimated background color to include (percentage) |
| new_color  | new background color  |

**Value**

magick image or giotto image object with updated background color

**Examples**

```
changeImageBg(mg_object)
```

---

|              |                     |
|--------------|---------------------|
| clusterCells | <i>clusterCells</i> |
|--------------|---------------------|

---

**Description**

cluster cells using a variety of different methods

**Usage**

```
clusterCells(
  gobject,
  cluster_method = c("leiden", "louvain_community", "louvain_multinet", "randomwalk",
    "sNNclust", "kmeans", "hierarchical"),
  name = "cluster_name",
  nn_network_to_use = "sNN",
  network_name = "sNN.pca",
  pyth_leid_resolution = 1,
```

```

pyth_leid_weight_col = "weight",
pyth_leid_part_type = c("RBConfigurationVertexPartition",
  "ModularityVertexPartition"),
pyth_leid_init_memb = NULL,
pyth_leid_iterations = 1000,
pyth_louv_resolution = 1,
pyth_louv_weight_col = NULL,
python_louv_random = F,
python_path = NULL,
louvain_gamma = 1,
louvain_omega = 1,
walk_steps = 4,
walk_clusters = 10,
walk_weights = NA,
sNNclust_k = 20,
sNNclust_eps = 4,
sNNclust_minPts = 16,
borderPoints = TRUE,
expression_values = c("normalized", "scaled", "custom"),
genes_to_use = NULL,
dim_reduction_to_use = c("cells", "pca", "umap", "tsne"),
dim_reduction_name = "pca",
dimensions_to_use = 1:10,
distance_method = c("original", "pearson", "spearman", "euclidean", "maximum",
  "manhattan", "canberra", "binary", "minkowski"),
km_centers = 10,
km_iter_max = 100,
km_nstart = 1000,
km_algorithm = "Hartigan-Wong",
hc_agglomeration_method = c("ward.D2", "ward.D", "single", "complete", "average",
  "mcquitty", "median", "centroid"),
hc_k = 10,
hc_h = NULL,
return_gobject = TRUE,
set_seed = T,
seed_number = 1234
)

```

### Arguments

|                      |  |
|----------------------|--|
| gobject              | giotto object                          |
| cluster_method       | community cluster method to use        |
| name                 | name for new clustering result         |
| nn_network_to_use    | type of NN network to use (kNN vs sNN) |
| network_name         | name of NN network to use              |
| pyth_leid_resolution | resolution for leiden                  |
| pyth_leid_weight_col | column to use for weights              |
| pyth_leid_part_type  | partition type to use                  |



|                         |  |
|-------------------------|--|
| pyth_leid_init_memb     | initial membership                             |
| pyth_leid_iterations    | number of iterations                           |
| pyth_louv_resolution    | resolution for louvain                         |
| pyth_louv_weight_col    | python louvain param: weight column            |
| python_louv_random      | python louvain param: random                   |
| python_path             | specify specific path to python if required    |
| louvain_gamma           | louvain param: gamma or resolution             |
| louvain_omega           | louvain param: omega                           |
| walk_steps              | randomwalk: number of steps                    |
| walk_clusters           | randomwalk: number of clusters                 |
| walk_weights            | randomwalk: weight column                      |
| sNNclust_k              | SNNclust: k neighbors to use                   |
| sNNclust_eps            | SNNclust: epsilon                              |
| sNNclust_minPts         | SNNclust: min points                           |
| borderPoints            | SNNclust: border points                        |
| expression_values       | expression values to use                       |
| genes_to_use            | = NULL,  |
| dim_reduction_to_use    | dimension reduction to use                     |
| dim_reduction_name      | name of reduction 'pca',                       |
| dimensions_to_use       | dimensions to use                              |
| distance_method         | distance method                                |
| km_centers              | kmeans centers                                 |
| km_iter_max             | kmeans iterations                              |
| km_nstart               | kmeans random starting points                  |
| km_algorithm            | kmeans algorithm                               |
| hc_agglomeration_method | hierarchical clustering method                 |
| hc_k                    | hierachical number of clusters                 |
| hc_h                    | hierarchical tree cutoff                       |
| return_gobject          | boolean: return giotto object (default = TRUE) |
| set_seed                | set seed                                       |
| seed_number             | number for seed                                |

## Details

Wrapper for the different clustering methods.

**Value**

giotto object with new clusters appended to cell metadata

**See Also**

[doLeidenCluster](#), [doLouvainCluster\\_community](#), [doLouvainCluster\\_multinet](#), [doLouvainCluster](#),  
[doRandomWalkCluster](#), [doSNNCluster](#), [doKmeans](#), [doHclust](#)

**Examples**

```
clusterCells(gobject)
```

---

```
clusterSpatialCorGenes
```

```
clusterSpatialCorGenes
```

---

**Description**

Cluster based on spatially correlated genes

**Usage**

```
clusterSpatialCorGenes(  
  spatCorObject,  
  name = "spat_clus",  
  hclust_method = "ward.D",  
  k = 10,  
  return_obj = TRUE  
)
```

**Arguments**

|               |   |
|---------------|---|
| spatCorObject | spatial correlation object                        |
| name          | name for spatial clustering results               |
| hclust_method | method for hierarchical clustering                |
| k             | number of clusters to extract                     |
| return_obj    | return spatial correlation object (spatCorObject) |

**Value**

spatCorObject or cluster results

**Examples**

```
clusterSpatialCorGenes(gobject)
```

---

|                 |                        |
|-----------------|------------------------|
| colMeans_giotto | <i>colMeans_giotto</i> |
|-----------------|------------------------|

---

**Description**

colMeans\_giotto

**Usage**

colMeans\_giotto(mymatrix)

---

|                |                       |
|----------------|-----------------------|
| colSums_giotto | <i>colSums_giotto</i> |
|----------------|-----------------------|

---

**Description**

colSums\_giotto

**Usage**

colSums\_giotto(mymatrix)

---

|           |                  |
|-----------|------------------|
| combCCcom | <i>combCCcom</i> |
|-----------|------------------|

---

**Description**

Combine spatial and expression based cell-cell communication data.tables

**Usage**

```
combCCcom(
  spatialCC,
  exprCC,
  min_lig_nr = 3,
  min_rec_nr = 3,
  min_padj_value = 1,
  min_log2fc = 0,
  min_av_diff = 0
)
```

**Arguments**

|                |   |
|----------------|---|
| spatialCC      | spatial cell-cell communication scores    |
| exprCC         | expression cell-cell communication scores |
| min_lig_nr     | minimum number of ligand cells            |
| min_rec_nr     | minimum number of receptor cells          |
| min_padj_value | minimum adjusted p-value                  |
| min_log2fc     | minimum log2 fold-change                  |
| min_av_diff    | minimum average expression difference     |

**Value**

combined data.table with spatial and expression communication data

**Examples**

```
combCCcom(gobject)
```

---

```
combineCellProximityGenes
```

```
combineCellProximityGenes
```

---

**Description**

Combine CPG scores in a pairwise manner.

**Usage**

```
combineCellProximityGenes(
  cpgObject,
  selected_ints = NULL,
  selected_genes = NULL,
  specific_genes_1 = NULL,
  specific_genes_2 = NULL,
  min_cells = 5,
  min_int_cells = 3,
  min_fdr = 0.05,
  min_spat_diff = 0,
  min_log2_fc = 0.5,
  do_parallel = TRUE,
  cores = NA,
  verbose = T
)
```

**Arguments**

|                  |  |
|------------------|--|
| cpgObject        | cell proximity gene score object                                 |
| selected_ints    | subset of selected cell-cell interactions (optional)             |
| selected_genes   | subset of selected genes (optional)                              |
| specific_genes_1 | specific geneset combo (need to position match specific_genes_2) |
| specific_genes_2 | specific geneset combo (need to position match specific_genes_1) |
| min_cells        | minimum number of target cell type                               |
| min_int_cells    | minimum number of interacting cell type                          |
| min_fdr          | minimum adjusted p-value   |
| min_spat_diff    | minimum absolute spatial expression difference                   |
| min_log2_fc      | minimum absolute log2 fold-change                                |
| do_parallel      | run calculations in parallel with mclapply                       |
| cores            | number of cores to use if do_parallel = TRUE                     |
| verbose          | verbose  |

**Value**

cpgObject that contains the filtered differential gene scores

**Examples**

```
combineCellProximityGenes(gobject)
```

---

```
combineCellProximityGenes_per_interaction
      combineCellProximityGenes_per_interaction
```

---

**Description**

Combine CPG scores per interaction

**Usage**

```
combineCellProximityGenes_per_interaction(
  cpgObject,
  sel_int,
  selected_genes = NULL,
  specific_genes_1 = NULL,
  specific_genes_2 = NULL,
  min_cells = 5,
  min_int_cells = 3,
  min_fdr = 0.05,
  min_spat_diff = 0,
  min_log2_fc = 0.5
)
```

**Examples**

```
combineCellProximityGenes_per_interaction()
```

---

```
combineCPG      combineCPG
```

---

**Description**

Combine CPG scores in a pairwise manner.

**Usage**

```
combineCPG(
  cpgObject,
  selected_ints = NULL,
  selected_genes = NULL,
  specific_genes_1 = NULL,
  specific_genes_2 = NULL,
  min_cells = 5,
  min_int_cells = 3,
  min_fdr = 0.05,
  min_spat_diff = 0,
  min_log2_fc = 0.5,
  do_parallel = TRUE,
  cores = NA,
  verbose = T
)
```

**Arguments**

|                  |  |
|------------------|--|
| cpgObject        | cell proximity gene score object                                 |
| selected_ints    | subset of selected cell-cell interactions (optional)             |
| selected_genes   | subset of selected genes (optional)                              |
| specific_genes_1 | specific geneset combo (need to position match specific_genes_2) |
| specific_genes_2 | specific geneset combo (need to position match specific_genes_1) |
| min_cells        | minimum number of target cell type                               |
| min_int_cells    | minimum number of interacting cell type                          |
| min_fdr          | minimum adjusted p-value   |
| min_spat_diff    | minimum absolute spatial expression difference                   |
| min_log2_fc      | minimum absolute log2 fold-change                                |
| do_parallel      | run calculations in parallel with mclapply                       |
| cores            | number of cores to use if do_parallel = TRUE                     |
| verbose          | verbose  |

**Value**

cpgObject that contains the filtered differential gene scores

**Examples**

```
combineCPG(gobject)
```

---

|                 |                        |
|-----------------|------------------------|
| combineMetadata | <i>combineMetadata</i> |
|-----------------|------------------------|

---

**Description**

This function combines the cell metadata with spatial locations and enrichment results from createSpatialEnrich

**Usage**

```
combineMetadata(gobject, spat_enr_names = NULL)
```

**Arguments**

|                |  |
|----------------|--|
| gobject        | Giotto object                                  |
| spat_enr_names | names of spatial enrichment results to include |

**Value**

Extended cell metadata in data.table format.

**Examples**

```
combineMetadata(gobject)
```

---

|                            |                                   |
|----------------------------|-----------------------------------|
| convertEnsemblToGeneSymbol | <i>convertEnsemblToGeneSymbol</i> |
|----------------------------|-----------------------------------|

---

**Description**

This function convert ensembl gene IDs from a matrix to official gene symbols

**Usage**

```
convertEnsemblToGeneSymbol(matrix, species = c("mouse", "human"))
```

**Arguments**

|         |  |
|---------|--|
| matrix  | an expression matrix with ensembl gene IDs as rownames |
| species | species to use for gene symbol conversion              |

**Details**

This function requires that the biomaRt library is installed

**Value**

expression matrix with gene symbols as rownames

**Examples**

```
convertEnsemblToGeneSymbol(matrix)
```

---

```
convert_mgImage_to_array_DT
```

```
convert_mgImage_to_array_DT
```

---

**Description**

converts a magick image object to a data.table

**Usage**

```
convert_mgImage_to_array_DT(mg_object)
```

**Arguments**

mg\_object            magick image or Giotto image object

**Value**

data.table with image pixel information

---

```
convert_to_full_spatial_network
```

```
convert_to_full_spatial_network
```

---

**Description**

convert to a full spatial network

**Usage**

```
convert_to_full_spatial_network(reduced_spatial_network_DT)
```

---

```
convert_to_reduced_spatial_network
```

```
convert_to_reduced_spatial_network
```

---

**Description**

convert to a reduced spatial network

**Usage**

```
convert_to_reduced_spatial_network(full_spatial_network_DT)
```



---

|            |                   |
|------------|-------------------|
| cor_giotto | <i>cor_giotto</i> |
|------------|-------------------|

---

**Description**

cor\_giotto

**Usage**

cor\_giotto(x, ...)

---

|            |   |
|------------|---|
| cor_sparse | <i>cor_sparse adapted from wydr package</i> |
|------------|---|

---

**Description**

cor\_sparse adapted from wydr package

**Usage**

cor\_sparse(x)

---

|                    |                           |
|--------------------|---------------------------|
| createCrossSection | <i>createCrossSection</i> |
|--------------------|---------------------------|

---

**Description**

Create a virtual 2D cross section.

**Usage**

```
createCrossSection(
  gobject,
  name = "cross_section",
  spatial_network_name = "Delaunay_network",
  thickness_unit = c("cell", "natural"),
  slice_thickness = 2,
  cell_distance_estimate_method = "mean",
  extend_ratio = 0.2,
  method = c("equation", "3 points", "point and norm vector",
    "point and two plane vectors"),
  equation = NULL,
  point1 = NULL,
  point2 = NULL,
  point3 = NULL,
  normVector = NULL,
  planeVector1 = NULL,
  planeVector2 = NULL,
  mesh_grid_n = 20,
  return_gobject = TRUE
)
```

**Arguments**

|  |  |
|--|--|
| <code>gobject</code>                       | giotto object  |
| <code>name</code>                          | name of cress section object. (default = <code>cross_sectino</code> )  |
| <code>spatial_network_name</code>          | name of spatial network object. (default = <code>Delaunay_network</code> )   |
| <code>thickness_unit</code>                | unit of the virtual section thickness. If "cell", average size of the observed cells is used as length unit. If "natural", the unit of cell location coordinates is used.(default = cell)  |
| <code>cell_distance_estimate_method</code> | method to estimate average distance between neighobring cells. (default = mean)  |
| <code>extend_ratio</code>                  | deciding the span of the cross section meshgrid, as a ratio of extension compared to the borders of the vitural tissue section. (default = 0.2)  |
| <code>method</code>                        | method to define the cross section plane. If equation, the plane is defined by a four element numerical vector (equation) in the form of $c(A,B,C,D)$ , corresponding to a plane with equation $Ax+By+Cz=D$ . If 3 points, the plane is define by the coordinates of 3 points, as given by point1, point2, and point3. If point and norm vector, the plane is defined by the coordinates of one point (point1) in the plane and the coordinates of one norm vector (normVector) to the plane. If point and two plane vector, the plane is defined by the coordinates of one point (point1) in the plane and the coordinates of two vectors (planeVector1, planeVector2) in the plane. (default = equation) |
| <code>equation</code>                      | equation required by method "equation".equations needs to be a numerical vector of length 4, in the form of $c(A,B,C,D)$ , which defines plane $Ax+By+Cz=D$ .  |
| <code>point1</code>                        | coordinates of the first point required by method "3 points","point and norm vector", and "point and two plane vectors".   |
| <code>point2</code>                        | coordinates of the second point required by method "3 points"  |
| <code>point3</code>                        | coordinates of the third point required by method "3 points"   |
| <code>normVector</code>                    | coordinates of the norm vector required by method "point and norm vector"  |
| <code>planeVector1</code>                  | coordinates of the first plane vector required by method "point and two plane vectors"   |
| <code>planeVector2</code>                  | coordinates of the second plane vector required by method "point and two plane vectors"  |
| <code>mesh_grid_n</code>                   | numner of meshgrid lines to generate along both directions for the cross section plane.  |
| <code>return_gobject</code>                | boolean: return giotto object (default = TRUE)   |

**Details**

Creates a virtual 2D cross section object for a given spatial network object. The users need to provide the definition of the cross section plane (see method).

**Value**

giotto object with updated spatial network slot

---

|                   |                          |
|-------------------|--------------------------|
| createGiottoImage | <i>createGiottoImage</i> |
|-------------------|--------------------------|

---

## Description

Creates a giotto image that can be added to a Giotto object and/or used to add an image to the spatial plotting functions

## Usage

```
createGiottoImage(  
  gobject = NULL,  
  spatial_locs = NULL,  
  mg_object,  
  name = "image",  
  xmax_adj = 0,  
  xmin_adj = 0,  
  ymax_adj = 0,  
  ymin_adj = 0  
)
```

## Arguments

|                           |  |
|---------------------------|--|
| <code>gobject</code>      | giotto object  |
| <code>spatial_locs</code> | spatial locations (alternative if <code>giobject = NULL</code> ) |
| <code>mg_object</code>    | magick image object  |
| <code>name</code>         | name for the image   |
| <code>xmax_adj</code>     | adjustment of the maximum x-value to align the image             |
| <code>xmin_adj</code>     | adjustment of the minimum x-value to align the image             |
| <code>ymax_adj</code>     | adjustment of the maximum y-value to align the image             |
| <code>ymin_adj</code>     | adjustment of the minimum y-value to align the image             |

## Value

a giotto image object

## Examples

```
createGiottoImage(mg_object)
```

```
createGiottoInstructions  
      createGiottoInstructions
```

---

## Description

Function to set global instructions for giotto functions

## Usage

```
createGiottoInstructions(  
  python_path = NULL,  
  show_plot = NULL,  
  return_plot = NULL,  
  save_plot = NULL,  
  save_dir = NULL,  
  plot_format = NULL,  
  dpi = NULL,  
  units = NULL,  
  height = NULL,  
  width = NULL  
)
```

## Arguments

|             |  |
|-------------|--|
| python_path | path to python binary to use             |
| show_plot   | print plot to console, default = TRUE    |
| return_plot | return plot as object, default = TRUE    |
| save_plot   | automatically save plot, default = FALSE |
| save_dir    | path to directory where to save plots    |
| dpi         | resolution for raster images             |
| height      | height of plots                          |
| width       | width of plots                           |

## Value

named vector with giotto instructions

## Examples

```
createGiottoInstructions()
```

---

|                    |                             |
|--------------------|-----------------------------|
| createGiottoObject | <i>create Giotto object</i> |
|--------------------|-----------------------------|

---

## Description

Function to create a giotto object

## Usage

```
createGiottoObject(
  raw_exprs,
  spatial_locs = NULL,
  norm_expr = NULL,
  norm_scaled_expr = NULL,
  custom_expr = NULL,
  cell_metadata = NULL,
  gene_metadata = NULL,
  spatial_network = NULL,
  spatial_network_name = NULL,
  spatial_grid = NULL,
  spatial_grid_name = NULL,
  spatial_enrichment = NULL,
  spatial_enrichment_name = NULL,
  dimension_reduction = NULL,
  nn_network = NULL,
  images = NULL,
  offset_file = NULL,
  instructions = NULL,
  cores = NA
)
```

## Arguments

|                      |  |
|----------------------|--|
| raw_exprs            | matrix with raw expression counts [required]                 |
| spatial_locs         | data.table or data.frame with coordinates for cell centroids |
| norm_expr            | normalized expression values                                 |
| norm_scaled_expr     | scaled expression values                                     |
| custom_expr          | custom expression values                                     |
| cell_metadata        | cell annotation metadata                                     |
| gene_metadata        | gene annotation metadata                                     |
| spatial_network      | list of spatial network(s)                                   |
| spatial_network_name | list of spatial network name(s)                              |
| spatial_grid         | list of spatial grid(s)                                      |
| spatial_grid_name    | list of spatial grid name(s)                                 |

|                         |   |
|-------------------------|---|
| spatial_enrichment      | list of spatial enrichment score(s) for each spatial region                         |
| spatial_enrichment_name | list of spatial enrichment name(s)  |
| dimension_reduction     | list of dimension reduction(s)  |
| nn_network              | list of nearest neighbor network(s)   |
| images                  | list of images  |
| offset_file             | file used to stitch fields together (optional)                                      |
| instructions            | list of instructions or output result from <a href="#">createGiottoInstructions</a> |
| cores                   | how many cores or threads to use to read data if paths are provided                 |

## Details

**[Requirements]** To create a giotto object you need to provide at least a matrix with genes as row names and cells as column names. This matrix can be provided as a base matrix, sparse Matrix, data.frame, data.table or as a path to any of those. To include spatial information about cells (or regions) you need to provide a matrix, data.table or data.frame (or path to them) with coordinates for all spatial dimensions. This can be 2D (x and y) or 3D (x, y, x). The row order for the cell coordinates should be the same as the column order for the provided expression data.

**[Instructions]** Additionally an instruction file, generated manually or with [createGiottoInstructions](#) can be provided to instructions, if not a default instruction file will be created for the Giotto object.

**[Multiple fields]** In case a dataset consists of multiple fields, like seqFISH+ for example, an offset file can be provided to stitch the different fields together. [stitchFieldCoordinates](#) can be used to generate such an offset file.

**[Processed data]** Processed count data, such as normalized data, can be provided using one of the different expression slots (norm\_expr, norm\_scaled\_expr, custom\_expr).

**[Metadata]** Cell and gene metadata can be provided using the cell and gene metadata slots. This data can also be added afterwards using the [addGeneMetadata](#) or [addCellMetadata](#) functions.

**[Other information]** Additional information can be provided through the appropriate slots:

- spatial networks
- spatial girds
- spatial enrichments
- dimensions reductions
- nearest neighbours networks
- images

## Value

giotto object

## Examples

```
createGiottoObject(raw_exprs, spatial_locs)
```

---

```
createGiottoVisiumObject
      createGiottoVisiumObject
```

---

## Description

creates Giotto object directly from a 10X visium folder

## Usage

```
createGiottoVisiumObject(
  visium_dir = NULL,
  expr_data = c("raw", "filter"),
  gene_column_index = 1,
  png_name = NULL,
  xmax_adj = 0,
  xmin_adj = 0,
  ymax_adj = 0,
  ymin_adj = 0,
  instructions = NULL,
  cores = NA
)
```

## Arguments

|                   |   |
|-------------------|---|
| visium_dir        | path to the 10X visium directory [required]   |
| expr_data         | raw or filtered data (see details)  |
| gene_column_index | which column index to select (see details)  |
| png_name          | select name of png to use (see details)   |
| xmax_adj          | adjustment of the maximum x-value to align the image                                |
| xmin_adj          | adjustment of the minimum x-value to align the image                                |
| ymax_adj          | adjustment of the maximum y-value to align the image                                |
| ymin_adj          | adjustment of the minimum y-value to align the image                                |
| instructions      | list of instructions or output result from <a href="#">createGiottoInstructions</a> |
| cores             | how many cores or threads to use to read data if paths are provided                 |

## Details

- `expr_data`: raw will take expression data from `raw_feature_bc_matrix` and filter from `filtered_feature_bc_matrix`
- `gene_column_index`: which gene identifiers (names) to use if there are multiple columns (e.g. ensemble and gene symbol)
- `png_name`: by default the first png will be selected, provide the png name to override this (e.g. myimage.png)

## Value

giotto object

**Examples**

```
createGiottoVisiumObject(visium_dir)
```

---

|                  |                         |
|------------------|-------------------------|
| createHeatmap_DT | <i>createHeatmap_DT</i> |
|------------------|-------------------------|

---

**Description**

creates order for clusters

**Usage**

```
createHeatmap_DT(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  genes,
  cluster_column = NULL,
  cluster_order = c("size", "correlation", "custom"),
  cluster_custom_order = NULL,
  cluster_cor_method = "pearson",
  cluster_hclust_method = "ward.D",
  gene_order = c("correlation", "custom"),
  gene_custom_order = NULL,
  gene_cor_method = "pearson",
  gene_hclust_method = "complete"
)
```

**Arguments**

|                       |  |
|-----------------------|--|
| gobject               | giotto object                                  |
| expression_values     | expression values to use                       |
| genes                 | genes to use                                   |
| cluster_column        | name of column to use for clusters             |
| cluster_order         | method to determine cluster order              |
| cluster_custom_order  | custom order for clusters                      |
| cluster_cor_method    | method for cluster correlation                 |
| cluster_hclust_method | method for hierarchical clustering of clusters |
| gene_order            | method to determine gene order                 |
| gene_custom_order     | custom order for genes                         |
| gene_cor_method       | method for gene correlation                    |
| gene_hclust_method    | method for hierarchical clustering of genes    |



**Details**

Creates input data.tables for plotHeatmap function.

**Value**

list

**Examples**

```
createHeatmap_DT(gobject)
```

---

|                 |                        |
|-----------------|------------------------|
| createMetagenes | <i>createMetagenes</i> |
|-----------------|------------------------|

---

**Description**

This function creates an average metagene for gene clusters.

**Usage**

```
createMetagenes(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  gene_clusters,
  name = "metagene",
  return_gobject = TRUE
)
```

**Arguments**

|                   |                                      |
|-------------------|--------------------------------------|
| gobject           | Giotto object                        |
| expression_values | expression values to use             |
| gene_clusters     | numerical vector with genes as names |
| name              | name of the metagene results         |
| return_gobject    | return giotto object                 |

**Details**

An example for the 'gene\_clusters' could be like this: cluster\_vector = c(1, 1, 2, 2); names(cluster\_vector) = c('geneA', 'geneB', 'geneC', 'geneD')

**Value**

giotto object

**Examples**

```
createMetagenes(gobject)
```

---

```
createNearestNetwork    createNearestNetwork
```

---

## Description

create a nearest neighbour (NN) network

## Usage

```
createNearestNetwork(
  gobject,
  type = c("sNN", "kNN"),
  dim_reduction_to_use = "pca",
  dim_reduction_name = "pca",
  dimensions_to_use = 1:10,
  genes_to_use = NULL,
  expression_values = c("normalized", "scaled", "custom"),
  name = "sNN.pca",
  return_gobject = TRUE,
  k = 30,
  minimum_shared = 5,
  top_shared = 3,
  verbose = T,
  ...
)
```

## Arguments

|                                   |  |
|-----------------------------------|--|
| <code>gobject</code>              | giotto object  |
| <code>type</code>                 | sNN or kNN   |
| <code>dim_reduction_to_use</code> | dimension reduction method to use                                |
| <code>dim_reduction_name</code>   | name of dimension reduction set to use                           |
| <code>dimensions_to_use</code>    | number of dimensions to use as input                             |
| <code>genes_to_use</code>         | if <code>dim_reduction_to_use = NULL</code> , which genes to use |
| <code>expression_values</code>    | expression values to use   |
| <code>name</code>                 | arbitrary name for NN network                                    |
| <code>return_gobject</code>       | boolean: return giotto object (default = TRUE)                   |
| <code>k</code>                    | number of k neighbors to use                                     |
| <code>minimum_shared</code>       | minimum shared neighbors   |
| <code>top_shared</code>           | keep at ...  |
| <code>verbose</code>              | be verbose   |
| <code>...</code>                  | additional parameters for kNN and sNN functions from dbSCAN      |

**Details**

This function creates a k-nearest neighbour (kNN) or shared nearest neighbour (sNN) network based on the provided dimension reduction space. To run it directly on the gene expression matrix set *dim\_reduction\_to\_use* = *NULL*.

See also [kNN](#) and [sNN](#) for more information about how the networks are created.

Output for kNN:

- from: cell\_ID for source cell
- to: cell\_ID for target cell
- distance: distance between cells
- weight: weight =  $1/(1 + \text{distance})$

Output for sNN:

- from: cell\_ID for source cell
- to: cell\_ID for target cell
- distance: distance between cells
- weight:  $1/(1 + \text{distance})$
- shared: number of shared neighbours
- rank: ranking of pairwise cell neighbours

For sNN networks two additional parameters can be set:

- minimum\_shared: minimum number of shared neighbours needed
- top\_shared: keep this number of the top shared neighbours, irrespective of minimum\_shared setting

**Value**

giotto object with updated NN network

**Examples**

```
createNearestNetwork(gobject)
```

---

```
createSpatialDelaunayNetwork
      createSpatialDelaunayNetwork
```

---

**Description**

Create a spatial Delaunay network based on cell centroid physical distances.

**Usage**

```
createSpatialDelaunayNetwork(
  gobject,
  method = c("deldir", "delaunayn_geometry", "RTriangle"),
  dimensions = "all",
  name = "delaunay_network",
  maximum_distance = "auto",
  minimum_k = 0,
  options = "Pp",
  Y = TRUE,
  j = TRUE,
  S = 0,
  verbose = T,
  return_gobject = TRUE,
  ...
)
```

**Arguments**

|                               |  |
|-------------------------------|--|
| <code>gobject</code>          | giotto object  |
| <code>dimensions</code>       | which spatial dimensions to use (default = all)  |
| <code>name</code>             | name for spatial network (default = 'delaunay_network')  |
| <code>maximum_distance</code> | distance cutoff for Delaunay neighbors to consider. If "auto", "upper whisker" value of the distance vector between neighbors is used; see the <code>boxplotgraphics</code> documentation for more details. (default = "auto")   |
| <code>minimum_k</code>        | minimum number of neighbours if <code>maximum_distance</code> != NULL  |
| <code>options</code>          | (geometry) String containing extra control options for the underlying Qhull command; see the Qhull documentation ( <a href="http://doc.qhull/html/qdelaun.html">../doc/qhull/html/qdelaun.html</a> ) for the available options. (default = 'Pp', do not report precision problems) |
| <code>Y</code>                | (RTriangle) If TRUE prohibits the insertion of Steiner points on the mesh boundary.  |
| <code>j</code>                | (RTriangle) If TRUE jettisons vertices that are not part of the final triangulation from the output.   |
| <code>S</code>                | (RTriangle) Specifies the maximum number of added Steiner points.  |
| <code>verbose</code>          | verbose  |
| <code>return_gobject</code>   | boolean: return giotto object (default = TRUE)   |
| <code>...</code>              | Other parameters of the <a href="#">triangulate</a> function   |

**Details**

Creates a spatial Delaunay network as explained in [delaunayn](#) (default), [deldir](#), or [triangulate](#).

**Value**

giotto object with updated spatial network slot

**Examples**

```
createSpatialDelaunayNetwork(gobject)
```

---

```
createSpatialEnrich    createSpatialEnrich
```

---

## Description

Function to calculate gene signature enrichment scores per spatial position using a hypergeometric test.

## Usage

```
createSpatialEnrich(
  gobject,
  enrich_method = c("PAGE", "rank", "hypergeometric"),
  sign_matrix,
  expression_values = c("normalized", "scaled", "custom"),
  reverse_log_scale = TRUE,
  logbase = 2,
  p_value = TRUE,
  n_genes = 100,
  n_times = 1000,
  top_percentage = 5,
  output_enrichment = c("original", "zscore"),
  name = "PAGE",
  return_gobject = TRUE
)
```

## Arguments

|                                |  |
|--------------------------------|--|
| <code>gobject</code>           | Giotto object  |
| <code>enrich_method</code>     | method for gene signature enrichment calculation   |
| <code>sign_matrix</code>       | Matrix of signature genes for each cell type / process   |
| <code>expression_values</code> | expression values to use   |
| <code>reverse_log_scale</code> | reverse expression values from log scale   |
| <code>logbase</code>           | log base to use if <code>reverse_log_scale = TRUE</code>   |
| <code>p_value</code>           | calculate p-value (default = FALSE)  |
| <code>n_times</code>           | (page/rank) number of permutation iterations to calculate p-value                                    |
| <code>top_percentage</code>    | (hyper) percentage of cells that will be considered to have gene expression with matrix binarization |
| <code>output_enrichment</code> | how to return enrichment output  |
| <code>name</code>              | to give to spatial enrichment results, default = PAGE  |
| <code>return_gobject</code>    | return giotto object   |

**Details**

For details see the individual functions:

- PAGE: [PAGEEnrich](#)
- PAGE: [rankEnrich](#)
- PAGE: [hyperGeometricEnrich](#)

**Value**

Giotto object or enrichment results if return\_gobject = FALSE

**Examples**

```
createSpatialEnrich(gobject)
```

---

|                   |                          |
|-------------------|--------------------------|
| createSpatialGrid | <i>createSpatialGrid</i> |
|-------------------|--------------------------|

---

**Description**

Create a spatial grid.

**Usage**

```
createSpatialGrid(
  gobject,
  sdimx_stepsize = NULL,
  sdimy_stepsize = NULL,
  sdimz_stepsize = NULL,
  minimum_padding = 1,
  name = "spatial_grid",
  return_gobject = TRUE
)
```

**Arguments**

|                 |  |
|-----------------|--|
| gobject         | giotto object                                    |
| sdimx_stepsize  | stepsize along the x-axis                        |
| sdimy_stepsize  | stepsize along the y-axis                        |
| sdimz_stepsize  | stepsize along the z-axis                        |
| minimum_padding | minimum padding on the edges                     |
| name            | name for spatial grid (default = 'spatial_grid') |
| return_gobject  | boolean: return giotto object (default = TRUE)   |

**Details**

Creates a spatial grid with defined x, y (and z) dimensions. The dimension units are based on the provided spatial location units.

**Value**

giotto object with updated spatial grid slot

**Examples**

```
createSpatialGrid(gobject)
```

---

```
createSpatialGrid_2D    createSpatialGrid_2D
```

---

**Description**

create a spatial grid for 2D spatial data.

**Usage**

```
createSpatialGrid_2D(
  gobject,
  sdimx_stepsize = NULL,
  sdimy_stepsize = NULL,
  minimum_padding = 1,
  name = "spatial_grid",
  return_gobject = TRUE
)
```

**Arguments**

|                              |  |
|------------------------------|--|
| <code>gobject</code>         | giotto object                                    |
| <code>sdimx_stepsize</code>  | stepsize along the x-axis                        |
| <code>sdimy_stepsize</code>  | stepsize along the y-axis                        |
| <code>minimum_padding</code> | minimum padding on the edges                     |
| <code>name</code>            | name for spatial grid (default = 'spatial_grid') |
| <code>return_gobject</code>  | boolean: return giotto object (default = TRUE)   |

**Details**

Creates a spatial grid with defined x, y (and z) dimensions. The dimension units are based on the provided spatial location units.

**Value**

giotto object with updated spatial grid slot

**Examples**

```
createSpatialGrid_2D(gobject)
```

---

createSpatialGrid\_3D    *createSpatialGrid\_3D*

---

## Description

Create a spatial grid for 3D spatial data.

## Usage

```
createSpatialGrid_3D(
  gobject,
  sdimx_stepsize = NULL,
  sdimy_stepsize = NULL,
  sdimz_stepsize = NULL,
  minimum_padding = 1,
  name = "spatial_grid",
  return_gobject = TRUE
)
```

## Arguments

|                              |  |
|------------------------------|--|
| <code>gobject</code>         | giotto object                                    |
| <code>sdimx_stepsize</code>  | stepsize along the x-axis                        |
| <code>sdimy_stepsize</code>  | stepsize along the y-axis                        |
| <code>sdimz_stepsize</code>  | stepsize along the z-axis                        |
| <code>minimum_padding</code> | minimum padding on the edges                     |
| <code>name</code>            | name for spatial grid (default = 'spatial_grid') |
| <code>return_gobject</code>  | boolean: return giotto object (default = TRUE)   |

## Details

Creates a spatial grid with defined x, y (and z) dimensions. The dimension units are based on the provided spatial location units.

## Value

giotto object with updated spatial grid slot

## Examples

```
createSpatialGrid_3D(gobject)
```



---

```
createSpatialKNNnetwork
      createSpatialKNNnetwork
```

---

## Description

Create a spatial knn network.

## Usage

```
createSpatialKNNnetwork(
  gobject,
  method = "dbscan",
  dimensions = "all",
  name = "knn_network",
  k = 4,
  maximum_distance = NULL,
  minimum_k = 0,
  verbose = F,
  return_gobject = TRUE,
  ...
)
```

## Arguments

|                               |   |
|-------------------------------|---|
| <code>gobject</code>          | giotto object   |
| <code>method</code>           | method to create kNN network  |
| <code>dimensions</code>       | which spatial dimensions to use (default = all)                     |
| <code>name</code>             | name for spatial network (default = 'spatial_network')              |
| <code>k</code>                | number of nearest neighbors based on physical distance              |
| <code>maximum_distance</code> | distance cutoff for nearest neighbors to consider for kNN network   |
| <code>minimum_k</code>        | minimum nearest neighbours if <code>maximum_distance</code> != NULL |
| <code>verbose</code>          | verbose   |
| <code>return_gobject</code>   | boolean: return giotto object (default = TRUE)                      |

## Value

giotto object with updated spatial network slot

**dimensions:** default = 'all' which takes all possible dimensions. Alternatively you can provide a character vector that specifies the spatial dimensions to use, e.g. `c("sdmx", "sdmy")` or a numerical vector, e.g. `2:3`

**maximum\_distance:** to create a network based on maximum distance only, you also need to set `k` to a very high value, e.g. `k = 100`

## Examples

```
createSpatialKNNnetwork(gobject)
```

---

```
createSpatialNetwork  createSpatialNetwork
```

---

## Description

Create a spatial network based on cell centroid physical distances.

## Usage

```
createSpatialNetwork(
  gobject,
  name = NULL,
  dimensions = "all",
  method = c("Delaunay", "kNN"),
  delaunay_method = c("deldir", "delaunayn_geometry", "RTriangle"),
  maximum_distance_delaunay = "auto",
  options = "Pp",
  Y = TRUE,
  j = TRUE,
  S = 0,
  minimum_k = 0,
  knn_method = "dbscan",
  k = 4,
  maximum_distance_knn = NULL,
  verbose = F,
  return_gobject = TRUE,
  ...
)
```

## Arguments

|  |   |
|--|---|
| <code>gobject</code>                   | giotto object   |
| <code>name</code>                      | name for spatial network (default = 'spatial_network')  |
| <code>dimensions</code>                | which spatial dimensions to use (default = all)   |
| <code>method</code>                    | which method to use to create a spatial network. (default = Delaunay)   |
| <code>delaunay_method</code>           | Delaunay method to use  |
| <code>maximum_distance_delaunay</code> | distance cutoff for nearest neighbors to consider for Delaunay network  |
| <code>options</code>                   | (geometry) String containing extra control options for the underlying Qhull command; see the Qhull documentation ( <a href="#">../doc/qhull/html/qdelaun.html</a> ) for the available options. (default = 'Pp', do not report precision problems) |
| <code>Y</code>                         | (RTriangle) If TRUE prohibits the insertion of Steiner points on the mesh boundary.   |
| <code>j</code>                         | (RTriangle) If TRUE jettisons vertices that are not part of the final triangulation from the output.  |
| <code>S</code>                         | (RTriangle) Specifies the maximum number of added Steiner points.   |
| <code>minimum_k</code>                 | minimum nearest neighbours if maximum_distance != NULL  |

|                      |   |
|----------------------|---|
| knn_method           | method to create kNN network                                      |
| k                    | number of nearest neighbors based on physical distance            |
| maximum_distance_knn | distance cutoff for nearest neighbors to consider for kNN network |
| verbose              | verbose   |
| return_gobject       | boolean: return giotto object (default = TRUE)                    |

## Details

Creates a spatial network connecting single-cells based on their physical distance to each other. For Delaunay method, neighbors will be decided by delaunay triangulation and a maximum distance criteria. For kNN method, number of neighbors can be determined by k, or maximum distance from each cell with or without setting a minimum k for each cell.

**dimensions:** default = 'all' which takes all possible dimensions. Alternatively you can provide a character vector that specifies the spatial dimensions to use, e.g. c("sdimx", "sdimy") or a numerical vector, e.g. 2:3

## Value

giotto object with updated spatial network slot

## Examples

```
createSpatialNetwork(gobject)
```

---

```
create_2d_mesh_grid_line_obj
      create_2d_mesh_grid_line_obj
```

---

## Description

create 2d mesh grid line object

## Usage

```
create_2d_mesh_grid_line_obj(x_min, x_max, y_min, y_max, mesh_grid_n)
```

---

```
create_average_detection_DT
      create_average_detection_DT
```

---

### Description

calculates average gene detection for a cell metadata factor (e.g. cluster)

### Usage

```
create_average_detection_DT(
  gobject,
  meta_data_name,
  expression_values = c("normalized", "scaled", "custom"),
  detection_threshold = 0
)
```

### Arguments

```
gobject          giotto object
meta_data_name   name of metadata column to use
expression_values
                  which expression values to use
detection_threshold
                  detection threshold to consider a gene detected
```

### Value

data.table with average gene expression values for each factor

---

```
create_average_DT      create_average_DT
```

---

### Description

calculates average gene expression for a cell metadata factor (e.g. cluster)

### Usage

```
create_average_DT(
  gobject,
  meta_data_name,
  expression_values = c("normalized", "scaled", "custom")
)
```

### Arguments

```
gobject          giotto object
meta_data_name   name of metadata column to use
expression_values
                  which expression values to use
```

**Value**

data.table with average gene expression values for each factor

---

```
create_cell_type_random_cell_IDs  
      create_cell_type_random_cell_IDs
```

---

**Description**

creates randomized cell ids within a selection of cell types

**Usage**

```
create_cell_type_random_cell_IDs(  
  gobject,  
  cluster_column = "cell_types",  
  needed_cell_types  
)
```

**Arguments**

`gobject`                giotto object to use

`cluster_column`   cluster column with cell type information

`needed_cell_types`  
                      vector of cell type names for which a random id will be found

**Details**

Details will follow.

**Value**

list of randomly sampled cell ids with same cell type composition

**Examples**

```
create_cell_type_random_cell_IDs(gobject)
```

---

`create_cluster_matrix` *create\_cluster\_matrix*

---

**Description**

creates aggregated matrix for a given clustering

**Usage**

```
create_cluster_matrix(  
  gobject,  
  expression_values = c("normalized", "scaled", "custom"),  
  cluster_column,  
  gene_subset = NULL  
)
```

**Examples**

```
create_cluster_matrix(gobject)
```

---

`create_crossSection_object`  
*create\_crossSection\_object*

---

**Description**

create a crossSection object

**Usage**

```
create_crossSection_object(  
  name = NULL,  
  method = NULL,  
  thickness_unit = NULL,  
  slice_thickness = NULL,  
  plane_equation = NULL,  
  mesh_grid_n = NULL,  
  mesh_obj = NULL,  
  cell_subset = NULL,  
  cell_subset_spatial_locations = NULL,  
  cell_subset_projection_locations = NULL,  
  cell_subset_projection_PCA = NULL,  
  cell_subset_projection_coords = NULL  
)
```

---

```
create_delaunayNetwork2D  
    create_delaunayNetwork2D
```

---

### Description

Create a spatial Delaunay network.

### Usage

```
create_delaunayNetwork2D(  
  gobject,  
  method = c("delaunayn_geometry", "RTriangle", "deldir"),  
  sdimx = "sdimx",  
  sdimy = "sdimy",  
  name = "delaunay_network",  
  maximum_distance = "auto",  
  minimum_k = 0,  
  options = "Pp",  
  Y = TRUE,  
  j = TRUE,  
  S = 0,  
  verbose = T,  
  return_gobject = TRUE,  
  ...  
)
```

### Examples

```
create_delaunayNetwork2D(gobject)
```

---

```
create_delaunayNetwork3D  
    create_delaunayNetwork3D
```

---

### Description

Create a spatial Delaunay network.

### Usage

```
create_delaunayNetwork3D(  
  gobject,  
  method = "delaunayn_geometry",  
  sdimx = "sdimx",  
  sdimy = "sdimy",  
  sdimz = "sdimz",  
  name = "delaunay_network_3D",  
  maximum_distance = "auto",
```

```

    minimum_k = 0,
    options = "Pp",
    return_gobject = TRUE,
    ...
)

```

### Examples

```
create_delaunayNetwork3D(gobject)
```

---

```

create_delaunayNetwork_deldir
    create_delaunayNetwork_deldir

```

---

### Description

Create a spatial Delaunay network.

### Usage

```

create_delaunayNetwork_deldir(
  spatial_locations,
  sdimx = "sdimx",
  sdimy = "sdimy",
  ...
)

```

### Examples

```
create_delaunayNetwork_deldir(gobject)
```

---

```

create_delaunayNetwork_geometry
    create_delaunayNetwork_geometry

```

---

### Description

Create a spatial Delaunay network.

### Usage

```

create_delaunayNetwork_geometry(
  spatial_locations,
  sdimx = "sdimx",
  sdimy = "sdimy",
  options = "Pp",
  ...
)

```

### Examples

```
create_delaunayNetwork_geometry(gobject)
```



---

```
create_delaunayNetwork_geometry_3D  
    create_delaunayNetwork_geometry_3D
```

---

### Description

Create a spatial Delaunay network.

### Usage

```
create_delaunayNetwork_geometry_3D(  
  spatial_locations,  
  sdimx = "sdimx",  
  sdimy = "sdimy",  
  sdimz = "sdimz",  
  options = options,  
  ...  
)
```

### Examples

```
create_delaunayNetwork_geometry_3D(gobject)
```

---

```
create_delaunayNetwork_RTriangle  
    create_delaunayNetwork_RTriangle
```

---

### Description

Create a spatial Delaunay network.

### Usage

```
create_delaunayNetwork_RTriangle(  
  spatial_locations,  
  sdimx = "sdimx",  
  sdimy = "sdimy",  
  Y = TRUE,  
  j = TRUE,  
  S = 0,  
  ...  
)
```

### Examples

```
create_delaunayNetwork_RTriangle(gobject)
```

---

|                  |                         |
|------------------|-------------------------|
| create_dimObject | <i>create_dimObject</i> |
|------------------|-------------------------|

---

**Description**

Creates an object that stores a dimension reduction output

**Usage**

```
create_dimObject(
  name = "test",
  reduction_method = NULL,
  coordinates = NULL,
  misc = NULL,
  my_rownames = NULL
)
```

**Arguments**

|                  |   |
|------------------|---|
| name             | arbitrary name for object                             |
| reduction_method | method used to reduce dimensions                      |
| coordinates      | accepts the coordinates after dimension reduction     |
| misc             | any additional information will be added to this slot |

**Value**

number of distinct colors

---

|                            |                                   |
|----------------------------|-----------------------------------|
| create_genes_to_use_matrix | <i>create_genes_to_use_matrix</i> |
|----------------------------|-----------------------------------|

---

**Description**

subsets matrix based on vector of genes or hvg column

**Usage**

```
create_genes_to_use_matrix(gobject, sel_matrix, genes_to_use, verbose = TRUE)
```

**Arguments**

|              |  |
|--------------|--|
| gobject      | giotto object                              |
| sel_matrix   | selected expression matrix                 |
| genes_to_use | genes to use, character or vector of genes |
| verbose      | verbosity                                  |

**Value**

subsetting matrix based on selected genes

---

```
create_jackstrawplot  create_jackstrawplot
```

---

**Description**

create jackstrawplot with ggplot

**Usage**

```
create_jackstrawplot(
  jackstraw_data,
  ncp = 20,
  ylim = c(0, 1),
  threshold = 0.01
)
```

**Arguments**

|                |   |
|----------------|---|
| jackstraw_data | result from jackstraw function              |
| ncp            | number of principal components to calculate |
| ylim           | y-axis limits on jackstraw plot             |
| p-value        | threshold to call a PC significant          |

**Value**

ggplot

---

```
create_KNNnetwork_dbscan
      create_KNNnetwork_dbscan
```

---

**Description**

Create a spatial knn network.

**Usage**

```
create_KNNnetwork_dbscan(
  spatial_locations,
  sdimx = "sdimx",
  sdimy = "sdimy",
  sdimz = "sdimz",
  k = 4,
  ...
)
```

**Examples**

```
create_KNNnetwork_dbscan(gobject)
```

---

|                        |                               |
|------------------------|-------------------------------|
| create_mesh_grid_lines |                               |
|                        | <i>create_mesh_grid_lines</i> |

---

**Description**

create mesh grid lines for cross section

**Usage**

```
create_mesh_grid_lines(  
  cell_subset_projection_locations,  
  extend_ratio,  
  mesh_grid_n  
)
```

---

|                  |                         |
|------------------|-------------------------|
| create_screepLOT | <i>create_screepLOT</i> |
|------------------|-------------------------|

---

**Description**

create screepLOT with ggplot

**Usage**

```
create_screepLOT(pca_obj, ncp = 20, ylim = c(0, 20))
```

**Arguments**

|         |   |
|---------|---|
| pca_obj | pca dimension reduction object              |
| ncp     | number of principal components to calculate |
| ylim    | y-axis limits on scree plot                 |

**Value**

ggplot

---

```
create_spatialNetworkObject
      create_spatialNetworkObject
```

---

### Description

creates a spatial network object to store the created spatial network and additional information

### Usage

```
create_spatialNetworkObject(
  name = NULL,
  method = NULL,
  parameters = NULL,
  outputObj = NULL,
  networkDT = NULL,
  cellShapeObj = NULL,
  networkDT_before_filter = NULL,
  crossSectionObjects = NULL,
  misc = NULL
)
```

---

```
crossSectionGenePlot  crossSectionGenePlot
```

---

### Description

Visualize cells and gene expression in a virtual cross section according to spatial coordinates

### Usage

```
crossSectionGenePlot(
  gobject = NULL,
  crossSection_obj = NULL,
  name = NULL,
  spatial_network_name = "Delaunay_network",
  expression_values = c("normalized", "scaled", "custom"),
  genes,
  genes_high_color = "red",
  genes_mid_color = "white",
  genes_low_color = "darkblue",
  show_network = F,
  network_color = NULL,
  edge_alpha = NULL,
  show_grid = F,
  grid_color = NULL,
  spatial_grid_name = "spatial_grid",
  midpoint = 0,
  scale_alpha_with_expression = FALSE,
```

```

point_shape = c("border", "no_border"),
point_size = 1,
point_border_col = "black",
point_border_stroke = 0.1,
show_legend = T,
legend_text = 8,
background_color = "white",
axis_text = 8,
axis_title = 8,
cow_n_col = 2,
cow_rel_h = 1,
cow_rel_w = 1,
cow_align = "h",
show_plot = NA,
return_plot = NA,
save_plot = NA,
save_param = list(),
default_save_name = "crossSectionGenePlot"
)

```

### Arguments

|  |  |
|--|--|
| <code>gobject</code>                     | giotto object                                  |
| <code>name</code>                        | name of virtual cross section to use           |
| <code>spatial_network_name</code>        | name of spatial network to use                 |
| <code>expression_values</code>           | gene expression values to use                  |
| <code>genes</code>                       | genes to show                                  |
| <code>genes_high_color</code>            | color represents high gene expression          |
| <code>genes_mid_color</code>             | color represents middle gene expression        |
| <code>genes_low_color</code>             | color represents low gene expression           |
| <code>show_network</code>                | show underlying spatial network                |
| <code>network_color</code>               | color of spatial network                       |
| <code>show_grid</code>                   | show spatial grid                              |
| <code>grid_color</code>                  | color of spatial grid                          |
| <code>spatial_grid_name</code>           | name of spatial grid to use                    |
| <code>midpoint</code>                    | expression midpoint                            |
| <code>scale_alpha_with_expression</code> | scale expression with ggplot alpha parameter   |
| <code>point_shape</code>                 | point with border or not (border or no_border) |
| <code>point_size</code>                  | size of point (cell)                           |
| <code>point_border_col</code>            | color of border around points                  |

|                     |  |
|---------------------|--|
| point_border_stroke | stroke size of border around points  |
| show_legend         | show legend  |
| legend_text         | size of legend text  |
| background_color    | color of plot background   |
| axis_text           | size of axis text  |
| axis_title          | size of axis title   |
| cow_n_col           | cowplot param: how many columns  |
| cow_rel_h           | cowplot param: relative height   |
| cow_rel_w           | cowplot param: relative width  |
| cow_align           | cowplot param: how to align  |
| show_plot           | show plots   |
| return_plot         | return ggplot object   |
| save_plot           | directly save the plot [boolean]   |
| save_param          | list of saving parameters from <a href="#">all_plots_save_function</a>     |
| default_save_name   | default save name for saving, don't change, change save_name in save_param |
| ...                 | parameters for cowplot::save_plot()  |

**Details**

Description of parameters.

**Value**

ggplot

**See Also**

[spatGenePlot3D](#) and [spatGenePlot2D](#)

**Examples**

```
crossSectionGenePlot(gobject)
```

---

crossSectionGenePlot3D

*crossSectionGenePlot3D*

---

**Description**

Visualize cells and gene expression in a virtual cross section according to spatial coordinates

**Usage**

```

crossSectionGenePlot3D(
  gobject,
  crossSection_obj = NULL,
  name = NULL,
  spatial_network_name = "Delaunay_network",
  expression_values = c("normalized", "scaled", "custom"),
  genes,
  show_network = F,
  network_color = NULL,
  edge_alpha = NULL,
  show_grid = F,
  cluster_column = NULL,
  select_cell_groups = NULL,
  select_cells = NULL,
  show_other_cells = T,
  other_cell_color = alpha("lightgrey", 0),
  other_point_size = 1,
  genes_high_color = "red",
  genes_mid_color = "white",
  genes_low_color = "darkblue",
  spatial_grid_name = "spatial_grid",
  point_size = 2,
  show_legend = T,
  axis_scale = c("cube", "real", "custom"),
  custom_ratio = NULL,
  x_ticks = NULL,
  y_ticks = NULL,
  z_ticks = NULL,
  show_plot = NA,
  return_plot = NA,
  save_plot = NA,
  save_param = list(),
  default_save_name = "crossSectionGenePlot3D"
)

```

**Arguments**

|                                   |                                       |
|-----------------------------------|---------------------------------------|
| <code>gobject</code>              | giotto object                         |
| <code>name</code>                 | name of virtual cross section to use  |
| <code>spatial_network_name</code> | name of spatial network to use        |
| <code>expression_values</code>    | gene expression values to use         |
| <code>genes</code>                | genes to show                         |
| <code>show_network</code>         | show underlying spatial network       |
| <code>network_color</code>        | color of spatial network              |
| <code>show_grid</code>            | show spatial grid                     |
| <code>genes_high_color</code>     | color represents high gene expression |



|                             |  |
|-----------------------------|--|
| genes_mid_color             | color represents middle gene expression                                    |
| genes_low_color             | color represents low gene expression                                       |
| spatial_grid_name           | name of spatial grid to use  |
| point_size                  | size of point (cell)   |
| show_legend                 | show legend  |
| show_plot                   | show plots   |
| return_plot                 | return ggplot object   |
| save_plot                   | directly save the plot [boolean]   |
| save_param                  | list of saving parameters from <a href="#">all_plots_save_function</a>     |
| default_save_name           | default save name for saving, don't change, change save_name in save_param |
| grid_color                  | color of spatial grid  |
| midpoint                    | expression midpoint  |
| scale_alpha_with_expression | scale expression with ggplot alpha parameter                               |
| ...                         | parameters for cowplot::save_plot()  |

**Details**

Description of parameters.

**Value**

ggplot

**Examples**

```
crossSectionGenePlot3D(gobject)
```

---

|                  |                         |
|------------------|-------------------------|
| crossSectionPlot | <i>crossSectionPlot</i> |
|------------------|-------------------------|

---

**Description**

Visualize cells in a virtual cross section according to spatial coordinates

**Usage**

```
crossSectionPlot(
  gobject,
  crossSection_obj = NULL,
  name = NULL,
  spatial_network_name = "Delaunay_network",
  group_by = NULL,
  group_by_subset = NULL,
```

```

sdimx = "sdimx",
sdimy = "sdimy",
spat_enr_names = NULL,
cell_color = NULL,
color_as_factor = T,
cell_color_code = NULL,
cell_color_gradient = c("blue", "white", "red"),
gradient_midpoint = NULL,
gradient_limits = NULL,
select_cell_groups = NULL,
select_cells = NULL,
point_shape = c("border", "no_border"),
point_size = 3,
point_border_col = "black",
point_border_stroke = 0.1,
show_cluster_center = F,
show_center_label = F,
center_point_size = 4,
center_point_border_col = "black",
center_point_border_stroke = 0.1,
label_size = 4,
label_fontface = "bold",
show_network = F,
network_color = NULL,
network_alpha = 1,
show_grid = F,
spatial_grid_name = "spatial_grid",
grid_color = NULL,
show_other_cells = T,
other_cell_color = "lightgrey",
other_point_size = 1,
other_cells_alpha = 0.1,
coord_fix_ratio = NULL,
title = NULL,
show_legend = T,
legend_text = 8,
legend_symbol_size = 1,
background_color = "white",
axis_text = 8,
axis_title = 8,
cow_n_col = 2,
cow_rel_h = 1,
cow_rel_w = 1,
cow_align = "h",
show_plot = NA,
return_plot = NA,
save_plot = NA,
save_param = list(),
default_save_name = "crossSectionPlot"
)

```

**Arguments**

|                                   |  |
|-----------------------------------|--|
| <code>gobject</code>              | giotto object  |
| <code>name</code>                 | name of virtual cross section to use                                       |
| <code>spatial_network_name</code> | name of spatial network to use   |
| <code>group_by_subset</code>      | subset the <code>group_by</code> factor column                             |
| <code>sdimx</code>                | x-axis dimension name (default = 'sdimx')                                  |
| <code>sdimy</code>                | y-axis dimension name (default = 'sdimy')                                  |
| <code>spat_enr_names</code>       | names of spatial enrichment results to include                             |
| <code>cell_color</code>           | color for cells (see details)  |
| <code>color_as_factor</code>      | convert color column to factor   |
| <code>cell_color_code</code>      | named vector with colors   |
| <code>cell_color_gradient</code>  | vector with 3 colors for numeric data                                      |
| <code>gradient_midpoint</code>    | midpoint for color gradient  |
| <code>gradient_limits</code>      | vector with lower and upper limits   |
| <code>select_cell_groups</code>   | select subset of cells/clusters based on <code>cell_color</code> parameter |
| <code>select_cells</code>         | select subset of cells based on cell IDs                                   |
| <code>point_shape</code>          | point with border or not (border or no_border)                             |
| <code>point_size</code>           | size of point (cell)   |
| <code>point_border_col</code>     | color of border around points  |
| <code>point_border_stroke</code>  | stroke size of border around points  |
| <code>show_cluster_center</code>  | plot center of selected clusters   |
| <code>show_center_label</code>    | plot label of selected clusters  |
| <code>center_point_size</code>    | size of center points  |
| <code>label_size</code>           | size of labels   |
| <code>label_fontface</code>       | font of labels   |
| <code>show_network</code>         | show underlying spatial network  |
| <code>network_color</code>        | color of spatial network   |
| <code>network_alpha</code>        | alpha of spatial network   |
| <code>show_grid</code>            | show spatial grid  |
| <code>spatial_grid_name</code>    | name of spatial grid to use  |
| <code>grid_color</code>           | color of spatial grid  |

|                    |  |
|--------------------|--|
| show_other_cells   | display not selected cells   |
| other_cell_color   | color of not selected cells  |
| other_point_size   | point size of not selected cells   |
| other_cells_alpha  | alpha of not selected cells  |
| coord_fix_ratio    | fix ratio between x and y-axis   |
| title              | title of plot  |
| show_legend        | show legend  |
| legend_text        | size of legend text  |
| legend_symbol_size | size of legend symbols   |
| background_color   | color of plot background   |
| axis_text          | size of axis text  |
| axis_title         | size of axis title   |
| cow_n_col          | cowplot param: how many columns  |
| cow_rel_h          | cowplot param: relative height   |
| cow_rel_w          | cowplot param: relative width  |
| cow_align          | cowplot param: how to align  |
| show_plot          | show plot  |
| return_plot        | return ggplot object   |
| save_plot          | directly save the plot [boolean]   |
| save_param         | list of saving parameters from <a href="#">all_plots_save_function</a>     |
| default_save_name  | default save name for saving, don't change, change save_name in save_param |
| groub_by           | create multiple plots based on cell annotation column                      |

## Details

Description of parameters.

