Package ‘nipalsMCIA’

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Title Multiple Co-Inertia Analysis via the NIPALS Method

Version 1.0.0

Description Computes Multiple Co-Inertia Analysis (MCIA), a dimensionality reduction (jDR) algorithm, for a multi-block dataset using a modification to the Nonlinear Iterative Partial Least Squares method (NIPALS) proposed in (Hanafi et. al, 2010). Allows multiple options for row- and table-level preprocessing, and speeds up computation of variance explained. Vignettes detail application to bulk- and single cell- multi-omics studies.

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URL https://github.com/Muunraker/nipalsMCIA

BugReports https://github.com/Muunraker/nipalsMCIA/issues

Depends R (>= 4.3.0)

Imports ComplexHeatmap, dplyr, fgsea, ggplot2 (>= 3.0.0), graphics, grid, methods, MultiAssayExperiment, SummarizedExperiment, pracma, rlang, RSpectra, scales, stats

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nipalsMCIA-package

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### nipalsMCIA-package

**nipalsMCIA: Multiple Co-Inertia Analysis via the NIPALS Method**

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**Description**

Computes Multiple Co-Inertia Analysis (MCIA), a dimensionality reduction (jDR) algorithm, for a multi-block dataset using a modification to the Nonlinear Iterative Partial Least Squares method (NIPALS) proposed in (Hanafi et. al, 2010). Allows multiple options for row- and table-level preprocessing, and speeds up computation of variance explained. Vignettes detail application to bulk- and single cell- multi-omics studies.

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**See Also**

Useful links:

- [https://github.com/Muunraker/nipalsMCIA](https://github.com/Muunraker/nipalsMCIA)
- Report bugs at [https://github.com/Muunraker/nipalsMCIA/issues](https://github.com/Muunraker/nipalsMCIA/issues)

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**block_preproc**

**Block-level preprocessing**

---

**Description**

A function that normalizes an input dataset (data block) according to a variety of options. Intended to be used after column/row-level normalization.

**Usage**

```r
block_preproc(df, block_preproc_method)
```
block_weights_heatmap

Arguments

df dataset to preprocess (must be in data matrix form)

block_preproc_method method which is used to normalize blocks, with options:
  • ‘unit_var’ FOR CENTERED MATRICES ONLY - divides each block by the square root of its variance
  • ‘num_cols’ divides each block by the number of variables in the block.
  • ‘largest_sv’ divides each block by its largest singular value.
  • ‘none’ performs no preprocessing

Value

the preprocessed dataset

Examples

df <- matrix(rbinom(15, 1, prob = 0.3), ncol = 3)
preprocessed_dataframe <- block_preproc(df,"unit_var")

block_weights_heatmap

Description

Function to plot heatmap of block score weights

Usage

block_weights_heatmap(mcia_results)

Arguments

mcia_results MCIA results object returned from ‘nipals_multiblock’

Details

Plotting function for heatmap of block score weights

Value

heatmap object containing the block weights as a heatmap
**cc_preproc**

### Description

Converts data blocks into centered column profiles where each block has unit variance. Mimics the pre-processing in the Omicade4 package (Meng et al. 2014)

### Usage

```r
cc_preproc(df)
```

### Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>df</td>
<td>the data frame to apply pre-processing to, in &quot;sample&quot; x &quot;variable&quot; format</td>
</tr>
</tbody>
</table>

### Details

Performs the following steps on a given data frame:

- Offsets data to make whole matrix non-negative
- Divides each column by its sum
- Subtracts (row sum/total sum) from each row
- Multiplies each column by sqrt(column sum/total sum)
- Divides the whole data frame by its total variance (the sqrt of the sum of singular values)

### Value

the processed data frame

### Examples

```r
df <- matrix(rbinom(15, 1, prob = 0.3), ncol = 3)
preprocessed_dataframe <- cc_preproc(df)
```
Centered Column Profile Pre-processing

Description

Converts data blocks into centered column profiles where each block has unit variance. Mimics the pre-processing in the Omicade4 package (Meng et al. 2014)

Usage

```r
col_preproc(df, col_preproc_method)
```

Arguments

- `df` - the data frame to apply pre-processing to, in "sample" x "variable" format
- `col_preproc_method` - denotes the type of column-centered preprocessing. Options are:
  - 'colprofile' Performs the following steps on a given data frame:
    - Offsets data to make whole matrix non-negative
    - Divides each column by its sum
    - Subtracts (row sum/total sum) from each row
    - Multiplies each column by sqrt(column sum/total sum)
  - 'standardized' centers each column and divides by its standard deviation.
  - 'centered_only' ONLY centers data

Details

Performs preprocessing on a sample/variable (row/column) level according to the parameter given.

Value

the processed data frame

Examples

```r
df <- matrix(rbinom(15, 1, prob = 0.3), ncol = 3)
preprocessed_dataframe <- col_preproc(df, col_preproc_method = 'colprofile')
```
**data_blocks**

---

**NCI-60 Multi-Omics Data**

**Description**

A dataset of measurements of 12,895 mRNA, 537 miRNA, and 7,016 protein variables (columns) on 21 cancer cell lines (rows) from the NCI-60 cancer cell line database.

**Value**

Large list with 3 elements (one for each omic)

**Source**

Meng et. al, 2016 supplementary materials https://doi.org/10.1