## Value

ggplot

## See Also

[crossSectionPlot](#)

---

|                    |                           |
|--------------------|---------------------------|
| crossSectionPlot3D | <i>crossSectionPlot3D</i> |
|--------------------|---------------------------|

---

## Description

Visualize cells in a virtual cross section according to spatial coordinates

## Usage

```
crossSectionPlot3D(
  gobject,
  crossSection_obj = NULL,
  name = NULL,
  spatial_network_name = "Delaunay_network",
  sdimx = "sdimx",
  sdimy = "sdimy",
  sdimz = "sdimz",
  point_size = 3,
  cell_color = NULL,
  cell_color_code = NULL,
  select_cell_groups = NULL,
  show_other_cells = T,
  other_cell_color = alpha("lightgrey", 0),
  other_point_size = 0.5,
  show_network = F,
  network_color = NULL,
  network_alpha = 1,
  other_cell_alpha = 0.5,
  show_grid = F,
  grid_color = NULL,
  spatial_grid_name = "spatial_grid",
  title = "",
  show_legend = T,
  axis_scale = c("cube", "real", "custom"),
  custom_ratio = NULL,
  x_ticks = NULL,
  y_ticks = NULL,
  z_ticks = NULL,
  show_plot = NA,
  return_plot = NA,
  save_plot = NA,
  save_param = list(),
  default_save_name = "crossSection3D"
)
```

## Arguments

|                                   |                                      |
|-----------------------------------|--------------------------------------|
| <code>gobject</code>              | giotto object                        |
| <code>name</code>                 | name of virtual cross section to use |
| <code>spatial_network_name</code> | name of spatial network to use       |

|                                 |  |
|---------------------------------|--|
| <code>sdimx</code>              | x-axis dimension name (default = 'sdimx')  |
| <code>sdimy</code>              | y-axis dimension name (default = 'sdimy')  |
| <code>sdimz</code>              | z-axis dimension name (default = 'sdimy')  |
| <code>point_size</code>         | size of point (cell)   |
| <code>cell_color</code>         | color for cells (see details)  |
| <code>cell_color_code</code>    | named vector with colors   |
| <code>select_cell_groups</code> | select subset of cells/clusters based on <code>cell_color</code> parameter                           |
| <code>show_other_cells</code>   | display not selected cells   |
| <code>other_cell_color</code>   | color of not selected cells  |
| <code>other_point_size</code>   | point size of not selected cells   |
| <code>network_color</code>      | color of spatial network   |
| <code>show_grid</code>          | show spatial grid  |
| <code>grid_color</code>         | color of spatial grid  |
| <code>spatial_grid_name</code>  | name of spatial grid to use  |
| <code>title</code>              | title of plot  |
| <code>show_legend</code>        | show legend  |
| <code>axis_scale</code>         | the way to scale the axis  |
| <code>custom_ratio</code>       | customize the scale of the plot  |
| <code>x_ticks</code>            | set the number of ticks on the x-axis  |
| <code>y_ticks</code>            | set the number of ticks on the y-axis  |
| <code>z_ticks</code>            | set the number of ticks on the z-axis  |
| <code>show_plot</code>          | show plot  |
| <code>return_plot</code>        | return ggplot object   |
| <code>save_plot</code>          | directly save the plot [boolean]   |
| <code>save_param</code>         | list of saving parameters from <a href="#">all_plots_save_function</a>                               |
| <code>default_save_name</code>  | default save name for saving, don't change, change <code>save_name</code> in <code>save_param</code> |

## Details

Description of parameters.

## Value

ggplot

## Examples

```
crossSectionPlot3D(gobject)
```

---

|                      |                             |
|----------------------|-----------------------------|
| decide_cluster_order | <i>decide_cluster_order</i> |
|----------------------|-----------------------------|

---

## Description

creates order for clusters

## Usage

```
decide_cluster_order(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  genes,
  cluster_column = NULL,
  cluster_order = c("size", "correlation", "custom"),
  cluster_custom_order = NULL,
  cor_method = "pearson",
  hclust_method = "ward.D"
)
```

## Arguments

|                                   |                                    |
|-----------------------------------|------------------------------------|
| <code>gobject</code>              | giotto object                      |
| <code>expression_values</code>    | expression values to use           |
| <code>genes</code>                | genes to use                       |
| <code>cluster_column</code>       | name of column to use for clusters |
| <code>cluster_order</code>        | method to determine cluster order  |
| <code>cluster_custom_order</code> | custom order for clusters          |
| <code>cor_method</code>           | method for correlation             |
| <code>hclust_method</code>        | method for hierarchical clustering |

## Details

Calculates order for clusters.

## Value

custom

## Examples

```
decide_cluster_order(gobject)
```

---

detectSpatialCorGenes    *detectSpatialCorGenes*

---

## Description

Detect genes that are spatially correlated

## Usage

```
detectSpatialCorGenes(
  gobject,
  method = c("grid", "network"),
  expression_values = c("normalized", "scaled", "custom"),
  subset_genes = NULL,
  spatial_network_name = "Delaunay_network",
  network_smoothing = NULL,
  spatial_grid_name = "spatial_grid",
  min_cells_per_grid = 4,
  cor_method = c("pearson", "kendall", "spearman")
)
```

## Arguments

|                      |   |
|----------------------|---|
| gobject              | giotto object   |
| method               | method to use for spatial averaging                   |
| expression_values    | gene expression values to use                         |
| subset_genes         | subset of genes to use                                |
| spatial_network_name | name of spatial network to use                        |
| network_smoothing    | smoothing factor between 0 and 1 (default: automatic) |
| spatial_grid_name    | name of spatial grid to use                           |
| min_cells_per_grid   | minimum number of cells to consider a grid            |
| b                    | smoothing factor between 0 and 1 (default: automatic) |

## Details

For method = network, it expects a fully connected spatial network. You can make sure to create a fully connected network by setting `minimal_k > 0` in the [createSpatialNetwork](#) function.

- 1. grid-averaging: average gene expression values within a predefined spatial grid
- 2. network-averaging: smoothens the gene expression matrix by averaging the expression within one cell by using the neighbours within the predefined spatial network. `b` is a smoothening factor that defaults to  $1 - 1/k$ , where `k` is the median number of `k`-neighbors in the selected spatial network. Setting `b = 0` means no smoothing and `b = 1` means no contribution from its own expression.

The `spatCorObject` can be further explored with `showSpatialCorGenes()`



**Value**

returns a spatial correlation object: "spatCorObject"

**See Also**

[showSpatialCorGenes](#)

**Examples**

```
detectSpatialCorGenes(gobject)
```

---

detectSpatialPatterns    *detectSpatialPatterns*

---

**Description**

Identify spatial patterns through PCA on average expression in a spatial grid.

**Usage**

```
detectSpatialPatterns(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  spatial_grid_name = "spatial_grid",
  min_cells_per_grid = 4,
  scale_unit = F,
  ncp = 100,
  show_plot = T,
  PC_zscore = 1.5
)
```

**Arguments**

|                                 |  |
|---------------------------------|--|
| <code>gobject</code>            | giotto object  |
| <code>expression_values</code>  | expression values to use                               |
| <code>spatial_grid_name</code>  | name of spatial grid to use (default = 'spatial_grid') |
| <code>min_cells_per_grid</code> | minimum number of cells in a grid to be considered     |
| <code>scale_unit</code>         | scale features   |
| <code>ncp</code>                | number of principal components to calculate            |
| <code>show_plot</code>          | show plots   |
| <code>PC_zscore</code>          | minimum z-score of variance explained by a PC          |

## Details

Steps to identify spatial patterns:

- 1. average gene expression for cells within a grid, see createSpatialGrid
- 2. perform PCA on the average grid expression profiles
- 3. convert variance of principal components (PCs) to z-scores and select PCs based on a z-score threshold

## Value

spatial pattern object 'spatPatObj'

## Examples

```
detectSpatialPatterns(gobject)
```

---

|             |                    |
|-------------|--------------------|
| dimCellPlot | <i>dimCellPlot</i> |
|-------------|--------------------|

---

## Description

Visualize cells according to dimension reduction coordinates

## Usage

```
dimCellPlot(
  gobject,
  dim_reduction_to_use = "umap",
  dim_reduction_name = "umap",
  dim1_to_use = 1,
  dim2_to_use = 2,
  spat_enr_names = NULL,
  cell_annotation_values = NULL,
  show_NN_network = F,
  nn_network_to_use = "sNN",
  network_name = "sNN.pca",
  cell_color_gradient = c("blue", "white", "red"),
  gradient_midpoint = NULL,
  gradient_limits = NULL,
  select_cell_groups = NULL,
  select_cells = NULL,
  show_other_cells = T,
  other_cell_color = "lightgrey",
  other_point_size = 0.5,
  show_cluster_center = F,
  show_center_label = T,
  center_point_size = 4,
  center_point_border_col = "black",
  center_point_border_stroke = 0.1,
  label_size = 4,
  label_fontface = "bold",
```

```

    edge_alpha = NULL,
    point_shape = c("border", "no_border"),
    point_size = 1,
    point_alpha = 1,
    point_border_col = "black",
    point_border_stroke = 0.1,
    show_legend = T,
    legend_text = 8,
    legend_symbol_size = 1,
    background_color = "white",
    axis_text = 8,
    axis_title = 8,
    cow_n_col = 2,
    cow_rel_h = 1,
    cow_rel_w = 1,
    cow_align = "h",
    show_plot = NA,
    return_plot = NA,
    save_plot = NA,
    save_param = list(),
    default_save_name = "dimCellPlot"
)

```

### Arguments

|                                     |  |
|-------------------------------------|--|
| <code>gobject</code>                | giotto object  |
| <code>dim_reduction_to_use</code>   | dimension reduction to use   |
| <code>dim_reduction_name</code>     | dimension reduction name   |
| <code>dim1_to_use</code>            | dimension to use on x-axis   |
| <code>dim2_to_use</code>            | dimension to use on y-axis   |
| <code>spat_enr_names</code>         | names of spatial enrichment results to include                             |
| <code>cell_annotation_values</code> | numeric cell annotation columns  |
| <code>show_NN_network</code>        | show underlying NN network   |
| <code>nn_network_to_use</code>      | type of NN network to use (kNN vs sNN)                                     |
| <code>network_name</code>           | name of NN network to use, if <code>show_NN_network = TRUE</code>          |
| <code>cell_color_gradient</code>    | vector with 3 colors for numeric data                                      |
| <code>gradient_midpoint</code>      | midpoint for color gradient  |
| <code>gradient_limits</code>        | vector with lower and upper limits   |
| <code>select_cell_groups</code>     | select subset of cells/clusters based on <code>cell_color</code> parameter |
| <code>select_cells</code>           | select subset of cells based on cell IDs                                   |

|                     |  |
|---------------------|--|
| show_other_cells    | display not selected cells   |
| other_cell_color    | color of not selected cells  |
| other_point_size    | size of not selected cells   |
| show_cluster_center | plot center of selected clusters   |
| show_center_label   | plot label of selected clusters  |
| center_point_size   | size of center points  |
| label_size          | size of labels   |
| label_fontface      | font of labels   |
| edge_alpha          | column to use for alpha of the edges                                       |
| point_shape         | point with border or not (border or no_border)                             |
| point_size          | size of point (cell)   |
| point_alpha         | transparency of dim. reduction points                                      |
| point_border_col    | color of border around points  |
| point_border_stroke | stroke size of border around points  |
| show_legend         | show legend  |
| legend_text         | size of legend text  |
| legend_symbol_size  | size of legend symbols   |
| background_color    | color of plot background   |
| axis_text           | size of axis text  |
| axis_title          | size of axis title   |
| show_plot           | show plot  |
| return_plot         | return ggplot object   |
| save_plot           | directly save the plot [boolean]   |
| save_param          | list of saving parameters from <a href="#">all_plots_save_function</a>     |
| default_save_name   | default save name for saving, don't change, change save_name in save_param |
| cell_color          | color for cells (see details)  |
| color_as_factor     | convert color column to factor   |
| cell_color_code     | named vector with colors   |
| title               | title for plot, defaults to cell_color parameter                           |

## Details

Description of parameters. For 3D plots see [dimCellPlot2D](#)

**Value**

ggplot

**Examples**

```
dimCellPlot(gobject)
```

---

dimCellPlot2D

*dimCellPlot2D*


---

**Description**

Visualize cells according to dimension reduction coordinates

**Usage**

```
dimCellPlot2D(
  gobject,
  dim_reduction_to_use = "umap",
  dim_reduction_name = "umap",
  dim1_to_use = 1,
  dim2_to_use = 2,
  spat_enr_names = NULL,
  cell_annotation_values = NULL,
  show_NN_network = F,
  nn_network_to_use = "sNN",
  network_name = "sNN.pca",
  cell_color_gradient = c("blue", "white", "red"),
  gradient_midpoint = NULL,
  gradient_limits = NULL,
  select_cell_groups = NULL,
  select_cells = NULL,
  show_other_cells = T,
  other_cell_color = "lightgrey",
  other_point_size = 0.5,
  show_cluster_center = F,
  show_center_label = T,
  center_point_size = 4,
  center_point_border_col = "black",
  center_point_border_stroke = 0.1,
  label_size = 4,
  label_fontface = "bold",
  edge_alpha = NULL,
  point_shape = c("border", "no_border"),
  point_size = 1,
  point_alpha = 1,
  point_border_col = "black",
  point_border_stroke = 0.1,
  show_legend = T,
  legend_text = 8,
  legend_symbol_size = 1,
```

```

background_color = "white",
axis_text = 8,
axis_title = 8,
cow_n_col = 2,
cow_rel_h = 1,
cow_rel_w = 1,
cow_align = "h",
show_plot = NA,
return_plot = NA,
save_plot = NA,
save_param = list(),
default_save_name = "dimCellPlot2D"
)

```

### Arguments

|                                     |  |
|-------------------------------------|--|
| <code>gobject</code>                | giotto object  |
| <code>dim_reduction_to_use</code>   | dimension reduction to use   |
| <code>dim_reduction_name</code>     | dimension reduction name   |
| <code>dim1_to_use</code>            | dimension to use on x-axis   |
| <code>dim2_to_use</code>            | dimension to use on y-axis   |
| <code>spat_enr_names</code>         | names of spatial enrichment results to include                             |
| <code>cell_annotation_values</code> | numeric cell annotation columns  |
| <code>show_NN_network</code>        | show underlying NN network   |
| <code>nn_network_to_use</code>      | type of NN network to use (kNN vs sNN)                                     |
| <code>network_name</code>           | name of NN network to use, if <code>show_NN_network = TRUE</code>          |
| <code>cell_color_gradient</code>    | vector with 3 colors for numeric data                                      |
| <code>gradient_midpoint</code>      | midpoint for color gradient  |
| <code>gradient_limits</code>        | vector with lower and upper limits   |
| <code>select_cell_groups</code>     | select subset of cells/clusters based on <code>cell_color</code> parameter |
| <code>select_cells</code>           | select subset of cells based on cell IDs                                   |
| <code>show_other_cells</code>       | display not selected cells   |
| <code>other_cell_color</code>       | color of not selected cells  |
| <code>other_point_size</code>       | size of not selected cells   |
| <code>show_cluster_center</code>    | plot center of selected clusters   |
| <code>show_center_label</code>      | plot label of selected clusters  |

|                     |  |
|---------------------|--|
| center_point_size   | size of center points  |
| label_size          | size of labels   |
| label_fontface      | font of labels   |
| edge_alpha          | column to use for alpha of the edges                                       |
| point_shape         | point with border or not (border or no_border)                             |
| point_size          | size of point (cell)   |
| point_alpha         | transparency of dim. reduction points                                      |
| point_border_col    | color of border around points  |
| point_border_stroke | stroke size of border around points  |
| show_legend         | show legend  |
| legend_text         | size of legend text  |
| legend_symbol_size  | size of legend symbols   |
| background_color    | color of plot background   |
| axis_text           | size of axis text  |
| axis_title          | size of axis title   |
| show_plot           | show plot  |
| return_plot         | return ggplot object   |
| save_plot           | directly save the plot [boolean]   |
| save_param          | list of saving parameters from <a href="#">all_plots_save_function</a>     |
| default_save_name   | default save name for saving, don't change, change save_name in save_param |
| cell_color          | color for cells (see details)  |
| color_as_factor     | convert color column to factor   |
| cell_color_code     | named vector with colors   |
| title               | title for plot, defaults to cell_color parameter                           |

## Details

Description of parameters. For 3D plots see [dimPlot3D](#)

## Value

ggplot

## Examples

```
dimCellPlot2D(gobject)
```

dimGenePlot

*dimGenePlot***Description**

Visualize cells and gene expression according to dimension reduction coordinates

**Usage**

```
dimGenePlot(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  genes = NULL,
  dim_reduction_to_use = "umap",
  dim_reduction_name = "umap",
  dim1_to_use = 1,
  dim2_to_use = 2,
  show_NN_network = F,
  nn_network_to_use = "sNN",
  network_name = "sNN.pca",
  network_color = "lightgray",
  edge_alpha = NULL,
  scale_alpha_with_expression = FALSE,
  point_shape = c("border", "no_border"),
  point_size = 1,
  point_alpha = 1,
  cell_color_gradient = c("blue", "white", "red"),
  gradient_midpoint = NULL,
  gradient_limits = NULL,
  point_border_col = "black",
  point_border_stroke = 0.1,
  show_legend = T,
  legend_text = 8,
  background_color = "white",
  axis_text = 8,
  axis_title = 8,
  cow_n_col = 2,
  cow_rel_h = 1,
  cow_rel_w = 1,
  cow_align = "h",
  show_plot = NA,
  return_plot = NA,
  save_plot = NA,
  save_param = list(),
  default_save_name = "dimGenePlot"
)
```

**Arguments**

gobject

giotto object



|                             |  |
|-----------------------------|--|
| expression_values           | gene expression values to use  |
| genes                       | genes to show  |
| dim_reduction_to_use        | dimension reduction to use   |
| dim_reduction_name          | dimension reduction name   |
| dim1_to_use                 | dimension to use on x-axis   |
| dim2_to_use                 | dimension to use on y-axis   |
| show_NN_network             | show underlying NN network   |
| nn_network_to_use           | type of NN network to use (kNN vs sNN)                                     |
| network_name                | name of NN network to use, if show_NN_network = TRUE                       |
| edge_alpha                  | column to use for alpha of the edges                                       |
| scale_alpha_with_expression | scale expression with ggplot alpha parameter                               |
| point_size                  | size of point (cell)   |
| point_alpha                 | transparency of points   |
| cell_color_gradient         | vector with 3 colors for numeric data                                      |
| gradient_midpoint           | midpoint for color gradient  |
| gradient_limits             | vector with lower and upper limits   |
| point_border_col            | color of border around points  |
| point_border_stroke         | stroke size of border around points  |
| show_legend                 | show legend  |
| cow_n_col                   | cowplot param: how many columns  |
| cow_rel_h                   | cowplot param: relative height   |
| cow_rel_w                   | cowplot param: relative width  |
| cow_align                   | cowplot param: how to align  |
| show_plot                   | show plots   |
| return_plot                 | return ggplot object   |
| save_plot                   | directly save the plot [boolean]   |
| save_param                  | list of saving parameters from <a href="#">all_plots_save_function</a>     |
| default_save_name           | default save name for saving, don't change, change save_name in save_param |
| ...                         | parameters for cowplot::save_plot()  |

## Details

Description of parameters.

**Value**

ggplot

**See Also**[dimGenePlot3D](#)**Examples**

```
dimGenePlot(gobject)
```

---

dimGenePlot2D

---

*dimGenePlot2D*


---

**Description**

Visualize cells and gene expression according to dimension reduction coordinates

**Usage**

```
dimGenePlot2D(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  genes = NULL,
  dim_reduction_to_use = "umap",
  dim_reduction_name = "umap",
  dim1_to_use = 1,
  dim2_to_use = 2,
  show_NN_network = F,
  nn_network_to_use = "sNN",
  network_name = "sNN.pca",
  network_color = "lightgray",
  edge_alpha = NULL,
  scale_alpha_with_expression = FALSE,
  point_shape = c("border", "no_border"),
  point_size = 1,
  point_alpha = 1,
  cell_color_gradient = c("blue", "white", "red"),
  gradient_midpoint = NULL,
  gradient_limits = NULL,
  point_border_col = "black",
  point_border_stroke = 0.1,
  show_legend = T,
  legend_text = 8,
  background_color = "white",
  axis_text = 8,
  axis_title = 8,
  cow_n_col = 2,
  cow_rel_h = 1,
  cow_rel_w = 1,
  cow_align = "h",
```

```

    show_plot = NA,
    return_plot = NA,
    save_plot = NA,
    save_param = list(),
    default_save_name = "dimGenePlot2D"
)

```

### Arguments

|  |   |
|--|---|
| <code>gobject</code>                     | giotto object   |
| <code>expression_values</code>           | gene expression values to use                                     |
| <code>genes</code>                       | genes to show   |
| <code>dim_reduction_to_use</code>        | dimension reduction to use  |
| <code>dim_reduction_name</code>          | dimension reduction name  |
| <code>dim1_to_use</code>                 | dimension to use on x-axis  |
| <code>dim2_to_use</code>                 | dimension to use on y-axis  |
| <code>show_NN_network</code>             | show underlying NN network  |
| <code>nn_network_to_use</code>           | type of NN network to use (kNN vs sNN)                            |
| <code>network_name</code>                | name of NN network to use, if <code>show_NN_network = TRUE</code> |
| <code>edge_alpha</code>                  | column to use for alpha of the edges                              |
| <code>scale_alpha_with_expression</code> | scale expression with ggplot alpha parameter                      |
| <code>point_shape</code>                 | point with border or not (border or no_border)                    |
| <code>point_size</code>                  | size of point (cell)  |
| <code>point_alpha</code>                 | transparancy of points  |
| <code>cell_color_gradient</code>         | vector with 3 colors for numeric data                             |
| <code>gradient_midpoint</code>           | midpoint for color gradient                                       |
| <code>gradient_limits</code>             | vector with lower and upper limits                                |
| <code>point_border_col</code>            | color of border around points                                     |
| <code>point_border_stroke</code>         | stroke size of border around points                               |
| <code>show_legend</code>                 | show legend   |
| <code>legend_text</code>                 | size of legend text   |
| <code>background_color</code>            | color of plot background  |
| <code>axis_text</code>                   | size of axis text   |
| <code>axis_title</code>                  | size of axis title  |
| <code>cow_n_col</code>                   | cowplot param: how many columns                                   |

|                   |  |
|-------------------|--|
| cow_rel_h         | cowplot param: relative height   |
| cow_rel_w         | cowplot param: relative width  |
| cow_align         | cowplot param: how to align  |
| show_plot         | show plots   |
| return_plot       | return ggplot object   |
| save_plot         | directly save the plot [boolean]   |
| save_param        | list of saving parameters from <a href="#">all_plots_save_function</a>     |
| default_save_name | default save name for saving, don't change, change save_name in save_param |
| ...               | parameters for cowplot::save_plot()  |

Details

Description of parameters.

Value

ggplot

See Also

[dimGenePlot3D](#)

Examples

dimGenePlot2D(gobject)

---

|               |                      |
|---------------|----------------------|
| dimGenePlot3D | <i>dimGenePlot3D</i> |
|---------------|----------------------|

---

Description

Visualize cells and gene expression according to dimension reduction coordinates

Usage

```
dimGenePlot3D(  
  gobject,  
  expression_values = c("normalized", "scaled", "custom"),  
  genes = NULL,  
  dim_reduction_to_use = "umap",  
  dim_reduction_name = "umap",  
  dim1_to_use = 1,  
  dim2_to_use = 2,  
  dim3_to_use = 3,  
  show_NN_network = F,  
  nn_network_to_use = "sNN",  
  network_name = "sNN.pca",  
  network_color = "lightgray",  
  cluster_column = NULL,
```

```

    select_cell_groups = NULL,
    select_cells = NULL,
    show_other_cells = T,
    other_cell_color = "lightgrey",
    other_point_size = 1,
    edge_alpha = NULL,
    point_size = 2,
    genes_high_color = NULL,
    genes_mid_color = "white",
    genes_low_color = "blue",
    show_legend = T,
    show_plot = NA,
    return_plot = NA,
    save_plot = NA,
    save_param = list(),
    default_save_name = "dimGenePlot3D"
)

```

### Arguments

|                                   |  |
|-----------------------------------|--|
| <code>gobject</code>              | giotto object  |
| <code>expression_values</code>    | gene expression values to use  |
| <code>genes</code>                | genes to show  |
| <code>dim_reduction_to_use</code> | dimension reduction to use   |
| <code>dim_reduction_name</code>   | dimension reduction name   |
| <code>dim1_to_use</code>          | dimension to use on x-axis   |
| <code>dim2_to_use</code>          | dimension to use on y-axis   |
| <code>dim3_to_use</code>          | dimension to use on z-axis   |
| <code>show_NN_network</code>      | show underlying NN network   |
| <code>nn_network_to_use</code>    | type of NN network to use (kNN vs sNN)   |
| <code>network_name</code>         | name of NN network to use, if <code>show_NN_network = TRUE</code>                                    |
| <code>edge_alpha</code>           | column to use for alpha of the edges   |
| <code>point_size</code>           | size of point (cell)   |
| <code>show_legend</code>          | show legend  |
| <code>show_plot</code>            | show plots   |
| <code>return_plot</code>          | return ggplot object   |
| <code>save_plot</code>            | directly save the plot [boolean]   |
| <code>save_param</code>           | list of saving parameters from <a href="#">all_plots_save_function</a>                               |
| <code>default_save_name</code>    | default save name for saving, don't change, change <code>save_name</code> in <code>save_param</code> |
| <code>...</code>                  | parameters for <code>cowplot::save_plot()</code>   |

**Details**

Description of parameters.

**Value**

ggplot

**Examples**

dimGenePlot3D(gobject)

---

|         |                |
|---------|----------------|
| dimPlot | <i>dimPlot</i> |
|---------|----------------|

---

**Description**

Visualize cells according to dimension reduction coordinates

**Usage**

```
dimPlot(  
  gobject,  
  group_by = NULL,  
  group_by_subset = NULL,  
  dim_reduction_to_use = "umap",  
  dim_reduction_name = "umap",  
  dim1_to_use = 1,  
  dim2_to_use = 2,  
  spat_enr_names = NULL,  
  show_NN_network = F,  
  nn_network_to_use = "sNN",  
  network_name = "sNN.pca",  
  cell_color = NULL,  
  color_as_factor = T,  
  cell_color_code = NULL,  
  cell_color_gradient = c("blue", "white", "red"),  
  gradient_midpoint = NULL,  
  gradient_limits = NULL,  
  select_cell_groups = NULL,  
  select_cells = NULL,  
  show_other_cells = T,  
  other_cell_color = "lightgrey",  
  other_point_size = 0.5,  
  show_cluster_center = F,  
  show_center_label = T,  
  center_point_size = 4,  
  center_point_border_col = "black",  
  center_point_border_stroke = 0.1,  
  label_size = 4,  
  label_fontface = "bold",  
  edge_alpha = NULL,  
)
```

```

point_shape = c("border", "no_border"),
point_size = 1,
point_alpha = 1,
point_border_col = "black",
point_border_stroke = 0.1,
show_legend = T,
legend_text = 8,
legend_symbol_size = 1,
background_color = "white",
axis_text = 8,
axis_title = 8,
title = NULL,
cow_n_col = 2,
cow_rel_h = 1,
cow_rel_w = 1,
cow_align = "h",
show_plot = NA,
return_plot = NA,
save_plot = NA,
save_param = list(),
default_save_name = "dimPlot"
)

```

## Arguments

|                                   |   |
|-----------------------------------|---|
| <code>gobject</code>              | giotto object   |
| <code>group_by_subset</code>      | subset the <code>group_by</code> factor column                    |
| <code>dim_reduction_to_use</code> | dimension reduction to use  |
| <code>dim_reduction_name</code>   | dimension reduction name  |
| <code>dim1_to_use</code>          | dimension to use on x-axis  |
| <code>dim2_to_use</code>          | dimension to use on y-axis  |
| <code>spat_enr_names</code>       | names of spatial enrichment results to include                    |
| <code>show_NN_network</code>      | show underlying NN network  |
| <code>nn_network_to_use</code>    | type of NN network to use (kNN vs sNN)                            |
| <code>network_name</code>         | name of NN network to use, if <code>show_NN_network = TRUE</code> |
| <code>cell_color</code>           | color for cells (see details)                                     |
| <code>color_as_factor</code>      | convert color column to factor                                    |
| <code>cell_color_code</code>      | named vector with colors  |
| <code>cell_color_gradient</code>  | vector with 3 colors for numeric data                             |
| <code>gradient_midpoint</code>    | midpoint for color gradient                                       |

|                     |  |
|---------------------|--|
| gradient_limits     | vector with lower and upper limits   |
| select_cell_groups  | select subset of cells/clusters based on cell_color parameter              |
| select_cells        | select subset of cells based on cell IDs                                   |
| show_other_cells    | display not selected cells   |
| other_cell_color    | color of not selected cells  |
| other_point_size    | size of not selected cells   |
| show_cluster_center | plot center of selected clusters   |
| show_center_label   | plot label of selected clusters  |
| center_point_size   | size of center points  |
| label_size          | size of labels   |
| label_fontface      | font of labels   |
| edge_alpha          | column to use for alpha of the edges                                       |
| point_shape         | point with border or not (border or no_border)                             |
| point_size          | size of point (cell)   |
| point_alpha         | transparency of point  |
| point_border_col    | color of border around points  |
| point_border_stroke | stroke size of border around points  |
| show_legend         | show legend  |
| legend_text         | size of legend text  |
| legend_symbol_size  | size of legend symbols   |
| background_color    | color of plot background   |
| axis_text           | size of axis text  |
| axis_title          | size of axis title   |
| title               | title for plot, defaults to cell_color parameter                           |
| cow_n_col           | cowplot param: how many columns  |
| cow_rel_h           | cowplot param: relative height   |
| cow_rel_w           | cowplot param: relative width  |
| cow_align           | cowplot param: how to align  |
| show_plot           | show plot  |
| return_plot         | return ggplot object   |
| save_plot           | directly save the plot [boolean]   |
| save_param          | list of saving parameters from <a href="#">all_plots_save_function</a>     |
| default_save_name   | default save name for saving, don't change, change save_name in save_param |
| groub_by            | create multiple plots based on cell annotation column                      |



**Details**

Description of parameters, see [dimPlot2D](#). For 3D plots see [dimPlot3D](#)

**Value**

ggplot

**Examples**

```
dimPlot(gobject)
```

---

|           |                  |
|-----------|------------------|
| dimPlot2D | <i>dimPlot2D</i> |
|-----------|------------------|

---

**Description**

Visualize cells according to dimension reduction coordinates

**Usage**

```
dimPlot2D(
  gobject,
  group_by = NULL,
  group_by_subset = NULL,
  dim_reduction_to_use = "umap",
  dim_reduction_name = "umap",
  dim1_to_use = 1,
  dim2_to_use = 2,
  spat_enr_names = NULL,
  show_NN_network = F,
  nn_network_to_use = "sNN",
  network_name = "sNN.pca",
  cell_color = NULL,
  color_as_factor = T,
  cell_color_code = NULL,
  cell_color_gradient = c("blue", "white", "red"),
  gradient_midpoint = NULL,
  gradient_limits = NULL,
  select_cell_groups = NULL,
  select_cells = NULL,
  show_other_cells = T,
  other_cell_color = "lightgrey",
  other_point_size = 0.5,
  show_cluster_center = F,
  show_center_label = T,
  center_point_size = 4,
  center_point_border_col = "black",
  center_point_border_stroke = 0.1,
  label_size = 4,
  label_fontface = "bold",
  edge_alpha = NULL,
```

```

point_shape = c("border", "no_border"),
point_size = 1,
point_alpha = 1,
point_border_col = "black",
point_border_stroke = 0.1,
title = NULL,
show_legend = T,
legend_text = 8,
legend_symbol_size = 1,
background_color = "white",
axis_text = 8,
axis_title = 8,
cow_n_col = 2,
cow_rel_h = 1,
cow_rel_w = 1,
cow_align = "h",
show_plot = NA,
return_plot = NA,
save_plot = NA,
save_param = list(),
default_save_name = "dimPlot2D"
)

```

### Arguments

|                                   |   |
|-----------------------------------|---|
| <code>gobject</code>              | giotto object   |
| <code>group_by_subset</code>      | subset the <code>group_by</code> factor column                    |
| <code>dim_reduction_to_use</code> | dimension reduction to use  |
| <code>dim_reduction_name</code>   | dimension reduction name  |
| <code>dim1_to_use</code>          | dimension to use on x-axis  |
| <code>dim2_to_use</code>          | dimension to use on y-axis  |
| <code>spat_enr_names</code>       | names of spatial enrichment results to include                    |
| <code>show_NN_network</code>      | show underlying NN network  |
| <code>nn_network_to_use</code>    | type of NN network to use (kNN vs sNN)                            |
| <code>network_name</code>         | name of NN network to use, if <code>show_NN_network = TRUE</code> |
| <code>cell_color</code>           | color for cells (see details)                                     |
| <code>color_as_factor</code>      | convert color column to factor                                    |
| <code>cell_color_code</code>      | named vector with colors  |
| <code>cell_color_gradient</code>  | vector with 3 colors for numeric data                             |
| <code>gradient_midpoint</code>    | midpoint for color gradient                                       |

|                     |  |
|---------------------|--|
| gradient_limits     | vector with lower and upper limits   |
| select_cell_groups  | select subset of cells/clusters based on cell_color parameter              |
| select_cells        | select subset of cells based on cell IDs                                   |
| show_other_cells    | display not selected cells   |
| other_cell_color    | color of not selected cells  |
| other_point_size    | size of not selected cells   |
| show_cluster_center | plot center of selected clusters   |
| show_center_label   | plot label of selected clusters  |
| center_point_size   | size of center points  |
| label_size          | size of labels   |
| label_fontface      | font of labels   |
| edge_alpha          | column to use for alpha of the edges                                       |
| point_shape         | point with border or not (border or no_border)                             |
| point_size          | size of point (cell)   |
| point_alpha         | transparency of point  |
| point_border_col    | color of border around points  |
| point_border_stroke | stroke size of border around points  |
| title               | title for plot, defaults to cell_color parameter                           |
| show_legend         | show legend  |
| legend_text         | size of legend text  |
| legend_symbol_size  | size of legend symbols   |
| background_color    | color of plot background   |
| axis_text           | size of axis text  |
| axis_title          | size of axis title   |
| cow_n_col           | cowplot param: how many columns  |
| cow_rel_h           | cowplot param: relative height   |
| cow_rel_w           | cowplot param: relative width  |
| cow_align           | cowplot param: how to align  |
| show_plot           | show plot  |
| return_plot         | return ggplot object   |
| save_plot           | directly save the plot [boolean]   |
| save_param          | list of saving parameters from <a href="#">all_plots_save_function</a>     |
| default_save_name   | default save name for saving, don't change, change save_name in save_param |
| groub_by            | create multiple plots based on cell annotation column                      |

**Details**

Description of parameters. For 3D plots see [dimPlot3D](#)

**Value**

ggplot

**Examples**

```
dimPlot2D(gobject)
```

---

|                  |                         |
|------------------|-------------------------|
| dimPlot2D_single | <i>dimPlot2D_single</i> |
|------------------|-------------------------|

---

**Description**

Visualize cells according to dimension reduction coordinates

**Usage**

```
dimPlot2D_single(
  gobject,
  dim_reduction_to_use = "umap",
  dim_reduction_name = "umap",
  dim1_to_use = 1,
  dim2_to_use = 2,
  spat_enr_names = NULL,
  show_NN_network = F,
  nn_network_to_use = "sNN",
  network_name = "sNN.pca",
  cell_color = NULL,
  color_as_factor = T,
  cell_color_code = NULL,
  cell_color_gradient = c("blue", "white", "red"),
  gradient_midpoint = NULL,
  gradient_limits = NULL,
  select_cell_groups = NULL,
  select_cells = NULL,
  show_other_cells = T,
  other_cell_color = "lightgrey",
  other_point_size = 0.5,
  show_cluster_center = F,
  show_center_label = T,
  center_point_size = 4,
  center_point_border_col = "black",
  center_point_border_stroke = 0.1,
  label_size = 4,
  label_fontface = "bold",
  edge_alpha = NULL,
  point_shape = c("border", "no_border"),
  point_size = 1,
```

```

    point_alpha = 1,
    point_border_col = "black",
    point_border_stroke = 0.1,
    title = NULL,
    show_legend = T,
    legend_text = 8,
    legend_symbol_size = 1,
    background_color = "white",
    axis_text = 8,
    axis_title = 8,
    show_plot = NA,
    return_plot = NA,
    save_plot = NA,
    save_param = list(),
    default_save_name = "dimPlot2D_single"
)

```

### Arguments

|                                   |  |
|-----------------------------------|--|
| <code>gobject</code>              | giotto object  |
| <code>dim_reduction_to_use</code> | dimension reduction to use   |
| <code>dim_reduction_name</code>   | dimension reduction name   |
| <code>dim1_to_use</code>          | dimension to use on x-axis   |
| <code>dim2_to_use</code>          | dimension to use on y-axis   |
| <code>spat_enr_names</code>       | names of spatial enrichment results to include                             |
| <code>show_NN_network</code>      | show underlying NN network   |
| <code>nn_network_to_use</code>    | type of NN network to use (kNN vs sNN)                                     |
| <code>network_name</code>         | name of NN network to use, if <code>show_NN_network = TRUE</code>          |
| <code>cell_color</code>           | color for cells (see details)  |
| <code>color_as_factor</code>      | convert color column to factor   |
| <code>cell_color_code</code>      | named vector with colors   |
| <code>cell_color_gradient</code>  | vector with 3 colors for numeric data                                      |
| <code>gradient_midpoint</code>    | midpoint for color gradient  |
| <code>gradient_limits</code>      | vector with lower and upper limits   |
| <code>select_cell_groups</code>   | select subset of cells/clusters based on <code>cell_color</code> parameter |
| <code>select_cells</code>         | select subset of cells based on cell IDs                                   |
| <code>show_other_cells</code>     | display not selected cells   |
| <code>other_cell_color</code>     | color of not selected cells  |

|                     |  |
|---------------------|--|
| other_point_size    | size of not selected cells   |
| show_cluster_center | plot center of selected clusters   |
| show_center_label   | plot label of selected clusters  |
| center_point_size   | size of center points  |
| label_size          | size of labels   |
| label_fontface      | font of labels   |
| edge_alpha          | column to use for alpha of the edges                                       |
| point_shape         | point with border or not (border or no_border)                             |
| point_size          | size of point (cell)   |
| point_alpha         | transparency of point  |
| point_border_col    | color of border around points  |
| point_border_stroke | stroke size of border around points  |
| title               | title for plot, defaults to cell_color parameter                           |
| show_legend         | show legend  |
| legend_text         | size of legend text  |
| legend_symbol_size  | size of legend symbols   |
| background_color    | color of plot background   |
| axis_text           | size of axis text  |
| axis_title          | size of axis title   |
| show_plot           | show plot  |
| return_plot         | return ggplot object   |
| save_plot           | directly save the plot [boolean]   |
| save_param          | list of saving parameters from <a href="#">all_plots_save_function</a>     |
| default_save_name   | default save name for saving, don't change, change save_name in save_param |

## Details

Description of parameters. For 3D plots see [dimPlot3D](#)

## Value

ggplot

## Examples

```
dimPlot2D_single(gobject)
```

---

dimPlot3D

*dimPlot3D*


---

## Description

Visualize cells according to dimension reduction coordinates

## Usage

```
dimPlot3D(
  gobject,
  dim_reduction_to_use = "umap",
  dim_reduction_name = "umap",
  dim1_to_use = 1,
  dim2_to_use = 2,
  dim3_to_use = 3,
  select_cell_groups = NULL,
  select_cells = NULL,
  show_other_cells = T,
  other_cell_color = "lightgrey",
  other_point_size = 2,
  show_NN_network = F,
  nn_network_to_use = "sNN",
  network_name = "sNN.pca",
  color_as_factor = T,
  cell_color = NULL,
  cell_color_code = NULL,
  show_cluster_center = F,
  show_center_label = T,
  center_point_size = 4,
  label_size = 4,
  edge_alpha = NULL,
  point_size = 3,
  show_plot = NA,
  return_plot = NA,
  save_plot = NA,
  save_param = list(),
  default_save_name = "dim3D"
)
```

## Arguments

|                                   |                            |
|-----------------------------------|----------------------------|
| <code>gobject</code>              | giotto object              |
| <code>dim_reduction_to_use</code> | dimension reduction to use |
| <code>dim_reduction_name</code>   | dimension reduction name   |
| <code>dim1_to_use</code>          | dimension to use on x-axis |
| <code>dim2_to_use</code>          | dimension to use on y-axis |
| <code>dim3_to_use</code>          | dimension to use on z-axis |

|                                  |  |
|----------------------------------|--|
| <code>select_cell_groups</code>  | select subset of cells/clusters based on <code>cell_color</code> parameter                           |
| <code>select_cells</code>        | select subset of cells based on cell IDs   |
| <code>show_other_cells</code>    | display not selected cells   |
| <code>other_cell_color</code>    | color of not selected cells  |
| <code>other_point_size</code>    | size of not selected cells   |
| <code>show_NN_network</code>     | show underlying NN network   |
| <code>nn_network_to_use</code>   | type of NN network to use (kNN vs sNN)   |
| <code>network_name</code>        | name of NN network to use, if <code>show_NN_network = TRUE</code>                                    |
| <code>color_as_factor</code>     | convert color column to factor   |
| <code>cell_color</code>          | color for cells (see details)  |
| <code>cell_color_code</code>     | named vector with colors   |
| <code>show_cluster_center</code> | plot center of selected clusters   |
| <code>show_center_label</code>   | plot label of selected clusters  |
| <code>center_point_size</code>   | size of center points  |
| <code>label_size</code>          | size of labels   |
| <code>edge_alpha</code>          | column to use for alpha of the edges   |
| <code>point_size</code>          | size of point (cell)   |
| <code>show_plot</code>           | show plot  |
| <code>return_plot</code>         | return ggplot object   |
| <code>save_plot</code>           | directly save the plot [boolean]   |
| <code>save_param</code>          | list of saving parameters from <a href="#">all_plots_save_function</a>                               |
| <code>default_save_name</code>   | default save name for saving, don't change, change <code>save_name</code> in <code>save_param</code> |
| <code>show_legend</code>         | show legend  |

### Details

Description of parameters.

### Value

plotly

### Examples

```
dimPlot3D(gobject)
```



---

|          |                 |
|----------|-----------------|
| doHclust | <i>doHclust</i> |
|----------|-----------------|

---

## Description

cluster cells using hierarchical clustering algorithm

## Usage

```
doHclust(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  genes_to_use = NULL,
  dim_reduction_to_use = c("cells", "pca", "umap", "tsne"),
  dim_reduction_name = "pca",
  dimensions_to_use = 1:10,
  distance_method = c("pearson", "spearman", "original", "euclidean", "maximum",
    "manhattan", "canberra", "binary", "minkowski"),
  agglomeration_method = c("ward.D2", "ward.D", "single", "complete", "average",
    "mcquitty", "median", "centroid"),
  k = 10,
  h = NULL,
  name = "hclust",
  return_gobject = TRUE,
  set_seed = T,
  seed_number = 1234
)
```

## Arguments

|                      |  |
|----------------------|--|
| gobject              | giotto object                                  |
| expression_values    | expression values to use                       |
| genes_to_use         | subset of genes to use                         |
| dim_reduction_to_use | dimension reduction to use                     |
| dim_reduction_name   | dimensions reduction name                      |
| dimensions_to_use    | dimensions to use                              |
| distance_method      | distance method                                |
| agglomeration_method | agglomeration method for hclust                |
| k                    | number of final clusters                       |
| h                    | cut hierarchical tree at height = h            |
| name                 | name for hierarchical clustering               |
| return_gobject       | boolean: return giotto object (default = TRUE) |
| set_seed             | set seed                                       |
| seed_number          | number for seed                                |

**Details**

Description on how to use Kmeans clustering method.

**Value**

giotto object with new clusters appended to cell metadata

**See Also**

[hclust](#)

**Examples**

```
doHclust(gobject)
```

---

|        |               |
|--------|---------------|
| doHMRF | <i>doHMRF</i> |
|--------|---------------|

---

**Description**

Run HMRF

**Usage**

```
doHMRF(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  spatial_network_name = "Delaunay_network",
  spatial_genes = NULL,
  spatial_dimensions = c("sdimx", "sdimy", "sdimz"),
  dim_reduction_to_use = NULL,
  dim_reduction_name = "pca",
  dimensions_to_use = 1:10,
  name = "test",
  k = 10,
  betas = c(0, 2, 50),
  tolerance = 1e-10,
  zscore = c("none", "rowcol", "colrow"),
  numinit = 100,
  python_path = NULL,
  output_folder = NULL,
  overwrite_output = TRUE
)
```

**Arguments**

|                                   |   |
|-----------------------------------|---|
| <code>gobject</code>              | giotto object                           |
| <code>expression_values</code>    | expression values to use                |
| <code>spatial_network_name</code> | name of spatial network to use for HMRF |

spatial\_genes    spatial genes to use for HMRF  
spatial\_dimensions    select spatial dimensions to use, default is all possible dimensions  
dim\_reduction\_to\_use    use another dimension reduction set as input  
dim\_reduction\_name    name of dimension reduction set to use  
dimensions\_to\_use    number of dimensions to use as input  
name    name of HMRF run  
k    number of HMRF domains  
betas    betas to test for  
tolerance    tolerance  
zscore    zscore  
numinit    number of initializations  
python\_path    python path to use  
output\_folder    output folder to save results  
overwrite\_output    overwrite output folder

Details

Description of HMRF parameters ...

Value

Creates a directory with results that can be viewed with viewHMRResults

Examples

doHMRF(gobject)

---

|          |                 |
|----------|-----------------|
| doKmeans | <i>doKmeans</i> |
|----------|-----------------|

---

Description

cluster cells using kmeans algorithm

Usage

```
doKmeans(  
  gobject,  
  expression_values = c("normalized", "scaled", "custom"),  
  genes_to_use = NULL,  
  dim_reduction_to_use = c("cells", "pca", "umap", "tsne"),  
  dim_reduction_name = "pca",  
  dimensions_to_use = 1:10,  
  distance_method = c("original", "pearson", "spearman", "euclidean", "maximum",
```

```

    "manhattan", "canberra", "binary", "minkowski"),
  centers = 10,
  iter_max = 100,
  nstart = 1000,
  algorithm = "Hartigan-Wong",
  name = "kmeans",
  return_gobject = TRUE,
  set_seed = T,
  seed_number = 1234
)

```

### Arguments

|                                   |  |
|-----------------------------------|--|
| <code>gobject</code>              | giotto object                                  |
| <code>expression_values</code>    | expression values to use                       |
| <code>genes_to_use</code>         | subset of genes to use                         |
| <code>dim_reduction_to_use</code> | dimension reduction to use                     |
| <code>dim_reduction_name</code>   | dimensions reduction name                      |
| <code>dimensions_to_use</code>    | dimensions to use                              |
| <code>distance_method</code>      | distance method                                |
| <code>centers</code>              | number of final clusters                       |
| <code>iter_max</code>             | kmeans maximum iterations                      |
| <code>nstart</code>               | kmeans nstart                                  |
| <code>algorithm</code>            | kmeans algorithm                               |
| <code>name</code>                 | name for kmeans clustering                     |
| <code>return_gobject</code>       | boolean: return giotto object (default = TRUE) |
| <code>set_seed</code>             | set seed                                       |
| <code>seed_number</code>          | number for seed                                |

### Details

Description on how to use Kmeans clustering method.

### Value

giotto object with new clusters appended to cell metadata

### See Also

[kmeans](#)

### Examples

```
doKmeans(gobject)
```

doLeidenCluster

*doLeidenCluster***Description**

cluster cells using a NN-network and the Leiden community detection algorithm

**Usage**

```
doLeidenCluster(
  gobject,
  name = "leiden_clus",
  nn_network_to_use = "sNN",
  network_name = "sNN.pca",
  python_path = NULL,
  resolution = 1,
  weight_col = "weight",
  partition_type = c("RBConfigurationVertexPartition", "ModularityVertexPartition"),
  init_membership = NULL,
  n_iterations = 1000,
  return_gobject = TRUE,
  set_seed = T,
  seed_number = 1234,
  ...
)
```

**Arguments**

|                                |  |
|--------------------------------|--|
| <code>gobject</code>           | giotto object  |
| <code>name</code>              | name for cluster   |
| <code>nn_network_to_use</code> | type of NN network to use (kNN vs sNN)   |
| <code>network_name</code>      | name of NN network to use  |
| <code>python_path</code>       | specify specific path to python if required  |
| <code>resolution</code>        | resolution   |
| <code>weight_col</code>        | weight column to use for edges   |
| <code>partition_type</code>    | The type of partition to use for optimisation.   |
| <code>init_membership</code>   | initial membership of cells for the partition  |
| <code>n_iterations</code>      | number of iterations to run the Leiden algorithm. If the number of iterations is negative, the Leiden algorithm is run until an iteration in which there was no improvement. |
| <code>return_gobject</code>    | boolean: return giotto object (default = TRUE)   |
| <code>set_seed</code>          | set seed   |
| <code>seed_number</code>       | number for seed  |

## Details

This function is a wrapper for the Leiden algorithm implemented in python, which can detect communities in graphs of millions of nodes (cells), as long as they can fit in memory. See the <https://github.com/vtraag/leidenalg> github page or the <https://leidenalg.readthedocs.io/en/stable/index.html> readthedocs page for more information.

Partition types available and information:

- **RBConfigurationVertexPartition**: Implements Reichardt and Bornholdt's Potts model with a configuration null model. This quality function is well-defined only for positive edge weights. This quality function uses a linear resolution parameter.
- **ModularityVertexPartition**: Implements modularity. This quality function is well-defined only for positive edge weights. It does *not* use the resolution parameter

Set `weight_col = NULL` to give equal weight (=1) to each edge.

## Value

giotto object with new clusters appended to cell metadata

## Examples

```
doLeidenCluster(gobject)
```

---

|                    |                           |
|--------------------|---------------------------|
| doLeidenSubCluster | <i>doLeidenSubCluster</i> |
|--------------------|---------------------------|

---

## Description

Further subcluster cells using a NN-network and the Leiden algorithm

## Usage

```
doLeidenSubCluster(
  gobject,
  name = "sub_pleiden_clus",
  cluster_column = NULL,
  selected_clusters = NULL,
  hvg_param = list(reverse_log_scale = T, difference_in_variance = 1, expression_values
    = "normalized"),
  hvg_min_perc_cells = 5,
  hvg_mean_expr_det = 1,
  use_all_genes_as_hvg = FALSE,
  min_nr_of_hvg = 5,
  pca_param = list(expression_values = "normalized", scale_unit = T),
  nn_param = list(dimensions_to_use = 1:20),
  k_neighbors = 10,
  resolution = 0.5,
  n_iterations = 500,
  python_path = NULL,
  nn_network_to_use = "sNN",
  network_name = "sNN.pca",
```

```

    return_gobject = TRUE,
    verbose = T
)
```

### Arguments

|                                   |   |
|-----------------------------------|---|
| <code>gobject</code>              | giotto object   |
| <code>name</code>                 | name for new clustering result                                    |
| <code>cluster_column</code>       | cluster column to subcluster                                      |
| <code>selected_clusters</code>    | only do subclustering on these clusters                           |
| <code>hvg_param</code>            | parameters for calculateHVG                                       |
| <code>hvg_min_perc_cells</code>   | threshold for detection in min percentage of cells                |
| <code>hvg_mean_expr_det</code>    | threshold for mean expression level in cells with detection       |
| <code>use_all_genes_as_hvg</code> | forces all genes to be HVG and to be used as input for PCA        |
| <code>min_nr_of_hvg</code>        | minimum number of HVG, or all genes will be used as input for PCA |
| <code>pca_param</code>            | parameters for runPCA   |
| <code>nn_param</code>             | parameters for parameters for createNearestNetwork                |
| <code>k_neighbors</code>          | number of k for createNearestNetwork                              |
| <code>resolution</code>           | resolution of Leiden clustering                                   |
| <code>n_iterations</code>         | number of iterations to run the Leiden algorithm.                 |
| <code>python_path</code>          | specify specific path to python if required                       |
| <code>nn_network_to_use</code>    | type of NN network to use (kNN vs sNN)                            |
| <code>network_name</code>         | name of NN network to use   |
| <code>return_gobject</code>       | boolean: return giotto object (default = TRUE)                    |
| <code>verbose</code>              | verbose   |

### Details

This function performs subclustering using the Leiden algorithm on selected clusters. The systematic steps are:

- 1. subset Giotto object
- 2. identify highly variable genes
- 3. run PCA
- 4. create nearest neighbouring network
- 5. do Leiden clustering

### Value

giotto object with new subclusters appended to cell metadata

**See Also**[doLeidenCluster](#)**Examples**

```
doLeidenSubCluster(gobject)
```

doLouvainCluster

*doLouvainCluster***Description**

cluster cells using a NN-network and the Louvain algorithm.

**Usage**

```
doLouvainCluster(
  gobject,
  version = c("community", "multinet"),
  name = "louvain_clus",
  nn_network_to_use = "sNN",
  network_name = "sNN.pca",
  python_path = NULL,
  resolution = 1,
  weight_col = NULL,
  gamma = 1,
  omega = 1,
  louv_random = F,
  return_gobject = TRUE,
  set_seed = F,
  seed_number = 1234,
  ...
)
```

**Arguments**

|                   |   |
|-------------------|---|
| gobject           | giotto object   |
| version           | implemented version of Louvain clustering to use                                  |
| name              | name for cluster  |
| nn_network_to_use | type of NN network to use (kNN vs sNN)  |
| network_name      | name of NN network to use   |
| python_path       | [community] specify specific path to python if required                           |
| resolution        | [community] resolution  |
| gamma             | [multinet] Resolution parameter for modularity in the generalized louvain method. |
| omega             | [multinet] Inter-layer weight parameter in the generalized louvain method.        |
| return_gobject    | boolean: return giotto object (default = TRUE)                                    |
| set_seed          | set seed  |
| seed_number       | number for seed   |



**Details**

Louvain clustering using the community or multinet implementation of the louvain clustering algorithm.

**Value**

giotto object with new clusters appended to cell metadata

**See Also**

[doLouvainCluster\\_community](#) and [doLouvainCluster\\_multinet](#)

**Examples**

```
doLouvainCluster(gobject)
```

---

```
doLouvainCluster_community
doLouvainCluster_community
```

---

**Description**

cluster cells using a NN-network and the Louvain algorithm from the community module in Python

**Usage**

```
doLouvainCluster_community(
    gobject,
    name = "louvain_clus",
    nn_network_to_use = "sNN",
    network_name = "sNN.pca",
    python_path = NULL,
    resolution = 1,
    weight_col = NULL,
    louv_random = F,
    return_gobject = TRUE,
    set_seed = F,
    seed_number = 1234,
    ...
)
```

**Arguments**

|                                |   |
|--------------------------------|---|
| <code>gobject</code>           | giotto object                               |
| <code>name</code>              | name for cluster                            |
| <code>nn_network_to_use</code> | type of NN network to use (kNN vs sNN)      |
| <code>network_name</code>      | name of NN network to use                   |
| <code>python_path</code>       | specify specific path to python if required |
| <code>resolution</code>        | resolution                                  |

|                |  |
|----------------|--|
| weight_col     | weight column to use for edges   |
| louv_random    | Will randomize the node evaluation order and the community evaluation order to get different partitions at each call |
| return_gobject | boolean: return giotto object (default = TRUE)   |
| set_seed       | set seed   |
| seed_number    | number for seed  |

### Details

This function is a wrapper for the Louvain algorithm implemented in Python, which can detect communities in graphs of nodes (cells). See the <https://python-louvain.readthedocs.io/en/latest/index.html> readthedocs page for more information.

Set *weight\_col* = *NULL* to give equal weight (=1) to each edge.

### Value

giotto object with new clusters appended to cell metadata

### Examples

```
doLouvainCluster_community(gobject)
```

---

```
doLouvainCluster_multinet
doLouvainCluster_multinet
```

---

### Description

cluster cells using a NN-network and the Louvain algorithm from the multinet package in R.

### Usage

```
doLouvainCluster_multinet(
  gobject,
  name = "louvain_clus",
  nn_network_to_use = "sNN",
  network_name = "sNN.pca",
  gamma = 1,
  omega = 1,
  return_gobject = TRUE,
  set_seed = F,
  seed_number = 1234,
  ...
)
```

Arguments

|                                |  |
|--------------------------------|--|
| <code>gobject</code>           | giotto object  |
| <code>name</code>              | name for cluster   |
| <code>nn_network_to_use</code> | type of NN network to use (kNN vs sNN)                                 |
| <code>network_name</code>      | name of NN network to use  |
| <code>gamma</code>             | Resolution parameter for modularity in the generalized louvain method. |
| <code>omega</code>             | Inter-layer weight parameter in the generalized louvain method.        |
| <code>return_gobject</code>    | boolean: return giotto object (default = TRUE)                         |
| <code>set_seed</code>          | set seed   |
| <code>seed_number</code>       | number for seed  |

Details

See [glouvain\\_ml](#) from the multinet package in R for more information.

Value

giotto object with new clusters appended to cell metadata

Examples

```
doLouvainCluster_multinet(gobject)
```

---

|                                  |                            |
|----------------------------------|----------------------------|
| <code>doLouvainSubCluster</code> | <i>doLouvainSubCluster</i> |
|----------------------------------|----------------------------|

---

Description

subcluster cells using a NN-network and the Louvain algorithm

Usage

```
doLouvainSubCluster(  
  gobject,  
  name = "sub_louvain_clus",  
  version = c("community", "multinet"),  
  cluster_column = NULL,  
  selected_clusters = NULL,  
  hvg_param = list(reverse_log_scale = T, difference_in_variance = 1, expression_values  
    = "normalized"),  
  hvg_min_perc_cells = 5,  
  hvg_mean_expr_det = 1,  
  use_all_genes_as_hvg = FALSE,  
  min_nr_of_hvg = 5,  
  pca_param = list(expression_values = "normalized", scale_unit = T),  
  nn_param = list(dimensions_to_use = 1:20),  
  k_neighbors = 10,  
  resolution = 0.5,
```

```

    gamma = 1,
    omega = 1,
    python_path = NULL,
    nn_network_to_use = "sNN",
    network_name = "sNN.pca",
    return_gobject = TRUE,
    verbose = T
)

```

### Arguments

|                                   |   |
|-----------------------------------|---|
| <code>gobject</code>              | giotto object   |
| <code>name</code>                 | name for new clustering result                                    |
| <code>version</code>              | version of Louvain algorithm to use                               |
| <code>cluster_column</code>       | cluster column to subcluster                                      |
| <code>selected_clusters</code>    | only do subclustering on these clusters                           |
| <code>hvg_param</code>            | parameters for calculateHVG                                       |
| <code>hvg_min_perc_cells</code>   | threshold for detection in min percentage of cells                |
| <code>hvg_mean_expr_det</code>    | threshold for mean expression level in cells with detection       |
| <code>use_all_genes_as_hvg</code> | forces all genes to be HVG and to be used as input for PCA        |
| <code>min_nr_of_hvg</code>        | minimum number of HVG, or all genes will be used as input for PCA |
| <code>pca_param</code>            | parameters for runPCA   |
| <code>nn_param</code>             | parameters for parameters for createNearestNetwork                |
| <code>k_neighbors</code>          | number of k for createNearestNetwork                              |
| <code>resolution</code>           | resolution for community algorithm                                |
| <code>gamma</code>                | gamma   |
| <code>omega</code>                | omega   |
| <code>python_path</code>          | specify specific path to python if required                       |
| <code>nn_network_to_use</code>    | type of NN network to use (kNN vs sNN)                            |
| <code>network_name</code>         | name of NN network to use   |
| <code>return_gobject</code>       | boolean: return giotto object (default = TRUE)                    |
| <code>verbose</code>              | verbose   |

### Details

This function performs subclustering using the Louvain algorithm on selected clusters. The systematic steps are:

- 1. subset Giotto object
- 2. identify highly variable genes
- 3. run PCA
- 4. create nearest neighbouring network
- 5. do Louvain clustering

**Value**

giotto object with new subclusters appended to cell metadata

**See Also**

[doLouvainCluster\\_multinet](#) and [doLouvainCluster\\_community](#)

**Examples**

```
doLouvainSubCluster(gobject)
```

---

```
doLouvainSubCluster_community
```

```
doLouvainSubCluster_community
```

---

**Description**

subcluster cells using a NN-network and the Louvain community detection algorithm

**Usage**

```
doLouvainSubCluster_community(
  gobject,
  name = "sub_louvain_comm_clus",
  cluster_column = NULL,
  selected_clusters = NULL,
  hvg_param = list(reverse_log_scale = T, difference_in_variance = 1, expression_values
    = "normalized"),
  hvg_min_perc_cells = 5,
  hvg_mean_expr_det = 1,
  use_all_genes_as_hvg = FALSE,
  min_nr_of_hvg = 5,
  pca_param = list(expression_values = "normalized", scale_unit = T),
  nn_param = list(dimensions_to_use = 1:20),
  k_neighbors = 10,
  resolution = 0.5,
  python_path = NULL,
  nn_network_to_use = "sNN",
  network_name = "sNN.pca",
  return_gobject = TRUE,
  verbose = T
)
```

**Arguments**

|                                |   |
|--------------------------------|---|
| <code>gobject</code>           | giotto object                           |
| <code>name</code>              | name for new clustering result          |
| <code>cluster_column</code>    | cluster column to subcluster            |
| <code>selected_clusters</code> | only do subclustering on these clusters |

|                                   |   |
|-----------------------------------|---|
| <code>hvg_param</code>            | parameters for calculateHVG                                       |
| <code>hvg_min_perc_cells</code>   | threshold for detection in min percentage of cells                |
| <code>hvg_mean_expr_det</code>    | threshold for mean expression level in cells with detection       |
| <code>use_all_genes_as_hvg</code> | forces all genes to be HVG and to be used as input for PCA        |
| <code>min_nr_of_hvg</code>        | minimum number of HVG, or all genes will be used as input for PCA |
| <code>pca_param</code>            | parameters for runPCA   |
| <code>nn_param</code>             | parameters for parameters for createNearestNetwork                |
| <code>k_neighbors</code>          | number of k for createNearestNetwork                              |
| <code>resolution</code>           | resolution  |
| <code>python_path</code>          | specify specific path to python if required                       |
| <code>nn_network_to_use</code>    | type of NN network to use (kNN vs sNN)                            |
| <code>network_name</code>         | name of NN network to use   |
| <code>return_gobject</code>       | boolean: return giotto object (default = TRUE)                    |
| <code>verbose</code>              | verbose   |

## Details

This function performs subclustering using the Louvain community algorithm on selected clusters. The systematic steps are:

- 1. subset Giotto object
- 2. identify highly variable genes
- 3. run PCA
- 4. create nearest neighbouring network
- 5. do Louvain community clustering

## Value

giotto object with new subclusters appended to cell metadata

## See Also

[doLouvainCluster\\_community](#)

## Examples

```
doLouvainSubCluster_community(gobject)
```

---

```
doLouvainSubCluster_multinet
    doLouvainSubCluster_multinet
```

---

## Description

subcluster cells using a NN-network and the Louvain multinet detection algorithm

## Usage

```
doLouvainSubCluster_multinet(
  gobject,
  name = "sub_louvain_mult_clus",
  cluster_column = NULL,
  selected_clusters = NULL,
  hvg_param = list(reverse_log_scale = T, difference_in_variance = 1, expression_values
    = "normalized"),
  hvg_min_perc_cells = 5,
  hvg_mean_expr_det = 1,
  use_all_genes_as_hvg = FALSE,
  min_nr_of_hvg = 5,
  pca_param = list(expression_values = "normalized", scale_unit = T),
  nn_param = list(dimensions_to_use = 1:20),
  k_neighbors = 10,
  gamma = 1,
  omega = 1,
  nn_network_to_use = "sNN",
  network_name = "sNN.pca",
  return_gobject = TRUE,
  verbose = T
)
```

## Arguments

|                                   |   |
|-----------------------------------|---|
| <code>gobject</code>              | giotto object   |
| <code>name</code>                 | name for new clustering result                                    |
| <code>cluster_column</code>       | cluster column to subcluster                                      |
| <code>selected_clusters</code>    | only do subclustering on these clusters                           |
| <code>hvg_param</code>            | parameters for calculateHVG                                       |
| <code>hvg_min_perc_cells</code>   | threshold for detection in min percentage of cells                |
| <code>hvg_mean_expr_det</code>    | threshold for mean expression level in cells with detection       |
| <code>use_all_genes_as_hvg</code> | forces all genes to be HVG and to be used as input for PCA        |
| <code>min_nr_of_hvg</code>        | minimum number of HVG, or all genes will be used as input for PCA |
| <code>pca_param</code>            | parameters for runPCA   |

|                   |  |
|-------------------|--|
| nn_param          | parameters for parameters for createNearestNetwork |
| k_neighbors       | number of k for createNearestNetwork               |
| gamma             | gamma  |
| omega             | omega  |
| nn_network_to_use | type of NN network to use (kNN vs sNN)             |
| network_name      | name of NN network to use                          |
| return_gobject    | boolean: return giotto object (default = TRUE)     |
| verbose           | verbose  |
| python_path       | specify specific path to python if required        |

### Details

This function performs subclustering using the Louvain multinet algorithm on selected clusters. The systematic steps are:

- 1. subset Giotto object
- 2. identify highly variable genes
- 3. run PCA
- 4. create nearest neighbouring network
- 5. do Louvain multinet clustering

### Value

giotto object with new subclusters appended to cell metadata

### See Also

[doLouvainCluster\\_multinet](#)

### Examples

```
doLouvainSubCluster_multinet(gobject)
```

---

doRandomWalkCluster     *doRandomWalkCluster*

---

### Description

Cluster cells using a random walk approach.



## Usage

```
doRandomWalkCluster(  
  gobject,  
  name = "random_walk_clus",  
  nn_network_to_use = "sNN",  
  network_name = "sNN.pca",  
  walk_steps = 4,  
  walk_clusters = 10,  
  walk_weights = NA,  
  return_gobject = TRUE,  
  set_seed = F,  
  seed_number = 1234,  
  ...  
)
```

## Arguments

|                   |  |
|-------------------|--|
| gobject           | giotto object                                  |
| name              | name for cluster                               |
| nn_network_to_use | type of NN network to use (kNN vs sNN)         |
| network_name      | name of NN network to use                      |
| walk_steps        | number of walking steps                        |
| walk_clusters     | number of final clusters                       |
| walk_weights      | cluster column defining the walk weights       |
| return_gobject    | boolean: return giotto object (default = TRUE) |
| set_seed          | set seed                                       |
| seed_number       | number for seed                                |

## Details

See [cluster\\_walktrap](#) function from the igraph package in R for more information.

## Value

giotto object with new clusters appended to cell metadata

## Examples

```
doRandomWalkCluster(gobject)
```

doSNNCluster

*doSNNCluster***Description**

Cluster cells using a SNN cluster approach.

**Usage**

```
doSNNCluster(
  gobject,
  name = "sNN_clus",
  nn_network_to_use = "kNN",
  network_name = "kNN.pca",
  k = 20,
  eps = 4,
  minPts = 16,
  borderPoints = TRUE,
  return_gobject = TRUE,
  set_seed = F,
  seed_number = 1234,
  ...
)
```

**Arguments**

|                                |   |
|--------------------------------|---|
| <code>gobject</code>           | giotto object   |
| <code>name</code>              | name for cluster  |
| <code>nn_network_to_use</code> | type of NN network to use (only works on kNN)   |
| <code>network_name</code>      | name of kNN network to use  |
| <code>k</code>                 | Neighborhood size for nearest neighbor sparsification to create the shared NN graph.  |
| <code>eps</code>               | Two objects are only reachable from each other if they share at least <code>eps</code> nearest neighbors.                   |
| <code>minPts</code>            | minimum number of points that share at least <code>eps</code> nearest neighbors for a point to be considered a core points. |
| <code>borderPoints</code>      | should borderPoints be assigned to clusters like in DBSCAN?   |
| <code>return_gobject</code>    | boolean: return giotto object (default = TRUE)  |
| <code>set_seed</code>          | set seed  |
| <code>seed_number</code>       | number for seed   |

**Details**

See [sNNclust](#) from dbscan package

**Value**

giotto object with new clusters appended to cell metadata

**Examples**

```
doSNNCluster(gobject)
```

---

```
do_cell_proximity_test
```

```
do_cell_proximity_test
```

---

**Description**

Performs a selected differential test on subsets of a matrix

**Usage**

```
do_cell_proximity_test(
  expr_values,
  select_ind,
  other_ind,
  diff_test = c("permutation", "limma", "t.test", "wilcox"),
  mean_method = c("arithmetic", "geometric"),
  offset = 0.1,
  n_perm = 100,
  adjust_method = c("bonferroni", "BH", "holm", "hochberg", "hommel", "BY", "fdr",
    "none"),
  cores = 2
)
```

**Examples**

```
do_cell_proximity_test()
```

---

```
do_limma_test
```

```
do_limma_test
```

---

**Description**

Performs limma t.test on subsets of a matrix

**Usage**

```
do_limma_test(expr_values, select_ind, other_ind, mean_method, offset = 0.1)
```

**Examples**

```
do_limma_test()
```

---

```
do_multi_permuttest_random  
do_multi_permuttest_random
```

---

**Description**

calculate multiple random values

**Usage**

```
do_multi_permuttest_random(  
  expr_values,  
  select_ind,  
  other_ind,  
  mean_method,  
  offset = 0.1,  
  n = 100,  
  cores = 2  
)
```

**Examples**

```
do_multi_permuttest_random()
```

---

```
do_page_permutation do_page_permutation
```

---

**Description**

creates permutation for the PAGEEnrich test

**Usage**

```
do_page_permutation(gobject, sig_gene, ntimes)
```

**Examples**

```
do_page_permutation()
```

---

|                        |                               |
|------------------------|-------------------------------|
| do_permuttest_original | <i>do_permuttest_original</i> |
|------------------------|-------------------------------|

---

**Description**

calculate original values

**Usage**

```
do_permuttest_original(  
  expr_values,  
  select_ind,  
  other_ind,  
  name = "orig",  
  mean_method,  
  offset = 0.1  
)
```

**Examples**

```
do_permuttest_original()
```

---

|                      |                             |
|----------------------|-----------------------------|
| do_permuttest_random | <i>do_permuttest_random</i> |
|----------------------|-----------------------------|

---

**Description**

calculate random values

Performs permutation test on subsets of a matrix

**Usage**

```
do_permuttest_random(  
  expr_values,  
  select_ind,  
  other_ind,  
  name = "perm_1",  
  mean_method,  
  offset = 0.1  
)
```

```
do_permuttest(  
  expr_values,  
  select_ind,  
  other_ind,  
  n_perm = 1000,  
  adjust_method = "fdr",  
  mean_method,
```

```

    offset = 0.1,
    cores = 2
)

```

### Examples

```

do_permuttest_random()
do_permuttest_random()

```

---

|                     |                            |
|---------------------|----------------------------|
| do_rank_permutation | <i>do_rank_permutation</i> |
|---------------------|----------------------------|

---

### Description

creates permutation for the rankEnrich test

### Usage

```
do_rank_permutation(sc_gene, n)
```

### Examples

```
do_rank_permutation()
```

---

|                           |                                  |
|---------------------------|----------------------------------|
| do_spatial_grid_averaging | <i>do_spatial_grid_averaging</i> |
|---------------------------|----------------------------------|

---

### Description

smooth gene expression over a defined spatial grid

### Usage

```

do_spatial_grid_averaging(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  subset_genes = NULL,
  spatial_grid_name = "spatial_grid",
  min_cells_per_grid = 4
)

```

### Arguments

|                    |  |
|--------------------|--|
| gobject            | giotto object                              |
| expression_values  | gene expression values to use              |
| subset_genes       | subset of genes to use                     |
| spatial_grid_name  | name of spatial grid to use                |
| min_cells_per_grid | minimum number of cells to consider a grid |

**Value**

matrix with smoothened gene expression values based on spatial grid

**Examples**

```
do_spatial_grid_averaging(gobject)
```

---

```
do_spatial_knn_smoothing
do_spatial_knn_smoothing
```

---

**Description**

smooth gene expression over a kNN spatial network

**Usage**

```
do_spatial_knn_smoothing(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  subset_genes = NULL,
  spatial_network_name = "Delaunay_network",
  b = NULL
)
```

**Arguments**

|                      |   |
|----------------------|---|
| gobject              | giotto object   |
| expression_values    | gene expression values to use                         |
| subset_genes         | subset of genes to use                                |
| spatial_network_name | name of spatial network to use                        |
| b                    | smoothing factor between 0 and 1 (default: automatic) |

**Details**

This function will smoothen the gene expression values per cell according to its neighbors in the selected spatial network.

b is a smoothening factor that defaults to  $1 - 1/k$ , where k is the median number of k-neighbors in the selected spatial network. Setting b = 0 means no smoothing and b = 1 means no contribution from its own expression.

**Value**

matrix with smoothened gene expression values based on kNN spatial network

**Examples**

```
do_spatial_knn_smoothing(gobject)
```

`do_ttest`*do\_ttest*

---

**Description**

Performs t.test on subsets of a matrix

Performs wilcoxon on subsets of a matrix

**Usage**

```
do_ttest(  
  expr_values,  
  select_ind,  
  other_ind,  
  adjust_method,  
  mean_method,  
  offset = 0.1  
)
```

```
do_wilctest(  
  expr_values,  
  select_ind,  
  other_ind,  
  adjust_method,  
  mean_method,  
  offset = 0.1  
)
```

**Examples**

```
do_ttest()  
do_ttest()
```

---

`DT_removeNA`*DT\_removeNA*

---

**Description**

set NA values to 0 in a data.table object

**Usage**

```
DT_removeNA(DT)
```



---

|              |                     |
|--------------|---------------------|
| dt_to_matrix | <i>dt_to_matrix</i> |
|--------------|---------------------|

---

**Description**

converts data.table to matrix

**Usage**

```
dt_to_matrix(x)
```

**Examples**

```
dt_to_matrix(x)
```

---

|                          |                                 |
|--------------------------|---------------------------------|
| estimateCellCellDistance | <i>estimateCellCellDistance</i> |
|--------------------------|---------------------------------|

---

**Description**

estimate average distance between neighboring cells

**Usage**

```
estimateCellCellDistance(  
  gobject,  
  spatial_network_name = "Delaunay_network",  
  method = c("mean", "median")  
)
```

---

|                 |                        |
|-----------------|------------------------|
| estimateImageBg | <i>estimateImageBg</i> |
|-----------------|------------------------|

---

**Description**

helps to estimate which color is the background color of your plot

**Usage**

```
estimateImageBg(mg_object, top_color_range = 1:50)
```

**Arguments**

|                 |  |
|-----------------|--|
| mg_object       | magick image or Giotto image object      |
| top_color_range | top possible background colors to return |

**Value**

vector of pixel color frequencies and an associated barplot

**Examples**

```
estimateImageBg(mg_object)
```

---

```
evaluate_expr_matrix    evaluate_expr_matrix
```

---

**Description**

Evaluate expression matrices.

**Usage**

```
evaluate_expr_matrix(inputmatrix, sparse = TRUE, cores = NA)
```

**Arguments**

`inputmatrix`      `inputmatrix` to evaluate

**Details**

The `inputmatrix` can be a matrix, sparse matrix, data.frame, data.table or path to any of these.

**Value**

sparse matrix

**Examples**

```
evaluate_expr_matrix()
```

---

```
exportGiottoViewer    exportGiottoViewer
```

---

**Description**

compute highly variable genes

**Usage**

```
exportGiottoViewer(
  gobject,
  output_directory = NULL,
  spat_enr_names = NULL,
  factor_annotations = NULL,
  numeric_annotations = NULL,
  dim_reductions,
  dim_reduction_names,
  expression_values = c("scaled", "normalized", "custom"),
  dim_red_rounding = NULL,
  dim_red_rescale = c(-20, 20),
  expression_rounding = 2,
  overwrite_dir = T,
  verbose = T
)
```

**Arguments**

|                                  |  |
|----------------------------------|--|
| <code>gobject</code>             | giotto object  |
| <code>output_directory</code>    | directory where to save the files                      |
| <code>spat_enr_names</code>      | spatial enrichment results to include for annotations  |
| <code>factor_annotations</code>  | giotto cell annotations to view as factor              |
| <code>numeric_annotations</code> | giotto cell annotations to view as numeric             |
| <code>dim_reductions</code>      | high level dimension reductions to view                |
| <code>dim_reduction_names</code> | specific dimension reduction names                     |
| <code>expression_values</code>   | expression values to use in Viewer                     |
| <code>dim_red_rounding</code>    | numerical indicating how to round the coordinates      |
| <code>dim_red_rescale</code>     | numericals to rescale the coordinates                  |
| <code>expression_rounding</code> | numerical indicating how to round the expression data  |
| <code>overwrite_dir</code>       | overwrite files in the directory if it already existed |
| <code>verbose</code>             | be verbose   |

**Details**

Giotto Viewer expects the results from Giotto Analyzer in a specific format, which is provided by this function. To include enrichment results from [createSpatialEnrich](#) include the provided spatial enrichment name (default PAGE or rank) and add the gene signature names (.e.g cell types) to the numeric annotations parameter.

**Value**

writes the necessary output to use in Giotto Viewer

Examples

```
exportGiottoViewer(gobject)
```

---

|                 |                        |
|-----------------|------------------------|
| exprCellCellcom | <i>exprCellCellcom</i> |
|-----------------|------------------------|

---

Description

Cell-Cell communication scores based on expression only

Usage

```
exprCellCellcom(  
  gobject,  
  cluster_column = "cell_types",  
  random_iter = 1000,  
  gene_set_1,  
  gene_set_2,  
  log2FC_addendum = 0.1,  
  adjust_method = c("fdr", "bonferroni", "BH", "holm", "hochberg", "hommel", "BY",  
    "none"),  
  adjust_target = c("genes", "cells"),  
  verbose = T  
)
```

Arguments

|                 |  |
|-----------------|--|
| gobject         | giotto object to use                                 |
| cluster_column  | cluster column with cell type information            |
| random_iter     | number of iterations                                 |
| gene_set_1      | first specific gene set from gene pairs              |
| gene_set_2      | second specific gene set from gene pairs             |
| log2FC_addendum | addendum to add when calculating log2FC              |
| adjust_method   | which method to adjust p-values                      |
| adjust_target   | adjust multiple hypotheses at the cell or gene level |
| verbose         | verbose  |

Details

Statistical framework to identify if pairs of genes (such as ligand-receptor combinations) are expressed at higher levels than expected based on a reshuffled null distribution of gene expression values, without considering the spatial position of cells. More details will follow soon.

Value

Cell-Cell communication scores for gene pairs based on expression only

Examples

```
exprCellCellcom(gobject)
```

---

|                   |                          |
|-------------------|--------------------------|
| extended_gini_fun | <i>extended_gini_fun</i> |
|-------------------|--------------------------|

---

**Description**

calculate gini coefficient on a minimum length vector

**Usage**

```
extended_gini_fun(x, weights = rep(1, length = length(x)), minimum_length = 16)
```

**Value**

gini coefficient

---

|               |                      |
|---------------|----------------------|
| extend_vector | <i>extend_vector</i> |
|---------------|----------------------|

---

**Description**

extend the range of a vector by a given ratio

**Usage**

```
extend_vector(x, extend_ratio)
```

---

|                       |                              |
|-----------------------|------------------------------|
| extractNearestNetwork | <i>extractNearestNetwork</i> |
|-----------------------|------------------------------|

---

**Description**

Extracts a NN-network from a Giotto object

**Usage**

```
extractNearestNetwork(
  gobject,
  nn_network_to_use = "sNN",
  network_name = "sNN.pca",
  output = c("igraph", "data.table")
)
```

**Arguments**

|                   |                                      |
|-------------------|--------------------------------------|
| gobject           | giotto object                        |
| nn_network_to_use | kNN or sNN                           |
| network_name      | name of NN network to be used        |
| output            | return a igraph or data.table object |

**Value**

igraph or data.table object

**Examples**

```
extractNearestNetwork(gobject)
```

---

|         |                |
|---------|----------------|
| fDataDT | <i>fDataDT</i> |
|---------|----------------|

---

**Description**

show gene metadata

**Usage**

```
fDataDT(gobject)
```

**Arguments**

gobject                  giotto object

**Value**

data.table with gene metadata

**Examples**

```
pDataDT(gobject)
```

---

|                          |                                 |
|--------------------------|---------------------------------|
| filterCellProximityGenes | <i>filterCellProximityGenes</i> |
|--------------------------|---------------------------------|

---

**Description**

Filter cell proximity gene scores.

**Usage**

```
filterCellProximityGenes(  
  cpqObject,  
  min_cells = 4,  
  min_cells_expr = 1,  
  min_int_cells = 4,  
  min_int_cells_expr = 1,  
  min_fdr = 0.1,  
  min_spat_diff = 0.2,  
  min_log2_fc = 0.2,  
  min_zscore = 2,  
  zscores_column = c("cell_type", "genes"),  
  direction = c("both", "up", "down")  
)
```

**Arguments**

|                    |   |
|--------------------|---|
| cpgObject          | cell proximity gene score object                            |
| min_cells          | minimum number of source cell type                          |
| min_cells_expr     | minimum expression level for source cell type               |
| min_int_cells      | minimum number of interacting neighbor cell type            |
| min_int_cells_expr | minimum expression level for interacting neighbor cell type |
| min_fdr            | minimum adjusted p-value                                    |
| min_spat_diff      | minimum absolute spatial expression difference              |
| min_log2_fc        | minimum log2 fold-change                                    |
| min_zscore         | minimum z-score change                                      |
| zscores_column     | calculate z-scores over cell types or genes                 |
| direction          | differential expression directions to keep                  |

**Value**

cpgObject that contains the filtered differential gene scores

**Examples**

```
filterCellProximityGenes(gobject)
```

---

|                    |                           |
|--------------------|---------------------------|
| filterCombinations | <i>filterCombinations</i> |
|--------------------|---------------------------|

---

**Description**

Shows how many genes and cells are lost with combinations of thresholds.

**Usage**

```
filterCombinations(
  gobject,
  expression_values = c("raw", "normalized", "scaled", "custom"),
  expression_thresholds = c(1, 2),
  gene_det_in_min_cells = c(5, 50),
  min_det_genes_per_cell = c(200, 400),
  scale_x_axis = "identity",
  x_axis_offset = 0,
  scale_y_axis = "identity",
  y_axis_offset = 0,
  show_plot = TRUE,
  return_plot = FALSE,
  save_plot = NA,
  save_param = list(),
  default_save_name = "filterCombinations"
)
```

**Arguments**

|                                     |  |
|-------------------------------------|--|
| <code>gobject</code>                | giotto object  |
| <code>expression_values</code>      | expression values to use   |
| <code>expression_thresholds</code>  | all thresholds to consider a gene expressed  |
| <code>gene_det_in_min_cells</code>  | minimum number of cells that should express a gene to consider that gene further                     |
| <code>min_det_genes_per_cell</code> | minimum number of expressed genes per cell to consider that cell further                             |
| <code>scale_x_axis</code>           | ggplot transformation for x-axis (e.g. log2)   |
| <code>x_axis_offset</code>          | x-axis offset to be used together with the scaling transformation                                    |
| <code>scale_y_axis</code>           | ggplot transformation for y-axis (e.g. log2)   |
| <code>y_axis_offset</code>          | y-axis offset to be used together with the scaling transformation                                    |
| <code>show_plot</code>              | show plot  |
| <code>return_plot</code>            | return only ggplot object  |
| <code>save_plot</code>              | directly save the plot [boolean]   |
| <code>save_param</code>             | list of saving parameters from <a href="#">all_plots_save_function</a>                               |
| <code>default_save_name</code>      | default save name for saving, don't change, change <code>save_name</code> in <code>save_param</code> |

**Details**

Creates a scatterplot that visualizes the number of genes and cells that are lost with a specific combination of a gene and cell threshold given an arbitrary cutoff to call a gene expressed. This function can be used to make an informed decision at the filtering step with `filterGiotto`.

**Value**

list of `data.table` and `ggplot` object

**Examples**

```
filterCombinations(gobject)
```

---

filterCPG

*filterCPG*


---

**Description**

Filter cell proximity gene scores.



**Usage**

```
filterCPG(
  cpgObject,
  min_cells = 4,
  min_cells_expr = 1,
  min_int_cells = 4,
  min_int_cells_expr = 1,
  min_fdr = 0.1,
  min_spat_diff = 0.2,
  min_log2_fc = 0.2,
  min_zscore = 2,
  zscores_column = c("cell_type", "genes"),
  direction = c("both", "up", "down")
)
```

**Arguments**

|                    |   |
|--------------------|---|
| cpgObject          | cell proximity gene score object                            |
| min_cells          | minimum number of source cell type                          |
| min_cells_expr     | minimum expression level for source cell type               |
| min_int_cells      | minimum number of interacting neighbor cell type            |
| min_int_cells_expr | minimum expression level for interacting neighbor cell type |
| min_fdr            | minimum adjusted p-value                                    |
| min_spat_diff      | minimum absolute spatial expression difference              |
| min_log2_fc        | minimum log2 fold-change                                    |
| min_zscore         | minimum z-score change                                      |
| zscores_column     | calculate z-scores over cell types or genes                 |
| direction          | differential expression directions to keep                  |

**Value**

cpgObject that contains the filtered differential gene scores

**Examples**

```
filterCPG(gobject)
```

---

|                     |                            |
|---------------------|----------------------------|
| filterDistributions | <i>filterDistributions</i> |
|---------------------|----------------------------|

---

**Description**

show gene or cell distribution after filtering on expression threshold

**Usage**

```
filterDistributions(
  gobject,
  expression_values = c("raw", "normalized", "scaled", "custom"),
  expression_threshold = 1,
  detection = c("genes", "cells"),
  plot_type = c("histogram", "violin"),
  nr_bins = 30,
  fill_color = "lightblue",
  scale_axis = "identity",
  axis_offset = 0,
  show_plot = NA,
  return_plot = NA,
  save_plot = NA,
  save_param = list(),
  default_save_name = "filterDistributions"
)
```

**Arguments**

|                                   |  |
|-----------------------------------|--|
| <code>gobject</code>              | giotto object  |
| <code>expression_values</code>    | expression values to use   |
| <code>expression_threshold</code> | threshold to consider a gene expressed   |
| <code>detection</code>            | consider genes or cells  |
| <code>plot_type</code>            | type of plot   |
| <code>nr_bins</code>              | number of bins for histogram plot  |
| <code>fill_color</code>           | fill color for plots   |
| <code>scale_axis</code>           | ggplot transformation for axis (e.g. log2)   |
| <code>axis_offset</code>          | offset to be used together with the scaling transformation   |
| <code>show_plot</code>            | show plot  |
| <code>return_plot</code>          | return ggplot object   |
| <code>save_plot</code>            | directly save the plot [boolean]   |
| <code>save_param</code>           | list of saving parameters from <a href="#">all_plots_save_function</a>                               |
| <code>default_save_name</code>    | default save name for saving, don't change, change <code>save_name</code> in <code>save_param</code> |

**Value**

ggplot object

**Examples**

```
filterDistributions(gobject)
```

---

|              |                     |
|--------------|---------------------|
| filterGiotto | <i>filterGiotto</i> |
|--------------|---------------------|

---

## Description

filter Giotto object based on expression threshold

## Usage

```
filterGiotto(  
  gobject,  
  expression_values = c("raw", "normalized", "scaled", "custom"),  
  expression_threshold = 1,  
  gene_det_in_min_cells = 100,  
  min_det_genes_per_cell = 100,  
  verbose = F  
)
```

## Arguments

|                        |   |
|------------------------|---|
| gobject                | giotto object   |
| expression_values      | expression values to use                              |
| expression_threshold   | threshold to consider a gene expressed                |
| gene_det_in_min_cells  | minimum # of cells that need to express a gene        |
| min_det_genes_per_cell | minimum # of genes that need to be detected in a cell |
| verbose                | verbose   |

## Details

The function [filterCombinations](#) can be used to explore the effect of different parameter values.

## Value

giotto object

## Examples

```
filterGiotto(gobject)
```

---

|                |                       |
|----------------|-----------------------|
| filter_network | <i>filter_network</i> |
|----------------|-----------------------|

---

### Description

function to filter a spatial network

### Usage

```
filter_network(networkDT, maximum_distance = NULL, minimum_k = NULL)
```

---

|                        |                               |
|------------------------|-------------------------------|
| findCellProximityGenes | <i>findCellProximityGenes</i> |
|------------------------|-------------------------------|

---

### Description

Identifies genes that are differentially expressed due to proximity to other cell types.

### Usage

```
findCellProximityGenes(
  gobject,
  expression_values = "normalized",
  selected_genes = NULL,
  cluster_column,
  spatial_network_name = "Delaunay_network",
  minimum_unique_cells = 1,
  minimum_unique_int_cells = 1,
  diff_test = c("permutation", "limma", "t.test", "wilcox"),
  mean_method = c("arithmetic", "geometric"),
  offset = 0.1,
  adjust_method = c("bonferroni", "BH", "holm", "hochberg", "hommel", "BY", "fdr",
    "none"),
  nr_permutations = 1000,
  exclude_selected_cells_from_test = T,
  do_parallel = TRUE,
  cores = NA
)
```

### Arguments

|                   |                                      |
|-------------------|--------------------------------------|
| gobject           | giotto object                        |
| expression_values | expression values to use             |
| selected_genes    | subset of selected genes (optional)  |
| cluster_column    | name of column to use for cell types |

|                                  |   |
|----------------------------------|---|
| spatial_network_name             | name of spatial network to use                    |
| minimum_unique_cells             | minimum number of target cells required           |
| minimum_unique_int_cells         | minimum number of interacting cells required      |
| diff_test                        | which differential expression test                |
| mean_method                      | method to use to calculate the mean               |
| offset                           | offset value to use when calculating log2 ratio   |
| adjust_method                    | which method to adjust p-values                   |
| nr_permutations                  | number of permutations if diff_test = permutation |
| exclude_selected_cells_from_test | exclude interacting cells other cells             |
| do_parallel                      | run calculations in parallel with mclapply        |
| cores                            | number of cores to use if do_parallel = TRUE      |

### Details

Function to calculate if genes are differentially expressed in cell types when they interact (approximated by physical proximity) with other cell types. The results data.table in the cpgObject contains - at least - the following columns:

- genes: All or selected list of tested genes
- sel: average gene expression in the interacting cells from the target cell type
- other: average gene expression in the NOT-interacting cells from the target cell type
- log2fc: log2 fold-change between sel and other
- diff: spatial expression difference between sel and other
- p.value: associated p-value
- p.adj: adjusted p-value
- cell\_type: target cell type
- int\_cell\_type: interacting cell type
- nr\_select: number of cells for selected target cell type
- int\_nr\_select: number of cells for interacting cell type
- nr\_other: number of other cells of selected target cell type
- int\_nr\_other: number of other cells for interacting cell type
- unif\_int: cell-cell interaction

### Value

cpgObject that contains the differential gene scores

### Examples

```
findCellProximityGenes(gobject)
```

---

```
findCellProximityGenes_per_interaction
      findCellProximityGenes_per_interaction
```

---

### Description

Identifies genes that are differentially expressed due to proximity to other cell types.

### Usage

```
findCellProximityGenes_per_interaction(
  expr_values,
  cell_metadata,
  annot_spatnetwork,
  sel_int,
  cluster_column = NULL,
  minimum_unique_cells = 1,
  minimum_unique_int_cells = 1,
  exclude_selected_cells_from_test = T,
  diff_test = c("permutation", "limma", "t.test", "wilcox"),
  mean_method = c("arithmetic", "geometric"),
  offset = 0.1,
  adjust_method = "bonferroni",
  nr_permutations = 100,
  cores = 1
)
```

### Examples

```
findCellProximityGenes_per_interaction()
```

---

```
findCPG      findCPG
```

---

### Description

Identifies genes that are differentially expressed due to proximity to other cell types.

### Usage

```
findCPG(
  gobject,
  expression_values = "normalized",
  selected_genes = NULL,
  cluster_column,
  spatial_network_name = "Delaunay_network",
  minimum_unique_cells = 1,
  minimum_unique_int_cells = 1,
  diff_test = c("permutation", "limma", "t.test", "wilcox"),
```

```

mean_method = c("arithmetic", "geometric"),
offset = 0.1,
adjust_method = c("bonferroni", "BH", "holm", "hochberg", "hommel", "BY", "fdr",
  "none"),
nr_permutations = 100,
exclude_selected_cells_from_test = T,
do_parallel = TRUE,
cores = NA
)

```

### Arguments

|   |  |
|---|--|
| <code>gobject</code>                          | giotto object  |
| <code>expression_values</code>                | expression values to use                                       |
| <code>selected_genes</code>                   | subset of selected genes (optional)                            |
| <code>cluster_column</code>                   | name of column to use for cell types                           |
| <code>spatial_network_name</code>             | name of spatial network to use                                 |
| <code>minimum_unique_cells</code>             | minimum number of target cells required                        |
| <code>minimum_unique_int_cells</code>         | minimum number of interacting cells required                   |
| <code>diff_test</code>                        | which differential expression test                             |
| <code>mean_method</code>                      | method to use to calculate the mean                            |
| <code>offset</code>                           | offset value to use when calculating log2 ratio                |
| <code>adjust_method</code>                    | which method to adjust p-values                                |
| <code>nr_permutations</code>                  | number of permutations if <code>diff_test = permutation</code> |
| <code>exclude_selected_cells_from_test</code> | exclude interacting cells other cells                          |
| <code>do_parallel</code>                      | run calculations in parallel with <code>mclapply</code>        |
| <code>cores</code>                            | number of cores to use if <code>do_parallel = TRUE</code>      |

### Details

Function to calculate if genes are differentially expressed in cell types when they interact (approximated by physical proximity) with other cell types. The results `data.table` in the `cpgObject` contains - at least - the following columns:

- `genes`: All or selected list of tested genes
- `sel`: average gene expression in the interacting cells from the target cell type
- `other`: average gene expression in the NOT-interacting cells from the target cell type
- `log2fc`: log2 fold-change between `sel` and `other`
- `diff`: spatial expression difference between `sel` and `other`
- `p.value`: associated p-value
- `p.adj`: adjusted p-value

- cell\_type: target cell type
- int\_cell\_type: interacting cell type
- nr\_select: number of cells for selected target cell type
- int\_nr\_select: number of cells for interacting cell type
- nr\_other: number of other cells of selected target cell type
- int\_nr\_other: number of other cells for interacting cell type
- unif\_int: cell-cell interaction

**Value**

cpgObject that contains the differential gene scores

**Examples**

```
findCPG(gobject)
```

---

|                 |                        |
|-----------------|------------------------|
| findGiniMarkers | <i>findGiniMarkers</i> |
|-----------------|------------------------|

---

**Description**

Identify marker genes for selected clusters based on gini detection and expression scores.

**Usage**

```
findGiniMarkers(  
  gobject,  
  expression_values = c("normalized", "scaled", "custom"),  
  cluster_column,  
  subset_clusters = NULL,  
  group_1 = NULL,  
  group_2 = NULL,  
  min_expr_gini_score = 0.2,  
  min_det_gini_score = 0.2,  
  detection_threshold = 0,  
  rank_score = 1,  
  min_genes = 5  
)
```

**Arguments**

- |                   |   |
|-------------------|---|
| gobject           | giotto object   |
| expression_values | gene expression values to use                                   |
| cluster_column    | clusters to use   |
| subset_clusters   | selection of clusters to compare                                |
| group_1           | group 1 cluster IDs from cluster_column for pairwise comparison |
| group_2           | group 2 cluster IDs from cluster_column for pairwise comparison |



|                     |  |
|---------------------|--|
| min_expr_gini_score | filter on minimum gini coefficient for expression        |
| min_det_gini_score  | filter on minimum gini coefficient for detection         |
| detection_threshold | detection threshold for gene expression                  |
| rank_score          | rank scores for both detection and expression to include |
| min_genes           | minimum number of top genes to return                    |

## Details

Detection of marker genes using the [https://en.wikipedia.org/wiki/Gini\\_coefficient](https://en.wikipedia.org/wiki/Gini_coefficient) gini coefficient is based on the following steps/principles per gene:

- 1. calculate average expression per cluster
- 2. calculate detection fraction per cluster
- 3. calculate gini-coefficient for av. expression values over all clusters
- 4. calculate gini-coefficient for detection fractions over all clusters
- 5. convert gini-scores to rank scores
- 6. for each gene create combined score = detection rank x expression rank x expr gini-coefficient x detection gini-coefficient
- 7. for each gene sort on expression and detection rank and combined score

As a results "top gini" genes are genes that are very selectively expressed in a specific cluster, however not always expressed in all cells of that cluster. In other words highly specific, but not necessarily sensitive at the single-cell level.

To perform differential expression between cluster groups you need to specify cluster IDs to the parameters *group\_1* and *group\_2*.

## Value

data.table with marker genes

## Examples

```
findGiniMarkers(gobject)
```

---

```
findGiniMarkers_one_vs_all
      findGiniMarkers_one_vs_all
```

---

## Description

Identify marker genes for all clusters in a one vs all manner based on gini detection and expression scores.

**Usage**

```
findGiniMarkers_one_vs_all(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  cluster_column,
  subset_clusters = NULL,
  min_expr_gini_score = 0.5,
  min_det_gini_score = 0.5,
  detection_threshold = 0,
  rank_score = 1,
  min_genes = 4,
  verbose = TRUE
)
```

**Arguments**

|                                  |  |
|----------------------------------|--|
| <code>gobject</code>             | giotto object  |
| <code>expression_values</code>   | gene expression values to use                            |
| <code>cluster_column</code>      | clusters to use  |
| <code>subset_clusters</code>     | selection of clusters to compare                         |
| <code>min_expr_gini_score</code> | filter on minimum gini coefficient on expression         |
| <code>min_det_gini_score</code>  | filter on minimum gini coefficient on detection          |
| <code>detection_threshold</code> | detection threshold for gene expression                  |
| <code>rank_score</code>          | rank scores for both detection and expression to include |
| <code>min_genes</code>           | minimum number of top genes to return                    |
| <code>verbose</code>             | be verbose   |

**Value**

data.table with marker genes

**See Also**

[findGiniMarkers](#)

**Examples**

```
findGiniMarkers_one_vs_all(gobject)
```

---

|             |                    |
|-------------|--------------------|
| findMarkers | <i>findMarkers</i> |
|-------------|--------------------|

---

## Description

Identify marker genes for selected clusters.

## Usage

```
findMarkers(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  cluster_column,
  method = c("scrn", "gini", "mast"),
  subset_clusters = NULL,
  group_1 = NULL,
  group_2 = NULL,
  min_expr_gini_score = 0.5,
  min_det_gini_score = 0.5,
  detection_threshold = 0,
  rank_score = 1,
  min_genes = 4,
  group_1_name = NULL,
  group_2_name = NULL,
  adjust_columns = NULL,
  ...
)
```

## Arguments

|                     |   |
|---------------------|---|
| gobject             | giotto object   |
| expression_values   | gene expression values to use                                   |
| cluster_column      | clusters to use   |
| method              | method to use to detect differentially expressed genes          |
| subset_clusters     | selection of clusters to compare                                |
| group_1             | group 1 cluster IDs from cluster_column for pairwise comparison |
| group_2             | group 2 cluster IDs from cluster_column for pairwise comparison |
| min_expr_gini_score | gini: filter on minimum gini coefficient for expression         |
| min_det_gini_score  | gini: filter minimum gini coefficient for detection             |
| detection_threshold | gini: detection threshold for gene expression                   |
| rank_score          | gini: rank scores to include                                    |
| min_genes           | minimum number of top genes to return (for gini)                |
| group_1_name        | mast: custom name for group_1 clusters                          |

|                |   |
|----------------|---|
| group_2_name   | mast: custom name for group_2 clusters  |
| adjust_columns | mast: column in pDataDT to adjust for (e.g. detection rate)                         |
| ...            | additional parameters for the findMarkers function in scran or zlm function in MAST |

### Details

Wrapper for all individual functions to detect marker genes for clusters.

### Value

data.table with marker genes

### See Also

[findScranMarkers](#), [findGiniMarkers](#) and [findMastMarkers](#)

### Examples

```
findMarkers(gobject)
```

---

```
findMarkers_one_vs_all
```

```
findMarkers_one_vs_all
```

---

### Description

Identify marker genes for all clusters in a one vs all manner.

### Usage

```
findMarkers_one_vs_all(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  cluster_column,
  subset_clusters = NULL,
  method = c("scrna", "gini", "mast"),
  pval = 0.01,
  logFC = 0.5,
  min_genes = 10,
  min_expr_gini_score = 0.5,
  min_det_gini_score = 0.5,
  detection_threshold = 0,
  rank_score = 1,
  adjust_columns = NULL,
  verbose = TRUE,
  ...
)
```

**Arguments**

|                                  |  |
|----------------------------------|--|
| <code>gobject</code>             | giotto object  |
| <code>expression_values</code>   | gene expression values to use  |
| <code>cluster_column</code>      | clusters to use  |
| <code>subset_clusters</code>     | selection of clusters to compare   |
| <code>method</code>              | method to use to detect differentially expressed genes                             |
| <code>pval</code>                | scan & mast: filter on minimal p-value   |
| <code>logFC</code>               | scan & mast: filter on logFC   |
| <code>min_genes</code>           | minimum genes to keep per cluster, overrides pval and logFC                        |
| <code>min_expr_gini_score</code> | gini: filter on minimum gini coefficient for expression                            |
| <code>min_det_gini_score</code>  | gini: filter minimum gini coefficient for detection                                |
| <code>detection_threshold</code> | gini: detection threshold for gene expression                                      |
| <code>rank_score</code>          | gini: rank scores to include   |
| <code>adjust_columns</code>      | mast: column in pDataDT to adjust for (e.g. detection rate)                        |
| <code>verbose</code>             | be verbose   |
| <code>...</code>                 | additional parameters for the findMarkers function in scan or zlm function in MAST |

**Details**

Wrapper for all one vs all functions to detect marker genes for clusters.

**Value**

data.table with marker genes

**See Also**

[findScranMarkers\\_one\\_vs\\_all](#), [findGiniMarkers\\_one\\_vs\\_all](#) and [findMastMarkers\\_one\\_vs\\_all](#)

**Examples**

```
findMarkers_one_vs_all(gobject)
```

---

|                 |                        |
|-----------------|------------------------|
| findMastMarkers | <i>findMastMarkers</i> |
|-----------------|------------------------|

---

## Description

Identify marker genes for selected clusters based on the MAST package.

## Usage

```
findMastMarkers(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  cluster_column,
  group_1 = NULL,
  group_1_name = NULL,
  group_2 = NULL,
  group_2_name = NULL,
  adjust_columns = NULL,
  ...
)
```

## Arguments

|                                |  |
|--------------------------------|--|
| <code>gobject</code>           | giotto object  |
| <code>expression_values</code> | gene expression values to use  |
| <code>cluster_column</code>    | clusters to use  |
| <code>group_1</code>           | group 1 cluster IDs from <code>cluster_column</code> for pairwise comparison |
| <code>group_1_name</code>      | custom name for <code>group_1</code> clusters                                |
| <code>group_2</code>           | group 2 cluster IDs from <code>cluster_column</code> for pairwise comparison |
| <code>group_2_name</code>      | custom name for <code>group_2</code> clusters                                |
| <code>adjust_columns</code>    | column in <code>pDataDT</code> to adjust for (e.g. detection rate)           |
| <code>...</code>               | additional parameters for the <code>zlm</code> function in MAST              |

## Details

This is a minimal convenience wrapper around the [zlm](#) from the MAST package to detect differentially expressed genes.

## Value

data.table with marker genes

## Examples

```
findMastMarkers(gobject)
```

---

```
findMastMarkers_one_vs_all
      findMastMarkers_one_vs_all
```

---

## Description

Identify marker genes for all clusters in a one vs all manner based on the MAST package.

## Usage

```
findMastMarkers_one_vs_all(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  cluster_column,
  subset_clusters = NULL,
  adjust_columns = NULL,
  pval = 0.001,
  logFC = 1,
  min_genes = 10,
  verbose = TRUE,
  ...
)
```

## Arguments

|                                |   |
|--------------------------------|---|
| <code>gobject</code>           | giotto object   |
| <code>expression_values</code> | gene expression values to use                               |
| <code>cluster_column</code>    | clusters to use   |
| <code>subset_clusters</code>   | selection of clusters to compare                            |
| <code>adjust_columns</code>    | column in pDataDT to adjust for (e.g. detection rate)       |
| <code>pval</code>              | filter on minimal p-value                                   |
| <code>logFC</code>             | filter on logFC   |
| <code>min_genes</code>         | minimum genes to keep per cluster, overrides pval and logFC |
| <code>verbose</code>           | be verbose  |
| <code>...</code>               | additional parameters for the zlm function in MAST          |

## Value

data.table with marker genes

## See Also

[findMastMarkers](#)

## Examples

```
findMastMarkers_one_vs_all(gobject)
```

---

findNetworkNeighbors    *findNetworkNeighbors*


---

### Description

Find the spatial neighbors for a selected group of cells within the selected spatial network.

### Usage

```
findNetworkNeighbors(
  gobject,
  spatial_network_name,
  source_cell_ids = NULL,
  name = "nb_cells"
)
```

### Arguments

|                      |   |
|----------------------|---|
| gobject              | Giotto object   |
| spatial_network_name | name of spatial network                                   |
| source_cell_ids      | cell ids for which you want to know the spatial neighbors |
| name                 | name of the results                                       |

### Value

data.table

### Examples

```
findNetworkNeighbors(gobject)
```

---

findScranMarkers    *findScranMarkers*


---

### Description

Identify marker genes for all or selected clusters based on scran's implementation of findMarkers.

### Usage

```
findScranMarkers(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  cluster_column,
  subset_clusters = NULL,
  group_1 = NULL,
  group_2 = NULL,
  ...
)
```



**Arguments**

|                                |  |
|--------------------------------|--|
| <code>gobject</code>           | giotto object  |
| <code>expression_values</code> | gene expression values to use  |
| <code>cluster_column</code>    | clusters to use  |
| <code>subset_clusters</code>   | selection of clusters to compare   |
| <code>group_1</code>           | group 1 cluster IDs from <code>cluster_column</code> for pairwise comparison         |
| <code>group_2</code>           | group 2 cluster IDs from <code>cluster_column</code> for pairwise comparison         |
| <code>...</code>               | additional parameters for the <code>findMarkers</code> function in <code>scrn</code> |

**Details**

This is a minimal convenience wrapper around the [findMarkers](#) function from the `scrn` package.

To perform differential expression between cluster groups you need to specify cluster IDs to the parameters `group_1` and `group_2`.

**Value**

data.table with marker genes

**Examples**

```
findScranMarkers(gobject)
```

---

```
findScranMarkers_one_vs_all
  findScranMarkers_one_vs_all
```

---

**Description**

Identify marker genes for all clusters in a one vs all manner based on `scrn`'s implementation of `findMarkers`.

**Usage**

```
findScranMarkers_one_vs_all(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  cluster_column,
  subset_clusters = NULL,
  pval = 0.01,
  logFC = 0.5,
  min_genes = 10,
  verbose = TRUE,
  ...
)
```

**Arguments**

|                                |   |
|--------------------------------|---|
| <code>gobject</code>           | giotto object   |
| <code>expression_values</code> | gene expression values to use                               |
| <code>cluster_column</code>    | clusters to use   |
| <code>subset_clusters</code>   | subset of clusters to use                                   |
| <code>pval</code>              | filter on minimal p-value                                   |
| <code>logFC</code>             | filter on logFC   |
| <code>min_genes</code>         | minimum genes to keep per cluster, overrides pval and logFC |
| <code>verbose</code>           | be verbose  |
| <code>...</code>               | additional parameters for the findMarkers function in scrn  |

**Value**

data.table with marker genes

**See Also**

[findScranMarkers](#)

**Examples**

```
findScranMarkers_one_vs_all(gobject)
```

---

|                           |                     |
|---------------------------|---------------------|
| <code>find_grid_2D</code> | <i>find_grid_2D</i> |
|---------------------------|---------------------|

---

**Description**

find grid location in 2D

**Usage**

```
find_grid_2D(grid_DT, x_loc, y_loc)
```

---

|                           |                     |
|---------------------------|---------------------|
| <code>find_grid_3D</code> | <i>find_grid_3D</i> |
|---------------------------|---------------------|

---

**Description**

find grid location in 3D

**Usage**

```
find_grid_3D(grid_DT, x_loc, y_loc, z_loc)
```

---

|             |                    |
|-------------|--------------------|
| find_grid_x | <i>find_grid_x</i> |
|-------------|--------------------|

---

**Description**

find grid location on x-axis

**Usage**

```
find_grid_x(grid_DT, x_loc)
```

---

---

|             |                    |
|-------------|--------------------|
| find_grid_y | <i>find_grid_y</i> |
|-------------|--------------------|

---

**Description**

find grid location on y-axis

**Usage**

```
find_grid_y(grid_DT, y_loc)
```

---

---

|             |                    |
|-------------|--------------------|
| find_grid_z | <i>find_grid_z</i> |
|-------------|--------------------|

---

**Description**

find grid location on z-axis

**Usage**

```
find_grid_z(grid_DT, z_loc)
```

---

---

|                 |                        |
|-----------------|------------------------|
| find_x_y_ranges | <i>find_x_y_ranges</i> |
|-----------------|------------------------|

---

**Description**

get the extended ranges of x and y

**Usage**

```
find_x_y_ranges(data, extend_ratio)
```

---

general\_save\_function    *general\_save\_function*

---

## Description

Function to automatically save plots to directory of interest

## Usage

```
general_save_function(
  gobject,
  plot_object,
  save_dir = NULL,
  save_folder = NULL,
  save_name = NULL,
  default_save_name = "giotto_plot",
  save_format = c("png", "tiff", "pdf", "svg"),
  show_saved_plot = F,
  base_width = NULL,
  base_height = NULL,
  base_aspect_ratio = NULL,
  units = NULL,
  dpi = NULL,
  ...
)
```

## Arguments

|                                |  |
|--------------------------------|--|
| <code>gobject</code>           | giotto object                              |
| <code>plot_object</code>       | non-ggplot object to plot                  |
| <code>save_dir</code>          | directory to save to                       |
| <code>save_folder</code>       | folder in <code>save_dir</code> to save to |
| <code>save_name</code>         | name of plot                               |
| <code>save_format</code>       | format (e.g. png, tiff, pdf, ...)          |
| <code>show_saved_plot</code>   | load & display the saved plot              |
| <code>base_width</code>        | width                                      |
| <code>base_height</code>       | height                                     |
| <code>base_aspect_ratio</code> | aspect ratio                               |
| <code>units</code>             | units                                      |
| <code>dpi</code>               | Plot resolution                            |

## Examples

```
general_save_function(gobject)
```

---

|              |                     |
|--------------|---------------------|
| get10Xmatrix | <i>get10Xmatrix</i> |
|--------------|---------------------|

---

**Description**

This function creates an expression matrix from a 10X structured folder

**Usage**

```
get10Xmatrix(path_to_data, gene_column_index = 1)
```

**Arguments**

path\_to\_data    path to the 10X folder  
 gene\_column\_index    which column from the features or genes .tsv file to use for row ids

**Details**

A typical 10X folder is named raw\_feature\_bc\_matrix or raw\_feature\_bc\_matrix and it has 3 files:

- barcodes.tsv(.gz)
- features.tsv(.gz) or genes.tsv(.gz)
- matrix.mtx(.gz)

By default the first column of the features or genes .tsv file will be used, however if multiple annotations are provided (e.g. ensembl gene ids and gene symbols) the user can select another column.

**Value**

sparse expression matrix from 10X

**Examples**

```
get10Xmatrix(10Xmatrix)
```

---

|                      |                             |
|----------------------|-----------------------------|
| getClusterSimilarity | <i>getClusterSimilarity</i> |
|----------------------|-----------------------------|

---

**Description**

Creates data.table with pairwise correlation scores between each cluster.

**Usage**

```
getClusterSimilarity(  
  gobject,  
  expression_values = c("normalized", "scaled", "custom"),  
  cluster_column,  
  cor = c("pearson", "spearman")  
)
```

**Arguments**

|                                |   |
|--------------------------------|---|
| <code>gobject</code>           | giotto object                           |
| <code>expression_values</code> | expression values to use                |
| <code>cluster_column</code>    | name of column to use for clusters      |
| <code>cor</code>               | correlation score to calculate distance |

**Details**

Creates `data.table` with pairwise correlation scores between each cluster and the group size (# of cells) for each cluster. This information can be used together with `mergeClusters` to combine very similar or small clusters into bigger clusters.

**Value**

`data.table`

**Examples**

```
getClusterSimilarity(gobject)
```

---

|                                  |                            |
|----------------------------------|----------------------------|
| <code>getDendrogramSplits</code> | <i>getDendrogramSplits</i> |
|----------------------------------|----------------------------|

---

**Description**

Split dendrogram at each node and keep the leave (label) information..

**Usage**

```
getDendrogramSplits(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  cluster_column,
  cor = c("pearson", "spearman"),
  distance = "ward.D",
  h = NULL,
  h_color = "red",
  show_dend = TRUE,
  verbose = TRUE
)
```

**Arguments**

|                                |   |
|--------------------------------|---|
| <code>gobject</code>           | giotto object                           |
| <code>expression_values</code> | expression values to use                |
| <code>cluster_column</code>    | name of column to use for clusters      |
| <code>cor</code>               | correlation score to calculate distance |

|           |  |
|-----------|--|
| distance  | distance method to use for hierarchical clustering |
| h         | height of horizontal lines to plot                 |
| h_color   | color of horizontal lines                          |
| show_dend | show dendrogram                                    |
| verbose   | be verbose   |

### Details

Creates a data.table with three columns and each row represents a node in the dendrogram. For each node the height of the node is given together with the two subdendrograms. This information can be used to determine in a hierarchical manner differentially expressed marker genes at each node.

### Value

data.table object

### Examples

```
getDendrogramSplits(gobject)
```

---

|                   |                          |
|-------------------|--------------------------|
| getDistinctColors | <i>getDistinctColors</i> |
|-------------------|--------------------------|

---

### Description

Returns a number of distinct colors based on the RGB scale

### Usage

```
getDistinctColors(n)
```

### Arguments

|   |                         |
|---|-------------------------|
| n | number of colors wanted |
|---|-------------------------|

### Value

number of distinct colors

---

|                |                       |
|----------------|-----------------------|
| getGiottoImage | <i>getGiottoImage</i> |
|----------------|-----------------------|

---

**Description**

get get a giotto image from a giotto object

**Usage**

```
getGiottoImage(gobject, image_name)
```

**Arguments**

|            |   |
|------------|---|
| gobject    | giotto object                                       |
| image_name | name of giotto image <a href="#">showImageNames</a> |

**Value**

a giotto image

**Examples**

```
getGiottoImage(gobject)
```

---

|                               |                                      |
|-------------------------------|--------------------------------------|
| get_cross_section_coordinates | <i>get_cross_section_coordinates</i> |
|-------------------------------|--------------------------------------|

---

**Description**

get local coordinates within cross section plane

**Usage**

```
get_cross_section_coordinates(cell_subset_projection_locations)
```

---

|              |                     |
|--------------|---------------------|
| get_distance | <i>get_distance</i> |
|--------------|---------------------|

---

**Description**

estimate average distance between neighboring cells with network table as input

**Usage**

```
get_distance(networkDT, method = c("mean", "median"))
```



---

get\_sectionThickness    *get\_sectionThickness*

---

### Description

get section thickness

### Usage

```
get_sectionThickness(  
  gobject,  
  thickness_unit = c("cell", "natural"),  
  slice_thickness = 2,  
  spatial_network_name = "Delaunay_network",  
  cell_distance_estimate_method = c("mean", "median"),  
  plane_equation = NULL  
)
```

---

ggplot\_save\_function    *ggplot\_save\_function*

---

### Description

Function to automatically save plots to directory of interest

### Usage

```
ggplot_save_function(  
  gobject,  
  plot_object,  
  save_dir = NULL,  
  save_folder = NULL,  
  save_name = NULL,  
  default_save_name = "giotto_plot",  
  save_format = NULL,  
  show_saved_plot = F,  
  ncol = 1,  
  nrow = 1,  
  scale = 1,  
  base_width = NULL,  
  base_height = NULL,  
  base_aspect_ratio = NULL,  
  units = NULL,  
  dpi = NULL,  
  limitsize = TRUE,  
  ...  
)
```

**Arguments**

|                                |  |
|--------------------------------|--|
| <code>gobject</code>           | giotto object  |
| <code>plot_object</code>       | ggplot object to plot  |
| <code>save_dir</code>          | directory to save to   |
| <code>save_folder</code>       | folder in <code>save_dir</code> to save to   |
| <code>save_name</code>         | name of plot   |
| <code>save_format</code>       | format (e.g. png, tiff, pdf, ...)  |
| <code>show_saved_plot</code>   | load & display the saved plot  |
| <code>ncol</code>              | number of columns  |
| <code>nrow</code>              | number of rows   |
| <code>scale</code>             | scale  |
| <code>base_width</code>        | width  |
| <code>base_height</code>       | height   |
| <code>base_aspect_ratio</code> | aspect ratio   |
| <code>units</code>             | units  |
| <code>dpi</code>               | Plot resolution  |
| <code>limitsize</code>         | When TRUE (the default), ggsave will not save images larger than 50x50 inches, to prevent the common error of specifying dimensions in pixels. |

**See Also**

[cowplot::save\\_plot](#)

**Examples**

```
ggplot_save_function(gobject)
```

---

giotto-class

*S4 giotto Class*


---

**Description**

Framework of giotto object to store and work with spatial expression data

**Slots**

|                               |   |
|-------------------------------|---|
| <code>raw_exprs</code>        | raw expression counts                   |
| <code>norm_expr</code>        | normalized expression counts            |
| <code>norm_scaled_expr</code> | normalized and scaled expression counts |
| <code>custom_expr</code>      | custom normalized counts                |
| <code>spatial_locs</code>     | spatial location coordinates for cells  |
| <code>cell_metadata</code>    | metadata for cells                      |
| <code>gene_metadata</code>    | metadata for genes                      |

cell\_ID unique cell IDs  
 gene\_ID unique gene IDs  
 spatial\_network spatial network in data.table/data.frame format  
 spatial\_grid spatial grid in data.table/data.frame format  
 dimension\_reduction slot to save dimension reduction coordinates  
 nn\_network nearest neighbor network in igraph format  
 parameters slot to save parameters that have been used  
 instructions slot for global function instructions  
 offset\_file offset file used to stitch together image fields  
 OS\_platform Operating System to run Giotto analysis on

---

heatmSpatialCorGenes    *heatmSpatialCorGenes*

---

## Description

Create heatmap of spatially correlated genes

## Usage

```

heatmSpatialCorGenes(
  gobject,
  spatCorObject,
  use_clus_name = NULL,
  show_cluster_annot = TRUE,
  show_row_dend = T,
  show_column_dend = F,
  show_row_names = F,
  show_column_names = F,
  show_plot = NA,
  return_plot = NA,
  save_plot = NA,
  save_param = list(),
  default_save_name = "heatmSpatialCorGenes",
  ...
)

```

## Arguments

|                    |   |
|--------------------|---|
| gobject            | giotto object   |
| spatCorObject      | spatial correlation object                                    |
| use_clus_name      | name of clusters to visualize (from clusterSpatialCorGenes()) |
| show_cluster_annot | show cluster annotation on top of heatmap                     |
| show_row_dend      | show row dendrogram   |
| show_column_dend   | show column dendrogram  |

```

show_row_names  show row names
show_column_names
                show column names

show_plot       show plot
return_plot     return ggplot object
save_plot       directly save the plot [boolean]
save_param      list of saving parameters from all\_plots\_save\_function
default_save_name
                default save name for saving, don't change, change save_name in save_param
...             additional parameters to the Heatmap function from ComplexHeatmap

```

**Value**

Heatmap generated by ComplexHeatmap

**Examples**

```
heatmSpatialCorGenes(gobject)
```

---

```
hyperGeometricEnrich  hyperGeometricEnrich
```

---

**Description**

Function to calculate gene signature enrichment scores per spatial position using a hypergeometric test.

**Usage**

```

hyperGeometricEnrich(
  gobject,
  sign_matrix,
  expression_values = c("normalized", "scaled", "custom"),
  reverse_log_scale = TRUE,
  logbase = 2,
  top_percentage = 5,
  output_enrichment = c("original", "zscore")
)

```

**Arguments**

```

gobject          Giotto object
sign_matrix       Matrix of signature genes for each cell type / process
expression_values expression values to use
reverse_log_scale reverse expression values from log scale
logbase           log base to use if reverse_log_scale = TRUE
top_percentage    percentage of cells that will be considered to have gene expression with matrix
                  binarization
output_enrichment how to return enrichment output

```

**Details**

The enrichment score is calculated based on the p-value from the hypergeometric test,  $-\log_{10}(\text{p-value})$ .

**Value**

data.table with enrichment results

**Examples**

```
hyperGeometricEnrich(gobject)
```

---

```
insertCrossSectionGenePlot3D
```

```
insertCrossSectionGenePlot3D
```

---

**Description**

Visualize cells and gene expression in a virtual cross section according to spatial coordinates

**Usage**

```
insertCrossSectionGenePlot3D(
  gobject,
  crossSection_obj = NULL,
  name = NULL,
  spatial_network_name = "Delaunay_network",
  mesh_grid_color = "#1f77b4",
  mesh_grid_width = 3,
  mesh_grid_style = "dot",
  sdimx = "sdimx",
  sdimy = "sdimy",
  sdimz = "sdimz",
  expression_values = c("normalized", "scaled", "custom"),
  genes,
  show_network = F,
  network_color = NULL,
  edge_alpha = NULL,
  show_grid = F,
  cluster_column = NULL,
  select_cell_groups = NULL,
  select_cells = NULL,
  show_other_cells = F,
  other_cell_color = "lightgrey",
  other_point_size = 1,
  genes_high_color = NULL,
  genes_mid_color = "white",
  genes_low_color = "darkblue",
  spatial_grid_name = "spatial_grid",
  point_size = 2,
  show_legend = T,
```

```

axis_scale = c("cube", "real", "custom"),
custom_ratio = NULL,
x_ticks = NULL,
y_ticks = NULL,
z_ticks = NULL,
show_plot = NA,
return_plot = NA,
save_plot = NA,
save_param = list(),
default_save_name = "spatGenePlot3D_with_cross_section"
)

```

### Arguments

|                                   |  |
|-----------------------------------|--|
| <code>gobject</code>              | giotto object  |
| <code>name</code>                 | name of virtual cross section to use                                   |
| <code>spatial_network_name</code> | name of spatial network to use   |
| <code>mesh_grid_color</code>      | color for the meshgrid lines   |
| <code>mesh_grid_width</code>      | width for the meshgrid lines   |
| <code>mesh_grid_style</code>      | style for the meshgrid lines   |
| <code>sdimx</code>                | x-axis dimension name (default = 'sdimx')                              |
| <code>sdimy</code>                | y-axis dimension name (default = 'sdimy')                              |
| <code>sdimz</code>                | z-axis dimension name (default = 'sdimy')                              |
| <code>expression_values</code>    | gene expression values to use  |
| <code>genes</code>                | genes to show  |
| <code>show_network</code>         | show underlying spatial network  |
| <code>network_color</code>        | color of spatial network   |
| <code>show_grid</code>            | show spatial grid  |
| <code>genes_high_color</code>     | color represents high gene expression                                  |
| <code>genes_mid_color</code>      | color represents middle gene expression                                |
| <code>genes_low_color</code>      | color represents low gene expression                                   |
| <code>spatial_grid_name</code>    | name of spatial grid to use  |
| <code>point_size</code>           | size of point (cell)   |
| <code>show_legend</code>          | show legend  |
| <code>show_plot</code>            | show plots   |
| <code>return_plot</code>          | return ggplot object   |
| <code>save_plot</code>            | directly save the plot [boolean]                                       |
| <code>save_param</code>           | list of saving parameters from <a href="#">all_plots_save_function</a> |

|                             |  |
|-----------------------------|--|
| default_save_name           | default save name for saving, don't change, change save_name in save_param |
| grid_color                  | color of spatial grid  |
| midpoint                    | expression midpoint  |
| scale_alpha_with_expression | scale expression with ggplot alpha parameter                               |
| ...                         | parameters for cowplot::save_plot()  |

### Details

Description of parameters.

### Value

ggplot

### Examples

```
insertCrossSectionGenePlot3D(gobject)
```

---

```
insertCrossSectionSpatPlot3D
```

```
insertCrossSectionSpatPlot3D
```

---

### Description

Visualize the meshgrid lines of cross section together with cells

### Usage

```
insertCrossSectionSpatPlot3D(
  gobject,
  crossSection_obj = NULL,
  name = NULL,
  spatial_network_name = "Delaunay_network",
  mesh_grid_color = "#1f77b4",
  mesh_grid_width = 3,
  mesh_grid_style = "dot",
  sdimx = "sdimx",
  sdimy = "sdimy",
  sdimz = "sdimz",
  point_size = 2,
  cell_color = NULL,
  cell_color_code = NULL,
  select_cell_groups = NULL,
  select_cells = NULL,
  show_other_cells = T,
  other_cell_color = "lightgrey",
  other_point_size = 0.5,
  show_network = F,
  network_color = NULL,
```

```

network_alpha = 1,
other_cell_alpha = 0.5,
show_grid = F,
grid_color = NULL,
spatial_grid_name = "spatial_grid",
title = "",
show_legend = T,
axis_scale = c("cube", "real", "custom"),
custom_ratio = NULL,
x_ticks = NULL,
y_ticks = NULL,
z_ticks = NULL,
show_plot = NA,
return_plot = NA,
save_plot = NA,
save_param = list(),
default_save_name = "spat3D_with_cross_section"
)

```

### Arguments

|                                   |   |
|-----------------------------------|---|
| <code>gobject</code>              | giotto object   |
| <code>name</code>                 | name of virtual cross section to use                          |
| <code>spatial_network_name</code> | name of spatial network to use                                |
| <code>mesh_grid_color</code>      | color for the meshgrid lines                                  |
| <code>mesh_grid_width</code>      | width for the meshgrid lines                                  |
| <code>mesh_grid_style</code>      | style for the meshgrid lines                                  |
| <code>sdimx</code>                | x-axis dimension name (default = 'sdimx')                     |
| <code>sdimy</code>                | y-axis dimension name (default = 'sdimy')                     |
| <code>sdimz</code>                | z-axis dimension name (default = 'sdimy')                     |
| <code>point_size</code>           | size of point (cell)  |
| <code>cell_color</code>           | color for cells (see details)                                 |
| <code>cell_color_code</code>      | named vector with colors                                      |
| <code>select_cell_groups</code>   | select subset of cells/clusters based on cell_color parameter |
| <code>show_other_cells</code>     | display not selected cells                                    |
| <code>other_cell_color</code>     | color of not selected cells                                   |
| <code>other_point_size</code>     | point size of not selected cells                              |
| <code>network_color</code>        | color of spatial network                                      |
| <code>show_grid</code>            | show spatial grid   |
| <code>grid_color</code>           | color of spatial grid   |



|                   |  |
|-------------------|--|
| spatial_grid_name | name of spatial grid to use  |
| title             | title of plot  |
| show_legend       | show legend  |
| axis_scale        | the way to scale the axis  |
| custom_ratio      | customize the scale of the plot  |
| x_ticks           | set the number of ticks on the x-axis                                      |
| y_ticks           | set the number of ticks on the y-axis                                      |
| z_ticks           | set the number of ticks on the z-axis                                      |
| show_plot         | show plot  |
| return_plot       | return ggplot object   |
| save_plot         | directly save the plot [boolean]   |
| save_param        | list of saving parameters from <a href="#">all_plots_save_function</a>     |
| default_save_name | default save name for saving, don't change, change save_name in save_param |

## Details

Description of parameters.

## Value

ggplot

## Examples

```
insertCrossSectionSpatPlot3D(gobject)
```

---

|               |                      |
|---------------|----------------------|
| jackstrawPlot | <i>jackstrawPlot</i> |
|---------------|----------------------|

---

## Description

identify significant principal components (PCs)

## Usage

```
jackstrawPlot(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  reduction = c("cells", "genes"),
  genes_to_use = NULL,
  center = F,
  scale_unit = F,
  ncp = 20,
  ylim = c(0, 1),
  iter = 10,
  threshold = 0.01,
```

```

    verbose = T,
    show_plot = NA,
    return_plot = NA,
    save_plot = NA,
    save_param = list(),
    default_save_name = "jackstrawPlot"
  )

```

## Arguments

|                                |  |
|--------------------------------|--|
| <code>gobject</code>           | giotto object  |
| <code>expression_values</code> | expression values to use   |
| <code>reduction</code>         | cells or genes   |
| <code>genes_to_use</code>      | subset of genes to use for PCA   |
| <code>center</code>            | center data before PCA   |
| <code>scale_unit</code>        | scale features before PCA  |
| <code>ncp</code>               | number of principal components to calculate  |
| <code>ylim</code>              | y-axis limits on jackstraw plot  |
| <code>iter</code>              | number of iterations for jackstraw   |
| <code>threshold</code>         | p-value threshold to call a PC significant   |
| <code>verbose</code>           | show progress of jackstraw method  |
| <code>show_plot</code>         | show plot  |
| <code>return_plot</code>       | return ggplot object   |
| <code>save_plot</code>         | directly save the plot [boolean]   |
| <code>save_param</code>        | list of saving parameters from <code>all_plots_save_function()</code>                                |
| <code>default_save_name</code> | default save name for saving, don't change, change <code>save_name</code> in <code>save_param</code> |

## Details

The Jackstraw method uses the [permutationPA](#) function. By systematically permuting genes it identifies robust, and thus significant, PCs. multiple PCA results can be stored by changing the *name* parameter

## Value

ggplot object for jackstraw method

## Examples

```
jackstrawPlot(gobject)
```

---

|                 |                        |
|-----------------|------------------------|
| kmeans_binarize | <i>kmeans_binarize</i> |
|-----------------|------------------------|

---

**Description**

create binarized scores from a vector using kmeans

**Usage**

```
kmeans_binarize(x, nstart = 3, iter.max = 10)
```

---

|                |                       |
|----------------|-----------------------|
| libNorm_giotto | <i>libNorm_giotto</i> |
|----------------|-----------------------|

---

**Description**

libNorm\_giotto

**Usage**

```
libNorm_giotto(mymatrix, scalefactor)
```

---

|          |                 |
|----------|-----------------|
| loadHMRf | <i>loadHMRf</i> |
|----------|-----------------|

---

**Description**

load previous HMRf

**Usage**

```
loadHMRf(
  name_used = "test",
  output_folder_used,
  k_used = 10,
  betas_used,
  python_path_used
)
```

**Arguments**

|                    |  |
|--------------------|--|
| name_used          | name of HMRf that was run              |
| output_folder_used | output folder that was used            |
| k_used             | number of HMRf domains that was tested |
| betas_used         | betas that were tested                 |
| python_path_used   | python path that was used              |

**Details**

Description of HMRF parameters ...

**Value**

reloads a previous ran HMRF from doHRMF

**Examples**

```
loadHMRF(gobject)
```

---

|                |                       |
|----------------|-----------------------|
| logNorm_giotto | <i>logNorm_giotto</i> |
|----------------|-----------------------|

---

**Description**

logNorm\_giotto

**Usage**

```
logNorm_giotto(mymatrix, base, offset)
```

---

|                    |                           |
|--------------------|---------------------------|
| makeSignMatrixPAGE | <i>makeSignMatrixPAGE</i> |
|--------------------|---------------------------|

---

**Description**

Function to convert a list of signature genes (e.g. for cell types or processes) into a binary matrix format that can be used with the PAGE enrichment option. Each cell type or process should have a vector of cell-type or process specific genes. These vectors need to be combined into a list (sign\_list). The names of the cell types or processes that are provided in the list need to be given (sign\_names).

**Usage**

```
makeSignMatrixPAGE(sign_names, sign_list)
```

**Arguments**

- sign\_names      vector with names for each provided gene signature
- sign\_list      list of genes (signature)

**Value**

matrix

**See Also**

[PAGEEnrich](#)

**Examples**

```
makeSignMatrixPAGE()
```

---

|                    |                           |
|--------------------|---------------------------|
| makeSignMatrixRank | <i>makeSignMatrixRank</i> |
|--------------------|---------------------------|

---

**Description**

Function to convert a single-cell count matrix and a corresponding single-cell cluster vector into a rank matrix that can be used with the Rank enrichment option.

**Usage**

```
makeSignMatrixRank(sc_matrix, sc_cluster_ids, gobject = NULL)
```

**Arguments**

|                |   |
|----------------|---|
| sc_matrix      | matrix of single-cell RNAseq expression data  |
| sc_cluster_ids | vector of cluster ids   |
| gobject        | if giotto object is given then only genes present in both datasets will be considered |

**Value**

matrix

**See Also**

[rankEnrich](#)

**Examples**

```
makeSignMatrixRank()
```

---

|                        |                               |
|------------------------|-------------------------------|
| make_simulated_network | <i>make_simulated_network</i> |
|------------------------|-------------------------------|

---

**Description**

Simulate random network.

**Usage**

```
make_simulated_network(
  gobject,
  spatial_network_name = "Delaunay_network",
  cluster_column,
  number_of_simulations = 100
)
```

**Examples**

```
make_simulated_network(gobject)
```

---

|                    |                           |
|--------------------|---------------------------|
| mean_expr_det_test | <i>mean_expr_det_test</i> |
|--------------------|---------------------------|

---

### Description

mean\_expr\_det\_test

### Usage

```
mean_expr_det_test(mymatrix, detection_threshold = 1)
```

---

|             |                    |
|-------------|--------------------|
| mean_giotto | <i>mean_giotto</i> |
|-------------|--------------------|

---

### Description

mean\_giotto

### Usage

```
mean_giotto(x, ...)
```

---

|               |                      |
|---------------|----------------------|
| mergeClusters | <i>mergeClusters</i> |
|---------------|----------------------|

---

### Description

Merge selected clusters based on pairwise correlation scores and size of cluster.

### Usage

```
mergeClusters(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  cluster_column,
  cor = c("pearson", "spearman"),
  new_cluster_name = "merged_cluster",
  min_cor_score = 0.8,
  max_group_size = 20,
  force_min_group_size = 10,
  return_gobject = TRUE,
  verbose = TRUE
)
```

**Arguments**

|                      |  |
|----------------------|--|
| gobject              | giotto object  |
| expression_values    | expression values to use   |
| cluster_column       | name of column to use for clusters                                       |
| cor                  | correlation score to calculate distance                                  |
| new_cluster_name     | new name for merged clusters   |
| min_cor_score        | min correlation score to merge pairwise clusters                         |
| max_group_size       | max cluster size that can be merged                                      |
| force_min_group_size | size of clusters that will be merged with their most similar neighbor(s) |
| return_gobject       | return giotto object   |
| verbose              | be verbose   |

**Details**

Merge selected clusters based on pairwise correlation scores and size of cluster. To avoid large clusters to merge the `max_group_size` can be lowered. Small clusters can be forcibly merged with their most similar pairwise cluster by adjusting the `force_min_group_size` parameter. Clusters smaller than this value will be merged independent on the provided `min_cor_score` value.

A giotto object is returned by default, if FALSE then the merging vector will be returned.

**Value**

Giotto object

**Examples**

```
mergeClusters(gobject)
```

---

mygini\_fun

*mygini\_fun*


---

**Description**

calculate gini coefficient

**Usage**

```
mygini_fun(x, weights = rep(1, length(x)))
```

**Value**

gini coefficient

---

|              |                     |
|--------------|---------------------|
| my_arowMeans | <i>my_arowMeans</i> |
|--------------|---------------------|

---

**Description**

arithmic rowMeans that works for a single column

**Usage**

```
my_arowMeans(x)
```

**Examples**

```
my_arowMeans(x)
```

---

|              |                     |
|--------------|---------------------|
| my_growMeans | <i>my_growMeans</i> |
|--------------|---------------------|

---

**Description**

geometric rowMeans that works for a single column

**Usage**

```
my_growMeans(x, offset = 0.1)
```

**Examples**

```
my_growMeans(x)
```

---

|             |                    |
|-------------|--------------------|
| my_rowMeans | <i>my_rowMeans</i> |
|-------------|--------------------|

---

**Description**

arithmic or geometric rowMeans that works for a single column

**Usage**

```
my_rowMeans(x, method = c("arithmic", "geometric"), offset = 0.1)
```

**Examples**

```
my_rowMeans(x)
```



---

nnDT\_to\_kNN

*nnDT\_to\_kNN*


---

**Description**

Convert a nearest network data.table to a kNN object

**Usage**

```
nnDT_to_kNN(nnDT)
```

**Arguments**

nnDT                    nearest neighbor network in data.table format

**Value**

kNN object

---

node\_clusters

*node\_clusters*


---

**Description**

Merge selected clusters based on pairwise correlation scores and size of cluster.

**Usage**

```
node_clusters(hclus_obj, verbose = TRUE)
```

**Arguments**

hclus\_obj            hclus object  
verbose              be verbose

**Value**

list of splitted dendrogram nodes from high to low node height

**Examples**

```
node_clusters(hclus_obj)
```

---

|                 |                        |
|-----------------|------------------------|
| normalizeGiotto | <i>normalizeGiotto</i> |
|-----------------|------------------------|

---

## Description

fast normalize and/or scale expression values of Giotto object

## Usage

```
normalizeGiotto(
  gobject,
  norm_methods = c("standard", "osmFISH"),
  library_size_norm = TRUE,
  scalefactor = 6000,
  log_norm = TRUE,
  log_offset = 1,
  logbase = 2,
  scale_genes = T,
  scale_cells = T,
  scale_order = c("first_genes", "first_cells"),
  verbose = F
)
```

## Arguments

|                   |   |
|-------------------|---|
| gobject           | giotto object   |
| norm_methods      | normalization method to use                           |
| library_size_norm | normalize cells by library size                       |
| scalefactor       | scale factor to use after library size normalization  |
| log_norm          | transform values to log-scale                         |
| log_offset        | offset value to add to expression matrix, default = 1 |
| logbase           | log base to use to log normalize expression values    |
| scale_genes       | z-score genes over all cells                          |
| scale_cells       | z-score cells over all genes                          |
| scale_order       | order to scale genes and cells                        |
| verbose           | be verbose  |

## Details

Currently there are two 'methods' to normalize your raw counts data.

A. The standard method follows the standard protocol which can be adjusted using the provided parameters and follows the following order:

- 1. Data normalization for total library size and scaling by a custom scale-factor.
- 2. Log transformation of data.
- 3. Z-scoring of data by genes and/or cells.

B. The normalization method as provided by the osmFISH paper is also implemented:

- 1. First normalize genes, for each gene divide the counts by the total gene count and multiply by the total number of genes.
- 2. Next normalize cells, for each cell divide the normalized gene counts by the total counts per cell and multiply by the total number of cells.

This data will be saved in the Giotto slot for custom expression.

### Value

giotto object

### Examples

```
normalizeGiotto(gobject)
```

---

|            |                   |
|------------|-------------------|
| PAGEEnrich | <i>PAGEEnrich</i> |
|------------|-------------------|

---

### Description

Function to calculate gene signature enrichment scores per spatial position using PAGE.

### Usage

```
PAGEEnrich(
  gobject,
  sign_matrix,
  expression_values = c("normalized", "scaled", "custom"),
  reverse_log_scale = TRUE,
  logbase = 2,
  output_enrichment = c("original", "zscore")
)
```

### Arguments

|                                |  |
|--------------------------------|--|
| <code>gobject</code>           | Giotto object  |
| <code>sign_matrix</code>       | Matrix of signature genes for each cell type / process   |
| <code>expression_values</code> | expression values to use                                 |
| <code>reverse_log_scale</code> | reverse expression values from log scale                 |
| <code>logbase</code>           | log base to use if <code>reverse_log_scale = TRUE</code> |
| <code>output_enrichment</code> | how to return enrichment output                          |

Details

sign\_matrix: a binary matrix with genes as row names and cell-types as column names. Alternatively a list of signature genes can be provided to makeSignMatrixPAGE, which will create the matrix for you.

The enrichment Z score is calculated by using method (PAGE) from Kim SY et al., BMC bioinformatics, 2005 as  $Z = ((Sm^{\circ}mu) * m^{(1/2)})/delta$ . For each gene in each spot, mu is the fold change values versus the mean expression and delta is the standard deviation. Sm is the mean fold change value of a specific marker gene set and m is the size of a given marker gene set.

Value

data.table with enrichment results

See Also

[makeSignMatrixPAGE](#)

Examples

```
PAGEEnrich(gobject)
```

---

|            |                   |
|------------|-------------------|
| pca_giotto | <i>pca_giotto</i> |
|------------|-------------------|

---

Description

performs PCA based on Rfast

Usage

```
pca_giotto(mymatrix, center = T, scale = T, k = 50)
```

Arguments

|          |  |
|----------|--|
| mymatrix | matrix or object that can be converted to matrix |
| center   | center data                                      |
| scale    | scale features                                   |
| k        | number of principal components to calculate      |

Value

list of eigenvalues, eigenvectors and pca coordinates

---

|         |                |
|---------|----------------|
| pDataDT | <i>pDataDT</i> |
|---------|----------------|

---

**Description**

show cell metadata

**Usage**

pDataDT(gobject)

**Arguments**

gobject                  giotto object

**Value**

data.table with cell metadata

**Examples**

pDataDT(gobject)

---

|                  |                         |
|------------------|-------------------------|
| plotCCcomDotplot | <i>plotCCcomDotplot</i> |
|------------------|-------------------------|

---

**Description**

Plots dotplot for ligand-receptor communication scores in cell-cell interactions

**Usage**

```
plotCCcomDotplot(  
  gobject,  
  comScores,  
  selected_LR = NULL,  
  selected_cell_LR = NULL,  
  show_LR_names = TRUE,  
  show_cell_LR_names = TRUE,  
  cluster_on = c("PI", "LR_expr", "log2fc"),  
  cor_method = c("pearson", "kendall", "spearman"),  
  aggl_method = c("ward.D", "ward.D2", "single", "complete", "average", "mcquitty",  
    "median", "centroid"),  
  show_plot = NA,  
  return_plot = NA,  
  save_plot = NA,  
  save_param = list(),  
  default_save_name = "plotCCcomDotplot"  
)
```

Arguments

|                    |  |
|--------------------|--|
| gobject            | giotto object  |
| comScores          | communication scores from <a href="#">exprCellCellcom</a> or <a href="#">spatCellCellcom</a> |
| selected_LR        | selected ligand-receptor combinations  |
| selected_cell_LR   | selected cell-cell combinations for ligand-receptor combinations                             |
| show_LR_names      | show ligand-receptor names   |
| show_cell_LR_names | show cell-cell names   |
| cluster_on         | values to use for clustering of cell-cell and ligand-receptor pairs                          |
| cor_method         | correlation method used for clustering   |
| aggl_method        | agglomeration method used by hclust  |
| show_plot          | show plots   |
| return_plot        | return plotting object   |
| save_plot          | directly save the plot [boolean]   |
| save_param         | list of saving parameters from <a href="#">all_plots_save_function</a>                       |
| default_save_name  | default save name for saving, don't change, change save_name in save_param                   |
| show               | values to show on heatmap  |

Value

ggplot

Examples

```
plotCCcomDotplot(CPGscores)
```

---

|                  |                         |
|------------------|-------------------------|
| plotCCcomHeatmap | <i>plotCCcomHeatmap</i> |
|------------------|-------------------------|

---

Description

Plots heatmap for ligand-receptor communication scores in cell-cell interactions

Usage

```
plotCCcomHeatmap(  
  gobject,  
  comScores,  
  selected_LR = NULL,  
  selected_cell_LR = NULL,  
  show_LR_names = TRUE,  
  show_cell_LR_names = TRUE,  
  show = c("PI", "LR_expr", "log2fc"),  
  cor_method = c("pearson", "kendall", "spearman"),  
  aggl_method = c("ward.D", "ward.D2", "single", "complete", "average", "mcquitty"),
```

```

    "median", "centroid"),
  show_plot = NA,
  return_plot = NA,
  save_plot = NA,
  save_param = list(),
  default_save_name = "plotCCcomHeatmap"
)

```

### Arguments

|                    |  |
|--------------------|--|
| gobject            | giotto object  |
| comScores          | communication scores from <a href="#">exprCellCellcom</a> or <a href="#">spatCellCellcom</a> |
| selected_LR        | selected ligand-receptor combinations  |
| selected_cell_LR   | selected cell-cell combinations for ligand-receptor combinations                             |
| show_LR_names      | show ligand-receptor names   |
| show_cell_LR_names | show cell-cell names   |
| show               | values to show on heatmap  |
| cor_method         | correlation method used for clustering   |
| aggl_method        | agglomeration method used by hclust  |
| show_plot          | show plots   |
| return_plot        | return plotting object   |
| save_plot          | directly save the plot [boolean]   |
| save_param         | list of saving parameters from <a href="#">all_plots_save_function</a>                       |
| default_save_name  | default save name for saving, don't change, change save_name in save_param                   |

### Value

ggplot

### Examples

```
plotCCcomHeatmap(CPGscores)
```

---

plotCellProximityGenes

*plotCellProximityGenes*

---

### Description

Create visualization for cell proximity gene scores

**Usage**

```
plotCellProximityGenes(
  gobject,
  cpqObject,
  method = c("volcano", "cell_barplot", "cell-cell", "cell_sankey", "heatmap",
    "dotplot"),
  min_cells = 4,
  min_cells_expr = 1,
  min_int_cells = 4,
  min_int_cells_expr = 1,
  min_fdr = 0.1,
  min_spat_diff = 0.2,
  min_log2_fc = 0.2,
  min_zscore = 2,
  zscores_column = c("cell_type", "genes"),
  direction = c("both", "up", "down"),
  cell_color_code = NULL,
  show_plot = NA,
  return_plot = NA,
  save_plot = NA,
  save_param = list(),
  default_save_name = "plotCellProximityGenes"
)
```

**Arguments**

|                    |  |
|--------------------|--|
| gobject            | giotto object  |
| cpqObject          | cell proximity gene score object   |
| method             | plotting method to use   |
| min_cells          | minimum number of source cell type   |
| min_cells_expr     | minimum expression level for source cell type                              |
| min_int_cells      | minimum number of interacting neighbor cell type                           |
| min_int_cells_expr | minimum expression level for interacting neighbor cell type                |
| min_fdr            | minimum adjusted p-value   |
| min_spat_diff      | minimum absolute spatial expression difference                             |
| min_log2_fc        | minimum log2 fold-change   |
| min_zscore         | minimum z-score change   |
| zscores_column     | calculate z-scores over cell types or genes                                |
| direction          | differential expression directions to keep                                 |
| cell_color_code    | vector of colors with cell types as names                                  |
| show_plot          | show plots   |
| return_plot        | return plotting object   |
| save_plot          | directly save the plot [boolean]   |
| save_param         | list of saving parameters from <a href="#">all_plots_save_function</a>     |
| default_save_name  | default save name for saving, don't change, change save_name in save_param |



**Value**

plot

**Examples**

```
plotCellProximityGenes(CPGscores)
```

---

plotCombineCCcom

*plotCombineCCcom*


---

**Description**

Create visualization for combined (pairwise) cell proximity gene scores

**Usage**

```
plotCombineCCcom(
  gobject,
  combCCcom,
  selected_LR = NULL,
  selected_cell_LR = NULL,
  detail_plot = T,
  simple_plot = F,
  simple_plot_facet = c("interaction", "genes"),
  facet_scales = "fixed",
  facet_ncol = length(selected_LR),
  facet_nrow = length(selected_cell_LR),
  colors = c("#9932CC", "#FF8C00"),
  show_plot = NA,
  return_plot = NA,
  save_plot = NA,
  save_param = list(),
  default_save_name = "plotCombineCCcom"
)
```

**Arguments**

|                   |  |
|-------------------|--|
| gobject           | giotto object  |
| combCCcom         | combined communication scores, output from combCCcom()       |
| selected_LR       | selected ligand-receptor pair                                |
| selected_cell_LR  | selected cell-cell interaction pair for ligand-receptor pair |
| detail_plot       | show detailed info in both interacting cell types            |
| simple_plot       | show a simplified plot                                       |
| simple_plot_facet | facet on interactions or genes with simple plot              |
| facet_scales      | ggplot facet scales paramter                                 |
| facet_ncol        | ggplot facet ncol parameter                                  |

|                   |  |
|-------------------|--|
| facet_nrow        | ggplot facet nrow parameter  |
| colors            | vector with two colors to use  |
| show_plot         | show plots   |
| return_plot       | return plotting object   |
| save_plot         | directly save the plot [boolean]   |
| save_param        | list of saving parameters from <a href="#">all_plots_save_function</a>     |
| default_save_name | default save name for saving, don't change, change save_name in save_param |

**Value**

ggplot

**Examples**

```
plotCombineCCcom(CPGscores)
```

---

```
plotCombineCellCellCommunication
      plotCombineCellCellCommunication
```

---

**Description**

Create visualization for combined (pairwise) cell proximity gene scores

**Usage**

```
plotCombineCellCellCommunication(
  gobject,
  combCCcom,
  selected_LR = NULL,
  selected_cell_LR = NULL,
  detail_plot = T,
  simple_plot = F,
  simple_plot_facet = c("interaction", "genes"),
  facet_scales = "fixed",
  facet_ncol = length(selected_LR),
  facet_nrow = length(selected_cell_LR),
  colors = c("#9932CC", "#FF8C00"),
  show_plot = NA,
  return_plot = NA,
  save_plot = NA,
  save_param = list(),
  default_save_name = "plotCombineCellCellCommunication"
)
```

**Arguments**

|                                |  |
|--------------------------------|--|
| <code>gobject</code>           | giotto object  |
| <code>combCCcom</code>         | combined communication scores, output from <code>combCCcom()</code>                                  |
| <code>selected_LR</code>       | selected ligand-receptor pair  |
| <code>selected_cell_LR</code>  | selected cell-cell interaction pair for ligand-receptor pair   |
| <code>detail_plot</code>       | show detailed info in both interacting cell types  |
| <code>simple_plot</code>       | show a simplified plot   |
| <code>simple_plot_facet</code> | facet on interactions or genes with simple plot  |
| <code>facet_scales</code>      | ggplot facet scales paramter   |
| <code>facet_ncol</code>        | ggplot facet ncol parameter  |
| <code>facet_nrow</code>        | ggplot facet nrow parameter  |
| <code>colors</code>            | vector with two colors to use  |
| <code>show_plot</code>         | show plots   |
| <code>return_plot</code>       | return plotting object   |
| <code>save_plot</code>         | directly save the plot [boolean]   |
| <code>save_param</code>        | list of saving parameters from <a href="#">all_plots_save_function</a>                               |
| <code>default_save_name</code> | default save name for saving, don't change, change <code>save_name</code> in <code>save_param</code> |

**Value**

ggplot

**Examples**

```
plotCombineCellCellCommunication(CPGscores)
```

---

```
plotCombineCellProximityGenes
```

```
plotCombineCellProximityGenes
```

---

**Description**

Create visualization for combined (pairwise) cell proximity gene scores

**Usage**

```
plotCombineCellProximityGenes(
  gobject,
  combCpgObject,
  selected_interactions = NULL,
  selected_gene_to_gene = NULL,
  detail_plot = T,
  simple_plot = F,
```

```

simple_plot_facet = c("interaction", "genes"),
facet_scales = "fixed",
facet_ncol = length(selected_gene_to_gene),
facet_nrow = length(selected_interactions),
colors = c("#9932CC", "#FF8C00"),
show_plot = NA,
return_plot = NA,
save_plot = NA,
save_param = list(),
default_save_name = "plotCombineCPG"
)

```

### Arguments

|                                    |  |
|------------------------------------|--|
| <code>gobject</code>               | giotto object  |
| <code>combCpgObject</code>         | CPGscores, output from <code>combineCellProximityGenes()</code>                                      |
| <code>selected_interactions</code> | interactions to show   |
| <code>selected_gene_to_gene</code> | pairwise gene combinations to show   |
| <code>detail_plot</code>           | show detailed info in both interacting cell types  |
| <code>simple_plot</code>           | show a simplified plot   |
| <code>simple_plot_facet</code>     | facet on interactions or genes with simple plot  |
| <code>facet_scales</code>          | ggplot facet scales parameter  |
| <code>facet_ncol</code>            | ggplot facet ncol parameter  |
| <code>facet_nrow</code>            | ggplot facet nrow parameter  |
| <code>colors</code>                | vector with two colors to use  |
| <code>show_plot</code>             | show plots   |
| <code>return_plot</code>           | return plotting object   |
| <code>save_plot</code>             | directly save the plot [boolean]   |
| <code>save_param</code>            | list of saving parameters from <a href="#">all_plots_save_function</a>                               |
| <code>default_save_name</code>     | default save name for saving, don't change, change <code>save_name</code> in <code>save_param</code> |

### Value

ggplot

### Examples

```
plotCombineCellProximityGenes(CPGscores)
```

---

|                |                       |
|----------------|-----------------------|
| plotCombineCPG | <i>plotCombineCPG</i> |
|----------------|-----------------------|

---

## Description

Create visualization for combined (pairwise) cell proximity gene scores

## Usage

```
plotCombineCPG(
  gobject,
  combCpgObject,
  selected_interactions = NULL,
  selected_gene_to_gene = NULL,
  detail_plot = T,
  simple_plot = F,
  simple_plot_facet = c("interaction", "genes"),
  facet_scales = "fixed",
  facet_ncol = length(selected_gene_to_gene),
  facet_nrow = length(selected_interactions),
  colors = c("#9932CC", "#FF8C00"),
  show_plot = NA,
  return_plot = NA,
  save_plot = NA,
  save_param = list(),
  default_save_name = "plotCombineCPG"
)
```

## Arguments

|                                    |  |
|------------------------------------|--|
| <code>gobject</code>               | giotto object  |
| <code>combCpgObject</code>         | CPGscores, output from <code>combineCellProximityGenes()</code>                                      |
| <code>selected_interactions</code> | interactions to show   |
| <code>selected_gene_to_gene</code> | pairwise gene combinations to show   |
| <code>detail_plot</code>           | show detailed info in both interacting cell types  |
| <code>simple_plot</code>           | show a simplified plot   |
| <code>simple_plot_facet</code>     | facet on interactions or genes with simple plot  |
| <code>facet_scales</code>          | ggplot facet scales paramter   |
| <code>facet_ncol</code>            | ggplot facet ncol parameter  |
| <code>facet_nrow</code>            | ggplot facet nrow parameter  |
| <code>colors</code>                | vector with two colors to use  |
| <code>show_plot</code>             | show plots   |
| <code>return_plot</code>           | return plotting object   |
| <code>save_plot</code>             | directly save the plot [boolean]   |
| <code>save_param</code>            | list of saving parameters from <a href="#">all_plots_save_function</a>                               |
| <code>default_save_name</code>     | default save name for saving, don't change, change <code>save_name</code> in <code>save_param</code> |

Value

ggplot

Examples

```
plotCombineCPG(CPGscores)
```

---

|         |                |
|---------|----------------|
| plotCPG | <i>plotCPG</i> |
|---------|----------------|

---

Description

Create visualization for cell proximity gene scores

Usage

```
plotCPG(  
  gobject,  
  cpgObject,  
  method = c("volcano", "cell_barplot", "cell-cell", "cell_sankey", "heatmap",  
             "dotplot"),  
  min_cells = 5,  
  min_cells_expr = 1,  
  min_int_cells = 3,  
  min_int_cells_expr = 1,  
  min_fdr = 0.05,  
  min_spat_diff = 0.2,  
  min_log2_fc = 0.2,  
  min_zscore = 2,  
  zscores_column = c("cell_type", "genes"),  
  direction = c("both", "up", "down"),  
  cell_color_code = NULL,  
  show_plot = NA,  
  return_plot = NA,  
  save_plot = NA,  
  save_param = list(),  
  default_save_name = "plotCPG"  
)
```

Arguments

- |                    |   |
|--------------------|---|
| gobject            | giotto object   |
| cpgObject          | cell proximity gene score object                            |
| method             | plotting method to use                                      |
| min_cells          | minimum number of source cell type                          |
| min_cells_expr     | minimum expression level for source cell type               |
| min_int_cells      | minimum number of interacting neighbor cell type            |
| min_int_cells_expr | minimum expression level for interacting neighbor cell type |

|                   |  |
|-------------------|--|
| min_fdr           | minimum adjusted p-value   |
| min_spat_diff     | minimum absolute spatial expression difference                             |
| min_log2_fc       | minimum log2 fold-change   |
| min_zscore        | minimum z-score change   |
| zscores_column    | calculate z-scores over cell types or genes                                |
| direction         | differential expression directions to keep                                 |
| cell_color_code   | vector of colors with cell types as names                                  |
| show_plot         | show plots   |
| return_plot       | return plotting object   |
| save_plot         | directly save the plot [boolean]   |
| save_param        | list of saving parameters from <a href="#">all_plots_save_function</a>     |
| default_save_name | default save name for saving, don't change, change save_name in save_param |

**Value**

plot

**Examples**

```
plotCPG(CPGscores)
```

---

|                 |                        |
|-----------------|------------------------|
| plotGiottoImage | <i>plotGiottoImage</i> |
|-----------------|------------------------|

---

**Description**

get plot a giotto image from a giotto object

**Usage**

```
plotGiottoImage(gobject, image_name)
```

**Arguments**

|            |   |
|------------|---|
| gobject    | giotto object                                       |
| image_name | name of giotto image <a href="#">showImageNames</a> |

**Value**

plot

**Examples**

```
plotGiottoImage(gobject)
```

---

plotHeatmap

*plotHeatmap*


---

## Description

Creates heatmap for genes and clusters.

## Usage

```
plotHeatmap(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  genes,
  cluster_column = NULL,
  cluster_order = c("size", "correlation", "custom"),
  cluster_custom_order = NULL,
  cluster_color_code = NULL,
  cluster_cor_method = "pearson",
  cluster_hclust_method = "ward.D",
  gene_order = c("correlation", "custom"),
  gene_custom_order = NULL,
  gene_cor_method = "pearson",
  gene_hclust_method = "complete",
  show_values = c("rescaled", "z-scaled", "original"),
  size_vertical_lines = 1.1,
  gradient_colors = c("blue", "yellow", "red"),
  gene_label_selection = NULL,
  axis_text_y_size = NULL,
  legend_nrows = 1,
  show_plot = NA,
  return_plot = NA,
  save_plot = NA,
  save_param = list(),
  default_save_name = "plotHeatmap"
)
```

## Arguments

|                                   |                                    |
|-----------------------------------|------------------------------------|
| <code>gobject</code>              | giotto object                      |
| <code>expression_values</code>    | expression values to use           |
| <code>genes</code>                | genes to use                       |
| <code>cluster_column</code>       | name of column to use for clusters |
| <code>cluster_order</code>        | method to determine cluster order  |
| <code>cluster_custom_order</code> | custom order for clusters          |
| <code>cluster_color_code</code>   | color code for clusters            |
| <code>cluster_cor_method</code>   | method for cluster correlation     |



|                       |  |
|-----------------------|--|
| cluster_hclust_method | method for hierarchical clustering of clusters                         |
| gene_order            | method to determine gene order   |
| gene_custom_order     | custom order for genes   |
| gene_cor_method       | method for gene correlation  |
| gene_hclust_method    | method for hierarchical clustering of genes                            |
| show_values           | which values to show on heatmap  |
| size_vertical_lines   | sizes for vertical lines   |
| gradient_colors       | colors for heatmap gradient  |
| gene_label_selection  | subset of genes to show on y-axis                                      |
| axis_text_y_size      | size for y-axis text   |
| legend_nrows          | number of rows for the cluster legend                                  |
| show_plot             | show plot  |
| return_plot           | return ggplot object   |
| save_plot             | directly save the plot [boolean]                                       |
| save_param            | list of saving parameters from <a href="#">all_plots_save_function</a> |
| default_save_name     | default save name  |

## Details

If you want to display many genes there are 2 ways to proceed:

- 1. set axis\_text\_y\_size to a really small value and show all genes
- 2. provide a subset of genes to display to gene\_label\_selection

## Value

ggplot

## Examples

```
plotHeatmap(gobject)
```

---

plotICG

*plotICG*


---

## Description

Create barplot to visualize interaction changed genes

## Usage

```
plotICG(
  gobject,
  cpgObject,
  source_type,
  source_markers,
  ICG_genes,
  cell_color_code = NULL,
  show_plot = NA,
  return_plot = NA,
  save_plot = NA,
  save_param = list(),
  default_save_name = "plotICG"
)
```

## Arguments

|                                |  |
|--------------------------------|--|
| <code>gobject</code>           | giotto object  |
| <code>cpgObject</code>         | cell proximity gene score object   |
| <code>source_type</code>       | cell type of the source cell   |
| <code>source_markers</code>    | markers for the source cell type   |
| <code>ICG_genes</code>         | named character vector of ICG genes  |
| <code>cell_color_code</code>   | cell color code for the interacting cell types   |
| <code>show_plot</code>         | show plots   |
| <code>return_plot</code>       | return plotting object   |
| <code>save_plot</code>         | directly save the plot [boolean]   |
| <code>save_param</code>        | list of saving parameters from <a href="#">all_plots_save_function</a>                               |
| <code>default_save_name</code> | default save name for saving, don't change, change <code>save_name</code> in <code>save_param</code> |

## Value

plot

## Examples

```
plotICG(CPGscores)
```

---

```
plotInteractionChangedGenes
      plotInteractionChangedGenes
```

---

**Description**

Create barplot to visualize interaction changed genes

**Usage**

```
plotInteractionChangedGenes(
  gobject,
  cpgObject,
  source_type,
  source_markers,
  ICG_genes,
  cell_color_code = NULL,
  show_plot = NA,
  return_plot = NA,
  save_plot = NA,
  save_param = list(),
  default_save_name = "plotInteractionChangedGenes"
)
```

**Arguments**

|                                |  |
|--------------------------------|--|
| <code>gobject</code>           | giotto object  |
| <code>cpgObject</code>         | cell proximity gene score object   |
| <code>source_type</code>       | cell type of the source cell   |
| <code>source_markers</code>    | markers for the source cell type   |
| <code>ICG_genes</code>         | named character vector of ICG genes  |
| <code>cell_color_code</code>   | cell color code for the interacting cell types   |
| <code>show_plot</code>         | show plots   |
| <code>return_plot</code>       | return plotting object   |
| <code>save_plot</code>         | directly save the plot [boolean]   |
| <code>save_param</code>        | list of saving parameters from <a href="#">all_plots_save_function</a>                               |
| <code>default_save_name</code> | default save name for saving, don't change, change <code>save_name</code> in <code>save_param</code> |

**Value**

plot

**Examples**

```
plotInteractionChangedGenes(CPGscores)
```

---

plotly\_axis\_scale\_2D    *plotly\_axis\_scale\_2D*

---

### Description

adjust the axis scale in 3D plotly plot

### Usage

```
plotly_axis_scale_2D(
  cell_locations,
  sdimx = NULL,
  sdimy = NULL,
  mode = c("cube", "real", "custom"),
  custom_ratio = NULL
)
```

### Arguments

|                |                                 |
|----------------|---------------------------------|
| cell_locations | spatial_loc in giotto object    |
| sdimx          | x axis of cell spatial location |
| sdimy          | y axis of cell spatial location |
| mode           | axis adjustment mode            |
| custom_ratio   | set the ratio artificially      |

### Value

edges in spatial grid as data.table()

### Examples

```
plotly_axis_scale_2D(gobject)
```

---

plotly\_axis\_scale\_3D    *plotly\_axis\_scale\_3D*

---

### Description

adjust the axis scale in 3D plotly plot

### Usage

```
plotly_axis_scale_3D(
  cell_locations,
  sdimx = NULL,
  sdimy = NULL,
  sdimz = NULL,
  mode = c("cube", "real", "custom"),
  custom_ratio = NULL
)
```

**Arguments**

cell\_locations   spatial\_loc in giotto object  
sdimx            x axis of cell spatial location  
sdimy            y axis of cell spatial location  
sdimz            z axis of cell spatial location  
mode             axis adjustment mode  
custom\_ratio    set the ratio artificially

**Value**

edges in spatial grid as data.table()

**Examples**

```
plotly_axis_scale_3D(gobject)
```

---

|             |                    |
|-------------|--------------------|
| plotly_grid | <i>plotly_grid</i> |
|-------------|--------------------|

---

**Description**

provide grid segment to draw in plot\_ly()

**Usage**

```
plotly_grid(  
  spatial_grid,  
  x_start = "x_start",  
  y_start = "y_start",  
  x_end = "x_end",  
  y_end = "y_end"  
)
```

**Arguments**

spatial\_grid    spatial\_grid in giotto object

**Value**

edges in spatial grid as data.table()

**Examples**

```
plotly_grid(gobject)
```

---

|                |                       |
|----------------|-----------------------|
| plotly_network | <i>plotly_network</i> |
|----------------|-----------------------|

---

### Description

provide network segment to draw in 3D plot\_ly()

### Usage

```
plotly_network(
  network,
  x = "sdimx_begin",
  y = "sdimy_begin",
  z = "sdimz_begin",
  x_end = "sdimx_end",
  y_end = "sdimy_end",
  z_end = "sdimz_end"
)
```

### Arguments

gobject                      network in giotto object

### Value

edges in network as data.table()

### Examples

```
plotly_network(gobject)
```

---

|                          |                                 |
|--------------------------|---------------------------------|
| plotMetaDataCellsHeatmap | <i>plotMetaDataCellsHeatmap</i> |
|--------------------------|---------------------------------|

---

### Description

Creates heatmap for numeric cell metadata within aggregated clusters.

### Usage

```
plotMetaDataCellsHeatmap(
  gobject,
  metadata_cols = NULL,
  spat_enr_names = NULL,
  value_cols = NULL,
  first_meta_col = NULL,
  second_meta_col = NULL,
  show_values = c("zscores", "original", "zscores_rescaled"),
  custom_cluster_order = NULL,
```

```

clus_cor_method = "pearson",
clus_cluster_method = "complete",
custom_values_order = NULL,
values_cor_method = "pearson",
values_cluster_method = "complete",
midpoint = 0,
x_text_size = 8,
x_text_angle = 45,
y_text_size = 8,
strip_text_size = 8,
show_plot = NA,
return_plot = NA,
save_plot = NA,
save_param = list(),
default_save_name = "plotMetaDataCellsHeatmap"
)

```

### Arguments

|                                   |  |
|-----------------------------------|--|
| <code>gobject</code>              | giotto object  |
| <code>metadata_cols</code>        | annotation columns found in <code>pDataDT(gobject)</code>  |
| <code>spat_enr_names</code>       | spatial enrichment results to include  |
| <code>value_cols</code>           | value columns to use   |
| <code>first_meta_col</code>       | if more than 1 metadata column, select the x-axis factor   |
| <code>second_meta_col</code>      | if more than 1 metadata column, select the facetting factor  |
| <code>show_values</code>          | which values to show on heatmap  |
| <code>custom_cluster_order</code> | custom cluster order (default = NULL)  |
| <code>clus_cor_method</code>      | correlation method for clusters  |
| <code>clus_cluster_method</code>  | hierarchical cluster method for the clusters   |
| <code>midpoint</code>             | midpoint of <code>show_values</code>   |
| <code>x_text_size</code>          | size of x-axis text  |
| <code>x_text_angle</code>         | angle of x-axis text   |
| <code>y_text_size</code>          | size of y-axis text  |
| <code>strip_text_size</code>      | size of strip text   |
| <code>show_plot</code>            | show plot  |
| <code>return_plot</code>          | return ggplot object   |
| <code>save_plot</code>            | directly save the plot [boolean]   |
| <code>save_param</code>           | list of saving parameters from <a href="#">all_plots_save_function</a>                               |
| <code>default_save_name</code>    | default save name for saving, don't change, change <code>save_name</code> in <code>save_param</code> |
| <code>custom_gene_order</code>    | custom gene order (default = NULL)   |

gene\_cor\_method  
correlation method for genes

gene\_cluster\_method  
hierarchical cluster method for the genes

### Details

Creates heatmap for the average values of selected value columns in the different annotation groups.

### Value

ggplot or data.table

### See Also

[plotMetaDataHeatmap](#) for gene expression instead of numeric cell annotation data.

### Examples

```
plotMetaDataCellsHeatmap(gobject)
```

---

|                     |                            |
|---------------------|----------------------------|
| plotMetaDataHeatmap | <i>plotMetaDataHeatmap</i> |
|---------------------|----------------------------|

---

### Description

Creates heatmap for genes within aggregated clusters.

### Usage

```
plotMetaDataHeatmap(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  metadata_cols = NULL,
  selected_genes = NULL,
  first_meta_col = NULL,
  second_meta_col = NULL,
  show_values = c("zscores", "original", "zscores_rescaled"),
  custom_cluster_order = NULL,
  clus_cor_method = "pearson",
  clus_cluster_method = "complete",
  custom_gene_order = NULL,
  gene_cor_method = "pearson",
  gene_cluster_method = "complete",
  gradient_color = c("blue", "white", "red"),
  gradient_midpoint = 0,
  gradient_limits = NULL,
  x_text_size = 10,
  x_text_angle = 45,
  y_text_size = 10,
  strip_text_size = 8,
  show_plot = NA,
```



```

    return_plot = NA,
    save_plot = NA,
    save_param = list(),
    default_save_name = "plotMetaDataHeatmap"
  )

```

### Arguments

|                                   |  |
|-----------------------------------|--|
| <code>gobject</code>              | giotto object  |
| <code>expression_values</code>    | expression values to use   |
| <code>metadata_cols</code>        | annotation columns found in <code>pDataDT(gobject)</code>              |
| <code>selected_genes</code>       | subset of genes to use   |
| <code>first_meta_col</code>       | if more than 1 metadata column, select the x-axis factor               |
| <code>second_meta_col</code>      | if more than 1 metadata column, select the facetting factor            |
| <code>show_values</code>          | which values to show on heatmap  |
| <code>custom_cluster_order</code> | custom cluster order (default = NULL)                                  |
| <code>clus_cor_method</code>      | correlation method for clusters  |
| <code>clus_cluster_method</code>  | hierarchical cluster method for the clusters                           |
| <code>custom_gene_order</code>    | custom gene order (default = NULL)                                     |
| <code>gene_cor_method</code>      | correlation method for genes   |
| <code>gene_cluster_method</code>  | hierarchical cluster method for the genes                              |
| <code>gradient_color</code>       | vector with 3 colors for numeric data                                  |
| <code>gradient_midpoint</code>    | midpoint for color gradient  |
| <code>gradient_limits</code>      | vector with lower and upper limits                                     |
| <code>x_text_size</code>          | size of x-axis text  |
| <code>x_text_angle</code>         | angle of x-axis text   |
| <code>y_text_size</code>          | size of y-axis text  |
| <code>strip_text_size</code>      | size of strip text   |
| <code>show_plot</code>            | show plot  |
| <code>return_plot</code>          | return ggplot object   |
| <code>save_plot</code>            | directly save the plot [boolean]                                       |
| <code>save_param</code>           | list of saving parameters from <a href="#">all_plots_save_function</a> |
| <code>default_save_name</code>    | default save name  |

**Details**

Creates heatmap for the average expression of selected genes in the different annotation/cluster groups. Calculation of cluster or gene order is done on the provided expression values, but visualization is by default on the z-scores. Other options are the original values or z-scores rescaled per gene (-1 to 1).

**Value**

ggplot or data.table

**See Also**

[plotMetaDataCellsHeatmap](#) for numeric cell annotation instead of gene expression.

**Examples**

```
plotMetaDataHeatmap(gobject)
```

---

|         |                |
|---------|----------------|
| plotPCA | <i>plotPCA</i> |
|---------|----------------|

---

**Description**

Short wrapper for PCA visualization

**Usage**

```
plotPCA(gobject, dim_reduction_name = "pca", default_save_name = "PCA", ...)
```

**Arguments**

- gobject            giotto object
- dim\_reduction\_name            dimension reduction name
- default\_save\_name            default save name for saving, don't change, change save\_name in save\_param
- groub\_by            create multiple plots based on cell annotation column
- group\_by\_subset            subset the group\_by factor column
- dim1\_to\_use            dimension to use on x-axis
- dim2\_to\_use            dimension to use on y-axis
- spat\_enr\_names    names of spatial enrichment results to include
- show\_NN\_network            show underlying NN network
- nn\_network\_to\_use            type of NN network to use (kNN vs sNN)
- network\_name        name of NN network to use, if show\_NN\_network = TRUE
- cell\_color            color for cells (see details)

|                     |   |
|---------------------|---|
| color_as_factor     | convert color column to factor                                |
| cell_color_code     | named vector with colors                                      |
| cell_color_gradient | vector with 3 colors for numeric data                         |
| gradient_midpoint   | midpoint for color gradient                                   |
| gradient_limits     | vector with lower and upper limits                            |
| select_cell_groups  | select subset of cells/clusters based on cell_color parameter |
| select_cells        | select subset of cells based on cell IDs                      |
| show_other_cells    | display not selected cells                                    |
| other_cell_color    | color of not selected cells                                   |
| other_point_size    | size of not selected cells                                    |
| show_cluster_center | plot center of selected clusters                              |
| show_center_label   | plot label of selected clusters                               |
| center_point_size   | size of center points   |
| label_size          | size of labels  |
| label_fontface      | font of labels  |
| edge_alpha          | column to use for alpha of the edges                          |
| point_shape         | point with border or not (border or no_border)                |
| point_size          | size of point (cell)  |
| point_alpha         | transparency of point   |
| point_border_col    | color of border around points                                 |
| point_border_stroke | stroke size of border around points                           |
| show_legend         | show legend   |
| title               | title for plot, defaults to cell_color parameter              |
| legend_text         | size of legend text   |
| legend_symbol_size  | size of legend symbols  |
| background_color    | color of plot background                                      |
| axis_text           | size of axis text   |
| axis_title          | size of axis title  |
| cow_n_col           | cowplot param: how many columns                               |
| cow_rel_h           | cowplot param: relative height                                |

|             |  |
|-------------|--|
| cow_rel_w   | cowplot param: relative width  |
| cow_align   | cowplot param: how to align  |
| show_plot   | show plot  |
| return_plot | return ggplot object   |
| save_plot   | directly save the plot [boolean]                                       |
| save_param  | list of saving parameters from <a href="#">all_plots_save_function</a> |

**Details**

Description of parameters, see [dimPlot2D](#). For 3D plots see [plotPCA\\_3D](#)

**Value**

ggplot

**Examples**

plotPCA(gobject)

---

|            |                   |
|------------|-------------------|
| plotPCA_2D | <i>plotPCA_2D</i> |
|------------|-------------------|

---

**Description**

Short wrapper for PCA visualization

**Usage**

```
plotPCA_2D(  
  gobject,  
  dim_reduction_name = "pca",  
  default_save_name = "PCA_2D",  
  ...  
)
```

**Arguments**

|                    |  |
|--------------------|--|
| gobject            | giotto object  |
| dim_reduction_name | dimension reduction name   |
| default_save_name  | default save name for saving, don't change, change save_name in save_param |
| groub_by           | create multiple plots based on cell annotation column                      |
| group_by_subset    | subset the group_by factor column  |
| dim1_to_use        | dimension to use on x-axis   |
| dim2_to_use        | dimension to use on y-axis   |
| spat_enr_names     | names of spatial enrichment results to include                             |

|                     |   |
|---------------------|---|
| show_NN_network     | show underlying NN network                                    |
| nn_network_to_use   | type of NN network to use (kNN vs sNN)                        |
| network_name        | name of NN network to use, if show_NN_network = TRUE          |
| cell_color          | color for cells (see details)                                 |
| color_as_factor     | convert color column to factor                                |
| cell_color_code     | named vector with colors                                      |
| cell_color_gradient | vector with 3 colors for numeric data                         |
| gradient_midpoint   | midpoint for color gradient                                   |
| gradient_limits     | vector with lower and upper limits                            |
| select_cell_groups  | select subset of cells/clusters based on cell_color parameter |
| select_cells        | select subset of cells based on cell IDs                      |
| show_other_cells    | display not selected cells                                    |
| other_cell_color    | color of not selected cells                                   |
| other_point_size    | size of not selected cells                                    |
| show_cluster_center | plot center of selected clusters                              |
| show_center_label   | plot label of selected clusters                               |
| center_point_size   | size of center points   |
| label_size          | size of labels  |
| label_fontface      | font of labels  |
| edge_alpha          | column to use for alpha of the edges                          |
| point_shape         | point with border or not (border or no_border)                |
| point_size          | size of point (cell)  |
| point_alpha         | transparency of point   |
| point_border_col    | color of border around points                                 |
| point_border_stroke | stroke size of border around points                           |
| title               | title for plot, defaults to cell_color parameter              |
| show_legend         | show legend   |
| legend_text         | size of legend text   |
| legend_symbol_size  | size of legend symbols  |

|                  |  |
|------------------|--|
| background_color | color of plot background   |
| axis_text        | size of axis text  |
| axis_title       | size of axis title   |
| cow_n_col        | cowplot param: how many columns  |
| cow_rel_h        | cowplot param: relative height   |
| cow_rel_w        | cowplot param: relative width  |
| cow_align        | cowplot param: how to align  |
| show_plot        | show plot  |
| return_plot      | return ggplot object   |
| save_plot        | directly save the plot [boolean]                                       |
| save_param       | list of saving parameters from <a href="#">all_plots_save_function</a> |

**Details**

Description of parameters, see [dimPlot2D](#). For 3D plots see [plotPCA\\_3D](#)

**Value**

ggplot

**Examples**

```
plotPCA_2D(gobject)
```

---

|            |                   |
|------------|-------------------|
| plotPCA_3D | <i>plotPCA_3D</i> |
|------------|-------------------|

---

**Description**

Visualize cells according to 3D PCA dimension reduction

**Usage**

```
plotPCA_3D(  
  gobject,  
  dim_reduction_name = "pca",  
  default_save_name = "PCA_3D",  
  ...  
)
```

**Arguments**

|                                  |  |
|----------------------------------|--|
| <code>gobject</code>             | giotto object  |
| <code>dim_reduction_name</code>  | pca dimension reduction name   |
| <code>default_save_name</code>   | default save name for saving, ideally change <code>save_name</code> in <code>save_param</code> |
| <code>dim1_to_use</code>         | dimension to use on x-axis   |
| <code>dim2_to_use</code>         | dimension to use on y-axis   |
| <code>dim3_to_use</code>         | dimension to use on z-axis   |
| <code>show_NN_network</code>     | show underlying NN network   |
| <code>nn_network_to_use</code>   | type of NN network to use (kNN vs sNN)   |
| <code>network_name</code>        | name of NN network to use, if <code>show_NN_network</code> = TRUE                              |
| <code>cell_color</code>          | color for cells (see details)  |
| <code>color_as_factor</code>     | convert color column to factor   |
| <code>cell_color_code</code>     | named vector with colors   |
| <code>select_cell_groups</code>  | select subset of cells/clusters based on <code>cell_color</code> parameter                     |
| <code>select_cells</code>        | select subset of cells based on cell IDs   |
| <code>show_other_cells</code>    | display not selected cells   |
| <code>other_cell_color</code>    | color of not selected cells  |
| <code>other_point_size</code>    | size of not selected cells   |
| <code>show_cluster_center</code> | plot center of selected clusters   |
| <code>show_center_label</code>   | plot label of selected clusters  |
| <code>center_point_size</code>   | size of center points  |
| <code>label_size</code>          | size of labels   |
| <code>edge_alpha</code>          | column to use for alpha of the edges   |
| <code>point_size</code>          | size of point (cell)   |
| <code>show_legend</code>         | show legend  |
| <code>show_plot</code>           | show plot  |
| <code>return_plot</code>         | return ggplot object   |
| <code>save_plot</code>           | directly save the plot [boolean]   |
| <code>save_param</code>          | list of saving parameters from <a href="#">all_plots_save_function</a>                         |

**Details**

Description of parameters.

**Value**

plotly

**Examples**

```
plotPCA_3D(gobject)
```

---

|                    |                           |
|--------------------|---------------------------|
| plotRankSpatvsExpr | <i>plotRankSpatvsExpr</i> |
|--------------------|---------------------------|

---

**Description**

Plots dotplot to compare ligand-receptor rankings from spatial and expression information

**Usage**

```
plotRankSpatvsExpr(
  gobject,
  combCC,
  expr_rnk_column = "LR_expr_rnk",
  spat_rnk_column = "LR_spat_rnk",
  midpoint = 10,
  size_range = c(0.01, 1.5),
  xlims = NULL,
  ylims = NULL,
  selected_ranks = c(1, 10, 20),
  show_plot = NA,
  return_plot = NA,
  save_plot = NA,
  save_param = list(),
  default_save_name = "plotRankSpatvsExpr"
)
```

**Arguments**

|                 |   |
|-----------------|---|
| gobject         | giotto object   |
| combCC          | combined communication scores from <a href="#">combCCcom</a>                                  |
| expr_rnk_column | column with expression rank information to use  |
| spat_rnk_column | column with spatial rank information to use   |
| midpoint        | midpoint of colors  |
| size_range      | size ranges of dotplot  |
| xlims           | x-limits, numerical vector of 2   |
| ylims           | y-limits, numerical vector of 2   |
| selected_ranks  | numerical vector, will be used to print out the percentage of top spatial ranks are recovered |
| show_plot       | show plots  |



|                   |  |
|-------------------|--|
| return_plot       | return plotting object   |
| save_plot         | directly save the plot [boolean]   |
| save_param        | list of saving parameters from <a href="#">all_plots_save_function</a>     |
| default_save_name | default save name for saving, don't change, change save_name in save_param |

**Value**

ggplot

**Examples**

```
plotRankSpatvsExpr(CPGscores)
```

---

|              |                     |
|--------------|---------------------|
| plotRecovery | <i>plotRecovery</i> |
|--------------|---------------------|

---

**Description**

Plots recovery plot to compare ligand-receptor rankings from spatial and expression information

**Usage**

```
plotRecovery(
  gobject,
  combCC,
  expr_rnk_column = "exprPI_rnk",
  spat_rnk_column = "spatPI_rnk",
  ground_truth = c("spatial", "expression"),
  show_plot = NA,
  return_plot = NA,
  save_plot = NA,
  save_param = list(),
  default_save_name = "plotRecovery"
)
```

**Arguments**

|                   |  |
|-------------------|--|
| gobject           | giotto object  |
| combCC            | combined communication scores from <a href="#">combCCcom</a>               |
| expr_rnk_column   | column with expression rank information to use                             |
| spat_rnk_column   | column with spatial rank information to use                                |
| ground_truth      | what to consider as ground truth (default: spatial)                        |
| show_plot         | show plots   |
| return_plot       | return plotting object   |
| save_plot         | directly save the plot [boolean]   |
| save_param        | list of saving parameters from <a href="#">all_plots_save_function</a>     |
| default_save_name | default save name for saving, don't change, change save_name in save_param |

**Value**

ggplot

**Examples**

```
plotRecovery(CPGscores)
```

---

|                  |                         |
|------------------|-------------------------|
| plotRecovery_sub | <i>plotRecovery_sub</i> |
|------------------|-------------------------|

---

**Description**

Plots recovery plot to compare ligand-receptor rankings from spatial and expression information

**Usage**

```
plotRecovery_sub(combCC, first_col = "LR_expr_rnk", second_col = "LR_spat_rnk")
```

**Arguments**

- combCC            combined communication scores from [combCCcom](#)
- first\_col        first column to use
- second\_col       second column to use

**Examples**

```
plotRecovery_sub(CPGscores)
```

---

|                         |                                |
|-------------------------|--------------------------------|
| plotStatDelaunayNetwork | <i>plotStatDelaunayNetwork</i> |
|-------------------------|--------------------------------|

---

**Description**

Plots network statistics for a Delaunay network..

**Usage**

```
plotStatDelaunayNetwork(  
  gobject,  
  method = c("deldir", "delaunayn_geometry", "RTriangle"),  
  dimensions = "all",  
  maximum_distance = "auto",  
  minimum_k = 0,  
  options = "Pp",  
  Y = TRUE,  
  j = TRUE,  
  S = 0,  
  show_plot = NA,
```

```

    return_plot = NA,
    save_plot = NA,
    save_param = list(),
    default_save_name = "plotStatDelaunayNetwork",
    ...
)

```

### Arguments

|                                |  |
|--------------------------------|--|
| <code>gobject</code>           | giotto object  |
| <code>dimensions</code>        | which spatial dimensions to use (maximum 2 dimensions)   |
| <code>maximum_distance</code>  | distance cutoff for Delaunay neighbors to consider   |
| <code>minimum_k</code>         | minimum neighbours if <code>maximum_distance</code> != NULL  |
| <code>options</code>           | (geometry) String containing extra control options for the underlying Qhull command; see the Qhull documentation ( <a href="http://doc.qhull/html/qdelaun.html">../doc/qhull/html/qdelaun.html</a> ) for the available options. (default = 'Pp', do not report precision problems) |
| <code>Y</code>                 | (RTriangle) If TRUE prohibits the insertion of Steiner points on the mesh boundary.  |
| <code>j</code>                 | (RTriangle) If TRUE jettisons vertices that are not part of the final triangulation from the output.   |
| <code>S</code>                 | (RTriangle) Specifies the maximum number of added Steiner points.  |
| <code>show_plot</code>         | show plots   |
| <code>return_plot</code>       | return ggplot object   |
| <code>save_plot</code>         | directly save the plot [boolean]   |
| <code>save_param</code>        | list of saving parameters from <a href="#">all_plots_save_function</a>   |
| <code>default_save_name</code> | default save name for saving, don't change, change <code>save_name</code> in <code>save_param</code>   |
| <code>...</code>               | Other parameters of the <a href="#">triangulate</a> function   |
| <code>name</code>              | name for spatial network (default = 'delaunay_network')  |

### Details

Plots statistics for a spatial Delaunay network as explained in [triangulate](#). This can be used to further finetune the [createDelaunayNetwork](#) function.

### Value

giotto object with updated spatial network slot

### Examples

```
plotStatDelaunayNetwork(gobject)
```

---

plotTSNE

*plotTSNE*


---

## Description

Short wrapper for tSNE visualization

## Usage

```
plotTSNE(gobject, dim_reduction_name = "tsne", default_save_name = "tSNE", ...)
```

## Arguments

|                     |  |
|---------------------|--|
| gobject             | giotto object  |
| dim_reduction_name  | dimension reduction name   |
| default_save_name   | default save name for saving, don't change, change save_name in save_param |
| groub_by            | create multiple plots based on cell annotation column                      |
| group_by_subset     | subset the group_by factor column  |
| dim1_to_use         | dimension to use on x-axis   |
| dim2_to_use         | dimension to use on y-axis   |
| spat_enr_names      | names of spatial enrichment results to include                             |
| show_NN_network     | show underlying NN network   |
| nn_network_to_use   | type of NN network to use (kNN vs sNN)                                     |
| network_name        | name of NN network to use, if show_NN_network = TRUE                       |
| cell_color          | color for cells (see details)  |
| color_as_factor     | convert color column to factor   |
| cell_color_code     | named vector with colors   |
| cell_color_gradient | vector with 3 colors for numeric data                                      |
| gradient_midpoint   | midpoint for color gradient  |
| gradient_limits     | vector with lower and upper limits   |
| select_cell_groups  | select subset of cells/clusters based on cell_color parameter              |
| select_cells        | select subset of cells based on cell IDs                                   |
| show_other_cells    | display not selected cells   |
| other_cell_color    | color of not selected cells  |

|                     |  |
|---------------------|--|
| other_point_size    | size of not selected cells   |
| show_cluster_center | plot center of selected clusters                                       |
| show_center_label   | plot label of selected clusters  |
| center_point_size   | size of center points  |
| label_size          | size of labels   |
| label_fontface      | font of labels   |
| edge_alpha          | column to use for alpha of the edges                                   |
| point_shape         | point with border or not (border or no_border)                         |
| point_size          | size of point (cell)   |
| point_alpha         | transparency of point  |
| point_border_col    | color of border around points  |
| point_border_stroke | stroke size of border around points                                    |
| title               | title for plot, defaults to cell_color parameter                       |
| show_legend         | show legend  |
| legend_text         | size of legend text  |
| legend_symbol_size  | size of legend symbols   |
| background_color    | color of plot background   |
| axis_text           | size of axis text  |
| axis_title          | size of axis title   |
| cow_n_col           | cowplot param: how many columns  |
| cow_rel_h           | cowplot param: relative height   |
| cow_rel_w           | cowplot param: relative width  |
| cow_align           | cowplot param: how to align  |
| show_plot           | show plot  |
| return_plot         | return ggplot object   |
| save_plot           | directly save the plot [boolean]                                       |
| save_param          | list of saving parameters from <a href="#">all_plots_save_function</a> |

### Details

Description of parameters, see [dimPlot2D](#). For 3D plots see [plotTSNE\\_3D](#)

### Value

ggplot

### Examples

```
plotTSNE(gobject)
```

---

plotTSNE\_2D

*plotTSNE\_2D*


---

## Description

Short wrapper for tSNE visualization

## Usage

```
plotTSNE_2D(
  gobject,
  dim_reduction_name = "tsne",
  default_save_name = "tSNE_2D",
  ...
)
```

## Arguments

|                                  |  |
|----------------------------------|--|
| <code>gobject</code>             | giotto object  |
| <code>dim_reduction_name</code>  | dimension reduction name   |
| <code>default_save_name</code>   | default save name for saving, don't change, change <code>save_name</code> in <code>save_param</code> |
| <code>groub_by</code>            | create multiple plots based on cell annotation column  |
| <code>group_by_subset</code>     | subset the <code>group_by</code> factor column   |
| <code>dim1_to_use</code>         | dimension to use on x-axis   |
| <code>dim2_to_use</code>         | dimension to use on y-axis   |
| <code>spat_enr_names</code>      | names of spatial enrichment results to include   |
| <code>show_NN_network</code>     | show underlying NN network   |
| <code>nn_network_to_use</code>   | type of NN network to use (kNN vs sNN)   |
| <code>network_name</code>        | name of NN network to use, if <code>show_NN_network = TRUE</code>                                    |
| <code>cell_color</code>          | color for cells (see details)  |
| <code>color_as_factor</code>     | convert color column to factor   |
| <code>cell_color_code</code>     | named vector with colors   |
| <code>cell_color_gradient</code> | vector with 3 colors for numeric data  |
| <code>gradient_midpoint</code>   | midpoint for color gradient  |
| <code>gradient_limits</code>     | vector with lower and upper limits   |
| <code>select_cell_groups</code>  | select subset of cells/clusters based on <code>cell_color</code> parameter                           |

|                                  |  |
|----------------------------------|--|
| <code>select_cells</code>        | select subset of cells based on cell IDs                               |
| <code>show_other_cells</code>    | display not selected cells   |
| <code>other_cell_color</code>    | color of not selected cells  |
| <code>other_point_size</code>    | size of not selected cells   |
| <code>show_cluster_center</code> | plot center of selected clusters                                       |
| <code>show_center_label</code>   | plot label of selected clusters  |
| <code>center_point_size</code>   | size of center points  |
| <code>label_size</code>          | size of labels   |
| <code>label_fontface</code>      | font of labels   |
| <code>edge_alpha</code>          | column to use for alpha of the edges                                   |
| <code>point_shape</code>         | point with border or not (border or no_border)                         |
| <code>point_size</code>          | size of point (cell)   |
| <code>point_alpha</code>         | transparancy of point  |
| <code>point_border_col</code>    | color of border around points  |
| <code>point_border_stroke</code> | stroke size of border around points                                    |
| <code>title</code>               | title for plot, defaults to cell_color parameter                       |
| <code>show_legend</code>         | show legend  |
| <code>legend_text</code>         | size of legend text  |
| <code>legend_symbol_size</code>  | size of legend symbols   |
| <code>background_color</code>    | color of plot background   |
| <code>axis_text</code>           | size of axis text  |
| <code>axis_title</code>          | size of axis title   |
| <code>cow_n_col</code>           | cowplot param: how many columns  |
| <code>cow_rel_h</code>           | cowplot param: relative height   |
| <code>cow_rel_w</code>           | cowplot param: relative width  |
| <code>cow_align</code>           | cowplot param: how to align  |
| <code>show_plot</code>           | show plot  |
| <code>return_plot</code>         | return ggplot object   |
| <code>save_plot</code>           | directly save the plot [boolean]                                       |
| <code>save_param</code>          | list of saving parameters from <a href="#">all_plots_save_function</a> |

## Details

Description of parameters, see [dimPlot2D](#). For 3D plots see [plotTSNE\\_3D](#)

Value

ggplot

Examples

```
plotTSNE_2D(gobject)
```

---

|             |                    |
|-------------|--------------------|
| plotTSNE_3D | <i>plotTSNE_3D</i> |
|-------------|--------------------|

---

Description

Visualize cells according to dimension reduction coordinates

Usage

```
plotTSNE_3D(  
  gobject,  
  dim_reduction_name = "tsne",  
  default_save_name = "TSNE_3D",  
  ...  
)
```

Arguments

- gobject            giotto object
- dim\_reduction\_name            tsne dimension reduction name
- default\_save\_name            default save name for saving, don't change, change save\_name in save\_param
- dim1\_to\_use            dimension to use on x-axis
- dim2\_to\_use            dimension to use on y-axis
- dim3\_to\_use            dimension to use on z-axis
- show\_NN\_network            show underlying NN network
- nn\_network\_to\_use            type of NN network to use (kNN vs sNN)
- network\_name            name of NN network to use, if show\_NN\_network = TRUE
- cell\_color            color for cells (see details)
- color\_as\_factor            convert color column to factor
- cell\_color\_code            named vector with colors
- select\_cell\_groups            select subset of cells/clusters based on cell\_color parameter
- select\_cells            select subset of cells based on cell IDs
- show\_other\_cells            display not selected cells



|                     |  |
|---------------------|--|
| other_cell_color    | color of not selected cells  |
| other_point_size    | size of not selected cells   |
| show_cluster_center | plot center of selected clusters                                       |
| show_center_label   | plot label of selected clusters  |
| center_point_size   | size of center points  |
| label_size          | size of labels   |
| edge_alpha          | column to use for alpha of the edges                                   |
| point_size          | size of point (cell)   |
| show_legend         | show legend  |
| show_plot           | show plot  |
| return_plot         | return ggplot object   |
| save_plot           | directly save the plot [boolean]                                       |
| save_param          | list of saving parameters from <a href="#">all_plots_save_function</a> |

**Details**

Description of parameters.

**Value**

plotly

**Examples**

```
plotTSNE_3D(gobject)
```

---

plotUMAP

*plotUMAP*


---

**Description**

Short wrapper for UMAP visualization

**Usage**

```
plotUMAP(gobject, dim_reduction_name = "umap", default_save_name = "UMAP", ...)
```

**Arguments**

|                                  |  |
|----------------------------------|--|
| <code>gobject</code>             | giotto object  |
| <code>dim_reduction_name</code>  | dimension reduction name   |
| <code>default_save_name</code>   | default save name for saving, don't change, change <code>save_name</code> in <code>save_param</code> |
| <code>groub_by</code>            | create multiple plots based on cell annotation column  |
| <code>group_by_subset</code>     | subset the <code>group_by</code> factor column   |
| <code>dim1_to_use</code>         | dimension to use on x-axis   |
| <code>dim2_to_use</code>         | dimension to use on y-axis   |
| <code>spat_enr_names</code>      | names of spatial enrichment results to include   |
| <code>show_NN_network</code>     | show underlying NN network   |
| <code>nn_network_to_use</code>   | type of NN network to use (kNN vs sNN)   |
| <code>network_name</code>        | name of NN network to use, if <code>show_NN_network</code> = TRUE                                    |
| <code>cell_color</code>          | color for cells (see details)  |
| <code>color_as_factor</code>     | convert color column to factor   |
| <code>cell_color_code</code>     | named vector with colors   |
| <code>cell_color_gradient</code> | vector with 3 colors for numeric data  |
| <code>gradient_midpoint</code>   | midpoint for color gradient  |
| <code>gradient_limits</code>     | vector with lower and upper limits   |
| <code>select_cell_groups</code>  | select subset of cells/clusters based on <code>cell_color</code> parameter                           |
| <code>select_cells</code>        | select subset of cells based on cell IDs   |
| <code>show_other_cells</code>    | display not selected cells   |
| <code>other_cell_color</code>    | color of not selected cells  |
| <code>other_point_size</code>    | size of not selected cells   |
| <code>show_cluster_center</code> | plot center of selected clusters   |
| <code>show_center_label</code>   | plot label of selected clusters  |
| <code>center_point_size</code>   | size of center points  |
| <code>label_size</code>          | size of labels   |
| <code>label_fontface</code>      | font of labels   |
| <code>edge_alpha</code>          | column to use for alpha of the edges   |

|                     |  |
|---------------------|--|
| point_shape         | point with border or not (border or no_border)                         |
| point_size          | size of point (cell)   |
| point_alpha         | transparency of point  |
| point_border_col    | color of border around points  |
| point_border_stroke | stroke size of border around points                                    |
| title               | title for plot, defaults to cell_color parameter                       |
| show_legend         | show legend  |
| legend_text         | size of legend text  |
| legend_symbol_size  | size of legend symbols   |
| background_color    | color of plot background   |
| axis_text           | size of axis text  |
| axis_title          | size of axis title   |
| cow_n_col           | cowplot param: how many columns  |
| cow_rel_h           | cowplot param: relative height   |
| cow_rel_w           | cowplot param: relative width  |
| cow_align           | cowplot param: how to align  |
| show_plot           | show plot  |
| return_plot         | return ggplot object   |
| save_plot           | directly save the plot [boolean]                                       |
| save_param          | list of saving parameters from <a href="#">all_plots_save_function</a> |

## Details

Description of parameters, see [dimPlot2D](#). For 3D plots see [plotUMAP\\_3D](#)

## Value

ggplot

## Examples

```
plotUMAP(gobject)
```

---

|             |                    |
|-------------|--------------------|
| plotUMAP_2D | <i>plotUMAP_2D</i> |
|-------------|--------------------|

---

## Description

Short wrapper for UMAP visualization

## Usage

```
plotUMAP_2D(
  gobject,
  dim_reduction_name = "umap",
  default_save_name = "UMAP_2D",
  ...
)
```

## Arguments

|                                  |  |
|----------------------------------|--|
| <code>gobject</code>             | giotto object  |
| <code>dim_reduction_name</code>  | dimension reduction name   |
| <code>default_save_name</code>   | default save name for saving, don't change, change <code>save_name</code> in <code>save_param</code> |
| <code>groub_by</code>            | create multiple plots based on cell annotation column  |
| <code>group_by_subset</code>     | subset the <code>group_by</code> factor column   |
| <code>dim1_to_use</code>         | dimension to use on x-axis   |
| <code>dim2_to_use</code>         | dimension to use on y-axis   |
| <code>spat_enr_names</code>      | names of spatial enrichment results to include   |
| <code>show_NN_network</code>     | show underlying NN network   |
| <code>nn_network_to_use</code>   | type of NN network to use (kNN vs sNN)   |
| <code>network_name</code>        | name of NN network to use, if <code>show_NN_network = TRUE</code>                                    |
| <code>cell_color</code>          | color for cells (see details)  |
| <code>color_as_factor</code>     | convert color column to factor   |
| <code>cell_color_code</code>     | named vector with colors   |
| <code>cell_color_gradient</code> | vector with 3 colors for numeric data  |
| <code>gradient_midpoint</code>   | midpoint for color gradient  |
| <code>gradient_limits</code>     | vector with lower and upper limits   |
| <code>select_cell_groups</code>  | select subset of cells/clusters based on <code>cell_color</code> parameter                           |

|                     |  |
|---------------------|--|
| select_cells        | select subset of cells based on cell IDs                               |
| show_other_cells    | display not selected cells   |
| other_cell_color    | color of not selected cells  |
| other_point_size    | size of not selected cells   |
| show_cluster_center | plot center of selected clusters                                       |
| show_center_label   | plot label of selected clusters  |
| center_point_size   | size of center points  |
| label_size          | size of labels   |
| label_fontface      | font of labels   |
| edge_alpha          | column to use for alpha of the edges                                   |
| point_shape         | point with border or not (border or no_border)                         |
| point_size          | size of point (cell)   |
| point_alpha         | transparancy of point  |
| point_border_col    | color of border around points  |
| point_border_stroke | stroke size of border around points                                    |
| title               | title for plot, defaults to cell_color parameter                       |
| show_legend         | show legend  |
| legend_text         | size of legend text  |
| legend_symbol_size  | size of legend symbols   |
| background_color    | color of plot background   |
| axis_text           | size of axis text  |
| axis_title          | size of axis title   |
| cow_n_col           | cowplot param: how many columns  |
| cow_rel_h           | cowplot param: relative height   |
| cow_rel_w           | cowplot param: relative width  |
| cow_align           | cowplot param: how to align  |
| show_plot           | show plot  |
| return_plot         | return ggplot object   |
| save_plot           | directly save the plot [boolean]                                       |
| save_param          | list of saving parameters from <a href="#">all_plots_save_function</a> |

## Details

Description of parameters, see [dimPlot2D](#). For 3D plots see [plotUMAP\\_3D](#)

Value

ggplot

Examples

```
plotUMAP_2D(gobject)
```

---

|             |                    |
|-------------|--------------------|
| plotUMAP_3D | <i>plotUMAP_3D</i> |
|-------------|--------------------|

---

Description

Visualize cells according to dimension reduction coordinates

Usage

```
plotUMAP_3D(  
  gobject,  
  dim_reduction_name = "umap",  
  default_save_name = "UMAP_3D",  
  ...  
)
```

Arguments

- gobject                  giotto object
- dim\_reduction\_name                  umap dimension reduction name
- default\_save\_name                  default save name for saving, don't change, change save\_name in save\_param
- dim1\_to\_use                  dimension to use on x-axis
- dim2\_to\_use                  dimension to use on y-axis
- dim3\_to\_use                  dimension to use on z-axis
- show\_NN\_network                  show underlying NN network
- nn\_network\_to\_use                  type of NN network to use (kNN vs sNN)
- network\_name                  name of NN network to use, if show\_NN\_network = TRUE
- cell\_color                  color for cells (see details)
- color\_as\_factor                  convert color column to factor
- cell\_color\_code                  named vector with colors
- select\_cell\_groups                  select subset of cells/clusters based on cell\_color parameter
- select\_cells                  select subset of cells based on cell IDs
- show\_other\_cells                  display not selected cells

|                     |  |
|---------------------|--|
| other_cell_color    | color of not selected cells  |
| other_point_size    | size of not selected cells   |
| show_cluster_center | plot center of selected clusters                                       |
| show_center_label   | plot label of selected clusters  |
| center_point_size   | size of center points  |
| label_size          | size of labels   |
| edge_alpha          | column to use for alpha of the edges                                   |
| point_size          | size of point (cell)   |
| show_legend         | show legend  |
| show_plot           | show plot  |
| return_plot         | return ggplot object   |
| save_plot           | directly save the plot [boolean]                                       |
| save_param          | list of saving parameters from <a href="#">all_plots_save_function</a> |

**Details**

Description of parameters.

**Value**

plotly

**Examples**

```
plotUMAP_3D(gobject)
```

---

```
plot_network_layer_ggplot
      plot_network_layer_ggplot
```

---

**Description**

Visualize cells in network layer according to dimension reduction coordinates

**Usage**

```
plot_network_layer_ggplot(
  ggobject,
  annotated_network_DT,
  edge_alpha = NULL,
  show_legend = T
)
```

**Arguments**

|                      |  |
|----------------------|--|
| annotated_network_DT | annotated network data.table of selected cells |
| edge_alpha           | alpha of network edges                         |
| show_legend          | show legend                                    |
| gobject              | giotto object                                  |

**Details**

Description of parameters.

**Value**

ggplot

**Examples**

```
plot_network_layer_ggplot(gobject)
```

---

```
plot_point_layer_ggplot
```

```
plot_point_layer_ggplot
```

---

**Description**

Visualize cells in point layer according to dimension reduction coordinates

**Usage**

```
plot_point_layer_ggplot(
  gobject,
  annotated_DT_selected,
  annotated_DT_other,
  cell_color = NULL,
  color_as_factor = T,
  cell_color_code = NULL,
  cell_color_gradient = c("blue", "white", "red"),
  gradient_midpoint = 0,
  gradient_limits = NULL,
  select_cell_groups = NULL,
  select_cells = NULL,
  point_size = 1,
  point_alpha = 1,
  point_border_col = "black",
  point_border_stroke = 0.1,
  show_cluster_center = F,
  show_center_label = T,
  center_point_size = 4,
  center_point_border_col = "black",
  center_point_border_stroke = 0.1,
```



```

    label_size = 4,
    label_fontface = "bold",
    edge_alpha = NULL,
    show_other_cells = T,
    other_cell_color = "lightgrey",
    other_point_size = 0.5,
    show_legend = T
  )

```

### Arguments

```

annotated_DT_selected
    annotated data.table of selected cells
annotated_DT_other
    annotated data.table of not selected cells
cell_color
    color for cells (see details)
color_as_factor
    convert color column to factor
cell_color_code
    named vector with colors
cell_color_gradient
    vector with 3 colors for numeric data
gradient_midpoint
    midpoint for color gradient
gradient_limits
    vector with lower and upper limits
select_cell_groups
    select subset of cells/clusters based on cell_color parameter
select_cells
    select subset of cells based on cell IDs
point_size
    size of point (cell)
point_alpha
    transparency of point
point_border_col
    color of border around points
point_border_stroke
    stroke size of border around points
show_cluster_center
    plot center of selected clusters
show_center_label
    plot label of selected clusters
center_point_size
    size of center points
label_size
    size of labels
label_fontface
    font of labels
edge_alpha
    column to use for alpha of the edges
show_other_cells
    display not selected cells
other_cell_color
    color of not selected cells

```

|                  |                            |
|------------------|----------------------------|
| other_point_size | size of not selected cells |
| show_legend      | show legend                |
| gobject          | giotto object              |

### Details

Description of parameters.

### Value

ggplot

### Examples

```
plot_point_layer_ggplot(gobject)
```

---

```
plot_point_layer_ggplot_noFILL
```

```
plot_point_layer_ggplot_noFILL
```

---

### Description

Visualize cells in point layer according to dimension reduction coordinates without borders

### Usage

```
plot_point_layer_ggplot_noFILL(
  ggobject,
  annotated_DT_selected,
  annotated_DT_other,
  cell_color = NULL,
  color_as_factor = T,
  cell_color_code = NULL,
  cell_color_gradient = c("blue", "white", "red"),
  gradient_midpoint = 0,
  gradient_limits = NULL,
  select_cell_groups = NULL,
  select_cells = NULL,
  point_size = 1,
  point_alpha = 1,
  show_cluster_center = F,
  show_center_label = T,
  center_point_size = 4,
  label_size = 4,
  label_fontface = "bold",
  edge_alpha = NULL,
  show_other_cells = T,
  other_cell_color = "lightgrey",
  other_point_size = 0.5,
  show_legend = T
)
```

**Arguments**

|                       |   |
|-----------------------|---|
| annotated_DT_selected | annotated data.table of selected cells                        |
| annotated_DT_other    | annotated data.table of not selected cells                    |
| cell_color            | color for cells (see details)                                 |
| color_as_factor       | convert color column to factor                                |
| cell_color_code       | named vector with colors                                      |
| cell_color_gradient   | vector with 3 colors for numeric data                         |
| gradient_midpoint     | midpoint for color gradient                                   |
| gradient_limits       | vector with lower and upper limits                            |
| select_cell_groups    | select subset of cells/clusters based on cell_color parameter |
| select_cells          | select subset of cells based on cell IDs                      |
| point_size            | size of point (cell)  |
| point_alpha           | transparency of point   |
| show_cluster_center   | plot center of selected clusters                              |
| show_center_label     | plot label of selected clusters                               |
| center_point_size     | size of center points   |
| label_size            | size of labels  |
| label_fontface        | font of labels  |
| edge_alpha            | column to use for alpha of the edges                          |
| show_other_cells      | display not selected cells                                    |
| other_cell_color      | color of not selected cells                                   |
| other_point_size      | size of not selected cells                                    |
| show_legend           | show legend   |
| gobject               | giotto object   |

**Details**

Description of parameters.

**Value**

ggplot

**Examples**

```
plot_point_layer_ggplot_noFILL(gobject)
```

---

```
plot_spat_image_layer_ggplot  
    plot_spat_image_layer_ggplot
```

---

### Description

create background image in ggplot

### Usage

```
plot_spat_image_layer_ggplot(  
  ggplot,  
  gobject,  
  gimage,  
  sdinx = NULL,  
  sdimy = NULL  
)
```

### Arguments

|         |   |
|---------|---|
| gobject | giotto object                             |
| gimage  | a giotto image                            |
| sdinx   | x-axis dimension name (default = 'sdinx') |
| sdimy   | y-axis dimension name (default = 'sdimy') |

### Value

ggplot

### Examples

```
plot_spat_image_layer_ggplot(gobject)
```

---

```
plot_spat_point_layer_ggplot  
    plot_spat_point_layer_ggplot
```

---

### Description

creat ggplot point layer for spatial coordinates

**Usage**

```
plot_spat_point_layer_ggplot(
  ggobject,
  sdimx = NULL,
  sdimy = NULL,
  cell_locations_metadata_selected,
  cell_locations_metadata_other,
  cell_color = NULL,
  color_as_factor = T,
  cell_color_code = NULL,
  cell_color_gradient = c("blue", "white", "red"),
  gradient_midpoint = NULL,
  gradient_limits = NULL,
  select_cell_groups = NULL,
  select_cells = NULL,
  point_size = 2,
  point_alpha = 1,
  point_border_col = "lightgrey",
  point_border_stroke = 0.1,
  show_cluster_center = F,
  show_center_label = T,
  center_point_size = 4,
  center_point_border_col = "black",
  center_point_border_stroke = 0.1,
  label_size = 4,
  label_fontface = "bold",
  show_other_cells = T,
  other_cell_color = "lightgrey",
  other_point_size = 1,
  show_legend = TRUE
)
```

**Arguments**

|                                  |  |
|----------------------------------|--|
| sdimx                            | x-axis dimension name (default = 'sdimx')  |
| sdimy                            | y-axis dimension name (default = 'sdimy')  |
| cell_locations_metadata_selected | annotated location from selected cells     |
| cell_locations_metadata_other    | annotated location from non-selected cells |
| cell_color                       | color for cells (see details)              |
| color_as_factor                  | convert color column to factor             |
| cell_color_code                  | named vector with colors                   |
| cell_color_gradient              | vector with 3 colors for numeric data      |
| gradient_midpoint                | midpoint for color gradient                |
| gradient_limits                  | vector with lower and upper limits         |

|                     |   |
|---------------------|---|
| select_cell_groups  | select subset of cells/clusters based on cell_color parameter |
| select_cells        | select subset of cells based on cell IDs                      |
| point_size          | size of point (cell)  |
| point_alpha         | transparency of point   |
| point_border_col    | color of border around points                                 |
| point_border_stroke | stroke size of border around points                           |
| show_cluster_center | plot center of selected clusters                              |
| show_center_label   | plot label of selected clusters                               |
| center_point_size   | size of center points   |
| label_size          | size of labels  |
| label_fontface      | font of labels  |
| show_other_cells    | display not selected cells                                    |
| other_cell_color    | color for not selected cells                                  |
| other_point_size    | point size for not selected cells                             |
| show_legend         | show legend   |
| gobject             | giotto object   |

**Details**

Description of parameters.

**Value**

ggplot

**Examples**

```
plot_spat_point_layer_ggplot(gobject)
```

---

```
plot_spat_point_layer_ggplot_noFILL
  plot_spat_point_layer_ggplot_noFILL
```

---

**Description**

creat ggplot point layer for spatial coordinates without borders

**Usage**

```

plot_spat_point_layer_ggplot_noFILL(
  ggobject,
  sdimx = NULL,
  sdimy = NULL,
  cell_locations_metadata_selected,
  cell_locations_metadata_other,
  cell_color = NULL,
  color_as_factor = T,
  cell_color_code = NULL,
  cell_color_gradient = c("blue", "white", "red"),
  gradient_midpoint = NULL,
  gradient_limits = NULL,
  select_cell_groups = NULL,
  select_cells = NULL,
  point_size = 2,
  point_alpha = 1,
  show_cluster_center = F,
  show_center_label = T,
  center_point_size = 4,
  label_size = 4,
  label_fontface = "bold",
  show_other_cells = T,
  other_cell_color = "lightgrey",
  other_point_size = 1,
  show_legend = TRUE
)

```

**Arguments**

|                                  |   |
|----------------------------------|---|
| sdimx                            | x-axis dimension name (default = 'sdimx')                     |
| sdimy                            | y-axis dimension name (default = 'sdimy')                     |
| cell_locations_metadata_selected | annotated location from selected cells                        |
| cell_locations_metadata_other    | annotated location from non-selected cells                    |
| cell_color                       | color for cells (see details)                                 |
| color_as_factor                  | convert color column to factor                                |
| cell_color_code                  | named vector with colors                                      |
| cell_color_gradient              | vector with 3 colors for numeric data                         |
| gradient_midpoint                | midpoint for color gradient                                   |
| gradient_limits                  | vector with lower and upper limits                            |
| select_cell_groups               | select subset of cells/clusters based on cell_color parameter |
| select_cells                     | select subset of cells based on cell IDs                      |

|                     |                                   |
|---------------------|-----------------------------------|
| point_size          | size of point (cell)              |
| point_alpha         | transparency of point             |
| show_cluster_center | plot center of selected clusters  |
| show_center_label   | plot label of selected clusters   |
| center_point_size   | size of center points             |
| label_size          | size of labels                    |
| label_fontface      | font of labels                    |
| show_other_cells    | display not selected cells        |
| other_cell_color    | color for not selected cells      |
| other_point_size    | point size for not selected cells |
| show_legend         | show legend                       |
| gobject             | giotto object                     |

**Details**

Description of parameters.

**Value**

ggplot

**Examples**

```
plot_spat_point_layer_ggplot_noFILL(gobject)
```

---

```
plot_spat_voronoi_layer_ggplot
```

```
plot_spat_voronoi_layer_ggplot
```

---

**Description**

creat ggplot point layer for spatial coordinates without borders

**Usage**

```
plot_spat_voronoi_layer_ggplot(
  ggobject,
  sdimx = NULL,
  sdimy = NULL,
  cell_locations_metadata_selected,
  cell_locations_metadata_other,
  cell_color = NULL,
  color_as_factor = T,
```



```

cell_color_code = NULL,
cell_color_gradient = c("blue", "white", "red"),
gradient_midpoint = NULL,
gradient_limits = NULL,
select_cell_groups = NULL,
select_cells = NULL,
point_size = 2,
point_alpha = 1,
show_cluster_center = F,
show_center_label = T,
center_point_size = 4,
label_size = 4,
label_fontface = "bold",
show_other_cells = T,
other_cell_color = "lightgrey",
other_point_size = 1,
background_color = "white",
vor_border_color = "white",
vor_max_radius = 200,
vor_alpha = 1,
show_legend = TRUE
)

```

### Arguments

|   |  |
|---|--|
| <code>sdimx</code>                            | x-axis dimension name (default = 'sdimx')                                  |
| <code>sdimy</code>                            | y-axis dimension name (default = 'sdimy')                                  |
| <code>cell_locations_metadata_selected</code> | annotated location from selected cells                                     |
| <code>cell_locations_metadata_other</code>    | annotated location from non-selected cells                                 |
| <code>cell_color</code>                       | color for cells (see details)  |
| <code>color_as_factor</code>                  | convert color column to factor   |
| <code>cell_color_code</code>                  | named vector with colors   |
| <code>cell_color_gradient</code>              | vector with 3 colors for numeric data                                      |
| <code>gradient_midpoint</code>                | midpoint for color gradient  |
| <code>gradient_limits</code>                  | vector with lower and upper limits   |
| <code>select_cell_groups</code>               | select subset of cells/clusters based on <code>cell_color</code> parameter |
| <code>select_cells</code>                     | select subset of cells based on cell IDs                                   |
| <code>point_size</code>                       | size of point (cell)   |
| <code>point_alpha</code>                      | transparency of point  |
| <code>show_cluster_center</code>              | plot center of selected clusters   |

show\_center\_label                    plot label of selected clusters  
center\_point\_size                    size of center points  
label\_size                    size of labels  
label\_fontface    font of labels  
show\_other\_cells                    display not selected cells  
other\_cell\_color                    color for not selected cells  
other\_point\_size                    point size for not selected cells  
background\_color                    background color  
vor\_border\_color                    borde colorr of voronoi plot  
vor\_max\_radius    maximum radius for voronoi 'cells'  
vor\_alpha                    transparancy of voronoi 'cells'  
show\_legend                    show legend  
gobject                    giotto object

**Details**

Description of parameters.

**Value**

ggplot

**Examples**

plot\_spat\_voronoi\_layer\_ggplot(gobject)

---

|              |                                      |
|--------------|--------------------------------------|
| print.giotto | <i>print method for giotto class</i> |
|--------------|--------------------------------------|

---

**Description**

print method for giotto class. Prints the chosen number of genes (rows) and cells (columns) from the raw count matrix. Also print the spatial locations for the chosen number of cells.

**Usage**

print.giotto(object, ...)

**Arguments**

nr\_genes                    number of genes (rows) to print  
nr\_cells                    number of cells (columns) to print

---

|                |                       |
|----------------|-----------------------|
| projection_fun | <i>projection_fun</i> |
|----------------|-----------------------|

---

**Description**

project a point onto a plane

**Usage**

```
projection_fun(point_to_project, plane_point, plane_norm)
```

---

|            |                   |
|------------|-------------------|
| rankEnrich | <i>rankEnrich</i> |
|------------|-------------------|

---

**Description**

Function to calculate gene signature enrichment scores per spatial position using a rank based approach.

**Usage**

```
rankEnrich(
  gobject,
  sign_matrix,
  expression_values = c("normalized", "scaled", "custom"),
  reverse_log_scale = TRUE,
  logbase = 2,
  output_enrichment = c("original", "zscore")
)
```

**Arguments**

|                   |  |
|-------------------|--|
| gobject           | Giotto object  |
| sign_matrix       | Matrix of signature genes for each cell type / process |
| expression_values | expression values to use                               |
| reverse_log_scale | reverse expression values from log scale               |
| logbase           | log base to use if reverse_log_scale = TRUE            |
| output_enrichment | how to return enrichment output                        |

**Details**

sign\_matrix: a rank-fold matrix with genes as row names and cell-types as column names. Alternatively a scRNA-seq matrix and vector with clusters can be provided to makeSignMatrixRank, which will create the matrix for you.

First a new rank is calculated as  $R = (R1 * R2)^{(1/2)}$ , where R1 is the rank of fold-change for each gene in each spot and R2 is the rank of each marker in each cell type. The Rank-Biased Precision is then calculated as:  $RBP = (1 - 0.99) * (0.99)^{(R - 1)}$  and the final enrichment score is then calculated as the sum of top 100 RBPs.

**Value**

data.table with enrichment results

**See Also**

[makeSignMatrixRank](#)

**Examples**

```
rankEnrich(gobject)
```

---

|                      |                             |
|----------------------|-----------------------------|
| rankSpatialCorGroups | <i>rankSpatialCorGroups</i> |
|----------------------|-----------------------------|

---

**Description**

Rank spatial correlated clusters according to correlation structure

**Usage**

```
rankSpatialCorGroups(
  gobject,
  spatCorObject,
  use_clus_name = NULL,
  show_plot = NA,
  return_plot = FALSE,
  save_plot = NA,
  save_param = list(),
  default_save_name = "rankSpatialCorGroups"
)
```

**Arguments**

|               |   |
|---------------|---|
| gobject       | giotto object   |
| spatCorObject | spatial correlation object                                    |
| use_clus_name | name of clusters to visualize (from clusterSpatialCorGenes()) |
| show_plot     | show plot   |
| return_plot   | return ggplot object  |

|                   |  |
|-------------------|--|
| save_plot         | directly save the plot [boolean]   |
| save_param        | list of saving parameters from <a href="#">all_plots_save_function</a>     |
| default_save_name | default save name for saving, don't change, change save_name in save_param |

**Value**

data.table with positive (within group) and negative (outside group) scores

**Examples**

```
rankSpatialCorGroups(gobject)
```

---

|               |                      |
|---------------|----------------------|
| rank_binarize | <i>rank_binarize</i> |
|---------------|----------------------|

---

**Description**

create binarized scores from a vector using arbitrary rank

**Usage**

```
rank_binarize(x, max_rank = 200)
```

---

|                |                       |
|----------------|-----------------------|
| readExprMatrix | <i>readExprMatrix</i> |
|----------------|-----------------------|

---

**Description**

Function to read an expression matrix into a sparse matrix.

**Usage**

```
readExprMatrix(path, cores = NA, transpose = FALSE)
```

**Arguments**

|           |                               |
|-----------|-------------------------------|
| path      | path to the expression matrix |
| cores     | number of cores to use        |
| transpose | transpose matrix              |

**Details**

The expression matrix needs to have both unique column names and row names

**Value**

sparse matrix

**Examples**

```
readExprMatrix()
```

---

|                        |                               |
|------------------------|-------------------------------|
| readGiottoInstructions | <i>readGiottoInstructions</i> |
|------------------------|-------------------------------|

---

### Description

Retrieves the instruction associated with the provided parameter

### Usage

```
readGiottoInstructions(giotto_instructions, param = NULL)
```

### Arguments

|                     |   |
|---------------------|---|
| giotto_instructions | giotto object or result from createGiottoInstructions() |
| param               | parameter to retrieve                                   |

### Value

specific parameter

### Examples

```
readGiottoInstructions()
```

---

|                   |                          |
|-------------------|--------------------------|
| read_crossSection | <i>read_crossSection</i> |
|-------------------|--------------------------|

---

### Description

read a cross section object from a giotto object

### Usage

```
read_crossSection(gobject, name = NULL, spatial_network_name = NULL)
```

---

|                      |                             |
|----------------------|-----------------------------|
| removeCellAnnotation | <i>removeCellAnnotation</i> |
|----------------------|-----------------------------|

---

**Description**

removes cell annotation of giotto object

**Usage**

```
removeCellAnnotation(gobject, columns = NULL, return_gobject = TRUE)
```

**Arguments**

|                |  |
|----------------|--|
| gobject        | giotto object                                  |
| columns        | names of columns to remove                     |
| return_gobject | boolean: return giotto object (default = TRUE) |

**Details**

if return\_gobject = FALSE, it will return the cell metadata

**Value**

giotto object

**Examples**

```
removeCellAnnotation(gobject)
```

---

|                      |                             |
|----------------------|-----------------------------|
| removeGeneAnnotation | <i>removeGeneAnnotation</i> |
|----------------------|-----------------------------|

---

**Description**

removes gene annotation of giotto object

**Usage**

```
removeGeneAnnotation(gobject, columns = NULL, return_gobject = TRUE)
```

**Arguments**

|                |  |
|----------------|--|
| gobject        | giotto object                                  |
| columns        | names of columns to remove                     |
| return_gobject | boolean: return giotto object (default = TRUE) |

**Details**

if return\_gobject = FALSE, it will return the gene metadata

**Value**

giotto object

**Examples**

```
removeGeneAnnotation(gobject)
```

---

```
replaceGiottoInstructions  
    replaceGiottoInstructions
```

---

**Description**

Function to replace all instructions from giotto object

**Usage**

```
replaceGiottoInstructions(gobject, instructions = NULL)
```

**Arguments**

|              |  |
|--------------|--|
| gobject      | giotto object  |
| instructions | new instructions (e.g. result from createGiottoInstructions) |

**Value**

giotto object with replaces instructions

**Examples**

```
replaceGiottoInstructions()
```

---

```
reshape_to_data_point  reshape_to_data_point
```

---

**Description**

reshape a mesh grid line object to data point matrix

**Usage**

```
reshape_to_data_point(mesh_grid_obj)
```



---

|                          |                                 |
|--------------------------|---------------------------------|
| reshape_to_mesh_grid_obj |                                 |
|                          | <i>reshape_to_mesh_grid_obj</i> |

---

**Description**

reshape a data point matrix to a mesh grid line object

**Usage**

```
reshape_to_mesh_grid_obj(data_points, mesh_grid_n)
```

---

|                 |                        |
|-----------------|------------------------|
| rowMeans_giotto | <i>rowMeans_giotto</i> |
|-----------------|------------------------|

---

**Description**

rowMeans\_giotto

**Usage**

```
rowMeans_giotto(mymatrix)
```

---

|                |                       |
|----------------|-----------------------|
| rowSums_giotto | <i>rowSums_giotto</i> |
|----------------|-----------------------|

---

**Description**

rowSums\_giotto

**Usage**

```
rowSums_giotto(mymatrix)
```

runPCA

*runPCA***Description**

runs a Principal Component Analysis

**Usage**

```
runPCA(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  reduction = c("cells", "genes"),
  name = "pca",
  genes_to_use = "hvg",
  return_gobject = TRUE,
  center = F,
  scale_unit = F,
  ncp = 100,
  method = c("irlba", "factominer"),
  rev = FALSE,
  verbose = TRUE,
  ...
)
```

**Arguments**

|                   |  |
|-------------------|--|
| gobject           | giotto object                                  |
| expression_values | expression values to use                       |
| reduction         | cells or genes                                 |
| name              | arbitrary name for PCA run                     |
| genes_to_use      | subset of genes to use for PCA                 |
| return_gobject    | boolean: return giotto object (default = TRUE) |
| center            | center data first (default = FALSE)            |
| scale_unit        | scale features before PCA                      |
| ncp               | number of principal components to calculate    |
| method            | which implementation to use                    |
| rev               | do a reverse PCA                               |
| verbose           | verbosity of the function                      |
| ...               | additional parameters for PCA (see details)    |

**Details**

See [prcomp\\_irlba](#) and [PCA](#) for more information about other parameters.

- genes\_to\_use = NULL: will use all genes from the selected matrix
- genes\_to\_use = <hvg name>: can be used to select a column name of highly variable genes (see [calculateHVG](#))
- genes\_to\_use = c('geneA', 'geneB', ...): will use all manually provided genes

**Value**

giotto object with updated PCA dimension reduction

**Examples**

```
runPCA(gobject)
```

---

|                   |                          |
|-------------------|--------------------------|
| runPCA_factominer | <i>runPCA_factominer</i> |
|-------------------|--------------------------|

---

**Description**

performs PCA based on the factominer package

**Usage**

```
runPCA_factominer(x, ncp = 100, scale = TRUE, rev = FALSE, ...)
```

**Arguments**

|       |  |
|-------|--|
| x     | matrix or object that can be converted to matrix |
| ncp   | number of principal components to calculate      |
| scale | scale features                                   |
| rev   | reverse PCA                                      |

**Value**

list of eigenvalues, loadings and pca coordinates

---

|                     |                            |
|---------------------|----------------------------|
| runPCA_prcomp_irlba | <i>runPCA_prcomp_irlba</i> |
|---------------------|----------------------------|

---

**Description**

performs PCA based on the irlba package

**Usage**

```
runPCA_prcomp_irlba(
  x,
  ncp = 100,
  center = TRUE,
  scale = TRUE,
  rev = FALSE,
  ...
)
```

**Arguments**

|        |  |
|--------|--|
| x      | matrix or object that can be converted to matrix |
| ncp    | number of principal components to calculate      |
| center | center data                                      |
| scale  | scale features                                   |
| rev    | reverse PCA                                      |

**Value**

list of eigenvalues, loadings and pca coordinates

---

|         |                |
|---------|----------------|
| runtSNE | <i>runtSNE</i> |
|---------|----------------|

---

**Description**

run tSNE

**Usage**

```
runtSNE(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  reduction = c("cells", "genes"),
  dim_reduction_to_use = "pca",
  dim_reduction_name = "pca",
  dimensions_to_use = 1:10,
  name = "tsne",
  genes_to_use = NULL,
  return_gobject = TRUE,
  dims = 2,
  perplexity = 30,
  theta = 0.5,
  do_PCA_first = F,
  set_seed = T,
  seed_number = 1234,
  verbose = TRUE,
  ...
)
```

**Arguments**

|                      |  |
|----------------------|--|
| gobject              | giotto object                                |
| expression_values    | expression values to use                     |
| reduction            | cells or genes                               |
| dim_reduction_to_use | use another dimension reduction set as input |

|                    |  |
|--------------------|--|
| dim_reduction_name | name of dimension reduction set to use             |
| dimensions_to_use  | number of dimensions to use as input               |
| name               | arbitrary name for tSNE run                        |
| genes_to_use       | if dim_reduction_to_use = NULL, which genes to use |
| return_gobject     | boolean: return giotto object (default = TRUE)     |
| dims               | tSNE param: number of dimensions to return         |
| perplexity         | tSNE param: perplexity                             |
| theta              | tSNE param: theta                                  |
| do_PCA_first       | tSNE param: do PCA before tSNE (default = FALSE)   |
| set_seed           | use of seed  |
| seed_number        | seed number to use                                 |
| verbose            | verbosity of the function                          |
| ...                | additional tSNE parameters                         |

### Details

See [Rtsne](#) for more information about these and other parameters.

- Input for tSNE dimension reduction can be another dimension reduction (default = 'pca')
- To use gene expression as input set dim\_reduction\_to\_use = NULL
- If dim\_reduction\_to\_use = NULL, genes\_to\_use can be used to select a column name of highly variable genes (see [calculateHVG](#)) or simply provide a vector of genes
- multiple tSNE results can be stored by changing the *name* of the analysis

### Value

giotto object with updated tSNE dimension reduction

### Examples

```
runtSNE(gobject)
```

---

runUMAP

---

runUMAP

---

### Description

run UMAP

**Usage**

```
runUMAP(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  reduction = c("cells", "genes"),
  dim_reduction_to_use = "pca",
  dim_reduction_name = "pca",
  dimensions_to_use = 1:10,
  name = "umap",
  genes_to_use = NULL,
  return_gobject = TRUE,
  n_neighbors = 40,
  n_components = 2,
  n_epochs = 400,
  min_dist = 0.01,
  n_threads = 1,
  spread = 5,
  set_seed = T,
  seed_number = 1234,
  verbose = T,
  ...
)
```

**Arguments**

|                                   |  |
|-----------------------------------|--|
| <code>gobject</code>              | giotto object  |
| <code>expression_values</code>    | expression values to use   |
| <code>reduction</code>            | cells or genes   |
| <code>dim_reduction_to_use</code> | use another dimension reduction set as input                     |
| <code>dim_reduction_name</code>   | name of dimension reduction set to use                           |
| <code>dimensions_to_use</code>    | number of dimensions to use as input                             |
| <code>name</code>                 | arbitrary name for UMAP run                                      |
| <code>genes_to_use</code>         | if <code>dim_reduction_to_use = NULL</code> , which genes to use |
| <code>return_gobject</code>       | boolean: return giotto object (default = TRUE)                   |
| <code>n_neighbors</code>          | UMAP param: number of neighbors                                  |
| <code>n_components</code>         | UMAP param: number of components                                 |
| <code>n_epochs</code>             | UMAP param: number of epochs                                     |
| <code>min_dist</code>             | UMAP param: minimum distance                                     |
| <code>n_threads</code>            | UMAP param: threads to use                                       |
| <code>spread</code>               | UMAP param: spread   |
| <code>set_seed</code>             | use of seed  |
| <code>seed_number</code>          | seed number to use   |
| <code>verbose</code>              | verbosity of function  |
| <code>...</code>                  | additional UMAP parameters                                       |

## Details

See [umap](#) for more information about these and other parameters.

- Input for UMAP dimension reduction can be another dimension reduction (default = 'pca')
- To use gene expression as input set `dim_reduction_to_use = NULL`
- If `dim_reduction_to_use = NULL`, `genes_to_use` can be used to select a column name of highly variable genes (see [calculateHVG](#)) or simply provide a vector of genes
- multiple UMAP results can be stored by changing the *name* of the analysis

## Value

giotto object with updated UMAP dimension reduction

## Examples

```
runUMAP(gobject)
```

---

|           |                  |
|-----------|------------------|
| screePlot | <i>screePlot</i> |
|-----------|------------------|

---

## Description

identify significant principal components (PCs) using an screeplot (a.k.a. elbowplot)

## Usage

```
screePlot(
  gobject,
  name = "pca",
  expression_values = c("normalized", "scaled", "custom"),
  reduction = c("cells", "genes"),
  method = c("irlba", "factominer"),
  rev = FALSE,
  genes_to_use = NULL,
  center = F,
  scale_unit = F,
  ncp = 100,
  ylim = c(0, 20),
  verbose = T,
  show_plot = NA,
  return_plot = NA,
  save_plot = NA,
  save_param = list(),
  default_save_name = "screePlot"
)
```

**Arguments**

|                                |  |
|--------------------------------|--|
| <code>gobject</code>           | giotto object  |
| <code>name</code>              | name of PCA object if available  |
| <code>expression_values</code> | expression values to use   |
| <code>reduction</code>         | cells or genes   |
| <code>method</code>            | which implementation to use  |
| <code>rev</code>               | do a reverse PCA   |
| <code>genes_to_use</code>      | subset of genes to use for PCA   |
| <code>center</code>            | center data before PCA   |
| <code>scale_unit</code>        | scale features before PCA  |
| <code>ncp</code>               | number of principal components to calculate  |
| <code>ylim</code>              | y-axis limits on scree plot  |
| <code>verbose</code>           | verbosity  |
| <code>show_plot</code>         | show plot  |
| <code>return_plot</code>       | return ggplot object   |
| <code>save_plot</code>         | directly save the plot [boolean]   |
| <code>save_param</code>        | list of saving parameters from <code>all_plots_save_function()</code>                                |
| <code>default_save_name</code> | default save name for saving, don't change, change <code>save_name</code> in <code>save_param</code> |

**Details**

Screeplot works by plotting the explained variance of each individual PC in a barplot allowing you to identify which PC does not show a significant contribution anymore (= 'elbow method').

**Value**

ggplot object for scree method

**Examples**

```
screePlot(gobject)
```

---

|                                 |                           |
|---------------------------------|---------------------------|
| <code>selectPatternGenes</code> | <i>selectPatternGenes</i> |
|---------------------------------|---------------------------|

---

**Description**

Select genes correlated with spatial patterns



Usage

```
selectPatternGenes(  
  spatPatObj,  
  dimensions = 1:5,  
  top_pos_genes = 10,  
  top_neg_genes = 10,  
  min_pos_cor = 0.5,  
  min_neg_cor = -0.5,  
  return_top_selection = FALSE  
)
```

Arguments

|               |   |
|---------------|---|
| spatPatObj    | Output from detectSpatialPatterns                     |
| dimensions    | dimensions to identify correlated genes for.          |
| top_pos_genes | Top positively correlated genes.                      |
| top_neg_genes | Top negatively correlated genes.                      |
| min_pos_cor   | Minimum positive correlation score to include a gene. |
| min_neg_cor   | Minimum negative correlation score to include a gene. |

Details

Description.

Value

Data.table with genes associated with selected dimension (PC).

Examples

```
selectPatternGenes(gobject)
```

---

|                                 |
|---------------------------------|
| select_expression_values        |
| <i>select_expression_values</i> |

---

Description

helper function to select expression values

Usage

```
select_expression_values(gobject, values)
```

Arguments

|         |                              |
|---------|------------------------------|
| gobject | giotto object                |
| values  | expression values to extract |

Value

expression matrix

---

```
select_spatialNetwork  select_spatialNetwork
```

---

### Description

function to select a spatial network

### Usage

```
select_spatialNetwork(gobject, name = NULL, return_network_Obj = FALSE)
```

---

```
set_giotto_python_path
      set_giotto_python_path
```

---

### Description

sets the python path and/or install miniconda and the python modules

### Usage

```
set_giotto_python_path(
  python_path = NULL,
  packages_to_install = c("pandas", "networkx", "python-igraph", "leidenalg",
    "python-louvain", "python.app", "scikit-learn")
)
```

---

```
show,giotto-method  show method for giotto class
```

---

### Description

show method for giotto class

### Usage

```
## S4 method for signature 'giotto'
show(object)
```

---

showClusterDendrogram *showClusterDendrogram*


---

## Description

Creates dendrogram for selected clusters.

## Usage

```
showClusterDendrogram(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  cluster_column,
  cor = c("pearson", "spearman"),
  distance = "ward.D",
  h = NULL,
  h_color = "red",
  rotate = FALSE,
  show_plot = NA,
  return_plot = NA,
  save_plot = NA,
  save_param = list(),
  default_save_name = "showClusterDendrogram",
  ...
)
```

## Arguments

|                                |  |
|--------------------------------|--|
| <code>gobject</code>           | giotto object  |
| <code>expression_values</code> | expression values to use   |
| <code>cluster_column</code>    | name of column to use for clusters   |
| <code>cor</code>               | correlation score to calculate distance  |
| <code>distance</code>          | distance method to use for hierarchical clustering   |
| <code>h</code>                 | height of horizontal lines to plot   |
| <code>h_color</code>           | color of horizontal lines  |
| <code>rotate</code>            | rotate dendrogram 90 degrees   |
| <code>show_plot</code>         | show plot  |
| <code>return_plot</code>       | return ggplot object   |
| <code>save_plot</code>         | directly save the plot [boolean]   |
| <code>save_param</code>        | list of saving parameters from <a href="#">all_plots_save_function</a>                               |
| <code>default_save_name</code> | default save name for saving, don't change, change <code>save_name</code> in <code>save_param</code> |
| <code>...</code>               | additional parameters for <code>ggdendrogram()</code>  |

## Details

Expression correlation dendrogram for selected clusters.

**Value**

ggplot

**Examples**

```
showClusterDendrogram(gobject)
```

---

|                    |                           |
|--------------------|---------------------------|
| showClusterHeatmap | <i>showClusterHeatmap</i> |
|--------------------|---------------------------|

---

**Description**

Creates heatmap based on identified clusters

**Usage**

```
showClusterHeatmap(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  genes = "all",
  cluster_column,
  cor = c("pearson", "spearman"),
  distance = "ward.D",
  show_plot = NA,
  return_plot = NA,
  save_plot = NA,
  save_param = list(),
  default_save_name = "showClusterHeatmap",
  ...
)
```

**Arguments**

|                   |  |
|-------------------|--|
| gobject           | giotto object  |
| expression_values | expression values to use   |
| genes             | vector of genes to use, default to 'all'                                   |
| cluster_column    | name of column to use for clusters   |
| cor               | correlation score to calculate distance                                    |
| distance          | distance method to use for hierarchical clustering                         |
| show_plot         | show plot  |
| return_plot       | return ggplot object   |
| save_plot         | directly save the plot [boolean]   |
| save_param        | list of saving parameters from <a href="#">all_plots_save_function</a>     |
| default_save_name | default save name for saving, don't change, change save_name in save_param |
| ...               | additional parameters for the Heatmap function from ComplexHeatmap         |

**Details**

Correlation heatmap of selected clusters.

**Value**

ggplot

**Examples**

```
showClusterHeatmap(gobject)
```

---

```
showGiottoImageNames  showGiottoImageNames
```

---

**Description**

Show wich images are attached to the Giotto object (prints the names)

**Usage**

```
showGiottoImageNames(gobject, verbose = TRUE)
```

**Arguments**

|         |                       |
|---------|-----------------------|
| gobject | a giotto object       |
| verbose | verbosity of function |

**Value**

a vector of giotto image names attached to the giotto object

**Examples**

```
showGiottoImageNames(gobject)
```

---

```
showGiottoInstructions  
  showGiottoInstructions
```

---

**Description**

Function to display all instructions from giotto object

**Usage**

```
showGiottoInstructions(gobject)
```

**Arguments**

|         |               |
|---------|---------------|
| gobject | giotto object |
|---------|---------------|

**Value**

named vector with giotto instructions

**Examples**

```
showGiottoInstructions()
```

---

|             |                    |
|-------------|--------------------|
| showPattern | <i>showPattern</i> |
|-------------|--------------------|

---

**Description**

show patterns for 2D spatial data

**Usage**

```
showPattern(gobject, spatPatObj, ...)
```

**Arguments**

- gobject               giotto object
- spatPatObj           Output from detectSpatialPatterns
- dimension            dimension to plot
- trim                  Trim ends of the PC values.
- background\_color      background color for plot
- grid\_border\_color     color for grid
- show\_legend           show legend of ggplot
- show\_plot            show plot
- return\_plot           return ggplot object
- save\_plot             directly save the plot [boolean]
- save\_param            list of saving parameters from [all\\_plots\\_save\\_function](#)
- default\_save\_name     default save name for saving, don't change, change save\_name in save\_param

**Value**

ggplot

**See Also**

[showPattern2D](#)

**Examples**

```
showPattern(gobject)
```

---

|               |                      |
|---------------|----------------------|
| showPattern2D | <i>showPattern2D</i> |
|---------------|----------------------|

---

## Description

show patterns for 2D spatial data

## Usage

```
showPattern2D(
  gobject,
  spatPatObj,
  dimension = 1,
  trim = c(0.02, 0.98),
  background_color = "white",
  grid_border_color = "grey",
  show_legend = T,
  point_size = 1,
  show_plot = NA,
  return_plot = NA,
  save_plot = NA,
  save_param = list(),
  default_save_name = "showPattern2D"
)
```

## Arguments

|                                |  |
|--------------------------------|--|
| <code>gobject</code>           | giotto object  |
| <code>spatPatObj</code>        | Output from <code>detectSpatialPatterns</code>   |
| <code>dimension</code>         | dimension to plot  |
| <code>trim</code>              | Trim ends of the PC values.  |
| <code>background_color</code>  | background color for plot  |
| <code>grid_border_color</code> | color for grid   |
| <code>show_legend</code>       | show legend of ggplot  |
| <code>show_plot</code>         | show plot  |
| <code>return_plot</code>       | return ggplot object   |
| <code>save_plot</code>         | directly save the plot [boolean]   |
| <code>save_param</code>        | list of saving parameters from <a href="#">all_plots_save_function</a>                               |
| <code>default_save_name</code> | default save name for saving, don't change, change <code>save_name</code> in <code>save_param</code> |

## Value

ggplot

## Examples

```
showPattern2D(gobject)
```

showPattern3D

*showPattern3D***Description**

show patterns for 3D spatial data

**Usage**

```
showPattern3D(
  gobject,
  spatPatObj,
  dimension = 1,
  trim = c(0.02, 0.98),
  background_color = "white",
  grid_border_color = "grey",
  show_legend = T,
  point_size = 1,
  axis_scale = c("cube", "real", "custom"),
  custom_ratio = NULL,
  x_ticks = NULL,
  y_ticks = NULL,
  z_ticks = NULL,
  show_plot = NA,
  return_plot = NA,
  save_plot = NA,
  save_param = list(),
  default_save_name = "showPattern3D"
)
```

**Arguments**

|                                |  |
|--------------------------------|--|
| <code>gobject</code>           | giotto object                                  |
| <code>spatPatObj</code>        | Output from <code>detectSpatialPatterns</code> |
| <code>dimension</code>         | dimension to plot                              |
| <code>trim</code>              | Trim ends of the PC values.                    |
| <code>background_color</code>  | background color for plot                      |
| <code>grid_border_color</code> | color for grid                                 |
| <code>show_legend</code>       | show legend of plot                            |
| <code>point_size</code>        | adjust the point size                          |
| <code>axis_scale</code>        | scale the axis                                 |
| <code>custom_ratio</code>      | customize the scale of the axis                |
| <code>x_ticks</code>           | the tick number of <code>x_axis</code>         |
| <code>y_ticks</code>           | the tick number of <code>y_axis</code>         |
| <code>z_ticks</code>           | the tick number of <code>z_axis</code>         |



|                   |  |
|-------------------|--|
| show_plot         | show plot  |
| return_plot       | return plot object   |
| save_plot         | directly save the plot [boolean]   |
| save_param        | list of saving parameters from <a href="#">all_plots_save_function</a>     |
| default_save_name | default save name for saving, don't change, change save_name in save_param |

**Value**

plotly

**Examples**

```
showPattern3D(gobject)
```

---

|                  |                         |
|------------------|-------------------------|
| showPatternGenes | <i>showPatternGenes</i> |
|------------------|-------------------------|

---

**Description**

show genes correlated with spatial patterns

**Usage**

```
showPatternGenes(
  gobject,
  spatPatObj,
  dimension = 1,
  top_pos_genes = 5,
  top_neg_genes = 5,
  point_size = 1,
  return_DT = FALSE,
  show_plot = NA,
  return_plot = NA,
  save_plot = NA,
  save_param = list(),
  default_save_name = "showPatternGenes"
)
```

**Arguments**

|               |   |
|---------------|---|
| gobject       | giotto object   |
| spatPatObj    | Output from detectSpatialPatterns                                 |
| dimension     | dimension to plot genes for.                                      |
| top_pos_genes | Top positively correlated genes.                                  |
| top_neg_genes | Top negatively correlated genes.                                  |
| point_size    | size of points  |
| return_DT     | if TRUE, it will return the data.table used to generate the plots |
| show_plot     | show plot   |

|                   |  |
|-------------------|--|
| return_plot       | return ggplot object   |
| save_plot         | directly save the plot [boolean]   |
| save_param        | list of saving parameters from all_plots_save_function()                   |
| default_save_name | default save name for saving, don't change, change save_name in save_param |

**Value**

ggplot

**Examples**

```
showPatternGenes(gobject)
```

---

|                     |                            |
|---------------------|----------------------------|
| showProcessingSteps | <i>showProcessingSteps</i> |
|---------------------|----------------------------|

---

**Description**

shows the sequential processing steps that were performed in a summarized format

**Usage**

```
showProcessingSteps(gobject)
```

**Arguments**

|         |               |
|---------|---------------|
| gobject | giotto object |
|---------|---------------|

**Value**

list of processing steps and names

**Examples**

```
showProcessingSteps(gobject)
```

---

|                    |                           |
|--------------------|---------------------------|
| showSaveParameters | <i>showSaveParameters</i> |
|--------------------|---------------------------|

---

**Description**

Description of Giotto saving options, links to [all\\_plots\\_save\\_function](#)

**Usage**

```
showSaveParameters()
```

**Value**

text

**Examples**

```
showSaveParameters()
```

---

|                     |                            |
|---------------------|----------------------------|
| showSpatialCorGenes | <i>showSpatialCorGenes</i> |
|---------------------|----------------------------|

---

**Description**

Shows and filters spatially correlated genes

**Usage**

```
showSpatialCorGenes(
  spatCorObject,
  use_clus_name = NULL,
  selected_clusters = NULL,
  genes = NULL,
  min_spat_cor = 0.5,
  min_expr_cor = NULL,
  min_cor_diff = NULL,
  min_rank_diff = NULL,
  show_top_genes = NULL
)
```

**Arguments**

|                   |  |
|-------------------|--|
| spatCorObject     | spatial correlation object                           |
| use_clus_name     | cluster information to show                          |
| selected_clusters | subset of clusters to show                           |
| genes             | subset of genes to show                              |
| min_spat_cor      | filter on minimum spatial correlation                |
| min_expr_cor      | filter on minimum single-cell expression correlation |

min\_cor\_diff    filter on minimum correlation difference (spatial vs expression)  
 min\_rank\_diff   filter on minimum correlation rank difference (spatial vs expression)  
 show\_top\_genes   show top genes per gene

**Value**

data.table with filtered information

**Examples**

```
showSpatialCorGenes(gobject)
```

---

|         |                |
|---------|----------------|
| signPCA | <i>signPCA</i> |
|---------|----------------|

---

**Description**

identify significant principal components (PCs)

**Usage**

```
signPCA(
  gobject,
  name = "pca",
  method = c("screeplot", "jackstraw"),
  expression_values = c("normalized", "scaled", "custom"),
  reduction = c("cells", "genes"),
  genes_to_use = NULL,
  center = T,
  scale_unit = T,
  ncp = 50,
  scree_ylim = c(0, 10),
  jack_iter = 10,
  jack_threshold = 0.01,
  jack_ylim = c(0, 1),
  verbose = TRUE,
  show_plot = NA,
  return_plot = NA,
  save_plot = NA,
  save_param = list(),
  default_save_name = "signPCA"
)
```

**Arguments**

gobject            giotto object  
 name               name of PCA object if available  
 method            method to use to identify significant PCs  
 expression\_values    expression values to use

|                   |  |
|-------------------|--|
| reduction         | cells or genes   |
| genes_to_use      | subset of genes to use for PCA   |
| center            | center data before PCA   |
| scale_unit        | scale features before PCA  |
| ncp               | number of principal components to calculate                                |
| scree_ylim        | y-axis limits on scree plot  |
| jack_iter         | number of iterations for jackstraw   |
| jack_threshold    | p-value threshold to call a PC significant                                 |
| jack_ylim         | y-axis limits on jackstraw plot  |
| verbose           | verbosity  |
| show_plot         | show plot  |
| return_plot       | return ggplot object   |
| save_plot         | directly save the plot [boolean]   |
| save_param        | list of saving parameters from all_plots_save_function()                   |
| default_save_name | default save name for saving, don't change, change save_name in save_param |

## Details

Two different methods can be used to assess the number of relevant or significant principal components (PC's).

1. Screeplot works by plotting the explained variance of each individual PC in a barplot allowing you to identify which PC does not show a significant contribution anymore (= 'elbow method').
2. The Jackstraw method uses the [permutationPA](#) function. By systematically permuting genes it identifies robust, and thus significant, PCs.

multiple PCA results can be stored by changing the *name* parameter

## Value

ggplot object for scree method and maxtrix of p-values for jackstraw

## Examples

```
signPCA(gobject)
```

---

silhouetteRank

*silhouetteRank*


---

## Description

Previously: calculate\_spatial\_genes\_python. This method computes a silhouette score per gene based on the spatial distribution of two partitions of cells (expressed L1, and non-expressed L0). Here, rather than L2 Euclidean norm, it uses a rank-transformed, exponentially weighted function to represent the local physical distance between two cells.

**Usage**

```
silhouetteRank(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  metric = "euclidean",
  subset_genes = NULL,
  rbp_p = 0.95,
  examine_top = 0.3,
  python_path = NULL
)
```

**Arguments**

|                                |   |
|--------------------------------|---|
| <code>gobject</code>           | giotto object                               |
| <code>expression_values</code> | expression values to use                    |
| <code>metric</code>            | distance metric to use                      |
| <code>subset_genes</code>      | only run on this subset of genes            |
| <code>rbp_p</code>             | fractional binarization threshold           |
| <code>examine_top</code>       | top fraction to evaluate with silhouette    |
| <code>python_path</code>       | specify specific path to python if required |

**Value**

data.table with spatial scores

**Examples**

```
silhouetteRank(gobject)
```

---

```
sort_combine_two_DT_columns
```

```
sort_combine_two_DT_columns
```

---

**Description**

fast sorting and pasting of 2 character columns

**Usage**

```
sort_combine_two_DT_columns(DT, column1, column2, myname = "unif_gene_gene")
```

**Examples**

```
sort_combine_two_DT_columns()
```

---

|                 |                        |
|-----------------|------------------------|
| spatCellCellcom | <i>spatCellCellcom</i> |
|-----------------|------------------------|

---

## Description

Spatial Cell-Cell communication scores based on spatial expression of interacting cells

## Usage

```
spatCellCellcom(
  gobject,
  spatial_network_name = "Delaunay_network",
  cluster_column = "cell_types",
  random_iter = 1000,
  gene_set_1,
  gene_set_2,
  log2FC_addendum = 0.1,
  min_observations = 2,
  adjust_method = c("fdr", "bonferroni", "BH", "holm", "hochberg", "hommel", "BY",
    "none"),
  adjust_target = c("genes", "cells"),
  do_parallel = TRUE,
  cores = NA,
  verbose = c("a little", "a lot", "none")
)
```

## Arguments

|                                   |   |
|-----------------------------------|---|
| <code>gobject</code>              | giotto object to use                                      |
| <code>spatial_network_name</code> | spatial network to use for identifying interacting cells  |
| <code>cluster_column</code>       | cluster column with cell type information                 |
| <code>random_iter</code>          | number of iterations                                      |
| <code>gene_set_1</code>           | first specific gene set from gene pairs                   |
| <code>gene_set_2</code>           | second specific gene set from gene pairs                  |
| <code>log2FC_addendum</code>      | addendum to add when calculating log2FC                   |
| <code>min_observations</code>     | minimum number of interactions needed to be considered    |
| <code>adjust_method</code>        | which method to adjust p-values                           |
| <code>adjust_target</code>        | adjust multiple hypotheses at the cell or gene level      |
| <code>do_parallel</code>          | run calculations in parallel with mclapply                |
| <code>cores</code>                | number of cores to use if <code>do_parallel = TRUE</code> |
| <code>verbose</code>              | verbose   |

## Details

Statistical framework to identify if pairs of genes (such as ligand-receptor combinations) are expressed at higher levels than expected based on a reshuffled null distribution of gene expression values in cells that are spatially in proximity to eachother.. More details will follow soon.

**Value**

Cell-Cell communication scores for gene pairs based on spatial interaction

**Examples**

```
spatCellCellcom(gobject)
```

---

|              |                     |
|--------------|---------------------|
| spatCellPlot | <i>spatCellPlot</i> |
|--------------|---------------------|

---

**Description**

Visualize cells according to spatial coordinates

**Usage**

```
spatCellPlot(  
  gobject,  
  show_image = F,  
  gimage = NULL,  
  image_name = "image",  
  sdimx = "sdimx",  
  sdimy = "sdimy",  
  spat_enr_names = NULL,  
  cell_annotation_values = NULL,  
  cell_color_gradient = c("blue", "white", "red"),  
  gradient_midpoint = NULL,  
  gradient_limits = NULL,  
  select_cell_groups = NULL,  
  select_cells = NULL,  
  point_shape = c("border", "no_border", "voronoi"),  
  point_size = 3,  
  point_alpha = 1,  
  point_border_col = "black",  
  point_border_stroke = 0.1,  
  show_cluster_center = F,  
  show_center_label = F,  
  center_point_size = 4,  
  center_point_border_col = "black",  
  center_point_border_stroke = 0.1,  
  label_size = 4,  
  label_fontface = "bold",  
  show_network = F,  
  spatial_network_name = NULL,  
  network_color = NULL,  
  network_alpha = 1,  
  show_grid = F,  
  spatial_grid_name = "spatial_grid",  
  grid_color = NULL,  
  show_other_cells = T,  
  other_cell_color = "lightgrey",
```



```

    other_point_size = 1,
    other_cells_alpha = 0.1,
    coord_fix_ratio = NULL,
    show_legend = T,
    legend_text = 8,
    legend_symbol_size = 1,
    background_color = "white",
    vor_border_color = "white",
    vor_max_radius = 200,
    axis_text = 8,
    axis_title = 8,
    cow_n_col = 2,
    cow_rel_h = 1,
    cow_rel_w = 1,
    cow_align = "h",
    show_plot = NA,
    return_plot = NA,
    save_plot = NA,
    save_param = list(),
    default_save_name = "spatCellPlot"
)

```

## Arguments

|                                     |  |
|-------------------------------------|--|
| <code>gobject</code>                | giotto object  |
| <code>show_image</code>             | show a tissue background image   |
| <code>gimage</code>                 | a giotto image   |
| <code>image_name</code>             | name of a giotto image   |
| <code>sdimx</code>                  | x-axis dimension name (default = 'sdimx')                                  |
| <code>sdimy</code>                  | y-axis dimension name (default = 'sdimy')                                  |
| <code>spat_enr_names</code>         | names of spatial enrichment results to include                             |
| <code>cell_annotation_values</code> | numeric cell annotation columns  |
| <code>cell_color_gradient</code>    | vector with 3 colors for numeric data                                      |
| <code>gradient_midpoint</code>      | midpoint for color gradient  |
| <code>gradient_limits</code>        | vector with lower and upper limits   |
| <code>select_cell_groups</code>     | select subset of cells/clusters based on <code>cell_color</code> parameter |
| <code>select_cells</code>           | select subset of cells based on cell IDs                                   |
| <code>point_shape</code>            | shape of points (border, no_border or voronoi)                             |
| <code>point_size</code>             | size of point (cell)   |
| <code>point_alpha</code>            | transparancy of spatial points   |
| <code>point_border_col</code>       | color of border around points  |
| <code>point_border_stroke</code>    | stroke size of border around points  |

|                      |  |
|----------------------|--|
| show_cluster_center  | plot center of selected clusters   |
| show_center_label    | plot label of selected clusters  |
| center_point_size    | size of center points  |
| label_size           | size of labels   |
| label_fontface       | font of labels   |
| show_network         | show underlying spatial network  |
| spatial_network_name | name of spatial network to use   |
| network_color        | color of spatial network   |
| network_alpha        | alpha of spatial network   |
| show_grid            | show spatial grid  |
| spatial_grid_name    | name of spatial grid to use  |
| grid_color           | color of spatial grid  |
| show_other_cells     | display not selected cells   |
| other_cell_color     | color of not selected cells  |
| other_point_size     | point size of not selected cells   |
| other_cells_alpha    | alpha of not selected cells  |
| coord_fix_ratio      | fix ratio between x and y-axis   |
| show_legend          | show legend  |
| legend_text          | size of legend text  |
| legend_symbol_size   | size of legend symbols   |
| background_color     | color of plot background   |
| vor_border_color     | border color for voronoi plot  |
| vor_max_radius       | maximum radius for voronoi 'cells'   |
| axis_text            | size of axis text  |
| axis_title           | size of axis title   |
| show_plot            | show plot  |
| return_plot          | return ggplot object   |
| save_plot            | directly save the plot [boolean]   |
| save_param           | list of saving parameters from <a href="#">all_plots_save_function</a>     |
| default_save_name    | default save name for saving, don't change, change save_name in save_param |
| vor_alpha            | transparency of voronoi 'cells'  |

**Details**

Description of parameters.

**Value**

ggplot

**Examples**

spatCellPlot(gobject)

---

|                |                       |
|----------------|-----------------------|
| spatCellPlot2D | <i>spatCellPlot2D</i> |
|----------------|-----------------------|

---

**Description**

Visualize cells according to spatial coordinates

**Usage**

```
spatCellPlot2D(  
  gobject,  
  show_image = F,  
  gimage = NULL,  
  image_name = "image",  
  sdimx = "sdimx",  
  sdimy = "sdimy",  
  spat_enr_names = NULL,  
  cell_annotation_values = NULL,  
  cell_color_gradient = c("blue", "white", "red"),  
  gradient_midpoint = NULL,  
  gradient_limits = NULL,  
  select_cell_groups = NULL,  
  select_cells = NULL,  
  point_shape = c("border", "no_border", "voronoi"),  
  point_size = 3,  
  point_alpha = 1,  
  point_border_col = "black",  
  point_border_stroke = 0.1,  
  show_cluster_center = F,  
  show_center_label = F,  
  center_point_size = 4,  
  center_point_border_col = "black",  
  center_point_border_stroke = 0.1,  
  label_size = 4,  
  label_fontface = "bold",  
  show_network = F,  
  spatial_network_name = NULL,  
  network_color = NULL,  
  network_alpha = 1,  
  show_grid = F,
```

```

    spatial_grid_name = "spatial_grid",
    grid_color = NULL,
    show_other_cells = T,
    other_cell_color = "lightgrey",
    other_point_size = 1,
    other_cells_alpha = 0.1,
    coord_fix_ratio = NULL,
    show_legend = T,
    legend_text = 8,
    legend_symbol_size = 1,
    background_color = "white",
    vor_border_color = "white",
    vor_max_radius = 200,
    vor_alpha = 1,
    axis_text = 8,
    axis_title = 8,
    cow_n_col = 2,
    cow_rel_h = 1,
    cow_rel_w = 1,
    cow_align = "h",
    show_plot = NA,
    return_plot = NA,
    save_plot = NA,
    save_param = list(),
    default_save_name = "spatCellPlot2D"
  )

```

### Arguments

|                                     |  |
|-------------------------------------|--|
| <code>gobject</code>                | giotto object  |
| <code>show_image</code>             | show a tissue background image   |
| <code>gimage</code>                 | a giotto image   |
| <code>image_name</code>             | name of a giotto image   |
| <code>sdimx</code>                  | x-axis dimension name (default = 'sdimx')                                  |
| <code>sdimy</code>                  | y-axis dimension name (default = 'sdimy')                                  |
| <code>spat_enr_names</code>         | names of spatial enrichment results to include                             |
| <code>cell_annotation_values</code> | numeric cell annotation columns  |
| <code>cell_color_gradient</code>    | vector with 3 colors for numeric data                                      |
| <code>gradient_midpoint</code>      | midpoint for color gradient  |
| <code>gradient_limits</code>        | vector with lower and upper limits   |
| <code>select_cell_groups</code>     | select subset of cells/clusters based on <code>cell_color</code> parameter |
| <code>select_cells</code>           | select subset of cells based on cell IDs                                   |
| <code>point_shape</code>            | shape of points (border, no_border or voronoi)                             |
| <code>point_size</code>             | size of point (cell)   |

|                      |                                     |
|----------------------|-------------------------------------|
| point_alpha          | transparancy of spatial points      |
| point_border_col     | color of border around points       |
| point_border_stroke  | stroke size of border around points |
| show_cluster_center  | plot center of selected clusters    |
| show_center_label    | plot label of selected clusters     |
| center_point_size    | size of center points               |
| label_size           | size of labels                      |
| label_fontface       | font of labels                      |
| show_network         | show underlying spatial network     |
| spatial_network_name | name of spatial network to use      |
| network_color        | color of spatial network            |
| network_alpha        | alpha of spatial network            |
| show_grid            | show spatial grid                   |
| spatial_grid_name    | name of spatial grid to use         |
| grid_color           | color of spatial grid               |
| show_other_cells     | display not selected cells          |
| other_cell_color     | color of not selected cells         |
| other_point_size     | point size of not selected cells    |
| other_cells_alpha    | alpha of not selected cells         |
| coord_fix_ratio      | fix ratio between x and y-axis      |
| show_legend          | show legend                         |
| legend_text          | size of legend text                 |
| legend_symbol_size   | size of legend symbols              |
| background_color     | color of plot background            |
| vor_border_color     | border color for voronoi plot       |
| vor_max_radius       | maximum radius for voronoi 'cells'  |
| vor_alpha            | transparancy of voronoi 'cells'     |
| axis_text            | size of axis text                   |
| axis_title           | size of axis title                  |
| show_plot            | show plot                           |

return\_plot      return ggplot object  
save\_plot        directly save the plot [boolean]  
save\_param       list of saving parameters from [all\\_plots\\_save\\_function](#)  
default\_save\_name      default save name for saving, don't change, change save\_name in save\_param

**Details**

Description of parameters.

**Value**

ggplot

**Examples**

spatCellPlot2D(gobject)

---

|                 |                        |
|-----------------|------------------------|
| spatDimCellPlot | <i>spatDimCellPlot</i> |
|-----------------|------------------------|

---

**Description**

Visualize numerical features of cells according to spatial AND dimension reduction coordinates in 2D

**Usage**

```
spatDimCellPlot(  
  gobject,  
  show_image = F,  
  gimage = NULL,  
  image_name = "image",  
  plot_alignment = c("vertical", "horizontal"),  
  spat_enr_names = NULL,  
  cell_annotation_values = NULL,  
  dim_reduction_to_use = "umap",  
  dim_reduction_name = "umap",  
  dim1_to_use = 1,  
  dim2_to_use = 2,  
  sdimx = "sdimx",  
  sdimy = "sdimy",  
  cell_color_gradient = c("blue", "white", "red"),  
  gradient_midpoint = NULL,  
  gradient_limits = NULL,  
  select_cell_groups = NULL,  
  select_cells = NULL,  
  dim_point_shape = c("border", "no_border"),  
  dim_point_size = 1,  
  dim_point_alpha = 1,  
  dim_point_border_col = "black",
```

```
dim_point_border_stroke = 0.1,
spat_point_shape = c("border", "no_border", "voronoi"),
spat_point_size = 1,
spat_point_alpha = 1,
spat_point_border_col = "black",
spat_point_border_stroke = 0.1,
dim_show_cluster_center = F,
dim_show_center_label = T,
dim_center_point_size = 4,
dim_center_point_border_col = "black",
dim_center_point_border_stroke = 0.1,
dim_label_size = 4,
dim_label_fontface = "bold",
spat_show_cluster_center = F,
spat_show_center_label = F,
spat_center_point_size = 4,
spat_center_point_border_col = "black",
spat_center_point_border_stroke = 0.1,
spat_label_size = 4,
spat_label_fontface = "bold",
show_NN_network = F,
nn_network_to_use = "sNN",
nn_network_name = "sNN.pca",
dim_edge_alpha = 0.5,
spat_show_network = F,
spatial_network_name = "Delaunay_network",
spat_network_color = "red",
spat_network_alpha = 0.5,
spat_show_grid = F,
spatial_grid_name = "spatial_grid",
spat_grid_color = "green",
show_other_cells = TRUE,
other_cell_color = "grey",
dim_other_point_size = 0.5,
spat_other_point_size = 0.5,
spat_other_cells_alpha = 0.5,
coord_fix_ratio = NULL,
cow_n_col = 2,
cow_rel_h = 1,
cow_rel_w = 1,
cow_align = "h",
show_legend = T,
legend_text = 8,
legend_symbol_size = 1,
dim_background_color = "white",
spat_background_color = "white",
vor_border_color = "white",
vor_max_radius = 200,
vor_alpha = 1,
axis_text = 8,
axis_title = 8,
show_plot = NA,
```

```

    return_plot = NA,
    save_plot = NA,
    save_param = list(),
    default_save_name = "spatDimCellPlot"
)

```

### Arguments

|                                      |  |
|--------------------------------------|--|
| <code>gobject</code>                 | giotto object  |
| <code>show_image</code>              | show a tissue background image   |
| <code>gimage</code>                  | a giotto image   |
| <code>image_name</code>              | name of a giotto image   |
| <code>plot_alignment</code>          | direction to align plot  |
| <code>spat_enr_names</code>          | names of spatial enrichment results to include   |
| <code>cell_annotation_values</code>  | numeric cell annotation columns  |
| <code>dim_reduction_to_use</code>    | dimension reduction to use   |
| <code>dim_reduction_name</code>      | dimension reduction name   |
| <code>dim1_to_use</code>             | dimension to use on x-axis   |
| <code>dim2_to_use</code>             | dimension to use on y-axis   |
| <code>sdimx</code>                   | = spatial dimension to use on x-axis   |
| <code>sdimy</code>                   | = spatial dimension to use on y-axis   |
| <code>cell_color_gradient</code>     | vector with 3 colors for numeric data  |
| <code>gradient_midpoint</code>       | midpoint for color gradient  |
| <code>gradient_limits</code>         | vector with lower and upper limits   |
| <code>select_cell_groups</code>      | select subset of cells/clusters based on <code>cell_color</code> parameter               |
| <code>select_cells</code>            | select subset of cells based on cell IDs   |
| <code>dim_point_shape</code>         | spatial points with border or not ( <code>border</code> or <code>no_border</code> )      |
| <code>dim_point_size</code>          | size of points in dim. reduction space   |
| <code>dim_point_alpha</code>         | transparency of dim. reduction points  |
| <code>dim_point_border_col</code>    | border color of points in dim. reduction space   |
| <code>dim_point_border_stroke</code> | border stroke of points in dim. reduction space  |
| <code>spat_point_shape</code>        | shape of points ( <code>border</code> , <code>no_border</code> or <code>voronoi</code> ) |
| <code>spat_point_size</code>         | size of spatial points   |



```

spat_point_alpha
    transparency of spatial points
spat_point_border_col
    border color of spatial points
spat_point_border_stroke
    border stroke of spatial points
dim_show_cluster_center
    show the center of each cluster
dim_show_center_label
    provide a label for each cluster
dim_center_point_size
    size of the center point
dim_center_point_border_col
    border color of center point
dim_center_point_border_stroke
    stroke size of center point
dim_label_size
    size of the center label
dim_label_fontface
    font of the center label
spat_show_cluster_center
    show the center of each cluster
spat_show_center_label
    provide a label for each cluster
spat_center_point_size
    size of the center point
spat_label_size
    size of the center label
spat_label_fontface
    font of the center label
show_NN_network
    show underlying NN network
nn_network_to_use
    type of NN network to use (kNN vs sNN)
nn_network_name
    name of NN network to use, if show_NN_network = TRUE
dim_edge_alpha
    column to use for alpha of the edges
spat_show_network
    show spatial network
spatial_network_name
    name of spatial network to use
spat_network_color
    color of spatial network
spat_show_grid
    show spatial grid
spatial_grid_name
    name of spatial grid to use
spat_grid_color
    color of spatial grid
show_other_cells
    display not selected cells

```

|                                     |  |
|-------------------------------------|--|
| <code>other_cell_color</code>       | color of not selected cells  |
| <code>dim_other_point_size</code>   | size of not selected dim cells   |
| <code>spat_other_point_size</code>  | size of not selected spat cells  |
| <code>spat_other_cells_alpha</code> | alpha of not selected spat cells   |
| <code>coord_fix_ratio</code>        | ratio for coordinates  |
| <code>cow_n_col</code>              | cowplot param: how many columns  |
| <code>cow_rel_h</code>              | cowplot param: relative height   |
| <code>cow_rel_w</code>              | cowplot param: relative width  |
| <code>cow_align</code>              | cowplot param: how to align  |
| <code>show_legend</code>            | show legend  |
| <code>legend_text</code>            | size of legend text  |
| <code>legend_symbol_size</code>     | size of legend symbols   |
| <code>dim_background_color</code>   | background color of points in dim. reduction space   |
| <code>spat_background_color</code>  | background color of spatial points   |
| <code>vor_border_color</code>       | border color for voronoi plot  |
| <code>vor_max_radius</code>         | maximum radius for voronoi 'cells'   |
| <code>vor_alpha</code>              | transparency of voronoi 'cells'  |
| <code>axis_text</code>              | size of axis text  |
| <code>axis_title</code>             | size of axis title   |
| <code>show_plot</code>              | show plot  |
| <code>return_plot</code>            | return ggplot object   |
| <code>save_plot</code>              | directly save the plot [boolean]   |
| <code>save_param</code>             | list of saving parameters from <a href="#">all_plots_save_function</a>                               |
| <code>default_save_name</code>      | default save name for saving, don't change, change <code>save_name</code> in <code>save_param</code> |

## Details

Description of parameters.

## Value

ggplot

## Examples

```
spatDimCellPlot(gobject)
```

---

|                   |                          |
|-------------------|--------------------------|
| spatDimCellPlot2D | <i>spatDimCellPlot2D</i> |
|-------------------|--------------------------|

---

## Description

Visualize numerical features of cells according to spatial AND dimension reduction coordinates in 2D

## Usage

```
spatDimCellPlot2D(
  gobject,
  show_image = F,
  gimage = NULL,
  image_name = "image",
  plot_alignment = c("vertical", "horizontal"),
  spat_enr_names = NULL,
  cell_annotation_values = NULL,
  dim_reduction_to_use = "umap",
  dim_reduction_name = "umap",
  dim1_to_use = 1,
  dim2_to_use = 2,
  sdinx = "sdinx",
  sdimy = "sdimy",
  cell_color_gradient = c("blue", "white", "red"),
  gradient_midpoint = NULL,
  gradient_limits = NULL,
  select_cell_groups = NULL,
  select_cells = NULL,
  dim_point_shape = c("border", "no_border"),
  dim_point_size = 1,
  dim_point_alpha = 1,
  dim_point_border_col = "black",
  dim_point_border_stroke = 0.1,
  spat_point_shape = c("border", "no_border", "voronoi"),
  spat_point_size = 1,
  spat_point_alpha = 1,
  spat_point_border_col = "black",
  spat_point_border_stroke = 0.1,
  dim_show_cluster_center = F,
  dim_show_center_label = T,
  dim_center_point_size = 4,
  dim_center_point_border_col = "black",
  dim_center_point_border_stroke = 0.1,
  dim_label_size = 4,
  dim_label_fontface = "bold",
  spat_show_cluster_center = F,
  spat_show_center_label = F,
  spat_center_point_size = 4,
  spat_center_point_border_col = "black",
  spat_center_point_border_stroke = 0.1,
```

```

    spat_label_size = 4,
    spat_label_fontface = "bold",
    show_NN_network = F,
    nn_network_to_use = "sNN",
    nn_network_name = "sNN.pca",
    dim_edge_alpha = 0.5,
    spat_show_network = F,
    spatial_network_name = "Delaunay_network",
    spat_network_color = "red",
    spat_network_alpha = 0.5,
    spat_show_grid = F,
    spatial_grid_name = "spatial_grid",
    spat_grid_color = "green",
    show_other_cells = TRUE,
    other_cell_color = "grey",
    dim_other_point_size = 0.5,
    spat_other_point_size = 0.5,
    spat_other_cells_alpha = 0.5,
    show_legend = T,
    legend_text = 8,
    legend_symbol_size = 1,
    dim_background_color = "white",
    spat_background_color = "white",
    vor_border_color = "white",
    vor_max_radius = 200,
    vor_alpha = 1,
    axis_text = 8,
    axis_title = 8,
    coord_fix_ratio = NULL,
    cow_n_col = 2,
    cow_rel_h = 1,
    cow_rel_w = 1,
    cow_align = "h",
    show_plot = NA,
    return_plot = NA,
    save_plot = NA,
    save_param = list(),
    default_save_name = "spatDimCellPlot2D"
)

```

### Arguments

|                                     |  |
|-------------------------------------|--|
| <code>gobject</code>                | giotto object                                  |
| <code>show_image</code>             | show a tissue background image                 |
| <code>gimage</code>                 | a giotto image                                 |
| <code>image_name</code>             | name of a giotto image                         |
| <code>plot_alignment</code>         | direction to align plot                        |
| <code>spat_enr_names</code>         | names of spatial enrichment results to include |
| <code>cell_annotation_values</code> | numeric cell annotation columns                |
| <code>dim_reduction_to_use</code>   | dimension reduction to use                     |

|                                |   |
|--------------------------------|---|
| dim_reduction_name             | dimension reduction name                                      |
| dim1_to_use                    | dimension to use on x-axis                                    |
| dim2_to_use                    | dimension to use on y-axis                                    |
| sdimx                          | = spatial dimension to use on x-axis                          |
| sdimy                          | = spatial dimension to use on y-axis                          |
| cell_color_gradient            | vector with 3 colors for numeric data                         |
| gradient_midpoint              | midpoint for color gradient                                   |
| gradient_limits                | vector with lower and upper limits                            |
| select_cell_groups             | select subset of cells/clusters based on cell_color parameter |
| select_cells                   | select subset of cells based on cell IDs                      |
| dim_point_shape                | dim reduction points with border or not (border or no_border) |
| dim_point_size                 | size of points in dim. reduction space                        |
| dim_point_alpha                | transparency of dim. reduction points                         |
| dim_point_border_col           | border color of points in dim. reduction space                |
| dim_point_border_stroke        | border stroke of points in dim. reduction space               |
| spat_point_shape               | shape of points (border, no_border or voronoi)                |
| spat_point_size                | size of spatial points  |
| spat_point_alpha               | transparency of spatial points                                |
| spat_point_border_col          | border color of spatial points                                |
| spat_point_border_stroke       | border stroke of spatial points                               |
| dim_show_cluster_center        | show the center of each cluster                               |
| dim_show_center_label          | provide a label for each cluster                              |
| dim_center_point_size          | size of the center point                                      |
| dim_center_point_border_col    | border color of center point                                  |
| dim_center_point_border_stroke | stroke size of center point                                   |
| dim_label_size                 | size of the center label                                      |
| dim_label_fontface             | font of the center label                                      |

```

spat_show_cluster_center
    show the center of each cluster
spat_show_center_label
    provide a label for each cluster
spat_center_point_size
    size of the center point
spat_label_size
    size of the center label
spat_label_fontface
    font of the center label
show_NN_network
    show underlying NN network
nn_network_to_use
    type of NN network to use (kNN vs sNN)
nn_network_name
    name of NN network to use, if show_NN_network = TRUE
dim_edge_alpha
    column to use for alpha of the edges
spat_show_network
    show spatial network
spatial_network_name
    name of spatial network to use
spat_network_color
    color of spatial network
spat_show_grid
    show spatial grid
spatial_grid_name
    name of spatial grid to use
spat_grid_color
    color of spatial grid
show_other_cells
    display not selected cells
other_cell_color
    color of not selected cells
dim_other_point_size
    size of not selected dim cells
spat_other_point_size
    size of not selected spat cells
spat_other_cells_alpha
    alpha of not selected spat cells
show_legend
    show legend
legend_text
    size of legend text
legend_symbol_size
    size of legend symbols
dim_background_color
    background color of points in dim. reduction space
spat_background_color
    background color of spatial points
vor_border_color
    border color for voronoi plot

```

|                   |  |
|-------------------|--|
| vor_max_radius    | maximum radius for voronoi 'cells'   |
| vor_alpha         | transparency of voronoi 'cells'  |
| axis_text         | size of axis text  |
| axis_title        | size of axis title   |
| coord_fix_ratio   | ratio for coordinates  |
| cow_n_col         | cowplot param: how many columns  |
| cow_rel_h         | cowplot param: relative height   |
| cow_rel_w         | cowplot param: relative width  |
| cow_align         | cowplot param: how to align  |
| show_plot         | show plot  |
| return_plot       | return ggplot object   |
| save_plot         | directly save the plot [boolean]   |
| save_param        | list of saving parameters from <a href="#">all_plots_save_function</a>     |
| default_save_name | default save name for saving, don't change, change save_name in save_param |

## Details

Description of parameters.

## Value

ggplot

## Examples

```
spatDimCellPlot2D(gobject)
```

---

|                 |                        |
|-----------------|------------------------|
| spatDimGenePlot | <i>spatDimGenePlot</i> |
|-----------------|------------------------|

---

## Description

Visualize cells according to spatial AND dimension reduction coordinates in ggplot mode

## Usage

```
spatDimGenePlot(
  gobject,
  show_image = F,
  gimage = NULL,
  image_name = "image",
  expression_values = c("normalized", "scaled", "custom"),
  plot_alignment = c("vertical", "horizontal"),
  genes,
  dim_reduction_to_use = "umap",
  dim_reduction_name = "umap",
```

```

dim1_to_use = 1,
dim2_to_use = 2,
dim_point_shape = c("border", "no_border"),
dim_point_size = 1,
dim_point_alpha = 1,
dim_point_border_col = "black",
dim_point_border_stroke = 0.1,
show_NN_network = F,
show_spatial_network = F,
show_spatial_grid = F,
nn_network_to_use = "sNN",
network_name = "sNN.pca",
edge_alpha_dim = NULL,
scale_alpha_with_expression = FALSE,
sdmx = "sdmx",
sdmy = "sdmy",
spatial_network_name = "Delaunay_network",
spatial_grid_name = "spatial_grid",
spat_point_shape = c("border", "no_border", "voronoi"),
spat_point_size = 1,
spat_point_alpha = 1,
spat_point_border_col = "black",
spat_point_border_stroke = 0.1,
cell_color_gradient = c("blue", "white", "red"),
gradient_midpoint = NULL,
gradient_limits = NULL,
show_legend = T,
legend_text = 8,
dim_background_color = "white",
spat_background_color = "white",
vor_border_color = "white",
vor_max_radius = 200,
vor_alpha = 1,
axis_text = 8,
axis_title = 8,
cow_n_col = 2,
cow_rel_h = 1,
cow_rel_w = 1,
cow_align = "h",
show_plot = NA,
return_plot = NA,
save_plot = NA,
save_param = list(),
default_save_name = "spatDimGenePlot"
)

```

### Arguments

|                         |                                |
|-------------------------|--------------------------------|
| <code>gobject</code>    | giotto object                  |
| <code>show_image</code> | show a tissue background image |
| <code>gimage</code>     | a giotto image                 |
| <code>image_name</code> | name of a giotto image         |



expression\_values      gene expression values to use  
 plot\_alignment      direction to align plot  
 genes      genes to show  
 dim\_reduction\_to\_use      dimension reduction to use  
 dim\_reduction\_name      dimension reduction name  
 dim1\_to\_use      dimension to use on x-axis  
 dim2\_to\_use      dimension to use on y-axis  
 dim\_point\_shape      dim reduction points with border or not (border or no\_border)  
 dim\_point\_size      dim reduction plot: point size  
 dim\_point\_alpha      transparency of dim. reduction points  
 dim\_point\_border\_col      color of border around points  
 dim\_point\_border\_stroke      stroke size of border around points  
 show\_NN\_network      show underlying NN network  
 nn\_network\_to\_use      type of NN network to use (kNN vs sNN)  
 network\_name      name of NN network to use, if show\_NN\_network = TRUE  
 edge\_alpha\_dim      dim reduction plot: column to use for alpha of the edges  
 scale\_alpha\_with\_expression      scale expression with ggplot alpha parameter  
 sdimx      spatial x-axis dimension name (default = 'sdimx')  
 sdimy      spatial y-axis dimension name (default = 'sdimy')  
 spatial\_network\_name      name of spatial network to use  
 spatial\_grid\_name      name of spatial grid to use  
 spat\_point\_shape      spatial points with border or not (border or no\_border)  
 spat\_point\_size      spatial plot: point size  
 spat\_point\_alpha      transparency of spatial points  
 spat\_point\_border\_col      color of border around points  
 spat\_point\_border\_stroke      stroke size of border around points  
 cell\_color\_gradient      vector with 3 colors for numeric data  
 gradient\_midpoint      midpoint for color gradient

|                       |  |
|-----------------------|--|
| gradient_limits       | vector with lower and upper limits   |
| show_legend           | show legend  |
| legend_text           | size of legend text  |
| dim_background_color  | color of plot background for dimension plot                                |
| spat_background_color | color of plot background for spatial plot                                  |
| vor_border_color      | border color for voronoi plot  |
| vor_max_radius        | maximum radius for voronoi 'cells'   |
| vor_alpha             | transparency of voronoi 'cells'  |
| axis_text             | size of axis text  |
| axis_title            | size of axis title   |
| cow_n_col             | cowplot param: how many columns  |
| cow_rel_h             | cowplot param: relative height   |
| cow_rel_w             | cowplot param: relative width  |
| cow_align             | cowplot param: how to align  |
| show_plot             | show plots   |
| return_plot           | return ggplot object   |
| save_plot             | directly save the plot [boolean]   |
| save_param            | list of saving parameters from <a href="#">all_plots_save_function</a>     |
| default_save_name     | default save name for saving, don't change, change save_name in save_param |

## Details

Description of parameters.

## Value

ggplot

## See Also

[spatDimGenePlot3D](#)

## Examples

```
spatDimGenePlot(gobject)
```

---

|                   |                          |
|-------------------|--------------------------|
| spatDimGenePlot2D | <i>spatDimGenePlot2D</i> |
|-------------------|--------------------------|

---

## Description

Visualize cells according to spatial AND dimension reduction coordinates in ggplot mode

## Usage

```
spatDimGenePlot2D(
  gobject,
  show_image = F,
  gimage = NULL,
  image_name = "image",
  expression_values = c("normalized", "scaled", "custom"),
  plot_alignment = c("vertical", "horizontal"),
  genes,
  dim_reduction_to_use = "umap",
  dim_reduction_name = "umap",
  dim1_to_use = 1,
  dim2_to_use = 2,
  dim_point_shape = c("border", "no_border"),
  dim_point_size = 1,
  dim_point_alpha = 1,
  dim_point_border_col = "black",
  dim_point_border_stroke = 0.1,
  show_NN_network = F,
  show_spatial_network = F,
  show_spatial_grid = F,
  nn_network_to_use = "sNN",
  network_name = "sNN.pca",
  edge_alpha_dim = NULL,
  scale_alpha_with_expression = FALSE,
  sdimx = "sdimx",
  sdimy = "sdimy",
  spatial_network_name = "Delaunay_network",
  spatial_grid_name = "spatial_grid",
  spat_point_shape = c("border", "no_border", "voronoi"),
  spat_point_size = 1,
  spat_point_alpha = 1,
  spat_point_border_col = "black",
  spat_point_border_stroke = 0.1,
  cell_color_gradient = c("blue", "white", "red"),
  gradient_midpoint = NULL,
  gradient_limits = NULL,
  cow_n_col = 2,
  cow_rel_h = 1,
  cow_rel_w = 1,
  cow_align = "h",
  show_legend = T,
  legend_text = 8,
```

```

dim_background_color = "white",
spat_background_color = "white",
vor_border_color = "white",
vor_max_radius = 200,
vor_alpha = 1,
axis_text = 8,
axis_title = 8,
show_plot = NA,
return_plot = NA,
save_plot = NA,
save_param = list(),
default_save_name = "spatDimGenePlot2D"
)

```

### Arguments

|  |   |
|--|---|
| <code>gobject</code>                     | giotto object   |
| <code>show_image</code>                  | show a tissue background image                                    |
| <code>gimage</code>                      | a giotto image  |
| <code>image_name</code>                  | name of a giotto image  |
| <code>expression_values</code>           | gene expression values to use                                     |
| <code>plot_alignment</code>              | direction to align plot   |
| <code>genes</code>                       | genes to show   |
| <code>dim_reduction_to_use</code>        | dimension reduction to use  |
| <code>dim_reduction_name</code>          | dimension reduction name  |
| <code>dim1_to_use</code>                 | dimension to use on x-axis  |
| <code>dim2_to_use</code>                 | dimension to use on y-axis  |
| <code>dim_point_shape</code>             | dim reduction points with border or not (border or no_border)     |
| <code>dim_point_size</code>              | dim reduction plot: point size                                    |
| <code>dim_point_alpha</code>             | transparency of dim. reduction points                             |
| <code>dim_point_border_col</code>        | color of border around points                                     |
| <code>dim_point_border_stroke</code>     | stroke size of border around points                               |
| <code>show_NN_network</code>             | show underlying NN network  |
| <code>nn_network_to_use</code>           | type of NN network to use (kNN vs sNN)                            |
| <code>network_name</code>                | name of NN network to use, if <code>show_NN_network = TRUE</code> |
| <code>edge_alpha_dim</code>              | dim reduction plot: column to use for alpha of the edges          |
| <code>scale_alpha_with_expression</code> | scale expression with ggplot alpha parameter                      |

|                          |  |
|--------------------------|--|
| sdimx                    | spatial x-axis dimension name (default = 'sdimx')                          |
| sdimy                    | spatial y-axis dimension name (default = 'sdimy')                          |
| spatial_network_name     | name of spatial network to use   |
| spatial_grid_name        | name of spatial grid to use  |
| spat_point_shape         | spatial points with border or not (border or no_border)                    |
| spat_point_size          | spatial plot: point size   |
| spat_point_alpha         | transparancy of spatial points   |
| spat_point_border_col    | color of border around points  |
| spat_point_border_stroke | stroke size of border around points  |
| cell_color_gradient      | vector with 3 colors for numeric data                                      |
| gradient_midpoint        | midpoint for color gradient  |
| gradient_limits          | vector with lower and upper limits   |
| cow_n_col                | cowplot param: how many columns  |
| cow_rel_h                | cowplot param: relative height   |
| cow_rel_w                | cowplot param: relative width  |
| cow_align                | cowplot param: how to align  |
| show_legend              | show legend  |
| legend_text              | size of legend text  |
| dim_background_color     | color of plot background for dimension plot                                |
| spat_background_color    | color of plot background for spatial plot                                  |
| vor_border_color         | border color for voronoi plot  |
| vor_max_radius           | maximum radius for voronoi 'cells'   |
| vor_alpha                | transparancy of voronoi 'cells'  |
| axis_text                | size of axis text  |
| axis_title               | size of axis title   |
| show_plot                | show plots   |
| return_plot              | return ggplot object   |
| save_plot                | directly save the plot [boolean]   |
| save_param               | list of saving parameters from <a href="#">all_plots_save_function</a>     |
| default_save_name        | default save name for saving, don't change, change save_name in save_param |

**Details**

Description of parameters.

**Value**

ggplot

**See Also**

[spatDimGenePlot3D](#)

**Examples**

```
spatDimGenePlot2D(gobject)
```

---

|                   |                          |
|-------------------|--------------------------|
| spatDimGenePlot3D | <i>spatDimGenePlot3D</i> |
|-------------------|--------------------------|

---

**Description**

Visualize cells according to spatial AND dimension reduction coordinates in ggplot mode

**Usage**

```
spatDimGenePlot3D(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  plot_alignment = c("horizontal", "vertical"),
  dim_reduction_to_use = "umap",
  dim_reduction_name = "umap",
  dim1_to_use = 1,
  dim2_to_use = 2,
  dim3_to_use = NULL,
  sdimx = "sdimx",
  sdimy = "sdimy",
  sdimz = "sdimz",
  genes,
  cluster_column = NULL,
  select_cell_groups = NULL,
  select_cells = NULL,
  show_other_cells = T,
  other_cell_color = "lightgrey",
  other_point_size = 1.5,
  show_NN_network = F,
  nn_network_to_use = "sNN",
  network_name = "sNN.pca",
  label_size = 16,
  genes_low_color = "blue",
  genes_mid_color = "white",
  genes_high_color = "red",
  dim_point_size = 3,
```

```

nn_network_alpha = 0.5,
show_spatial_network = F,
spatial_network_name = "Delaunay_network",
network_color = "lightgray",
spatial_network_alpha = 0.5,
show_spatial_grid = F,
spatial_grid_name = "spatial_grid",
spatial_grid_color = NULL,
spatial_grid_alpha = 0.5,
spatial_point_size = 3,
legend_text_size = 12,
axis_scale = c("cube", "real", "custom"),
custom_ratio = NULL,
x_ticks = NULL,
y_ticks = NULL,
z_ticks = NULL,
show_plot = NA,
return_plot = NA,
save_plot = NA,
save_param = list(),
default_save_name = "spatDimGenePlot3D"
)

```

### Arguments

|                                   |   |
|-----------------------------------|---|
| <code>gobject</code>              | giotto object   |
| <code>expression_values</code>    | gene expression values to use                                     |
| <code>plot_alignment</code>       | direction to align plot   |
| <code>dim_reduction_to_use</code> | dimension reduction to use  |
| <code>dim_reduction_name</code>   | dimension reduction name  |
| <code>dim1_to_use</code>          | dimension to use on x-axis  |
| <code>dim2_to_use</code>          | dimension to use on y-axis  |
| <code>dim3_to_use</code>          | dimension to use on z-axis  |
| <code>genes</code>                | genes to show   |
| <code>show_NN_network</code>      | show underlying NN network  |
| <code>nn_network_to_use</code>    | type of NN network to use (kNN vs sNN)                            |
| <code>network_name</code>         | name of NN network to use, if <code>show_NN_network = TRUE</code> |
| <code>dim_point_size</code>       | dim reduction plot: point size                                    |
| <code>spatial_network_name</code> | name of spatial network to use                                    |
| <code>spatial_grid_name</code>    | name of spatial grid to use                                       |
| <code>spatial_point_size</code>   | spatial plot: point size  |

|                             |  |
|-----------------------------|--|
| show_plot                   | show plots   |
| return_plot                 | return plotly object   |
| save_plot                   | directly save the plot [boolean]   |
| save_param                  | list of saving parameters from <a href="#">all_plots_save_function</a>     |
| default_save_name           | default save name for saving, don't change, change save_name in save_param |
| edge_alpha_dim              | dim reduction plot: column to use for alpha of the edges                   |
| scale_alpha_with_expression | scale expression with ggplot alpha parameter                               |
| point_size                  | size of point (cell)   |
| show_legend                 | show legend  |

Details

Description of parameters.

Value

plotly

Examples

```
spatDimGenePlot3D(gobject)
```

---

|             |                    |
|-------------|--------------------|
| spatDimPlot | <i>spatDimPlot</i> |
|-------------|--------------------|

---

Description

Visualize cells according to spatial AND dimension reduction coordinates 2D

Usage

```
spatDimPlot(  
  gobject,  
  show_image = F,  
  gimage = NULL,  
  image_name = "image",  
  plot_alignment = c("vertical", "horizontal"),  
  dim_reduction_to_use = "umap",  
  dim_reduction_name = "umap",  
  dim1_to_use = 1,  
  dim2_to_use = 2,  
  sdimx = "sdimx",  
  sdimy = "sdimy",  
  spat_enr_names = NULL,  
  cell_color = NULL,  
  color_as_factor = T,  
  cell_color_code = NULL,
```



```
cell_color_gradient = c("blue", "white", "red"),
gradient_midpoint = NULL,
gradient_limits = NULL,
select_cell_groups = NULL,
select_cells = NULL,
dim_point_shape = c("border", "no_border"),
dim_point_size = 1,
dim_point_alpha = 1,
dim_point_border_col = "black",
dim_point_border_stroke = 0.1,
spat_point_shape = c("border", "no_border", "voronoi"),
spat_point_size = 1,
spat_point_alpha = 1,
spat_point_border_col = "black",
spat_point_border_stroke = 0.1,
dim_show_cluster_center = F,
dim_show_center_label = T,
dim_center_point_size = 4,
dim_center_point_border_col = "black",
dim_center_point_border_stroke = 0.1,
dim_label_size = 4,
dim_label_fontface = "bold",
spat_show_cluster_center = F,
spat_show_center_label = F,
spat_center_point_size = 4,
spat_label_size = 4,
spat_label_fontface = "bold",
show_NN_network = F,
nn_network_to_use = "sNN",
network_name = "sNN.pca",
nn_network_alpha = 0.05,
show_spatial_network = F,
spat_network_name = NULL,
spat_network_color = "blue",
spat_network_alpha = 0.5,
show_spatial_grid = F,
spat_grid_name = "spatial_grid",
spat_grid_color = "blue",
show_other_cells = T,
other_cell_color = "lightgrey",
dim_other_point_size = 1,
spat_other_point_size = 1,
spat_other_cells_alpha = 0.5,
dim_show_legend = F,
spat_show_legend = F,
legend_text = 8,
legend_symbol_size = 1,
dim_background_color = "white",
spat_background_color = "white",
vor_border_color = "white",
vor_max_radius = 200,
vor_alpha = 1,
```

```

axis_text = 8,
axis_title = 8,
show_plot = NA,
return_plot = NA,
save_plot = NA,
save_param = list(),
default_save_name = "spatDimPlot"
)

```

### Arguments

|                                      |  |
|--------------------------------------|--|
| <code>gobject</code>                 | giotto object  |
| <code>show_image</code>              | show a tissue background image   |
| <code>gimage</code>                  | a giotto image   |
| <code>image_name</code>              | name of a giotto image   |
| <code>plot_alignment</code>          | direction to align plot  |
| <code>dim_reduction_to_use</code>    | dimension reduction to use   |
| <code>dim_reduction_name</code>      | dimension reduction name   |
| <code>dim1_to_use</code>             | dimension to use on x-axis   |
| <code>dim2_to_use</code>             | dimension to use on y-axis   |
| <code>sdimx</code>                   | = spatial dimension to use on x-axis                                       |
| <code>sdimy</code>                   | = spatial dimension to use on y-axis                                       |
| <code>spat_enr_names</code>          | names of spatial enrichment results to include                             |
| <code>cell_color</code>              | color for cells (see details)  |
| <code>color_as_factor</code>         | convert color column to factor   |
| <code>cell_color_code</code>         | named vector with colors   |
| <code>cell_color_gradient</code>     | vector with 3 colors for numeric data                                      |
| <code>gradient_midpoint</code>       | midpoint for color gradient  |
| <code>gradient_limits</code>         | vector with lower and upper limits   |
| <code>select_cell_groups</code>      | select subset of cells/clusters based on <code>cell_color</code> parameter |
| <code>select_cells</code>            | select subset of cells based on cell IDs                                   |
| <code>dim_point_shape</code>         | point with border or not ( <code>border</code> or <code>no_border</code> ) |
| <code>dim_point_size</code>          | size of points in dim. reduction space                                     |
| <code>dim_point_alpha</code>         | transparency of point in dim. reduction space                              |
| <code>dim_point_border_col</code>    | border color of points in dim. reduction space                             |
| <code>dim_point_border_stroke</code> | border stroke of points in dim. reduction space                            |

```

spat_point_shape
    shape of points (border, no_border or voronoi)
spat_point_size
    size of spatial points
spat_point_alpha
    transparency of spatial points
spat_point_border_col
    border color of spatial points
spat_point_border_stroke
    border stroke of spatial points
dim_show_cluster_center
    show the center of each cluster
dim_show_center_label
    provide a label for each cluster
dim_center_point_size
    size of the center point
dim_center_point_border_col
    border color of center point
dim_center_point_border_stroke
    stroke size of center point
dim_label_size size of the center label
dim_label_fontface
    font of the center label
spat_show_cluster_center
    show the center of each cluster
spat_show_center_label
    provide a label for each cluster
spat_center_point_size
    size of the center point
spat_label_size
    size of the center label
spat_label_fontface
    font of the center label
show_NN_network
    show underlying NN network
nn_network_to_use
    type of NN network to use (kNN vs sNN)
network_name name of NN network to use, if show_NN_network = TRUE
nn_network_alpha
    column to use for alpha of the edges
show_spatial_network
    show spatial network
spat_network_name
    name of spatial network to use
spat_network_color
    color of spatial network
show_spatial_grid
    show spatial grid

```

|                        |  |
|------------------------|--|
| spat_grid_name         | name of spatial grid to use  |
| spat_grid_color        | color of spatial grid  |
| show_other_cells       | display not selected cells   |
| other_cell_color       | color of not selected cells  |
| dim_other_point_size   | size of not selected dim cells   |
| spat_other_point_size  | size of not selected spat cells  |
| spat_other_cells_alpha | alpha of not selected spat cells   |
| dim_show_legend        | show legend of dimension reduction plot                                    |
| spat_show_legend       | show legend of spatial plot  |
| legend_text            | size of legend text  |
| legend_symbol_size     | size of legend symbols   |
| dim_background_color   | background color of points in dim. reduction space                         |
| spat_background_color  | background color of spatial points   |
| vor_border_color       | border color for voronoi plot  |
| vor_max_radius         | maximum radius for voronoi 'cells'   |
| vor_alpha              | transparency of voronoi 'cells'  |
| axis_text              | size of axis text  |
| axis_title             | size of axis title   |
| show_plot              | show plot  |
| return_plot            | return ggplot object   |
| save_plot              | directly save the plot [boolean]   |
| save_param             | list of saving parameters from <a href="#">all_plots_save_function</a>     |
| default_save_name      | default save name for saving, don't change, change save_name in save_param |

## Details

Description of parameters.

## Value

ggplot

## See Also

[spatDimPlot2D](#) and [spatDimPlot3D](#) for 3D visualization.

## Examples

```
spatDimPlot(gobject)
```

---

spatDimPlot2D

*spatDimPlot2D*


---

## Description

Visualize cells according to spatial AND dimension reduction coordinates 2D

## Usage

```
spatDimPlot2D(
  gobject,
  show_image = F,
  gimage = NULL,
  image_name = "image",
  plot_alignment = c("vertical", "horizontal"),
  dim_reduction_to_use = "umap",
  dim_reduction_name = "umap",
  dim1_to_use = 1,
  dim2_to_use = 2,
  sdimx = "sdimx",
  sdimy = "sdimy",
  spat_enr_names = NULL,
  cell_color = NULL,
  color_as_factor = T,
  cell_color_code = NULL,
  cell_color_gradient = c("blue", "white", "red"),
  gradient_midpoint = NULL,
  gradient_limits = NULL,
  select_cell_groups = NULL,
  select_cells = NULL,
  dim_point_shape = c("border", "no_border"),
  dim_point_size = 1,
  dim_point_alpha = 1,
  dim_point_border_col = "black",
  dim_point_border_stroke = 0.1,
  spat_point_shape = c("border", "no_border", "voronoi"),
  spat_point_size = 1,
  spat_point_alpha = 1,
  spat_point_border_col = "black",
  spat_point_border_stroke = 0.1,
  dim_show_cluster_center = F,
  dim_show_center_label = T,
  dim_center_point_size = 4,
  dim_center_point_border_col = "black",
  dim_center_point_border_stroke = 0.1,
  dim_label_size = 4,
  dim_label_fontface = "bold",
```

```

    spat_show_cluster_center = F,
    spat_show_center_label = F,
    spat_center_point_size = 4,
    spat_label_size = 4,
    spat_label_fontface = "bold",
    show_NN_network = F,
    nn_network_to_use = "sNN",
    network_name = "sNN.pca",
    nn_network_alpha = 0.05,
    show_spatial_network = F,
    spat_network_name = NULL,
    spat_network_color = "blue",
    spat_network_alpha = 0.5,
    show_spatial_grid = F,
    spat_grid_name = "spatial_grid",
    spat_grid_color = "blue",
    show_other_cells = T,
    other_cell_color = "lightgrey",
    dim_other_point_size = 1,
    spat_other_point_size = 1,
    spat_other_cells_alpha = 0.5,
    dim_show_legend = F,
    spat_show_legend = F,
    legend_text = 8,
    legend_symbol_size = 1,
    dim_background_color = "white",
    spat_background_color = "white",
    vor_border_color = "white",
    vor_max_radius = 200,
    vor_alpha = 1,
    axis_text = 8,
    axis_title = 8,
    show_plot = NA,
    return_plot = NA,
    save_plot = NA,
    save_param = list(),
    default_save_name = "spatDimPlot2D"
)

```

### Arguments

|                                   |                                |
|-----------------------------------|--------------------------------|
| <code>gobject</code>              | giotto object                  |
| <code>show_image</code>           | show a tissue background image |
| <code>gimage</code>               | a giotto image                 |
| <code>image_name</code>           | name of a giotto image         |
| <code>plot_alignment</code>       | direction to align plot        |
| <code>dim_reduction_to_use</code> | dimension reduction to use     |
| <code>dim_reduction_name</code>   | dimension reduction name       |
| <code>dim1_to_use</code>          | dimension to use on x-axis     |

|                                |   |
|--------------------------------|---|
| dim2_to_use                    | dimension to use on y-axis                                    |
| sdimx                          | = spatial dimension to use on x-axis                          |
| sdimy                          | = spatial dimension to use on y-axis                          |
| spat_enr_names                 | names of spatial enrichment results to include                |
| cell_color                     | color for cells (see details)                                 |
| color_as_factor                | convert color column to factor                                |
| cell_color_code                | named vector with colors                                      |
| cell_color_gradient            | vector with 3 colors for numeric data                         |
| gradient_midpoint              | midpoint for color gradient                                   |
| gradient_limits                | vector with lower and upper limits                            |
| select_cell_groups             | select subset of cells/clusters based on cell_color parameter |
| select_cells                   | select subset of cells based on cell IDs                      |
| dim_point_shape                | point with border or not (border or no_border)                |
| dim_point_size                 | size of points in dim. reduction space                        |
| dim_point_alpha                | transparency of point in dim. reduction space                 |
| dim_point_border_col           | border color of points in dim. reduction space                |
| dim_point_border_stroke        | border stroke of points in dim. reduction space               |
| spat_point_shape               | shape of points (border, no_border or voronoi)                |
| spat_point_size                | size of spatial points  |
| spat_point_alpha               | transparency of spatial points                                |
| spat_point_border_col          | border color of spatial points                                |
| spat_point_border_stroke       | border stroke of spatial points                               |
| dim_show_cluster_center        | show the center of each cluster                               |
| dim_show_center_label          | provide a label for each cluster                              |
| dim_center_point_size          | size of the center point                                      |
| dim_center_point_border_col    | border color of center point                                  |
| dim_center_point_border_stroke | stroke size of center point                                   |

```

dim_label_size  size of the center label
dim_label_fontface
                font of the center label
spat_show_cluster_center
                show the center of each cluster
spat_show_center_label
                provide a label for each cluster
spat_center_point_size
                size of the center point
spat_label_size
                size of the center label
spat_label_fontface
                font of the center label
show_NN_network
                show underlying NN network
nn_network_to_use
                type of NN network to use (kNN vs sNN)
network_name    name of NN network to use, if show_NN_network = TRUE
nn_network_alpha
                column to use for alpha of the edges
show_spatial_network
                show spatial network
spat_network_name
                name of spatial network to use
spat_network_color
                color of spatial network
show_spatial_grid
                show spatial grid
spat_grid_name  name of spatial grid to use
spat_grid_color
                color of spatial grid
show_other_cells
                display not selected cells
other_cell_color
                color of not selected cells
dim_other_point_size
                size of not selected dim cells
spat_other_point_size
                size of not selected spat cells
spat_other_cells_alpha
                alpha of not selected spat cells
dim_show_legend
                show legend of dimension reduction plot
spat_show_legend
                show legend of spatial plot
legend_text     size of legend text
legend_symbol_size
                size of legend symbols

```



|                       |  |
|-----------------------|--|
| dim_background_color  | background color of points in dim. reduction space                         |
| spat_background_color | background color of spatial points   |
| vor_border_color      | border color for voronoi plot  |
| vor_max_radius        | maximum radius for voronoi 'cells'   |
| vor_alpha             | transparency of voronoi 'cells'  |
| axis_text             | size of axis text  |
| axis_title            | size of axis title   |
| show_plot             | show plot  |
| return_plot           | return ggplot object   |
| save_plot             | directly save the plot [boolean]   |
| save_param            | list of saving parameters from <a href="#">all_plots_save_function</a>     |
| default_save_name     | default save name for saving, don't change, change save_name in save_param |

## Details

Description of parameters.

## Value

ggplot

## See Also

[spatDimPlot3D](#)

## Examples

```
spatDimPlot2D(gobject)
```

---

|               |                      |
|---------------|----------------------|
| spatDimPlot3D | <i>spatDimPlot3D</i> |
|---------------|----------------------|

---

## Description

Visualize cells according to spatial AND dimension reduction coordinates in plotly mode

## Usage

```
spatDimPlot3D(
  gobject,
  plot_alignment = c("horizontal", "vertical"),
  dim_reduction_to_use = "umap",
  dim_reduction_name = "umap",
  dim1_to_use = 1,
  dim2_to_use = 2,
```

```

dim3_to_use = 3,
sdimx = "sdimx",
sdimy = "sdimy",
sdimz = "sdimz",
show_NN_network = F,
nn_network_to_use = "sNN",
network_name = "sNN.pca",
show_cluster_center = F,
show_center_label = T,
center_point_size = 4,
label_size = 16,
select_cell_groups = NULL,
select_cells = NULL,
show_other_cells = T,
other_cell_color = "lightgrey",
other_point_size = 1.5,
cell_color = NULL,
color_as_factor = T,
cell_color_code = NULL,
dim_point_size = 3,
nn_network_alpha = 0.5,
show_spatial_network = F,
spatial_network_name = "Delaunay_network",
network_color = "lightgray",
spatial_network_alpha = 0.5,
show_spatial_grid = F,
spatial_grid_name = "spatial_grid",
spatial_grid_color = NULL,
spatial_grid_alpha = 0.5,
spatial_point_size = 3,
axis_scale = c("cube", "real", "custom"),
custom_ratio = NULL,
x_ticks = NULL,
y_ticks = NULL,
z_ticks = NULL,
legend_text_size = 12,
show_plot = NA,
return_plot = NA,
save_plot = NA,
save_param = list(),
default_save_name = "spatDimPlot3D"
)

```

### Arguments

|                                   |                            |
|-----------------------------------|----------------------------|
| <code>gobject</code>              | giotto object              |
| <code>plot_alignment</code>       | direction to align plot    |
| <code>dim_reduction_to_use</code> | dimension reduction to use |
| <code>dim_reduction_name</code>   | dimension reduction name   |
| <code>dim1_to_use</code>          | dimension to use on x-axis |

|                       |   |
|-----------------------|---|
| dim2_to_use           | dimension to use on y-axis                                    |
| dim3_to_use           | dimension to use on z-axis                                    |
| sdimx                 | = spatial dimension to use on x-axis                          |
| sdimy                 | = spatial dimension to use on y-axis                          |
| sdimz                 | = spatial dimension to use on z-axis                          |
| show_NN_network       | show underlying NN network                                    |
| nn_network_to_use     | type of NN network to use (kNN vs sNN)                        |
| network_name          | name of NN network to use, if show_NN_network = TRUE          |
| show_cluster_center   | show the center of each cluster                               |
| show_center_label     | provide a label for each cluster                              |
| center_point_size     | size of the center point                                      |
| label_size            | size of the center label                                      |
| select_cell_groups    | select subset of cells/clusters based on cell_color parameter |
| select_cells          | select subset of cells based on cell IDs                      |
| show_other_cells      | display not selected cells                                    |
| other_cell_color      | color of not selected cells                                   |
| other_point_size      | size of not selected cells                                    |
| cell_color            | color for cells (see details)                                 |
| color_as_factor       | convert color column to factor                                |
| cell_color_code       | named vector with colors                                      |
| dim_point_size        | size of points in dim. reduction space                        |
| nn_network_alpha      | column to use for alpha of the edges                          |
| show_spatial_network  | show spatial network  |
| spatial_network_name  | name of spatial network to use                                |
| spatial_network_alpha | alpha of spatial network                                      |
| show_spatial_grid     | show spatial grid   |
| spatial_grid_name     | name of spatial grid to use                                   |
| spatial_grid_color    | color of spatial grid   |

|                           |  |
|---------------------------|--|
| spatial_point_size        | size of spatial points   |
| show_plot                 | show plot  |
| return_plot               | return ggplot object   |
| save_plot                 | directly save the plot [boolean]   |
| save_param                | list of saving parameters from <a href="#">all_plots_save_function</a>     |
| default_save_name         | default save name for saving, don't change, change save_name in save_param |
| dim_point_border_col      | border color of points in dim. reduction space                             |
| dim_point_border_stroke   | border stroke of points in dim. reduction space                            |
| spatial_network_color     | color of spatial network   |
| spatial_other_point_size  | size of not selected spatial points  |
| spatial_other_cells_alpha | alpha of not selected spatial points                                       |
| dim_other_point_size      | size of not selected dim. reduction points                                 |
| show_legend               | show legend  |

### Details

Description of parameters.

### Value

plotly

### Examples

```
spatDimPlot3D(gobject)
```

---

spatGenePlot

*spatGenePlot*


---

### Description

Visualize cells and gene expression according to spatial coordinates

**Usage**

```

spatGenePlot(
  gobject,
  show_image = F,
  gimage = NULL,
  image_name = "image",
  sdimx = "sdimx",
  sdimy = "sdimy",
  expression_values = c("normalized", "scaled", "custom"),
  genes,
  cell_color_gradient = c("blue", "white", "red"),
  gradient_midpoint = NULL,
  gradient_limits = NULL,
  show_network = F,
  network_color = NULL,
  spatial_network_name = NULL,
  edge_alpha = NULL,
  show_grid = F,
  grid_color = NULL,
  spatial_grid_name = "spatial_grid",
  midpoint = 0,
  scale_alpha_with_expression = FALSE,
  point_shape = c("border", "no_border", "voronoi"),
  point_size = 1,
  point_alpha = 1,
  point_border_col = "black",
  point_border_stroke = 0.1,
  show_legend = T,
  legend_text = 8,
  background_color = "white",
  vor_border_color = "white",
  vor_max_radius = 200,
  vor_alpha = 1,
  axis_text = 8,
  axis_title = 8,
  cow_n_col = 2,
  cow_rel_h = 1,
  cow_rel_w = 1,
  cow_align = "h",
  show_plot = NA,
  return_plot = NA,
  save_plot = NA,
  save_param = list(),
  default_save_name = "spatGenePlot"
)

```

**Arguments**

|                         |                                |
|-------------------------|--------------------------------|
| <code>gobject</code>    | giotto object                  |
| <code>show_image</code> | show a tissue background image |
| <code>gimage</code>     | a giotto image                 |

|                             |  |
|-----------------------------|--|
| image_name                  | name of a giotto image                         |
| sdimx                       | x-axis dimension name (default = 'sdimx')      |
| sdimy                       | y-axis dimension name (default = 'sdimy')      |
| expression_values           | gene expression values to use                  |
| genes                       | genes to show                                  |
| cell_color_gradient         | vector with 3 colors for numeric data          |
| gradient_midpoint           | midpoint for color gradient                    |
| gradient_limits             | vector with lower and upper limits             |
| show_network                | show underlying spatial network                |
| network_color               | color of spatial network                       |
| spatial_network_name        | name of spatial network to use                 |
| show_grid                   | show spatial grid                              |
| grid_color                  | color of spatial grid                          |
| spatial_grid_name           | name of spatial grid to use                    |
| midpoint                    | expression midpoint                            |
| scale_alpha_with_expression | scale expression with ggplot alpha parameter   |
| point_shape                 | shape of points (border, no_border or voronoi) |
| point_size                  | size of point (cell)                           |
| point_alpha                 | transparency of points                         |
| point_border_col            | color of border around points                  |
| point_border_stroke         | stroke size of border around points            |
| show_legend                 | show legend                                    |
| legend_text                 | size of legend text                            |
| background_color            | color of plot background                       |
| vor_border_color            | border color for voronoi plot                  |
| vor_max_radius              | maximum radius for voronoi 'cells'             |
| vor_alpha                   | transparency of voronoi 'cells'                |
| axis_text                   | size of axis text                              |
| axis_title                  | size of axis title                             |
| cow_n_col                   | cowplot param: how many columns                |
| cow_rel_h                   | cowplot param: relative height                 |
| cow_rel_w                   | cowplot param: relative width                  |
| cow_align                   | cowplot param: how to align                    |

|                   |  |
|-------------------|--|
| show_plot         | show plots   |
| return_plot       | return ggplot object   |
| save_plot         | directly save the plot [boolean]   |
| save_param        | list of saving parameters from <a href="#">all_plots_save_function</a>     |
| default_save_name | default save name for saving, don't change, change save_name in save_param |
| ...               | parameters for cowplot::save_plot()  |

Details

Description of parameters.

Value

ggplot

See Also

[spatGenePlot3D](#) and [spatGenePlot2D](#)

Examples

spatGenePlot(gobject)

---

|                |                       |
|----------------|-----------------------|
| spatGenePlot2D | <i>spatGenePlot2D</i> |
|----------------|-----------------------|

---

Description

Visualize cells and gene expression according to spatial coordinates

Usage

```
spatGenePlot2D(  
  gobject,  
  show_image = F,  
  gimage = NULL,  
  image_name = "image",  
  sdimx = "sdimx",  
  sdimy = "sdimy",  
  expression_values = c("normalized", "scaled", "custom"),  
  genes,  
  cell_color_gradient = c("blue", "white", "red"),  
  gradient_midpoint = NULL,  
  gradient_limits = NULL,  
  show_network = F,  
  network_color = NULL,  
  spatial_network_name = NULL,  
  edge_alpha = NULL,  
  show_grid = F,  
)
```

```

grid_color = NULL,
spatial_grid_name = "spatial_grid",
midpoint = 0,
scale_alpha_with_expression = FALSE,
point_shape = c("border", "no_border", "voronoi"),
point_size = 1,
point_alpha = 1,
point_border_col = "black",
point_border_stroke = 0.1,
show_legend = T,
legend_text = 8,
background_color = "white",
vor_border_color = "white",
vor_alpha = 1,
vor_max_radius = 200,
axis_text = 8,
axis_title = 8,
cow_n_col = 2,
cow_rel_h = 1,
cow_rel_w = 1,
cow_align = "h",
show_plot = NA,
return_plot = NA,
save_plot = NA,
save_param = list(),
default_save_name = "spatGenePlot2D"
)

```

### Arguments

|                                   |   |
|-----------------------------------|---|
| <code>gobject</code>              | giotto object                             |
| <code>show_image</code>           | show a tissue background image            |
| <code>gimage</code>               | a giotto image                            |
| <code>image_name</code>           | name of a giotto image                    |
| <code>sdimx</code>                | x-axis dimension name (default = 'sdimx') |
| <code>sdimy</code>                | y-axis dimension name (default = 'sdimy') |
| <code>expression_values</code>    | gene expression values to use             |
| <code>genes</code>                | genes to show                             |
| <code>cell_color_gradient</code>  | vector with 3 colors for numeric data     |
| <code>gradient_midpoint</code>    | midpoint for color gradient               |
| <code>gradient_limits</code>      | vector with lower and upper limits        |
| <code>show_network</code>         | show underlying spatial network           |
| <code>network_color</code>        | color of spatial network                  |
| <code>spatial_network_name</code> | name of spatial network to use            |



|                             |  |
|-----------------------------|--|
| show_grid                   | show spatial grid  |
| grid_color                  | color of spatial grid  |
| spatial_grid_name           | name of spatial grid to use  |
| midpoint                    | expression midpoint  |
| scale_alpha_with_expression | scale expression with ggplot alpha parameter                               |
| point_shape                 | shape of points (border, no_border or voronoi)                             |
| point_size                  | size of point (cell)   |
| point_alpha                 | transparency of points   |
| point_border_col            | color of border around points  |
| point_border_stroke         | stroke size of border around points  |
| show_legend                 | show legend  |
| legend_text                 | size of legend text  |
| background_color            | color of plot background   |
| vor_border_color            | border color for voronoi plot  |
| vor_alpha                   | transparency of voronoi 'cells'  |
| vor_max_radius              | maximum radius for voronoi 'cells'   |
| axis_text                   | size of axis text  |
| axis_title                  | size of axis title   |
| cow_n_col                   | cowplot param: how many columns  |
| cow_rel_h                   | cowplot param: relative height   |
| cow_rel_w                   | cowplot param: relative width  |
| cow_align                   | cowplot param: how to align  |
| show_plot                   | show plots   |
| return_plot                 | return ggplot object   |
| save_plot                   | directly save the plot [boolean]   |
| save_param                  | list of saving parameters from <a href="#">all_plots_save_function</a>     |
| default_save_name           | default save name for saving, don't change, change save_name in save_param |
| ...                         | parameters for cowplot::save_plot()  |

## Details

Description of parameters.

## Value

ggplot

**See Also**[spatGenePlot3D](#)**Examples**

```
spatGenePlot2D(gobject)
```

---

spatGenePlot3D

*spatGenePlot3D*


---

**Description**

Visualize cells and gene expression according to spatial coordinates

**Usage**

```
spatGenePlot3D(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  genes,
  show_network = F,
  network_color = NULL,
  spatial_network_name = "Delaunay_network",
  edge_alpha = NULL,
  show_grid = F,
  cluster_column = NULL,
  select_cell_groups = NULL,
  select_cells = NULL,
  show_other_cells = T,
  other_cell_color = "lightgrey",
  other_point_size = 1,
  genes_high_color = NULL,
  genes_mid_color = "white",
  genes_low_color = "blue",
  spatial_grid_name = "spatial_grid",
  point_size = 2,
  show_legend = T,
  axis_scale = c("cube", "real", "custom"),
  custom_ratio = NULL,
  x_ticks = NULL,
  y_ticks = NULL,
  z_ticks = NULL,
  show_plot = NA,
  return_plot = NA,
  save_plot = NA,
  save_param = list(),
  default_save_name = "spatGenePlot3D"
)
```

**Arguments**

|  |  |
|--|--|
| <code>gobject</code>                     | giotto object  |
| <code>expression_values</code>           | gene expression values to use  |
| <code>genes</code>                       | genes to show  |
| <code>show_network</code>                | show underlying spatial network  |
| <code>network_color</code>               | color of spatial network   |
| <code>spatial_network_name</code>        | name of spatial network to use   |
| <code>show_grid</code>                   | show spatial grid  |
| <code>genes_high_color</code>            | color represents high gene expression  |
| <code>genes_mid_color</code>             | color represents middle gene expression  |
| <code>genes_low_color</code>             | color represents low gene expression   |
| <code>spatial_grid_name</code>           | name of spatial grid to use  |
| <code>point_size</code>                  | size of point (cell)   |
| <code>show_legend</code>                 | show legend  |
| <code>show_plot</code>                   | show plots   |
| <code>return_plot</code>                 | return ggplot object   |
| <code>save_plot</code>                   | directly save the plot [boolean]   |
| <code>save_param</code>                  | list of saving parameters from <a href="#">all_plots_save_function</a>                               |
| <code>default_save_name</code>           | default save name for saving, don't change, change <code>save_name</code> in <code>save_param</code> |
| <code>grid_color</code>                  | color of spatial grid  |
| <code>midpoint</code>                    | expression midpoint  |
| <code>scale_alpha_with_expression</code> | scale expression with ggplot alpha parameter   |
| <code>...</code>                         | parameters for <code>cowplot::save_plot()</code>   |

**Details**

Description of parameters.

**Value**

ggplot

**Examples**

```
spatGenePlot3D(gobject)
```

---

spatialAEH

*spatialAEH*


---

## Description

Compute spatial variable genes with spatialDE method

## Usage

```
spatialAEH(
  gobject = NULL,
  SpatialDE_results = NULL,
  name_pattern = "AEH_patterns",
  expression_values = c("raw", "normalized", "scaled", "custom"),
  pattern_num = 6,
  l = 1.05,
  python_path = NULL,
  return_gobject = TRUE
)
```

## Arguments

|                                |   |
|--------------------------------|---|
| <code>gobject</code>           | Giotto object                                 |
| <code>SpatialDE_results</code> | results of <a href="#">SpatialDE</a> function |
| <code>name_pattern</code>      | name for the computed spatial patterns        |
| <code>expression_values</code> | gene expression values to use                 |
| <code>pattern_num</code>       | number of spatial patterns to look for        |
| <code>l</code>                 | lengthscale                                   |
| <code>python_path</code>       | specify specific path to python if required   |
| <code>return_gobject</code>    | show plot                                     |

## Details

This function is a wrapper for the SpatialAEH method implemented in the ...

## Value

An updated giotto object

## Examples

```
spatialAEH(gobject)
```

spatialDE

*spatialDE***Description**

Compute spatial variable genes with spatialDE method

**Usage**

```
spatialDE(
  gobject = NULL,
  expression_values = c("raw", "normalized", "scaled", "custom"),
  size = c(4, 2, 1),
  color = c("blue", "green", "red"),
  sig_alpha = 0.5,
  unsig_alpha = 0.5,
  python_path = NULL,
  show_plot = NA,
  return_plot = NA,
  save_plot = NA,
  save_param = list(),
  default_save_name = "SpatialDE"
)
```

**Arguments**

|                                |  |
|--------------------------------|--|
| <code>gobject</code>           | Giotto object  |
| <code>expression_values</code> | gene expression values to use  |
| <code>size</code>              | size of plot   |
| <code>color</code>             | low/medium/high color scheme for plot  |
| <code>sig_alpha</code>         | alpha value for significance   |
| <code>unsig_alpha</code>       | alpha value for unsignificance   |
| <code>python_path</code>       | specify specific path to python if required  |
| <code>show_plot</code>         | show plot  |
| <code>return_plot</code>       | return ggplot object   |
| <code>save_plot</code>         | directly save the plot [boolean]   |
| <code>save_param</code>        | list of saving parameters from <code>all_plots_save_function()</code>                                |
| <code>default_save_name</code> | default save name for saving, don't change, change <code>save_name</code> in <code>save_param</code> |

**Details**

This function is a wrapper for the SpatialDE method implemented in the ...

**Value**

a list of data.frames with results and plot (optional)

**Examples**

```
spatialDE(gobject)
```

---

|             |                    |
|-------------|--------------------|
| Spatial_AEH | <i>Spatial_AEH</i> |
|-------------|--------------------|

---

**Description**

calculate automatic expression histology with spatialDE method

**Usage**

```
Spatial_AEH(  
  gobject = NULL,  
  results = NULL,  
  pattern_num = 5,  
  l = 1.05,  
  show_AEH = T,  
  sdimx = NULL,  
  sdimy = NULL,  
  point_size = 3,  
  point_alpha = 1,  
  low_color = "blue",  
  mid_color = "white",  
  high_color = "red",  
  midpoint = 0,  
  python_path = NULL  
)
```

**Arguments**

|                          |   |
|--------------------------|---|
| <code>gobject</code>     | Giotto object                               |
| <code>results</code>     | output from spatial_DE                      |
| <code>pattern_num</code> | the number of gene expression patterns      |
| <code>show_AEH</code>    | show AEH plot                               |
| <code>python_path</code> | specify specific path to python if required |

**Details**

Description.

**Value**

a list or a dataframe of SVs

**Examples**

```
Spatial_AEH(gobject)
```

---

Spatial\_DE

*Spatial\_DE*


---

**Description**

calculate spatial variable genes with spatialDE method

**Usage**

```
Spatial_DE(
  gobject = NULL,
  show_plot = T,
  size = c(4, 2, 1),
  color = c("blue", "green", "red"),
  sig_alpha = 0.5,
  unsig_alpha = 0.5,
  python_path = NULL
)
```

**Arguments**

|                          |   |
|--------------------------|---|
| <code>gobject</code>     | Giotto object                               |
| <code>show_plot</code>   | show FSV plot                               |
| <code>python_path</code> | specify specific path to python if required |

**Details**

Description.

**Value**

a list or a dataframe of SVs

**Examples**

```
Spatial_DE(gobject)
```

---

spatNetwDistributions *spatNetwDistributionsDistance*


---

**Description**

This function return histograms displaying the distance distribution for each spatial k-neighbor

**Usage**

```

spatNetwDistributions(
  gobject,
  spatial_network_name = "spatial_network",
  distribution = c("distance", "k_neighbors"),
  hist_bins = 30,
  test_distance_limit = NULL,
  ncol = 1,
  show_plot = NA,
  return_plot = NA,
  save_plot = NA,
  save_param = list(),
  default_save_name = "spatNetwDistributions"
)

```

**Arguments**

|                                   |  |
|-----------------------------------|--|
| <code>gobject</code>              | Giotto object  |
| <code>spatial_network_name</code> | name of spatial network  |
| <code>distribution</code>         | show the distribution of cell-to-cell distance or number of k neighbors                              |
| <code>hist_bins</code>            | number of binds to use for the histogram   |
| <code>test_distance_limit</code>  | effect of different distance threshold on k-neighbors  |
| <code>ncol</code>                 | number of columns to visualize the histograms in   |
| <code>show_plot</code>            | show plot  |
| <code>return_plot</code>          | return ggplot object   |
| <code>save_plot</code>            | directly save the plot [boolean]   |
| <code>save_param</code>           | list of saving parameters from <a href="#">all_plots_save_function</a>                               |
| <code>default_save_name</code>    | default save name for saving, alternatively change <code>save_name</code> in <code>save_param</code> |

**Details**

The **distance** option shows the spatial distance distribution for each nearest neighbor rank (1st, 2nd, 3th, ... neighbor). With this option the user can also test the effect of a distance limit on the spatial network. This distance limit can be used to remove neighbor cells that are considered to far away. The **k\_neighbors** option shows the number of k neighbors distribution over all cells.

**Value**

ggplot plot

**Examples**

```
spatNetwDistributionsDistance(gobject)
```



---

```
spatNetwDistributionsDistance
      spatNetwDistributionsDistance
```

---

## Description

This function return histograms displaying the distance distribution for each spatial k-neighbor

## Usage

```
spatNetwDistributionsDistance(
  gobject,
  spatial_network_name = "spatial_network",
  hist_bins = 30,
  test_distance_limit = NULL,
  ncol = 1,
  show_plot = NA,
  return_plot = NA,
  save_plot = NA,
  save_param = list(),
  default_save_name = "spatNetwDistributionsDistance"
)
```

## Arguments

|                                   |  |
|-----------------------------------|--|
| <code>gobject</code>              | Giotto object  |
| <code>spatial_network_name</code> | name of spatial network  |
| <code>hist_bins</code>            | number of binds to use for the histogram   |
| <code>test_distance_limit</code>  | effect of different distance threshold on k-neighbors  |
| <code>ncol</code>                 | number of columns to visualize the histograms in   |
| <code>show_plot</code>            | show plot  |
| <code>return_plot</code>          | return ggplot object   |
| <code>save_plot</code>            | directly save the plot [boolean]   |
| <code>save_param</code>           | list of saving parameters from <a href="#">all_plots_save_function</a>                               |
| <code>default_save_name</code>    | default save name for saving, alternatively change <code>save_name</code> in <code>save_param</code> |

## Value

ggplot plot

## Examples

```
spatNetwDistributionsDistance(gobject)
```

---

```
spatNetwDistributionsKneighbors
      spatNetwDistributionsKneighbors
```

---

## Description

This function returns a histogram displaying the number of k-neighbors distribution for each cell

## Usage

```
spatNetwDistributionsKneighbors(
  gobject,
  spatial_network_name = "spatial_network",
  hist_bins = 30,
  show_plot = NA,
  return_plot = NA,
  save_plot = NA,
  save_param = list(),
  default_save_name = "spatNetwDistributionsKneighbors"
)
```

## Arguments

|                                   |  |
|-----------------------------------|--|
| <code>gobject</code>              | Giotto object  |
| <code>spatial_network_name</code> | name of spatial network  |
| <code>hist_bins</code>            | number of binds to use for the histogram   |
| <code>show_plot</code>            | show plot  |
| <code>return_plot</code>          | return ggplot object   |
| <code>save_plot</code>            | directly save the plot [boolean]   |
| <code>save_param</code>           | list of saving parameters from <a href="#">all_plots_save_function</a>                               |
| <code>default_save_name</code>    | default save name for saving, alternatively change <code>save_name</code> in <code>save_param</code> |

## Value

ggplot plot

## Examples

```
spatNetwDistributionsKneighbors(gobject)
```

---

spatPlot

*spatPlot*


---

## Description

Visualize cells according to spatial coordinates

## Usage

```
spatPlot(
  gobject,
  show_image = F,
  gimage = NULL,
  image_name = "image",
  group_by = NULL,
  group_by_subset = NULL,
  sdimx = "sdimx",
  sdimy = "sdimy",
  spat_enr_names = NULL,
  cell_color = NULL,
  color_as_factor = T,
  cell_color_code = NULL,
  cell_color_gradient = c("blue", "white", "red"),
  gradient_midpoint = NULL,
  gradient_limits = NULL,
  select_cell_groups = NULL,
  select_cells = NULL,
  point_shape = c("border", "no_border", "voronoi"),
  point_size = 3,
  point_alpha = 1,
  point_border_col = "black",
  point_border_stroke = 0.1,
  show_cluster_center = F,
  show_center_label = F,
  center_point_size = 4,
  center_point_border_col = "black",
  center_point_border_stroke = 0.1,
  label_size = 4,
  label_fontface = "bold",
  show_network = F,
  spatial_network_name = NULL,
  network_color = NULL,
  network_alpha = 1,
  show_grid = F,
  spatial_grid_name = "spatial_grid",
  grid_color = NULL,
  show_other_cells = T,
  other_cell_color = "lightgrey",
  other_point_size = 1,
  other_cells_alpha = 0.1,
  coord_fix_ratio = NULL,
```

```

title = NULL,
show_legend = T,
legend_text = 8,
legend_symbol_size = 1,
background_color = "white",
vor_border_color = "white",
vor_max_radius = 200,
vor_alpha = 1,
axis_text = 8,
axis_title = 8,
cow_n_col = 2,
cow_rel_h = 1,
cow_rel_w = 1,
cow_align = "h",
show_plot = NA,
return_plot = NA,
save_plot = NA,
save_param = list(),
default_save_name = "spatPlot"
)

```

### Arguments

|                                  |  |
|----------------------------------|--|
| <code>gobject</code>             | giotto object  |
| <code>show_image</code>          | show a tissue background image   |
| <code>gimage</code>              | a giotto image   |
| <code>image_name</code>          | name of a giotto image   |
| <code>group_by_subset</code>     | subset the <code>group_by</code> factor column                             |
| <code>sdimx</code>               | x-axis dimension name (default = 'sdimx')                                  |
| <code>sdimy</code>               | y-axis dimension name (default = 'sdimy')                                  |
| <code>spat_enr_names</code>      | names of spatial enrichment results to include                             |
| <code>cell_color</code>          | color for cells (see details)  |
| <code>color_as_factor</code>     | convert color column to factor   |
| <code>cell_color_code</code>     | named vector with colors   |
| <code>cell_color_gradient</code> | vector with 3 colors for numeric data                                      |
| <code>gradient_midpoint</code>   | midpoint for color gradient  |
| <code>gradient_limits</code>     | vector with lower and upper limits   |
| <code>select_cell_groups</code>  | select subset of cells/clusters based on <code>cell_color</code> parameter |
| <code>select_cells</code>        | select subset of cells based on cell IDs                                   |
| <code>point_shape</code>         | shape of points (border, no_border or voronoi)                             |
| <code>point_size</code>          | size of point (cell)   |
| <code>point_alpha</code>         | transparency of point  |

|                      |                                     |
|----------------------|-------------------------------------|
| point_border_col     | color of border around points       |
| point_border_stroke  | stroke size of border around points |
| show_cluster_center  | plot center of selected clusters    |
| show_center_label    | plot label of selected clusters     |
| center_point_size    | size of center points               |
| label_size           | size of labels                      |
| label_fontface       | font of labels                      |
| show_network         | show underlying spatial network     |
| spatial_network_name | name of spatial network to use      |
| network_color        | color of spatial network            |
| network_alpha        | alpha of spatial network            |
| show_grid            | show spatial grid                   |
| spatial_grid_name    | name of spatial grid to use         |
| grid_color           | color of spatial grid               |
| show_other_cells     | display not selected cells          |
| other_cell_color     | color of not selected cells         |
| other_point_size     | point size of not selected cells    |
| other_cells_alpha    | alpha of not selected cells         |
| coord_fix_ratio      | fix ratio between x and y-axis      |
| title                | title of plot                       |
| show_legend          | show legend                         |
| legend_text          | size of legend text                 |
| legend_symbol_size   | size of legend symbols              |
| background_color     | color of plot background            |
| vor_border_color     | border color for voronoi plot       |
| vor_max_radius       | maximum radius for voronoi 'cells'  |
| vor_alpha            | transparency of voronoi 'cells'     |
| axis_text            | size of axis text                   |
| axis_title           | size of axis title                  |
| cow_n_col            | cowplot param: how many columns     |

|                   |  |
|-------------------|--|
| cow_rel_h         | cowplot param: relative height   |
| cow_rel_w         | cowplot param: relative width  |
| cow_align         | cowplot param: how to align  |
| show_plot         | show plot  |
| return_plot       | return ggplot object   |
| save_plot         | directly save the plot [boolean]   |
| save_param        | list of saving parameters from <a href="#">all_plots_save_function</a>     |
| default_save_name | default save name for saving, don't change, change save_name in save_param |
| groub_by          | create multiple plots based on cell annotation column                      |

Details

Description of parameters.

Value

ggplot

See Also

[spatPlot3D](#)

Examples

spatPlot(gobject)

---

|            |                   |
|------------|-------------------|
| spatPlot2D | <i>spatPlot2D</i> |
|------------|-------------------|

---

Description

Visualize cells according to spatial coordinates

Usage

```
spatPlot2D(  
  gobject,  
  show_image = F,  
  gimage = NULL,  
  image_name = "image",  
  group_by = NULL,  
  group_by_subset = NULL,  
  sdimx = "sdimx",  
  sdimy = "sdimy",  
  spat_enr_names = NULL,  
  cell_color = NULL,  
  color_as_factor = T,  
  cell_color_code = NULL,  
  cell_color_gradient = c("blue", "white", "red"),
```

```

gradient_midpoint = NULL,
gradient_limits = NULL,
select_cell_groups = NULL,
select_cells = NULL,
point_shape = c("border", "no_border", "voronoi"),
point_size = 3,
point_alpha = 1,
point_border_col = "black",
point_border_stroke = 0.1,
show_cluster_center = F,
show_center_label = F,
center_point_size = 4,
center_point_border_col = "black",
center_point_border_stroke = 0.1,
label_size = 4,
label_fontface = "bold",
show_network = F,
spatial_network_name = NULL,
network_color = NULL,
network_alpha = 1,
show_grid = F,
spatial_grid_name = "spatial_grid",
grid_color = NULL,
show_other_cells = T,
other_cell_color = "lightgrey",
other_point_size = 1,
other_cells_alpha = 0.1,
coord_fix_ratio = NULL,
title = NULL,
show_legend = T,
legend_text = 8,
legend_symbol_size = 1,
background_color = "white",
vor_border_color = "white",
vor_max_radius = 200,
vor_alpha = 1,
axis_text = 8,
axis_title = 8,
cow_n_col = 2,
cow_rel_h = 1,
cow_rel_w = 1,
cow_align = "h",
show_plot = NA,
return_plot = NA,
save_plot = NA,
save_param = list(),
default_save_name = "spatPlot2D"
)

```

### Arguments

gobject                  giotto object

|                      |   |
|----------------------|---|
| show_image           | show a tissue background image                                |
| gimage               | a giotto image  |
| image_name           | name of a giotto image  |
| group_by_subset      | subset the group_by factor column                             |
| sdimx                | x-axis dimension name (default = 'sdimx')                     |
| sdimy                | y-axis dimension name (default = 'sdimy')                     |
| spat_enr_names       | names of spatial enrichment results to include                |
| cell_color           | color for cells (see details)                                 |
| color_as_factor      | convert color column to factor                                |
| cell_color_code      | named vector with colors                                      |
| cell_color_gradient  | vector with 3 colors for numeric data                         |
| gradient_midpoint    | midpoint for color gradient                                   |
| gradient_limits      | vector with lower and upper limits                            |
| select_cell_groups   | select subset of cells/clusters based on cell_color parameter |
| select_cells         | select subset of cells based on cell IDs                      |
| point_shape          | shape of points (border, no_border or voronoi)                |
| point_size           | size of point (cell)  |
| point_alpha          | transparency of point   |
| point_border_col     | color of border around points                                 |
| point_border_stroke  | stroke size of border around points                           |
| show_cluster_center  | plot center of selected clusters                              |
| show_center_label    | plot label of selected clusters                               |
| center_point_size    | size of center points   |
| label_size           | size of labels  |
| label_fontface       | font of labels  |
| show_network         | show underlying spatial network                               |
| spatial_network_name | name of spatial network to use                                |
| network_color        | color of spatial network                                      |
| network_alpha        | alpha of spatial network                                      |
| show_grid            | show spatial grid   |
| spatial_grid_name    | name of spatial grid to use                                   |



|                    |  |
|--------------------|--|
| grid_color         | color of spatial grid  |
| show_other_cells   | display not selected cells   |
| other_cell_color   | color of not selected cells  |
| other_point_size   | point size of not selected cells   |
| other_cells_alpha  | alpha of not selected cells  |
| coord_fix_ratio    | fix ratio between x and y-axis   |
| title              | title of plot  |
| show_legend        | show legend  |
| legend_text        | size of legend text  |
| legend_symbol_size | size of legend symbols   |
| background_color   | color of plot background   |
| vor_border_color   | border color for voronoi plot  |
| vor_max_radius     | maximum radius for voronoi 'cells'   |
| vor_alpha          | transparency of voronoi 'cells'  |
| axis_text          | size of axis text  |
| axis_title         | size of axis title   |
| cow_n_col          | cowplot param: how many columns  |
| cow_rel_h          | cowplot param: relative height   |
| cow_rel_w          | cowplot param: relative width  |
| cow_align          | cowplot param: how to align  |
| show_plot          | show plot  |
| return_plot        | return ggplot object   |
| save_plot          | directly save the plot [boolean]   |
| save_param         | list of saving parameters from <a href="#">all_plots_save_function</a>     |
| default_save_name  | default save name for saving, don't change, change save_name in save_param |
| groub_by           | create multiple plots based on cell annotation column                      |

## Details

Description of parameters.

## Value

ggplot

## See Also

[spatPlot3D](#)

**Examples**

```
spatPlot2D(gobject)
```

---

|                   |                          |
|-------------------|--------------------------|
| spatPlot2D_single | <i>spatPlot2D_single</i> |
|-------------------|--------------------------|

---

**Description**

Visualize cells according to spatial coordinates

**Usage**

```
spatPlot2D_single(
  gobject,
  show_image = F,
  gimage = NULL,
  image_name = "image",
  sdimx = "sdimx",
  sdimy = "sdimy",
  spat_enr_names = NULL,
  cell_color = NULL,
  color_as_factor = T,
  cell_color_code = NULL,
  cell_color_gradient = c("blue", "white", "red"),
  gradient_midpoint = NULL,
  gradient_limits = NULL,
  select_cell_groups = NULL,
  select_cells = NULL,
  point_shape = c("border", "no_border", "voronoi"),
  point_size = 3,
  point_alpha = 1,
  point_border_col = "black",
  point_border_stroke = 0.1,
  show_cluster_center = F,
  show_center_label = F,
  center_point_size = 4,
  center_point_border_col = "black",
  center_point_border_stroke = 0.1,
  label_size = 4,
  label_fontface = "bold",
  show_network = F,
  spatial_network_name = NULL,
  network_color = NULL,
  network_alpha = 1,
  show_grid = F,
  spatial_grid_name = "spatial_grid",
  grid_color = NULL,
  show_other_cells = T,
  other_cell_color = "lightgrey",
  other_point_size = 1,
```

```

other_cells_alpha = 0.1,
coord_fix_ratio = NULL,
title = NULL,
show_legend = T,
legend_text = 8,
legend_symbol_size = 1,
background_color = "white",
vor_border_color = "white",
vor_max_radius = 200,
vor_alpha = 1,
axis_text = 8,
axis_title = 8,
show_plot = NA,
return_plot = NA,
save_plot = NA,
save_param = list(),
default_save_name = "spatPlot2D_single"
)

```

### Arguments

|                                  |   |
|----------------------------------|---|
| <code>gobject</code>             | giotto object   |
| <code>show_image</code>          | show a tissue background image                                |
| <code>gimage</code>              | a giotto image  |
| <code>image_name</code>          | name of a giotto image  |
| <code>sdimx</code>               | x-axis dimension name (default = 'sdimx')                     |
| <code>sdimy</code>               | y-axis dimension name (default = 'sdimy')                     |
| <code>spat_enr_names</code>      | names of spatial enrichment results to include                |
| <code>cell_color</code>          | color for cells (see details)                                 |
| <code>color_as_factor</code>     | convert color column to factor                                |
| <code>cell_color_code</code>     | named vector with colors                                      |
| <code>cell_color_gradient</code> | vector with 3 colors for numeric data                         |
| <code>gradient_midpoint</code>   | midpoint for color gradient                                   |
| <code>gradient_limits</code>     | vector with lower and upper limits                            |
| <code>select_cell_groups</code>  | select subset of cells/clusters based on cell_color parameter |
| <code>select_cells</code>        | select subset of cells based on cell IDs                      |
| <code>point_shape</code>         | shape of points (border, no_border or voronoi)                |
| <code>point_size</code>          | size of point (cell)  |
| <code>point_alpha</code>         | transparency of point   |
| <code>point_border_col</code>    | color of border around points                                 |
| <code>point_border_stroke</code> | stroke size of border around points                           |

|                      |  |
|----------------------|--|
| show_cluster_center  | plot center of selected clusters   |
| show_center_label    | plot label of selected clusters  |
| center_point_size    | size of center points  |
| label_size           | size of labels   |
| label_fontface       | font of labels   |
| show_network         | show underlying spatial network  |
| spatial_network_name | name of spatial network to use   |
| network_color        | color of spatial network   |
| network_alpha        | alpha of spatial network   |
| show_grid            | show spatial grid  |
| spatial_grid_name    | name of spatial grid to use  |
| grid_color           | color of spatial grid  |
| show_other_cells     | display not selected cells   |
| other_cell_color     | color of not selected cells  |
| other_point_size     | point size of not selected cells   |
| other_cells_alpha    | alpha of not selected cells  |
| coord_fix_ratio      | fix ratio between x and y-axis   |
| title                | title of plot  |
| show_legend          | show legend  |
| legend_text          | size of legend text  |
| legend_symbol_size   | size of legend symbols   |
| background_color     | color of plot background   |
| vor_border_color     | border color for voronoi plot  |
| vor_max_radius       | maximum radius for voronoi 'cells'   |
| vor_alpha            | transparency of voronoi 'cells'  |
| axis_text            | size of axis text  |
| axis_title           | size of axis title   |
| show_plot            | show plot  |
| return_plot          | return ggplot object   |
| save_plot            | directly save the plot [boolean]   |
| save_param           | list of saving parameters from <a href="#">all_plots_save_function</a>     |
| default_save_name    | default save name for saving, don't change, change save_name in save_param |

**Details**

Description of parameters.

**Value**

ggplot

**See Also**

[spatPlot3D](#)

**Examples**

```
spatPlot2D_single(gobject)
```

---

|            |                   |
|------------|-------------------|
| spatPlot3D | <i>spatPlot3D</i> |
|------------|-------------------|

---

**Description**

Visualize cells according to spatial coordinates

**Usage**

```
spatPlot3D(  
  gobject,  
  sdimx = "sdimx",  
  sdimy = "sdimy",  
  sdimz = "sdimz",  
  point_size = 3,  
  cell_color = NULL,  
  cell_color_code = NULL,  
  select_cell_groups = NULL,  
  select_cells = NULL,  
  show_other_cells = T,  
  other_cell_color = "lightgrey",  
  other_point_size = 0.5,  
  show_network = F,  
  network_color = NULL,  
  network_alpha = 1,  
  other_cell_alpha = 0.5,  
  spatial_network_name = "Delaunay_network",  
  show_grid = F,  
  grid_color = NULL,  
  spatial_grid_name = "spatial_grid",  
  title = "",  
  show_legend = T,  
  axis_scale = c("cube", "real", "custom"),  
  custom_ratio = NULL,  
  x_ticks = NULL,  
  y_ticks = NULL,
```

```

    z_ticks = NULL,
    show_plot = NA,
    return_plot = NA,
    save_plot = NA,
    save_param = list(),
    default_save_name = "spat3D"
)

```

## Arguments

|                                   |  |
|-----------------------------------|--|
| <code>gobject</code>              | giotto object  |
| <code>sdimx</code>                | x-axis dimension name (default = 'sdimx')  |
| <code>sdimy</code>                | y-axis dimension name (default = 'sdimy')  |
| <code>sdimz</code>                | z-axis dimension name (default = 'sdimy')  |
| <code>point_size</code>           | size of point (cell)   |
| <code>cell_color</code>           | color for cells (see details)  |
| <code>cell_color_code</code>      | named vector with colors   |
| <code>select_cell_groups</code>   | select subset of cells/clusters based on <code>cell_color</code> parameter                           |
| <code>select_cells</code>         | select subset of cells based on cell IDs   |
| <code>show_other_cells</code>     | display not selected cells   |
| <code>other_cell_color</code>     | color of not selected cells  |
| <code>show_network</code>         | show underlying spatial network  |
| <code>network_color</code>        | color of spatial network   |
| <code>spatial_network_name</code> | name of spatial network to use   |
| <code>show_grid</code>            | show spatial grid  |
| <code>grid_color</code>           | color of spatial grid  |
| <code>spatial_grid_name</code>    | name of spatial grid to use  |
| <code>title</code>                | title of plot  |
| <code>show_legend</code>          | show legend  |
| <code>axis_scale</code>           | the way to scale the axis  |
| <code>custom_ratio</code>         | customize the scale of the plot  |
| <code>x_ticks</code>              | set the number of ticks on the x-axis  |
| <code>y_ticks</code>              | set the number of ticks on the y-axis  |
| <code>z_ticks</code>              | set the number of ticks on the z-axis  |
| <code>show_plot</code>            | show plot  |
| <code>return_plot</code>          | return ggplot object   |
| <code>save_plot</code>            | directly save the plot [boolean]   |
| <code>save_param</code>           | list of saving parameters from <a href="#">all_plots_save_function</a>                               |
| <code>default_save_name</code>    | default save name for saving, don't change, change <code>save_name</code> in <code>save_param</code> |

**Details**

Description of parameters.

**Value**

ggplot

**Examples**

spatPlot3D(gobject)

---

|                |                       |
|----------------|-----------------------|
| spat_fish_func | <i>spat_fish_func</i> |
|----------------|-----------------------|

---

**Description**

performs fisher exact test

**Usage**

spat\_fish\_func(gene, bin\_matrix, spat\_mat, calc\_hub = F, hub\_min\_int = 3)

---

|              |                     |
|--------------|---------------------|
| spat_OR_func | <i>spat_OR_func</i> |
|--------------|---------------------|

---

**Description**

calculate odds-ratio

**Usage**

spat\_OR\_func(gene, bin\_matrix, spat\_mat, calc\_hub = F, hub\_min\_int = 3)

---

```
specificCellCellcommunicationScores
      specificCellCellcommunicationScores
```

---

## Description

Specific Cell-Cell communication scores based on spatial expression of interacting cells

## Usage

```
specificCellCellcommunicationScores(
  gobject,
  spatial_network_name = "Delaunay_network",
  cluster_column = "cell_types",
  random_iter = 100,
  cell_type_1 = "astrocyte",
  cell_type_2 = "endothelial",
  gene_set_1,
  gene_set_2,
  log2FC_addendum = 0.1,
  min_observations = 2,
  adjust_method = c("fdr", "bonferroni", "BH", "holm", "hochberg", "hommel", "BY",
    "none"),
  adjust_target = c("genes", "cells"),
  verbose = T
)
```

## Arguments

|                                   |  |
|-----------------------------------|--|
| <code>gobject</code>              | giotto object to use                                     |
| <code>spatial_network_name</code> | spatial network to use for identifying interacting cells |
| <code>cluster_column</code>       | cluster column with cell type information                |
| <code>random_iter</code>          | number of iterations                                     |
| <code>cell_type_1</code>          | first cell type  |
| <code>cell_type_2</code>          | second cell type   |
| <code>gene_set_1</code>           | first specific gene set from gene pairs                  |
| <code>gene_set_2</code>           | second specific gene set from gene pairs                 |
| <code>log2FC_addendum</code>      | addendum to add when calculating log2FC                  |
| <code>min_observations</code>     | minimum number of interactions needed to be considered   |
| <code>adjust_method</code>        | which method to adjust p-values                          |
| <code>adjust_target</code>        | adjust multiple hypotheses at the cell or gene level     |
| <code>verbose</code>              | verbose  |



**Details**

Statistical framework to identify if pairs of genes (such as ligand-receptor combinations) are expressed at higher levels than expected based on a reshuffled null distribution of gene expression values in cells that are spatially in proximity to eachother.. More details will follow soon.

**Value**

Cell-Cell communication scores for gene pairs based on spatial interaction

**Examples**

```
specificCellCellcommunicationScores(gobject)
```

---

|                         |                                |
|-------------------------|--------------------------------|
| split_dendrogram_in_two | <i>split_dendrogram_in_two</i> |
|-------------------------|--------------------------------|

---

**Description**

Merge selected clusters based on pairwise correlation scores and size of cluster.

**Usage**

```
split_dendrogram_in_two(dend)
```

**Arguments**

dend                      dendrogram object

**Value**

list of two dendrograms and height of node

**Examples**

```
split_dendrogram_in_two(dend)
```

---

|                    |                           |
|--------------------|---------------------------|
| standardise_giotto | <i>standardise_giotto</i> |
|--------------------|---------------------------|

---

**Description**

standardises a matrix

**Usage**

```
standardise_giotto(x, center = TRUE, scale = TRUE)
```

**Arguments**

|        |             |
|--------|-------------|
| x      | matrix      |
| center | center data |
| scale  | scale data  |

**Value**

standardized matrix

---

stitchFieldCoordinates

*stitchFieldCoordinates*


---

**Description**

Helper function to stitch field coordinates together to form one complete picture

**Usage**

```
stitchFieldCoordinates(
  location_file,
  offset_file,
  cumulate_offset_x = F,
  cumulate_offset_y = F,
  field_col = "Field of View",
  X_coord_col = "X",
  Y_coord_col = "Y",
  reverse_final_x = F,
  reverse_final_y = T
)
```

**Arguments**

|                   |  |
|-------------------|--|
| location_file     | location dataframe with X and Y coordinates                      |
| offset_file       | dataframe that describes the offset for each field (see details) |
| cumulate_offset_x | (boolean) Do the x-axis offset values need to be cumulated?      |
| cumulate_offset_y | (boolean) Do the y-axis offset values need to be cumulated?      |
| field_col         | column that indicates the field within the location_file         |
| X_coord_col       | column that indicates the x coordinates                          |
| Y_coord_col       | column that indicates the x coordinates                          |
| reverse_final_x   | (boolean) Do the final x coordinates need to be reversed?        |
| reverse_final_y   | (boolean) Do the final y coordinates need to be reversed?        |

**Details**

Stitching of fields:

- 1. have cell locations: at least 3 columns: field, X, Y
- 2. create offset file: offset file has 3 columns: field, x\_offset, y\_offset
- 3. create new cell location file by stitching original cell locations with stitchFieldCoordinates
- 4. provide new cell location file to [createGiottoObject](#)

**Value**

Updated location dataframe with new X ['X\_final'] and Y ['Y\_final'] coordinates

**Examples**

```
stitchFieldCoordinates(gobject)
```

---

stitchTileCoordinates *stitchTileCoordinates*

---

**Description**

Helper function to stitch tile coordinates together to form one complete picture

**Usage**

```
stitchTileCoordinates(location_file, Xtilespan, Ytilespan)
```

**Arguments**

|               |  |
|---------------|--|
| location_file | location dataframe with X and Y coordinates        |
| Xtilespan     | numerical value specifying the width of each tile  |
| Ytilespan     | numerical value specifying the height of each tile |

**Details**

...

**Examples**

```
stitchTileCoordinates(gobject)
```

---

|                 |                        |
|-----------------|------------------------|
| subClusterCells | <i>subClusterCells</i> |
|-----------------|------------------------|

---

## Description

subcluster cells

## Usage

```
subClusterCells(
  gobject,
  name = "sub_clus",
  cluster_method = c("leiden", "louvain_community", "louvain_multinet"),
  cluster_column = NULL,
  selected_clusters = NULL,
  hvg_param = list(reverse_log_scale = T, difference_in_variance = 1, expression_values
    = "normalized"),
  hvg_min_perc_cells = 5,
  hvg_mean_expr_det = 1,
  use_all_genes_as_hvg = FALSE,
  min_nr_of_hvg = 5,
  pca_param = list(expression_values = "normalized", scale_unit = T),
  nn_param = list(dimensions_to_use = 1:20),
  k_neighbors = 10,
  resolution = 1,
  gamma = 1,
  omega = 1,
  python_path = NULL,
  nn_network_to_use = "sNN",
  network_name = "sNN.pca",
  return_gobject = TRUE,
  verbose = T
)
```

## Arguments

|                      |   |
|----------------------|---|
| gobject              | giotto object   |
| name                 | name for new clustering result                              |
| cluster_method       | clustering method to use                                    |
| cluster_column       | cluster column to subcluster                                |
| selected_clusters    | only do subclustering on these clusters                     |
| hvg_param            | parameters for calculateHVG                                 |
| hvg_min_perc_cells   | threshold for detection in min percentage of cells          |
| hvg_mean_expr_det    | threshold for mean expression level in cells with detection |
| use_all_genes_as_hvg | forces all genes to be HVG and to be used as input for PCA  |

|                   |   |
|-------------------|---|
| min_nr_of_hvg     | minimum number of HVG, or all genes will be used as input for PCA |
| pca_param         | parameters for runPCA   |
| nn_param          | parameters for parameters for createNearestNetwork                |
| k_neighbors       | number of k for createNearestNetwork                              |
| resolution        | resolution  |
| gamma             | gamma   |
| omega             | omega   |
| python_path       | specify specific path to python if required                       |
| nn_network_to_use | type of NN network to use (kNN vs sNN)                            |
| network_name      | name of NN network to use   |
| return_gobject    | boolean: return giotto object (default = TRUE)                    |
| verbose           | verbose   |

### Details

This function performs subclustering on selected clusters. The systematic steps are:

- 1. subset Giotto object
- 2. identify highly variable genes
- 3. run PCA
- 4. create nearest neighbouring network
- 5. do clustering

### Value

giotto object with new subclusters appended to cell metadata

### See Also

[doLouvainCluster\\_multinet](#), [doLouvainCluster\\_community](#) and @seealso [doLeidenCluster](#)

### Examples

```
subClusterCells(gobject)
```

---

subsetGiotto

*subsetGiotto*


---

### Description

subsets Giotto object including previous analyses.

### Usage

```
subsetGiotto(gobject, cell_ids = NULL, gene_ids = NULL, verbose = FALSE)
```

Arguments

|                       |                  |
|-----------------------|------------------|
| <code>gobject</code>  | giotto object    |
| <code>cell_ids</code> | cell IDs to keep |
| <code>gene_ids</code> | gene IDs to keep |
| <code>verbose</code>  | be verbose       |

Value

giotto object

Examples

```
subsetGiotto(gobject)
```

---

|                               |                         |
|-------------------------------|-------------------------|
| <code>subsetGiottoLocs</code> | <i>subsetGiottoLocs</i> |
|-------------------------------|-------------------------|

---

Description

subsets Giotto object based on spatial locations

Usage

```
subsetGiottoLocs(  
  gobject,  
  x_max = NULL,  
  x_min = NULL,  
  y_max = NULL,  
  y_min = NULL,  
  z_max = NULL,  
  z_min = NULL,  
  return_gobject = T,  
  verbose = FALSE  
)
```

Arguments

|                             |                      |
|-----------------------------|----------------------|
| <code>gobject</code>        | giotto object        |
| <code>x_max</code>          | maximum x-coordinate |
| <code>x_min</code>          | minimum x-coordinate |
| <code>y_max</code>          | maximum y-coordinate |
| <code>y_min</code>          | minimum y-coordinate |
| <code>z_max</code>          | maximum z-coordinate |
| <code>z_min</code>          | minimum z-coordinate |
| <code>return_gobject</code> | return Giotto object |

Details

if `return_gobject = FALSE`, then a filtered combined metadata `data.table` will be returned

**Value**

giotto object

**Examples**

```
subsetGiottoLocs(gobject)
```

---

```
transform_2d_mesh_to_3d_mesh
```

```
transform_2d_mesh_to_3d_mesh
```

---

**Description**

transform 2d mesh to 3d mesh by reversing PCA

**Usage**

```
transform_2d_mesh_to_3d_mesh(  
  mesh_line_obj_2d,  
  pca_out,  
  center_vec,  
  mesh_grid_n  
)
```

---

```
trendSceek
```

```
trendSceek
```

---

**Description**

Compute spatial variable genes with trendsceek method

**Usage**

```
trendSceek(  
  gobject,  
  expression_values = c("normalized", "raw"),  
  subset_genes = NULL,  
  nrand = 100,  
  ncores = 8,  
  ...  
)
```

Arguments

|                                |   |
|--------------------------------|---|
| <code>gobject</code>           | Giotto object   |
| <code>expression_values</code> | gene expression values to use   |
| <code>subset_genes</code>      | subset of genes to run trendsceek on  |
| <code>nrand</code>             | An integer specifying the number of random resamplings of the mark distribution as to create the null-distribution. |
| <code>ncores</code>            | An integer specifying the number of cores to be used by BiocParallel  |
| <code>...</code>               | Additional parameters to the <code>trendsceek_test</code> function  |

Details

This function is a wrapper for the `trendsceek_test` method implemented in the `trendsceek` package

Value

data.frame with trendsceek spatial genes results

Examples

```
trendSceek(gobject)
```

---

|                       |                 |
|-----------------------|-----------------|
| <code>t_giotto</code> | <i>t_giotto</i> |
|-----------------------|-----------------|

---

Description

`t_giotto`

Usage

```
t_giotto(mymatrix)
```

---

|                                |                          |
|--------------------------------|--------------------------|
| <code>updateGiottoImage</code> | <i>updateGiottoImage</i> |
|--------------------------------|--------------------------|

---

Description

Updates the boundaries of a giotto image attached to a giotto object

Usage

```
updateGiottoImage(  
  gobject,  
  image_name,  
  xmax_adj = 0,  
  xmin_adj = 0,  
  ymax_adj = 0,  
  ymin_adj = 0,  
  return_gobject = TRUE  
)
```



Arguments

|                |  |
|----------------|--|
| gobject        | giotto object  |
| image_name     | spatial locations                                    |
| xmax_adj       | adjustment of the maximum x-value to align the image |
| xmin_adj       | adjustment of the minimum x-value to align the image |
| ymax_adj       | adjustment of the maximum y-value to align the image |
| ymin_adj       | adjustment of the minimum y-value to align the image |
| return_gobject | return a giotto object                               |

Value

a giotto object or an updated giotto image if return\_gobject = F

Examples

```
updateGiottoImage(gobject)
```

---

|                 |                        |
|-----------------|------------------------|
| viewHMRFresults | <i>viewHMRFresults</i> |
|-----------------|------------------------|

---

Description

View results from doHMRF.

Usage

```
viewHMRFresults(  
  gobject,  
  HMRFOutput,  
  k = NULL,  
  betas_to_view = NULL,  
  third_dim = NULL,  
  ...  
)
```

Arguments

|               |  |
|---------------|--|
| gobject       | giotto object                                      |
| HMRFOutput    | HMRF output from doHMRF                            |
| k             | number of HMRF domains                             |
| betas_to_view | results from different betas that you want to view |
| ...           | paramters to visPlot()                             |

Details

Description ...

**Value**

spatial plots with HMRF domains

**See Also**

[visPlot](#)

**Examples**

```
viewHMRFresults(gobject)
```

---

|                   |                          |
|-------------------|--------------------------|
| viewHMRFresults2D | <i>viewHMRFresults2D</i> |
|-------------------|--------------------------|

---

**Description**

View results from doHMRF.

**Usage**

```
viewHMRFresults2D(  
  gobject,  
  HMRFoutput,  
  k = NULL,  
  betas_to_view = NULL,  
  third_dim = NULL,  
  ...  
)
```

**Arguments**

|               |  |
|---------------|--|
| gobject       | giotto object                                      |
| HMRFoutput    | HMRF output from doHMRF                            |
| k             | number of HMRF domains                             |
| betas_to_view | results from different betas that you want to view |
| ...           | paramters to visPlot()                             |

**Details**

Description ...

**Value**

spatial plots with HMRF domains

**See Also**

[spatPlot2D](#)

**Examples**

```
viewHMRFresults2D(gobject)
```

---

|                   |                          |
|-------------------|--------------------------|
| viewHMRFresults3D | <i>viewHMRFresults3D</i> |
|-------------------|--------------------------|

---

## Description

View results from doHMRF.

## Usage

```
viewHMRFresults3D(  
  gobject,  
  HMRFoutput,  
  k = NULL,  
  betas_to_view = NULL,  
  third_dim = NULL,  
  ...  
)
```

## Arguments

|               |  |
|---------------|--|
| gobject       | giotto object                                      |
| HMRFoutput    | HMRF output from doHMRF                            |
| k             | number of HMRF domains                             |
| betas_to_view | results from different betas that you want to view |
| ...           | paramters to visPlot()                             |

## Details

Description ...

## Value

spatial plots with HMRF domains

## See Also

[spatPlot3D](#)

## Examples

```
viewHMRFresults3D(gobject)
```

---

violinPlot

*violinPlot*


---

## Description

Creates violinplot for selected clusters

## Usage

```
violinPlot(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  genes,
  cluster_column,
  cluster_custom_order = NULL,
  color_violin = c("genes", "cluster"),
  cluster_color_code = NULL,
  strip_position = c("top", "right", "left", "bottom"),
  strip_text = 7,
  axis_text_x_size = 10,
  axis_text_y_size = 6,
  show_plot = NA,
  return_plot = NA,
  save_plot = NA,
  save_param = list(),
  default_save_name = "violinPlot"
)
```

## Arguments

|                      |   |
|----------------------|---|
| gobject              | giotto object                               |
| expression_values    | expression values to use                    |
| genes                | genes to plot                               |
| cluster_column       | name of column to use for clusters          |
| cluster_custom_order | custom order of clusters                    |
| color_violin         | color violin according to genes or clusters |
| cluster_color_code   | color code for clusters                     |
| strip_position       | position of gene labels                     |
| strip_text           | size of strip text                          |
| axis_text_x_size     | size of x-axis text                         |
| axis_text_y_size     | size of y-axis text                         |
| show_plot            | show plot                                   |
| return_plot          | return ggplot object                        |

|                   |  |
|-------------------|--|
| save_plot         | directly save the plot [boolean]   |
| save_param        | list of saving parameters from <a href="#">all_plots_save_function</a>     |
| default_save_name | default save name for saving, don't change, change save_name in save_param |

**Value**

ggplot

**Examples**

```
violinPlot(gobject)
```

---

|                |                       |
|----------------|-----------------------|
| visDimGenePlot | <i>visDimGenePlot</i> |
|----------------|-----------------------|

---

**Description**

Visualize cells and gene expression according to dimension reduction coordinates

**Usage**

```
visDimGenePlot(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  genes = NULL,
  dim_reduction_to_use = "umap",
  dim_reduction_name = "umap",
  dim1_to_use = 1,
  dim2_to_use = 2,
  dim3_to_use = NULL,
  show_NN_network = F,
  nn_network_to_use = "sNN",
  network_name = "sNN.pca",
  network_color = "lightgray",
  edge_alpha = NULL,
  scale_alpha_with_expression = FALSE,
  point_size = 1,
  genes_high_color = NULL,
  genes_mid_color = "white",
  genes_low_color = "blue",
  point_border_col = "black",
  point_border_stroke = 0.1,
  midpoint = 0,
  cow_n_col = 2,
  cow_rel_h = 1,
  cow_rel_w = 1,
  cow_align = "h",
  show_legend = T,
  plot_method = c("ggplot", "plotly"),
  show_plots = F
)
```

**Arguments**

|  |   |
|--|---|
| <code>gobject</code>                     | giotto object   |
| <code>expression_values</code>           | gene expression values to use                                     |
| <code>genes</code>                       | genes to show   |
| <code>dim_reduction_to_use</code>        | dimension reduction to use  |
| <code>dim_reduction_name</code>          | dimension reduction name  |
| <code>dim1_to_use</code>                 | dimension to use on x-axis  |
| <code>dim2_to_use</code>                 | dimension to use on y-axis  |
| <code>dim3_to_use</code>                 | dimension to use on z-axis  |
| <code>show_NN_network</code>             | show underlying NN network  |
| <code>nn_network_to_use</code>           | type of NN network to use (kNN vs sNN)                            |
| <code>network_name</code>                | name of NN network to use, if <code>show_NN_network = TRUE</code> |
| <code>edge_alpha</code>                  | column to use for alpha of the edges                              |
| <code>scale_alpha_with_expression</code> | scale expression with ggplot alpha parameter                      |
| <code>point_size</code>                  | size of point (cell)  |
| <code>point_border_col</code>            | color of border around points                                     |
| <code>point_border_stroke</code>         | stroke size of border around points                               |
| <code>midpoint</code>                    | size of point (cell)  |
| <code>cow_n_col</code>                   | cowplot param: how many columns                                   |
| <code>cow_rel_h</code>                   | cowplot param: relative height                                    |
| <code>cow_rel_w</code>                   | cowplot param: relative width                                     |
| <code>cow_align</code>                   | cowplot param: how to align                                       |
| <code>show_legend</code>                 | show legend   |
| <code>show_plots</code>                  | show plots  |

**Details**

Description of parameters.

**Value**

ggplot

**Examples**

```
visDimGenePlot(gobject)
```

---

```
visDimGenePlot_2D_ggplot
      visDimGenePlot_2D_ggplot
```

---

## Description

Visualize cells and gene expression according to dimension reduction coordinates

## Usage

```
visDimGenePlot_2D_ggplot(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  genes = NULL,
  dim_reduction_to_use = "umap",
  dim_reduction_name = "umap",
  dim1_to_use = 1,
  dim2_to_use = 2,
  show_NN_network = F,
  nn_network_to_use = "sNN",
  network_name = "sNN.pca",
  network_color = "lightgray",
  edge_alpha = NULL,
  scale_alpha_with_expression = FALSE,
  point_size = 1,
  genes_high_color = "red",
  genes_mid_color = "white",
  genes_low_color = "blue",
  point_border_col = "black",
  point_border_stroke = 0.1,
  midpoint = 0,
  cow_n_col = 2,
  cow_rel_h = 1,
  cow_rel_w = 1,
  cow_align = "h",
  show_legend = T,
  show_plots = F
)
```

## Arguments

|                      |                               |
|----------------------|-------------------------------|
| gobject              | giotto object                 |
| expression_values    | gene expression values to use |
| genes                | genes to show                 |
| dim_reduction_to_use | dimension reduction to use    |
| dim_reduction_name   | dimension reduction name      |
| dim1_to_use          | dimension to use on x-axis    |

|                             |  |
|-----------------------------|--|
| dim2_to_use                 | dimension to use on y-axis                           |
| show_NN_network             | show underlying NN network                           |
| nn_network_to_use           | type of NN network to use (kNN vs sNN)               |
| network_name                | name of NN network to use, if show_NN_network = TRUE |
| edge_alpha                  | column to use for alpha of the edges                 |
| scale_alpha_with_expression | scale expression with ggplot alpha parameter         |
| point_size                  | size of point (cell)                                 |
| point_border_col            | color of border around points                        |
| point_border_stroke         | stroke size of border around points                  |
| midpoint                    | size of point (cell)                                 |
| cow_n_col                   | cowplot param: how many columns                      |
| cow_rel_h                   | cowplot param: relative height                       |
| cow_rel_w                   | cowplot param: relative width                        |
| cow_align                   | cowplot param: how to align                          |
| show_legend                 | show legend  |
| show_plots                  | show plots   |

## Details

Description of parameters.

## Value

ggplot

## Examples

```
visDimGenePlot_2D_ggplot(gobject)
```

---

```
visDimGenePlot_3D_plotly
visDimGenePlot_3D_plotly
```

---

## Description

Visualize cells and gene expression according to dimension reduction coordinates



**Usage**

```
visDimGenePlot_3D_plotly(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  genes = NULL,
  dim_reduction_to_use = "umap",
  dim_reduction_name = "umap",
  dim1_to_use = 1,
  dim2_to_use = 2,
  dim3_to_use = 3,
  show_NN_network = F,
  nn_network_to_use = "sNN",
  network_name = "sNN.pca",
  network_color = "lightgray",
  edge_alpha = NULL,
  point_size = 1,
  genes_high_color = NULL,
  genes_mid_color = "white",
  genes_low_color = "blue",
  show_legend = T,
  show_plots = F
)
```

**Arguments**

|                                   |   |
|-----------------------------------|---|
| <code>gobject</code>              | giotto object   |
| <code>expression_values</code>    | gene expression values to use                                     |
| <code>genes</code>                | genes to show   |
| <code>dim_reduction_to_use</code> | dimension reduction to use  |
| <code>dim_reduction_name</code>   | dimension reduction name  |
| <code>dim1_to_use</code>          | dimension to use on x-axis  |
| <code>dim2_to_use</code>          | dimension to use on y-axis  |
| <code>dim3_to_use</code>          | dimension to use on z-axis  |
| <code>show_NN_network</code>      | show underlying NN network  |
| <code>nn_network_to_use</code>    | type of NN network to use (kNN vs sNN)                            |
| <code>network_name</code>         | name of NN network to use, if <code>show_NN_network = TRUE</code> |
| <code>edge_alpha</code>           | column to use for alpha of the edges                              |
| <code>point_size</code>           | size of point (cell)  |
| <code>show_legend</code>          | show legend   |
| <code>show_plots</code>           | show plots  |

**Details**

Description of parameters.

Value

ggplot

Examples

```
visDimGenePlot_3D_plotly(gobject)
```

---

|            |                   |
|------------|-------------------|
| visDimPlot | <i>visDimPlot</i> |
|------------|-------------------|

---

Description

Visualize cells according to dimension reduction coordinates

Usage

```
visDimPlot(  
  gobject,  
  dim_reduction_to_use = "umap",  
  dim_reduction_name = "umap",  
  dim1_to_use = 1,  
  dim2_to_use = 2,  
  dim3_to_use = NULL,  
  show_NN_network = F,  
  nn_network_to_use = "sNN",  
  network_name = "sNN.pca",  
  cell_color = NULL,  
  color_as_factor = T,  
  cell_color_code = NULL,  
  select_cell_groups = NULL,  
  select_cells = NULL,  
  show_other_cells = T,  
  other_cell_color = "lightgrey",  
  other_point_size = 0.5,  
  show_cluster_center = F,  
  show_center_label = T,  
  center_point_size = 4,  
  center_point_border_col = "black",  
  center_point_border_stroke = 0.1,  
  label_size = 4,  
  label_fontface = "bold",  
  edge_alpha = NULL,  
  point_size = 3,  
  point_border_col = "black",  
  point_border_stroke = 0.1,  
  plot_method = c("ggplot", "plotly"),  
  show_legend = T,  
  show_plot = F,  
  return_plot = TRUE,  
  save_plot = F,  
  save_dir = NULL,
```

```

    save_folder = NULL,
    save_name = NULL,
    save_format = NULL,
    show_saved_plot = F,
    ...
)

```

### Arguments

|                                   |   |
|-----------------------------------|---|
| <code>gobject</code>              | giotto object   |
| <code>dim_reduction_to_use</code> | dimension reduction to use  |
| <code>dim_reduction_name</code>   | dimension reduction name  |
| <code>dim1_to_use</code>          | dimension to use on x-axis  |
| <code>dim2_to_use</code>          | dimension to use on y-axis  |
| <code>dim3_to_use</code>          | dimension to use on z-axis  |
| <code>show_NN_network</code>      | show underlying NN network  |
| <code>nn_network_to_use</code>    | type of NN network to use (kNN vs sNN)                            |
| <code>network_name</code>         | name of NN network to use, if <code>show_NN_network = TRUE</code> |
| <code>cell_color</code>           | color for cells (see details)                                     |
| <code>color_as_factor</code>      | convert color column to factor                                    |
| <code>cell_color_code</code>      | named vector with colors  |
| <code>show_cluster_center</code>  | plot center of selected clusters                                  |
| <code>show_center_label</code>    | plot label of selected clusters                                   |
| <code>center_point_size</code>    | size of center points   |
| <code>label_size</code>           | size of labels  |
| <code>label_fontface</code>       | font of labels  |
| <code>edge_alpha</code>           | column to use for alpha of the edges                              |
| <code>point_size</code>           | size of point (cell)  |
| <code>point_border_col</code>     | color of border around points                                     |
| <code>point_border_stroke</code>  | stroke size of border around points                               |
| <code>show_legend</code>          | show legend   |
| <code>show_plot</code>            | show plot   |
| <code>return_plot</code>          | return ggplot object  |
| <code>save_plot</code>            | directly save the plot [boolean]                                  |
| <code>save_dir</code>             | directory to save the plot  |

|                 |   |
|-----------------|---|
| save_folder     | (optional) folder in directory to save the plot |
| save_name       | name of plot                                    |
| save_format     | format of plot (e.g. tiff, png, pdf, ...)       |
| show_saved_plot | load & display the saved plot                   |

### Details

Description of parameters.

### Value

ggplot or plotly

### Examples

```
visDimPlot(gobject)
```

---

|                      |                             |
|----------------------|-----------------------------|
| visDimPlot_2D_ggplot | <i>visDimPlot_2D_ggplot</i> |
|----------------------|-----------------------------|

---

### Description

Visualize cells according to dimension reduction coordinates

### Usage

```
visDimPlot_2D_ggplot(
  gobject,
  dim_reduction_to_use = "umap",
  dim_reduction_name = "umap",
  dim1_to_use = 1,
  dim2_to_use = 2,
  show_NN_network = F,
  nn_network_to_use = "sNN",
  network_name = "sNN.pca",
  cell_color = NULL,
  color_as_factor = T,
  cell_color_code = NULL,
  select_cell_groups = NULL,
  select_cells = NULL,
  show_other_cells = T,
  other_cell_color = "lightgrey",
  other_point_size = 0.5,
  show_cluster_center = F,
  show_center_label = T,
  center_point_size = 4,
  center_point_border_col = "black",
  center_point_border_stroke = 0.1,
  label_size = 4,
  label_fontface = "bold",
```

```

    edge_alpha = NULL,
    point_size = 1,
    point_border_col = "black",
    point_border_stroke = 0.1,
    show_legend = T,
    show_plot = F,
    return_plot = TRUE,
    save_plot = F,
    save_dir = NULL,
    save_folder = NULL,
    save_name = NULL,
    save_format = NULL,
    show_saved_plot = F,
    ...
)

```

### Arguments

|                                   |  |
|-----------------------------------|--|
| <code>gobject</code>              | giotto object  |
| <code>dim_reduction_to_use</code> | dimension reduction to use   |
| <code>dim_reduction_name</code>   | dimension reduction name   |
| <code>dim1_to_use</code>          | dimension to use on x-axis   |
| <code>dim2_to_use</code>          | dimension to use on y-axis   |
| <code>show_NN_network</code>      | show underlying NN network   |
| <code>nn_network_to_use</code>    | type of NN network to use (kNN vs sNN)                                     |
| <code>network_name</code>         | name of NN network to use, if <code>show_NN_network = TRUE</code>          |
| <code>cell_color</code>           | color for cells (see details)  |
| <code>color_as_factor</code>      | convert color column to factor   |
| <code>cell_color_code</code>      | named vector with colors   |
| <code>select_cell_groups</code>   | select subset of cells/clusters based on <code>cell_color</code> parameter |
| <code>select_cells</code>         | select subset of cells based on cell IDs                                   |
| <code>show_other_cells</code>     | display not selected cells   |
| <code>other_cell_color</code>     | color of not selected cells  |
| <code>other_point_size</code>     | size of not selected cells   |
| <code>show_cluster_center</code>  | plot center of selected clusters   |
| <code>show_center_label</code>    | plot label of selected clusters  |
| <code>center_point_size</code>    | size of center points  |

|                     |                                      |
|---------------------|--------------------------------------|
| label_size          | size of labels                       |
| label_fontface      | font of labels                       |
| edge_alpha          | column to use for alpha of the edges |
| point_size          | size of point (cell)                 |
| point_border_col    | color of border around points        |
| point_border_stroke | stroke size of border around points  |
| show_legend         | show legend                          |

### Details

Description of parameters.

### Value

ggplot

### Examples

```
visDimPlot_2D_ggplot(gobject)
```

---

visDimPlot\_2D\_plotly    *visDimPlot\_2D\_plotly*

---

### Description

Visualize cells according to dimension reduction coordinates

### Usage

```
visDimPlot_2D_plotly(
  gobject,
  dim_reduction_to_use = "umap",
  dim_reduction_name = "umap",
  dim1_to_use = 1,
  dim2_to_use = 2,
  select_cell_groups = NULL,
  select_cells = NULL,
  show_other_cells = T,
  other_cell_color = "lightgrey",
  other_point_size = 0.5,
  show_NN_network = F,
  nn_network_to_use = "sNN",
  network_name = "sNN.pca",
  color_as_factor = T,
  cell_color = NULL,
  cell_color_code = NULL,
  show_cluster_center = F,
  show_center_label = T,
```

```

        center_point_size = 4,
        label_size = 4,
        edge_alpha = NULL,
        point_size = 5
    )

```

### Arguments

|                                   |   |
|-----------------------------------|---|
| <code>gobject</code>              | giotto object   |
| <code>dim_reduction_to_use</code> | dimension reduction to use  |
| <code>dim_reduction_name</code>   | dimension reduction name  |
| <code>dim1_to_use</code>          | dimension to use on x-axis  |
| <code>dim2_to_use</code>          | dimension to use on y-axis  |
| <code>show_NN_network</code>      | show underlying NN network  |
| <code>nn_network_to_use</code>    | type of NN network to use (kNN vs sNN)                            |
| <code>network_name</code>         | name of NN network to use, if <code>show_NN_network = TRUE</code> |
| <code>color_as_factor</code>      | convert color column to factor                                    |
| <code>cell_color</code>           | color for cells (see details)                                     |
| <code>cell_color_code</code>      | named vector with colors  |
| <code>show_cluster_center</code>  | plot center of selected clusters                                  |
| <code>show_center_label</code>    | plot label of selected clusters                                   |
| <code>center_point_size</code>    | size of center points   |
| <code>label_size</code>           | size of labels  |
| <code>edge_alpha</code>           | column to use for alpha of the edges                              |
| <code>point_size</code>           | size of point (cell)  |

### Details

Description of parameters.

### Value

plotly

### Examples

```
visDimPlot_2D_plotly(gobject)
```

---

visDimPlot\_3D\_plotly    *visDimPlot\_3D\_plotly*


---

## Description

Visualize cells according to dimension reduction coordinates

## Usage

```
visDimPlot_3D_plotly(
  gobject,
  dim_reduction_to_use = "umap",
  dim_reduction_name = "umap",
  dim1_to_use = 1,
  dim2_to_use = 2,
  dim3_to_use = 3,
  select_cell_groups = NULL,
  select_cells = NULL,
  show_other_cells = T,
  other_cell_color = "lightgrey",
  other_point_size = 0.5,
  show_NN_network = F,
  nn_network_to_use = "sNN",
  network_name = "sNN.pca",
  color_as_factor = T,
  cell_color = NULL,
  cell_color_code = NULL,
  show_cluster_center = F,
  show_center_label = T,
  center_point_size = 4,
  label_size = 4,
  edge_alpha = NULL,
  point_size = 1
)
```

## Arguments

|                      |  |
|----------------------|--|
| gobject              | giotto object                          |
| dim_reduction_to_use | dimension reduction to use             |
| dim_reduction_name   | dimension reduction name               |
| dim1_to_use          | dimension to use on x-axis             |
| dim2_to_use          | dimension to use on y-axis             |
| dim3_to_use          | dimension to use on z-axis             |
| show_NN_network      | show underlying NN network             |
| nn_network_to_use    | type of NN network to use (kNN vs sNN) |



|                     |  |
|---------------------|--|
| network_name        | name of NN network to use, if show_NN_network = TRUE |
| color_as_factor     | convert color column to factor                       |
| cell_color          | color for cells (see details)                        |
| cell_color_code     | named vector with colors                             |
| show_cluster_center | plot center of selected clusters                     |
| show_center_label   | plot label of selected clusters                      |
| center_point_size   | size of center points                                |
| label_size          | size of labels                                       |
| edge_alpha          | column to use for alpha of the edges                 |
| point_size          | size of point (cell)                                 |

### Details

Description of parameters.

### Value

plotly

### Examples

```
visDimPlot_3D_plotly(gobject)
```

---

|                    |                           |
|--------------------|---------------------------|
| visForceLayoutPlot | <i>visForceLayoutPlot</i> |
|--------------------|---------------------------|

---

### Description

Visualize cells according to forced layout algorithm coordinates

### Usage

```
visForceLayoutPlot(
  gobject,
  nn_network_to_use = "sNN",
  network_name = "sNN.pca",
  layout_name = "layout",
  dim1_to_use = 1,
  dim2_to_use = 2,
  show_NN_network = T,
  cell_color = NULL,
  color_as_factor = TRUE,
  cell_color_code = NULL,
  edge_alpha = NULL,
  point_size = 1,
```

```

    point_border_col = "black",
    point_border_stroke = 0.1,
    show_legend = T,
    show_plot = F,
    return_plot = TRUE,
    save_plot = F,
    save_dir = NULL,
    save_folder = NULL,
    save_name = NULL,
    save_format = NULL,
    show_saved_plot = F,
    ...
)

```

### Arguments

|                                  |   |
|----------------------------------|---|
| <code>gobject</code>             | giotto object                                   |
| <code>nn_network_to_use</code>   | type of NN network to use (kNN vs sNN)          |
| <code>network_name</code>        | NN network to use                               |
| <code>layout_name</code>         | name of layout to use                           |
| <code>dim1_to_use</code>         | dimension to use on x-axis                      |
| <code>dim2_to_use</code>         | dimension to use on y-axis                      |
| <code>show_NN_network</code>     | show underlying NN network                      |
| <code>cell_color</code>          | color for cells (see details)                   |
| <code>color_as_factor</code>     | convert color column to factor                  |
| <code>cell_color_code</code>     | named vector with colors                        |
| <code>edge_alpha</code>          | column to use for alpha of the edges            |
| <code>point_size</code>          | size of point (cell)                            |
| <code>point_border_col</code>    | color of border around points                   |
| <code>point_border_stroke</code> | stroke size of border around points             |
| <code>show_legend</code>         | show legend                                     |
| <code>show_plot</code>           | show plot                                       |
| <code>return_plot</code>         | return ggplot object                            |
| <code>save_plot</code>           | directly save the plot [boolean]                |
| <code>save_dir</code>            | directory to save the plot                      |
| <code>save_folder</code>         | (optional) folder in directory to save the plot |
| <code>save_name</code>           | name of plot                                    |
| <code>save_format</code>         | format of plot (e.g. tiff, png, pdf, ...)       |
| <code>show_saved_plot</code>     | load & display the saved plot                   |

**Details**

Description of parameters.

**Value**

ggplot

**Examples**

```
visForceLayoutPlot(gobject)
```

---

|             |                    |
|-------------|--------------------|
| visGenePlot | <i>visGenePlot</i> |
|-------------|--------------------|

---

**Description**

Visualize cells and gene expression according to spatial coordinates

**Usage**

```
visGenePlot(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  genes,
  genes_high_color = NULL,
  genes_mid_color = "white",
  genes_low_color = "blue",
  show_network = F,
  network_color = NULL,
  spatial_network_name = "spatial_network",
  edge_alpha = NULL,
  show_grid = F,
  grid_color = NULL,
  spatial_grid_name = "spatial_grid",
  midpoint = 0,
  scale_alpha_with_expression = FALSE,
  point_size = 1,
  point_border_col = "black",
  point_border_stroke = 0.1,
  show_legend = T,
  cow_n_col = 2,
  cow_rel_h = 1,
  cow_rel_w = 1,
  cow_align = "h",
  axis_scale = c("cube", "real", "custom"),
  custom_ratio = NULL,
  x_ticks = NULL,
  y_ticks = NULL,
  z_ticks = NULL,
  plot_method = c("ggplot", "plotly"),
  show_plots = F
)
```

**Arguments**

|  |  |
|--|--|
| <code>gobject</code>                     | giotto object                                |
| <code>expression_values</code>           | gene expression values to use                |
| <code>genes</code>                       | genes to show                                |
| <code>genes_high_color</code>            | color represents high gene expression        |
| <code>genes_mid_color</code>             | color represents middle gene expression      |
| <code>genes_low_color</code>             | color represents low gene expression         |
| <code>show_network</code>                | show underlying spatial network              |
| <code>network_color</code>               | color of spatial network                     |
| <code>spatial_network_name</code>        | name of spatial network to use               |
| <code>show_grid</code>                   | show spatial grid                            |
| <code>grid_color</code>                  | color of spatial grid                        |
| <code>spatial_grid_name</code>           | name of spatial grid to use                  |
| <code>midpoint</code>                    | expression midpoint                          |
| <code>scale_alpha_with_expression</code> | scale expression with ggplot alpha parameter |
| <code>point_size</code>                  | size of point (cell)                         |
| <code>point_border_col</code>            | color of border around points                |
| <code>point_border_stroke</code>         | stroke size of border around points          |
| <code>show_legend</code>                 | show legend                                  |
| <code>cow_n_col</code>                   | cowplot param: how many columns              |
| <code>cow_rel_h</code>                   | cowplot param: relative height               |
| <code>cow_rel_w</code>                   | cowplot param: relative width                |
| <code>cow_align</code>                   | cowplot param: how to align                  |
| <code>axis_scale</code>                  | three mode to adjust axis scale              |
| <code>x_ticks</code>                     | number of ticks on x axis                    |
| <code>y_ticks</code>                     | number of ticks on y axis                    |
| <code>z_ticks</code>                     | number of ticks on z axis                    |
| <code>plot_method</code>                 | two methods of plot                          |
| <code>show_plots</code>                  | show plots                                   |

**Details**

Description of parameters.

**Value**

ggplot or plotly

**Examples**

```
visGenePlot(gobject)
```

---

```
visGenePlot_2D_ggplot  visGenePlot_2D_ggplot
```

---

**Description**

Visualize cells and gene expression according to spatial coordinates

**Usage**

```
visGenePlot_2D_ggplot(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  genes,
  genes_high_color = "darkred",
  genes_mid_color = "white",
  genes_low_color = "darkblue",
  show_network = F,
  network_color = NULL,
  spatial_network_name = "spatial_network",
  edge_alpha = NULL,
  show_grid = F,
  grid_color = NULL,
  spatial_grid_name = "spatial_grid",
  midpoint = 0,
  scale_alpha_with_expression = FALSE,
  point_size = 1,
  point_border_col = "black",
  point_border_stroke = 0.1,
  show_legend = T,
  cow_n_col = 2,
  cow_rel_h = 1,
  cow_rel_w = 1,
  cow_align = "h",
  show_plots = F
)
```

**Arguments**

|                                |   |
|--------------------------------|---|
| <code>gobject</code>           | giotto object                           |
| <code>expression_values</code> | gene expression values to use           |
| <code>genes</code>             | genes to show                           |
| <code>genes_high_color</code>  | color represents high gene expression   |
| <code>genes_mid_color</code>   | color represents middle gene expression |

|                             |  |
|-----------------------------|--|
| genes_low_color             | color represents low gene expression         |
| show_network                | show underlying spatial network              |
| network_color               | color of spatial network                     |
| spatial_network_name        | name of spatial network to use               |
| show_grid                   | show spatial grid                            |
| grid_color                  | color of spatial grid                        |
| spatial_grid_name           | name of spatial grid to use                  |
| midpoint                    | expression midpoint                          |
| scale_alpha_with_expression | scale expression with ggplot alpha parameter |
| point_size                  | size of point (cell)                         |
| point_border_col            | color of border around points                |
| point_border_stroke         | stroke size of border around points          |
| show_legend                 | show legend                                  |
| cow_n_col                   | cowplot param: how many columns              |
| cow_rel_h                   | cowplot param: relative height               |
| cow_rel_w                   | cowplot param: relative width                |
| cow_align                   | cowplot param: how to align                  |
| show_plots                  | show plots                                   |

### Details

Description of parameters.

### Value

ggplot

### Examples

```
visGenePlot_2D_ggplot(gobject)
```

---

visGenePlot\_3D\_plotly    *visGenePlot\_3D\_plotly*

---

### Description

Visualize cells and gene expression according to spatial coordinates

**Usage**

```
visGenePlot_3D_plotly(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  genes,
  show_network = F,
  network_color = NULL,
  spatial_network_name = "spatial_network",
  edge_alpha = NULL,
  show_grid = F,
  genes_high_color = NULL,
  genes_mid_color = "white",
  genes_low_color = "blue",
  spatial_grid_name = "spatial_grid",
  point_size = 1,
  show_legend = T,
  axis_scale = c("cube", "real", "custom"),
  custom_ratio = NULL,
  x_ticks = NULL,
  y_ticks = NULL,
  z_ticks = NULL,
  show_plots = F
)
```

**Arguments**

|                                   |   |
|-----------------------------------|---|
| <code>gobject</code>              | giotto object                           |
| <code>expression_values</code>    | gene expression values to use           |
| <code>genes</code>                | genes to show                           |
| <code>show_network</code>         | show underlying spatial network         |
| <code>network_color</code>        | color of spatial network                |
| <code>spatial_network_name</code> | name of spatial network to use          |
| <code>show_grid</code>            | show spatial grid                       |
| <code>genes_high_color</code>     | color represents high gene expression   |
| <code>genes_mid_color</code>      | color represents middle gene expression |
| <code>genes_low_color</code>      | color represents low gene expression    |
| <code>spatial_grid_name</code>    | name of spatial grid to use             |
| <code>point_size</code>           | size of point (cell)                    |
| <code>show_legend</code>          | show legend                             |
| <code>axis_scale</code>           | three mode to adjust axis scale         |
| <code>x_ticks</code>              | number of ticks on x axis               |
| <code>y_ticks</code>              | number of ticks on y axis               |

|            |                                 |
|------------|---------------------------------|
| z_ticks    | number of ticks on z axis       |
| show_plots | show plots                      |
| grid_color | color of spatial grid           |
| cow_n_col  | cowplot param: how many columns |
| cow_rel_h  | cowplot param: relative height  |
| cow_rel_w  | cowplot param: relative width   |
| cow_align  | cowplot param: how to align     |

Details

Description of parameters.

Value

plotly

Examples

```
visGenePlot_3D_plotly(gobject)
```

---

|         |                |
|---------|----------------|
| visPlot | <i>visPlot</i> |
|---------|----------------|

---

Description

Visualize cells according to spatial coordinates

Usage

```
visPlot(  
  gobject,  
  sdimx = NULL,  
  sdimy = NULL,  
  sdimz = NULL,  
  point_size = 3,  
  point_border_col = "black",  
  point_border_stroke = 0.1,  
  cell_color = NULL,  
  cell_color_code = NULL,  
  color_as_factor = T,  
  select_cell_groups = NULL,  
  select_cells = NULL,  
  show_other_cells = T,  
  other_cell_color = "lightgrey",  
  show_network = F,  
  network_color = NULL,  
  network_alpha = 1,  
  other_cell_alpha = 0.1,  
  spatial_network_name = "spatial_network",  
  show_grid = F,  
)
```



```

    grid_color = NULL,
    grid_alpha = 1,
    spatial_grid_name = "spatial_grid",
    coord_fix_ratio = 0.6,
    title = "",
    show_legend = T,
    axis_scale = c("cube", "real", "custom"),
    custom_ratio = NULL,
    x_ticks = NULL,
    y_ticks = NULL,
    z_ticks = NULL,
    plot_method = c("ggplot", "plotly"),
    show_plot = F,
    return_plot = TRUE,
    save_plot = F,
    save_dir = NULL,
    save_folder = NULL,
    save_name = NULL,
    save_format = NULL,
    show_saved_plot = F,
    ...
)

```

### Arguments

|                                   |  |
|-----------------------------------|--|
| <code>gobject</code>              | giotto object  |
| <code>sdimx</code>                | x-axis dimension name (default = 'sdimx')                                  |
| <code>sdimy</code>                | y-axis dimension name (default = 'sdimy')                                  |
| <code>sdimz</code>                | z-axis dimension name (default = 'sdimz')                                  |
| <code>point_size</code>           | size of point (cell)   |
| <code>point_border_col</code>     | color of border around points  |
| <code>point_border_stroke</code>  | stroke size of border around points  |
| <code>cell_color</code>           | color for cells (see details)  |
| <code>cell_color_code</code>      | named vector with colors   |
| <code>color_as_factor</code>      | convert color column to factor   |
| <code>select_cell_groups</code>   | select subset of cells/clusters based on <code>cell_color</code> parameter |
| <code>select_cells</code>         | select subset of cells based on cell IDs                                   |
| <code>show_other_cells</code>     | display not selected cells   |
| <code>other_cell_color</code>     | color of not selected cells  |
| <code>show_network</code>         | show underlying spatial network  |
| <code>network_color</code>        | color of spatial network   |
| <code>spatial_network_name</code> | name of spatial network to use   |

|                   |   |
|-------------------|---|
| show_grid         | show spatial grid                               |
| grid_color        | color of spatial grid                           |
| spatial_grid_name | name of spatial grid to use                     |
| coord_fix_ratio   | fix ratio between x and y-axis                  |
| title             | title of plot                                   |
| show_legend       | show legend                                     |
| show_plot         | show plot                                       |
| return_plot       | return ggplot object                            |
| save_plot         | directly save the plot [boolean]                |
| save_dir          | directory to save the plot                      |
| save_folder       | (optional) folder in directory to save the plot |
| save_name         | name of plot                                    |
| save_format       | format of plot (e.g. tiff, png, pdf, ...)       |
| show_saved_plot   | load & display the saved plot                   |

Details

Description of parameters.

Value

ggplot

Examples

visPlot(gobject)

---

|                   |                          |
|-------------------|--------------------------|
| visPlot_2D_ggplot | <i>visPlot_2D_ggplot</i> |
|-------------------|--------------------------|

---

Description

Visualize cells according to spatial coordinates

Usage

```
visPlot_2D_ggplot(  
  gobject,  
  sdimx = NULL,  
  sdimy = NULL,  
  point_size = 3,  
  point_border_col = "black",  
  point_border_stroke = 0.1,  
  cell_color = NULL,  
  cell_color_code = NULL,
```

```

    color_as_factor = T,
    select_cell_groups = NULL,
    select_cells = NULL,
    show_other_cells = T,
    other_cell_color = "lightgrey",
    show_network = F,
    network_color = NULL,
    network_alpha = 1,
    other_cells_alpha = 0.1,
    spatial_network_name = "spatial_network",
    show_grid = F,
    grid_color = NULL,
    spatial_grid_name = "spatial_grid",
    coord_fix_ratio = 0.6,
    title = "",
    show_legend = T,
    axis_scale = c("cube", "real", "custom"),
    custom_ratio = NULL,
    x_ticks = NULL,
    y_ticks = NULL,
    z_ticks = NULL,
    show_plot = F,
    return_plot = TRUE,
    save_plot = F,
    save_dir = NULL,
    save_folder = NULL,
    save_name = NULL,
    save_format = NULL,
    show_saved_plot = F,
    ...
)

```

### Arguments

|                                  |  |
|----------------------------------|--|
| <code>gobject</code>             | giotto object  |
| <code>sdimx</code>               | x-axis dimension name (default = 'sdimx')                                  |
| <code>sdimy</code>               | y-axis dimension name (default = 'sdimy')                                  |
| <code>point_size</code>          | size of point (cell)   |
| <code>point_border_col</code>    | color of border around points  |
| <code>point_border_stroke</code> | stroke size of border around points  |
| <code>cell_color</code>          | color for cells (see details)  |
| <code>cell_color_code</code>     | named vector with colors   |
| <code>color_as_factor</code>     | convert color column to factor   |
| <code>select_cell_groups</code>  | select subset of cells/clusters based on <code>cell_color</code> parameter |
| <code>select_cells</code>        | select subset of cells based on cell IDs                                   |

|                      |   |
|----------------------|---|
| show_other_cells     | display not selected cells                      |
| other_cell_color     | color of not selected cells                     |
| show_network         | show underlying spatial network                 |
| network_color        | color of spatial network                        |
| spatial_network_name | name of spatial network to use                  |
| show_grid            | show spatial grid                               |
| grid_color           | color of spatial grid                           |
| spatial_grid_name    | name of spatial grid to use                     |
| coord_fix_ratio      | fix ratio between x and y-axis                  |
| title                | title of plot                                   |
| show_legend          | show legend                                     |
| show_plot            | show plot                                       |
| return_plot          | return ggplot object                            |
| save_plot            | directly save the plot [boolean]                |
| save_dir             | directory to save the plot                      |
| save_folder          | (optional) folder in directory to save the plot |
| save_name            | name of plot                                    |
| save_format          | format of plot (e.g. tiff, png, pdf, ...)       |
| show_saved_plot      | load & display the saved plot                   |

## Details

Description of parameters.

## Value

ggplot

## Examples

```
visPlot_2D_ggplot(gobject)
```

---

|                   |                          |
|-------------------|--------------------------|
| visPlot_2D_plotly | <i>visPlot_2D_plotly</i> |
|-------------------|--------------------------|

---

## Description

Visualize cells according to spatial coordinates

## Usage

```
visPlot_2D_plotly(
  gobject,
  sdimx = NULL,
  sdimy = NULL,
  point_size = 3,
  cell_color = NULL,
  cell_color_code = NULL,
  color_as_factor = T,
  select_cell_groups = NULL,
  select_cells = NULL,
  show_other_cells = T,
  other_cell_color = "lightgrey",
  other_point_size = 0.5,
  show_network = F,
  network_color = "lightgray",
  network_alpha = 1,
  other_cell_alpha = 0.5,
  spatial_network_name = "spatial_network",
  show_grid = F,
  grid_color = NULL,
  grid_alpha = 1,
  spatial_grid_name = "spatial_grid",
  show_legend = T,
  axis_scale = c("cube", "real", "custom"),
  custom_ratio = NULL,
  x_ticks = NULL,
  y_ticks = NULL,
  show_plot = F
)
```

## Arguments

|                              |   |
|------------------------------|---|
| <code>gobject</code>         | giotto object                             |
| <code>sdimx</code>           | x-axis dimension name (default = 'sdimx') |
| <code>sdimy</code>           | y-axis dimension name (default = 'sdimy') |
| <code>point_size</code>      | size of point (cell)                      |
| <code>cell_color</code>      | color for cells (see details)             |
| <code>cell_color_code</code> | named vector with colors                  |
| <code>color_as_factor</code> | convert color column to factor            |

|                      |   |
|----------------------|---|
| select_cell_groups   | select a subset of the groups from cell_color |
| show_network         | show underlying spatial network               |
| network_color        | color of spatial network                      |
| spatial_network_name | name of spatial network to use                |
| show_grid            | show spatial grid                             |
| grid_color           | color of spatial grid                         |
| grid_alpha           | alpha of spatial grid                         |
| spatial_grid_name    | name of spatial grid to use                   |
| show_legend          | show legend                                   |
| show_plot            | show plot                                     |

Details

Description of parameters.

Value

plotly

Examples

visPlot\_2D\_plotly(gobject)

---

|                   |                          |
|-------------------|--------------------------|
| visPlot_3D_plotly | <i>visPlot_3D_plotly</i> |
|-------------------|--------------------------|

---

Description

Visualize cells according to spatial coordinates

Usage

```
visPlot_3D_plotly(  
  gobject,  
  sdimx = NULL,  
  sdimy = NULL,  
  sdimz = NULL,  
  point_size = 3,  
  cell_color = NULL,  
  cell_color_code = NULL,  
  select_cell_groups = NULL,  
  select_cells = NULL,  
  show_other_cells = T,  
  other_cell_color = "lightgrey",  
  other_point_size = 0.5,  
  show_network = F,
```

```

    network_color = NULL,
    network_alpha = 1,
    other_cell_alpha = 0.5,
    spatial_network_name = "spatial_network",
    spatial_grid_name = "spatial_grid",
    title = "",
    show_legend = T,
    axis_scale = c("cube", "real", "custom"),
    custom_ratio = NULL,
    x_ticks = NULL,
    y_ticks = NULL,
    z_ticks = NULL,
    show_plot = F
)

```

### Arguments

|                                   |  |
|-----------------------------------|--|
| <code>gobject</code>              | giotto object  |
| <code>sdimx</code>                | x-axis dimension name (default = 'sdimx')                  |
| <code>sdimy</code>                | y-axis dimension name (default = 'sdimy')                  |
| <code>sdimz</code>                | z-axis dimension name (default = 'sdimz')                  |
| <code>point_size</code>           | size of point (cell)                                       |
| <code>cell_color</code>           | color for cells (see details)                              |
| <code>cell_color_code</code>      | named vector with colors                                   |
| <code>select_cell_groups</code>   | select a subset of the groups from <code>cell_color</code> |
| <code>show_network</code>         | show underlying spatial network                            |
| <code>network_color</code>        | color of spatial network                                   |
| <code>spatial_network_name</code> | name of spatial network to use                             |
| <code>spatial_grid_name</code>    | name of spatial grid to use                                |
| <code>title</code>                | title of plot  |
| <code>show_legend</code>          | show legend  |
| <code>show_plot</code>            | show plot  |
| <code>point_border_col</code>     | color of border around points                              |
| <code>point_border_stroke</code>  | stroke size of border around points                        |
| <code>color_as_factor</code>      | convert color column to factor                             |
| <code>show_grid</code>            | show spatial grid  |
| <code>grid_color</code>           | color of spatial grid                                      |
| <code>coord_fix_ratio</code>      | fix ratio between x and y-axis                             |

**Details**

Description of parameters.

**Value**

ggplot

**Examples**

```
visPlot_3D_plotly(gobject)
```

---

|                    |                           |
|--------------------|---------------------------|
| visSpatDimGenePlot | <i>visSpatDimGenePlot</i> |
|--------------------|---------------------------|

---

**Description**

integration of visSpatDimGenePlot\_2D(ggplot) and visSpatDimGenePlot\_3D(plotly)

**Usage**

```
visSpatDimGenePlot(
  gobject,
  plot_method = c("ggplot", "plotly"),
  expression_values = c("normalized", "scaled", "custom"),
  plot_alignment = c("horizontal", "vertical"),
  dim_reduction_to_use = "umap",
  dim_reduction_name = "umap",
  dim1_to_use = 1,
  dim2_to_use = 2,
  dim3_to_use = NULL,
  sdimx = NULL,
  sdimy = NULL,
  sdimz = NULL,
  genes,
  dim_point_border_col = "black",
  dim_point_border_stroke = 0.1,
  show_NN_network = F,
  nn_network_to_use = "sNN",
  network_name = "sNN.pca",
  edge_alpha_dim = NULL,
  scale_alpha_with_expression = FALSE,
  label_size = 16,
  genes_low_color = "blue",
  genes_mid_color = "white",
  genes_high_color = "red",
  dim_point_size = 3,
  nn_network_alpha = 0.5,
  show_spatial_network = F,
  spatial_network_name = "spatial_network",
  network_color = "lightgray",
  spatial_network_alpha = 0.5,
```



```

show_spatial_grid = F,
spatial_grid_name = "spatial_grid",
spatial_grid_color = NULL,
spatial_grid_alpha = 0.5,
spatial_point_size = 3,
spatial_point_border_col = "black",
spatial_point_border_stroke = 0.1,
legend_text_size = 12,
axis_scale = c("cube", "real", "custom"),
custom_ratio = NULL,
x_ticks = NULL,
y_ticks = NULL,
z_ticks = NULL,
midpoint = 0,
point_size = 1,
cow_n_col = 2,
cow_rel_h = 1,
cow_rel_w = 1,
cow_align = "h",
show_legend = T,
show_plots = F
)

```

### Arguments

|                                      |   |
|--------------------------------------|---|
| <code>gobject</code>                 | giotto object   |
| <code>expression_values</code>       | gene expression values to use                                     |
| <code>plot_alignment</code>          | direction to align plot   |
| <code>dim_reduction_to_use</code>    | dimension reduction to use  |
| <code>dim_reduction_name</code>      | dimension reduction name  |
| <code>dim1_to_use</code>             | dimension to use on x-axis  |
| <code>dim2_to_use</code>             | dimension to use on y-axis  |
| <code>dim3_to_use</code>             | dimension to use on z-axis  |
| <code>sdimx</code>                   | x-axis dimension name (default = 'sdimx')                         |
| <code>sdimy</code>                   | y-axis dimension name (default = 'sdimy')                         |
| <code>sdimz</code>                   | z-axis dimension name (default = 'sdimz')                         |
| <code>genes</code>                   | genes to show   |
| <code>dim_point_border_col</code>    | color of border around points                                     |
| <code>dim_point_border_stroke</code> | stroke size of border around points                               |
| <code>show_NN_network</code>         | show underlying NN network  |
| <code>nn_network_to_use</code>       | type of NN network to use (kNN vs sNN)                            |
| <code>network_name</code>            | name of NN network to use, if <code>show_NN_network = TRUE</code> |

|                             |  |
|-----------------------------|--|
| edge_alpha_dim              | dim reduction plot: column to use for alpha of the edges |
| scale_alpha_with_expression | scale expression with ggplot alpha parameter             |
| label_size                  | size for the label                                       |
| genes_low_color             | color to represent low expression of gene                |
| genes_high_color            | color to represent high expression of gene               |
| dim_point_size              | dim reduction plot: point size                           |
| spatial_network_name        | name of spatial network to use                           |
| spatial_grid_name           | name of spatial grid to use                              |
| spatial_point_size          | spatial plot: point size                                 |
| spatial_point_border_col    | color of border around points                            |
| spatial_point_border_stroke | stroke size of border around points                      |
| legend_text_size            | the size of the text in legend                           |
| axis_scale                  | three modes to adjust axis scale ratio                   |
| custom_ratio                | set the axis scale ratio on custom                       |
| x_ticks                     | number of ticks on x axis                                |
| y_ticks                     | number of ticks on y axis                                |
| z_ticks                     | number of ticks on z axis                                |
| midpoint                    | size of point (cell)                                     |
| point_size                  | size of point (cell)                                     |
| cow_n_col                   | cowplot param: how many columns                          |
| cow_rel_h                   | cowplot param: relative height                           |
| cow_rel_w                   | cowplot param: relative width                            |
| cow_align                   | cowplot param: how to align                              |
| show_legend                 | show legend  |
| show_plot                   | show plot  |

## Details

Description of parameters.

## Value

ggplot or plotly

## Examples

```
visSpatDimGenePlot(gobject)
```

---

visSpatDimGenePlot\_2D    *visSpatDimGenePlot\_2D*


---

## Description

Visualize cells according to spatial AND dimension reduction coordinates in ggplot mode

## Usage

```
visSpatDimGenePlot_2D(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  plot_alignment = c("horizontal", "vertical"),
  genes,
  dim_reduction_to_use = "umap",
  dim_reduction_name = "umap",
  dim1_to_use = 1,
  dim2_to_use = 2,
  point_size = 1,
  dim_point_border_col = "black",
  dim_point_border_stroke = 0.1,
  show_NN_network = F,
  show_spatial_network = F,
  show_spatial_grid = F,
  nn_network_to_use = "sNN",
  network_name = "sNN.pca",
  edge_alpha_dim = NULL,
  scale_alpha_with_expression = FALSE,
  spatial_network_name = "spatial_network",
  spatial_grid_name = "spatial_grid",
  spatial_point_size = 1,
  spatial_point_border_col = "black",
  spatial_point_border_stroke = 0.1,
  midpoint = 0,
  genes_high_color = "red",
  genes_mid_color = "white",
  genes_low_color = "blue",
  cow_n_col = 2,
  cow_rel_h = 1,
  cow_rel_w = 1,
  cow_align = "h",
  axis_scale = c("cube", "real", "custom"),
  custom_ratio = NULL,
  x_ticks = NULL,
  y_ticks = NULL,
  show_legend = T,
  show_plots = F
)
```

## Arguments

gobject                      giotto object

|                             |  |
|-----------------------------|--|
| expression_values           | gene expression values to use                            |
| plot_alignment              | direction to align plot                                  |
| genes                       | genes to show  |
| dim_reduction_to_use        | dimension reduction to use                               |
| dim_reduction_name          | dimension reduction name                                 |
| dim1_to_use                 | dimension to use on x-axis                               |
| dim2_to_use                 | dimension to use on y-axis                               |
| point_size                  | size of point (cell)                                     |
| dim_point_border_col        | color of border around points                            |
| dim_point_border_stroke     | stroke size of border around points                      |
| show_NN_network             | show underlying NN network                               |
| nn_network_to_use           | type of NN network to use (kNN vs sNN)                   |
| network_name                | name of NN network to use, if show_NN_network = TRUE     |
| edge_alpha_dim              | dim reduction plot: column to use for alpha of the edges |
| scale_alpha_with_expression | scale expression with ggplot alpha parameter             |
| spatial_network_name        | name of spatial network to use                           |
| spatial_grid_name           | name of spatial grid to use                              |
| spatial_point_size          | spatial plot: point size                                 |
| spatial_point_border_col    | color of border around points                            |
| spatial_point_border_stroke | stroke size of border around points                      |
| midpoint                    | size of point (cell)                                     |
| cow_n_col                   | cowplot param: how many columns                          |
| cow_rel_h                   | cowplot param: relative height                           |
| cow_rel_w                   | cowplot param: relative width                            |
| cow_align                   | cowplot param: how to align                              |
| show_legend                 | show legend  |
| dim_point_size              | dim reduction plot: point size                           |
| show_plot                   | show plot  |

## Details

Description of parameters.

**Value**

ggplot

**Examples**

```
visSpatDimGenePlot_2D(gobject)
```

---

```
visSpatDimGenePlot_3D  visSpatDimGenePlot_3D
```

---

**Description**

Visualize cells according to spatial AND dimension reduction coordinates in plotly mode

**Usage**

```
visSpatDimGenePlot_3D(
  gobject,
  expression_values = c("normalized", "scaled", "custom"),
  plot_alignment = c("horizontal", "vertical"),
  dim_reduction_to_use = "umap",
  dim_reduction_name = "umap",
  dim1_to_use = 1,
  dim2_to_use = 2,
  dim3_to_use = NULL,
  sdimx = NULL,
  sdimy = NULL,
  sdimz = NULL,
  genes,
  show_NN_network = F,
  nn_network_to_use = "sNN",
  network_name = "sNN.pca",
  label_size = 16,
  genes_low_color = "blue",
  genes_mid_color = "white",
  genes_high_color = "red",
  dim_point_size = 3,
  nn_network_alpha = 0.5,
  show_spatial_network = F,
  spatial_network_name = "spatial_network",
  network_color = "lightgray",
  spatial_network_alpha = 0.5,
  show_spatial_grid = F,
  spatial_grid_name = "spatial_grid",
  spatial_grid_color = NULL,
  spatial_grid_alpha = 0.5,
  spatial_point_size = 3,
  legend_text_size = 12,
  axis_scale = c("cube", "real", "custom"),
  custom_ratio = NULL,
  x_ticks = NULL,
```

```

    y_ticks = NULL,
    z_ticks = NULL
  )

```

### Arguments

|                                    |   |
|------------------------------------|---|
| <code>gobject</code>               | giotto object   |
| <code>plot_alignment</code>        | direction to align plot   |
| <code>dim_reduction_to_use</code>  | dimension reduction to use  |
| <code>dim_reduction_name</code>    | dimension reduction name  |
| <code>dim1_to_use</code>           | dimension to use on x-axis  |
| <code>dim2_to_use</code>           | dimension to use on y-axis  |
| <code>dim3_to_use</code>           | dimension to use on z-axis  |
| <code>show_NN_network</code>       | show underlying NN network  |
| <code>nn_network_to_use</code>     | type of NN network to use (kNN vs sNN)                            |
| <code>network_name</code>          | name of NN network to use, if <code>show_NN_network = TRUE</code> |
| <code>genes_low_color</code>       | color represent high gene expression (see details)                |
| <code>genes_high_color</code>      | color represent high gene expression (see details)                |
| <code>nn_network_alpha</code>      | column to use for alpha of the edges                              |
| <code>show_spatial_network</code>  | show spatial network  |
| <code>spatial_network_name</code>  | name of spatial network to use                                    |
| <code>network_color</code>         | color of spatial/nn network                                       |
| <code>spatial_network_alpha</code> | alpha of spatial network  |
| <code>show_spatial_grid</code>     | show spatial grid   |
| <code>spatial_grid_name</code>     | name of spatial grid to use                                       |
| <code>spatial_grid_color</code>    | color of spatial grid   |
| <code>spatial_grid_alpha</code>    | alpha of spatial grid   |
| <code>legend_text_size</code>      | text size of legend   |
| <code>show_legend</code>           | show legend   |
| <code>show_plot</code>             | show plot   |

### Details

Description of parameters.

**Value**

plotly

**Examples**

```
visSpatDimPlot_3D(gobject)
```

---

visSpatDimPlot

*visSpatDimPlot*


---

**Description**

integration of visSpatDimPlot\_2D and visSpatDimPlot\_3D

**Usage**

```
visSpatDimPlot(
  gobject,
  plot_method = c("ggplot", "plotly"),
  plot_alignment = NULL,
  dim_reduction_to_use = "umap",
  dim_reduction_name = "umap",
  dim1_to_use = 1,
  dim2_to_use = 2,
  dim3_to_use = NULL,
  sdims = NULL,
  sdims = NULL,
  sdims = NULL,
  show_NN_network = F,
  nn_network_to_use = "sNN",
  network_name = "sNN.pca",
  show_cluster_center = F,
  show_center_label = T,
  center_point_size = 4,
  label_size = NULL,
  label_fontface = "bold",
  cell_color = NULL,
  color_as_factor = T,
  cell_color_code = NULL,
  select_cell_groups = NULL,
  select_cells = NULL,
  show_other_cells = T,
  other_cell_color = "lightgrey",
  dim_point_size = 3,
  dim_point_border_col = "black",
  dim_point_border_stroke = 0.1,
  nn_network_alpha = NULL,
  show_spatial_network = F,
  spatial_network_name = "spatial_network",
  network_color = "lightgray",
  spatial_network_alpha = 0.5,
```

```

show_spatial_grid = F,
spatial_grid_name = "spatial_grid",
spatial_grid_color = NULL,
spatial_grid_alpha = 0.5,
spatial_point_size = 3,
legend_text_size = 12,
spatial_point_border_col = "black",
spatial_point_border_stroke = 0.1,
show_legend = T,
axis_scale = c("cube", "real", "custom"),
custom_ratio = NULL,
x_ticks = NULL,
y_ticks = NULL,
z_ticks = NULL,
show_plot = F
)

```

### Arguments

|                                   |  |
|-----------------------------------|--|
| <code>gobject</code>              | giotto object  |
| <code>plot_alignment</code>       | direction to align plot  |
| <code>dim_reduction_to_use</code> | dimension reduction to use   |
| <code>dim_reduction_name</code>   | dimension reduction name   |
| <code>dim1_to_use</code>          | dimension to use on x-axis   |
| <code>dim2_to_use</code>          | dimension to use on y-axis   |
| <code>dim3_to_use</code>          | dimension to use on z-axis   |
| <code>show_NN_network</code>      | show underlying NN network   |
| <code>nn_network_to_use</code>    | type of NN network to use (kNN vs sNN)                                     |
| <code>network_name</code>         | name of NN network to use, if <code>show_NN_network = TRUE</code>          |
| <code>cell_color</code>           | color for cells (see details)  |
| <code>color_as_factor</code>      | convert color column to factor   |
| <code>cell_color_code</code>      | named vector with colors   |
| <code>select_cell_groups</code>   | select subset of cells/clusters based on <code>cell_color</code> parameter |
| <code>select_cells</code>         | select subset of cells based on cell IDs                                   |
| <code>show_other_cells</code>     | display not selected cells   |
| <code>other_cell_color</code>     | color of not selected cells  |
| <code>nn_network_alpha</code>     | column to use for alpha of the edges                                       |
| <code>show_spatial_network</code> | show spatial network   |



```

spatial_network_name
    name of spatial network to use
spatial_network_alpha
    alpha of spatial network
show_spatial_grid
    show spatial grid
spatial_grid_name
    name of spatial grid to use
spatial_grid_color
    color of spatial grid
spatial_grid_alpha
    alpha of spatial grid
legend_text_size
    text size of legend
show_legend
    show legend
show_plot
    show plot
plot_mode
    choose the mode to draw plot : ggplot or plotly
spatial_network_color
    color of spatial network

```

### Details

Description of parameters.

### Value

ggplot or plotly

### Examples

```
visSpatDimPlot(gobject)
```

---

|                   |                          |
|-------------------|--------------------------|
| visSpatDimPlot_2D | <i>visSpatDimPlot_2D</i> |
|-------------------|--------------------------|

---

### Description

Visualize cells according to spatial AND dimension reduction coordinates in ggplot2 mode

### Usage

```

visSpatDimPlot_2D(
  gobject,
  plot_alignment = c("vertical", "horizontal"),
  dim_reduction_to_use = "umap",
  dim_reduction_name = "umap",
  dim1_to_use = 1,
  dim2_to_use = 2,
  sdimx = NULL,
  sdimy = NULL,

```

```

show_NN_network = F,
nn_network_to_use = "sNN",
network_name = "sNN.pca",
show_cluster_center = F,
show_center_label = T,
center_point_size = 4,
label_size = 4,
label_fontface = "bold",
cell_color = NULL,
color_as_factor = T,
cell_color_code = NULL,
select_cell_groups = NULL,
select_cells = NULL,
show_other_cells = T,
other_cell_color = "lightgrey",
dim_plot_mode = NULL,
dim_point_size = 1,
dim_point_border_col = "black",
dim_point_border_stroke = 0.1,
nn_network_alpha = 0.05,
show_spatial_network = F,
spatial_network_name = "spatial_network",
spatial_network_color = NULL,
show_spatial_grid = F,
spatial_grid_name = "spatial_grid",
spatial_grid_color = NULL,
spatial_point_size = 1,
spatial_point_border_col = "black",
spatial_point_border_stroke = 0.1,
show_legend = T,
show_plot = F,
plot_method = "ggplot"
)

```

### Arguments

|                                   |   |
|-----------------------------------|---|
| <code>gobject</code>              | giotto object   |
| <code>plot_alignment</code>       | direction to align plot   |
| <code>dim_reduction_to_use</code> | dimension reduction to use  |
| <code>dim_reduction_name</code>   | dimension reduction name  |
| <code>dim1_to_use</code>          | dimension to use on x-axis  |
| <code>dim2_to_use</code>          | dimension to use on y-axis  |
| <code>show_NN_network</code>      | show underlying NN network  |
| <code>nn_network_to_use</code>    | type of NN network to use (kNN vs sNN)                            |
| <code>network_name</code>         | name of NN network to use, if <code>show_NN_network = TRUE</code> |
| <code>cell_color</code>           | color for cells (see details)                                     |

|                       |   |
|-----------------------|---|
| color_as_factor       | convert color column to factor                                |
| cell_color_code       | named vector with colors                                      |
| select_cell_groups    | select subset of cells/clusters based on cell_color parameter |
| select_cells          | select subset of cells based on cell IDs                      |
| show_other_cells      | display not selected cells                                    |
| other_cell_color      | color of not selected cells                                   |
| nn_network_alpha      | column to use for alpha of the edges                          |
| show_spatial_network  | show spatial network  |
| spatial_network_name  | name of spatial network to use                                |
| spatial_network_color | color of spatial network                                      |
| show_spatial_grid     | show spatial grid   |
| spatial_grid_name     | name of spatial grid to use                                   |
| spatial_grid_color    | color of spatial grid   |
| show_legend           | show legend   |
| show_plot             | show plot   |
| return_plot           | return ggplot object  |
| save_plot             | directly save the plot [boolean]                              |
| save_dir              | directory to save the plot                                    |
| save_folder           | (optional) folder in directory to save the plot               |
| save_name             | name of plot  |
| save_format           | format of plot (e.g. tiff, png, pdf, ...)                     |
| show_saved_plot       | load & display the saved plot                                 |

### Details

Description of parameters.

### Value

ggplot

### Examples

```
visSpatDimPlot_2D(gobject)
```

---

|                   |                          |
|-------------------|--------------------------|
| visSpatDimPlot_3D | <i>visSpatDimPlot_3D</i> |
|-------------------|--------------------------|

---

## Description

Visualize cells according to spatial AND dimension reduction coordinates in plotly mode

## Usage

```
visSpatDimPlot_3D(
  gobject,
  plot_alignment = c("horizontal", "vertical"),
  dim_reduction_to_use = "umap",
  dim_reduction_name = "umap",
  dim1_to_use = 1,
  dim2_to_use = 2,
  dim3_to_use = NULL,
  sdims = NULL,
  sdims = NULL,
  sdims = NULL,
  show_NN_network = F,
  nn_network_to_use = "sNN",
  network_name = "sNN.pca",
  show_cluster_center = F,
  show_center_label = T,
  center_point_size = 4,
  label_size = 16,
  cell_color = NULL,
  color_as_factor = T,
  cell_color_code = NULL,
  dim_point_size = 3,
  nn_network_alpha = 0.5,
  show_spatial_network = F,
  spatial_network_name = "spatial_network",
  network_color = "lightgray",
  spatial_network_alpha = 0.5,
  show_spatial_grid = F,
  spatial_grid_name = "spatial_grid",
  spatial_grid_color = NULL,
  spatial_grid_alpha = 0.5,
  spatial_point_size = 3,
  axis_scale = c("cube", "real", "custom"),
  custom_ratio = NULL,
  x_ticks = NULL,
  y_ticks = NULL,
  z_ticks = NULL,
  legend_text_size = 12
)
```

## Arguments

gobject                  giotto object

|                       |  |
|-----------------------|--|
| plot_alignment        | direction to align plot                              |
| dim_reduction_to_use  | dimension reduction to use                           |
| dim_reduction_name    | dimension reduction name                             |
| dim1_to_use           | dimension to use on x-axis                           |
| dim2_to_use           | dimension to use on y-axis                           |
| dim3_to_use           | dimension to use on z-axis                           |
| show_NN_network       | show underlying NN network                           |
| nn_network_to_use     | type of NN network to use (kNN vs sNN)               |
| network_name          | name of NN network to use, if show_NN_network = TRUE |
| cell_color            | color for cells (see details)                        |
| color_as_factor       | convert color column to factor                       |
| cell_color_code       | named vector with colors                             |
| nn_network_alpha      | column to use for alpha of the edges                 |
| show_spatial_network  | show spatial network                                 |
| spatial_network_name  | name of spatial network to use                       |
| spatial_network_alpha | alpha of spatial network                             |
| show_spatial_grid     | show spatial grid                                    |
| spatial_grid_name     | name of spatial grid to use                          |
| spatial_grid_color    | color of spatial grid                                |
| spatial_grid_alpha    | alpha of spatial grid                                |
| legend_text_size      | text size of legend                                  |
| spatial_network_color | color of spatial network                             |
| show_legend           | show legend  |
| show_plot             | show plot  |

## Details

Description of parameters.

## Value

plotly

**Examples**

```
visSpatDimPlot_3D(gobject)
```

---

|                 |                        |
|-----------------|------------------------|
| writeHMRResults | <i>writeHMRResults</i> |
|-----------------|------------------------|

---

**Description**

write results from doHMRF to a data.table.

**Usage**

```
writeHMRResults(
  gobject,
  HMRFoutput,
  k = NULL,
  betas_to_view = NULL,
  print_command = F
)
```

**Arguments**

|               |  |
|---------------|--|
| gobject       | giotto object                                      |
| HMRFoutput    | HMRF output from doHMRF                            |
| k             | k to write results for                             |
| betas_to_view | results from different betas that you want to view |
| print_command | see the python command                             |

**Value**

data.table with HMRF results for each b and the selected k

**Examples**

```
writeHMRResults(gobject)
```

---

|                                |                                       |
|--------------------------------|---------------------------------------|
| write_giotto_viewer_annotation | <i>write_giotto_viewer_annotation</i> |
|--------------------------------|---------------------------------------|

---

**Description**

write out factor-like annotation data from a giotto object for the Viewer

**Usage**

```
write_giotto_viewer_annotation(
  annotation,
  annot_name = "test",
  output_directory = getwd()
)
```

**Arguments**

|                  |   |
|------------------|---|
| annotation       | annotation from the data.table from giotto object |
| annot_name       | name of the annotation                            |
| output_directory | directory where to save the files                 |

**Value**

write a .txt and .annot file for the selection annotation

---

```
write_giotto_viewer_dim_reduction
      write_giotto_viewer_dim_reduction
```

---

**Description**

write out dimensional reduction data from a giotto object for the Viewer

**Usage**

```
write_giotto_viewer_dim_reduction(
  dim_reduction_cell,
  dim_red = NULL,
  dim_red_name = NULL,
  dim_red_rounding = NULL,
  dim_red_rescale = c(-20, 20),
  output_directory = getwd()
)
```

**Arguments**

|                    |   |
|--------------------|---|
| dim_reduction_cell | dimension reduction slot from giotto object       |
| dim_red            | high level name of dimension reduction            |
| dim_red_name       | specific name of dimension reduction to use       |
| dim_red_rounding   | numerical indicating how to round the coordinates |
| dim_red_rescale    | numericals to rescale the coordinates             |
| output_directory   | directory where to save the files                 |

**Value**

write a .txt and .annot file for the selection annotation

---

```
write_giotto_viewer_numeric_annotation  
    write_giotto_viewer_numeric_annotation
```

---

**Description**

write out numeric annotation data from a giotto object for the Viewer

**Usage**

```
write_giotto_viewer_numeric_annotation(  
  annotation,  
  annot_name = "test",  
  output_directory = getwd()  
)
```

**Arguments**

|                  |   |
|------------------|---|
| annotation       | annotation from the data.table from giotto object |
| annot_name       | name of the annotation                            |
| output_directory | directory where to save the files                 |

**Value**

write a .txt and .annot file for the selection annotation



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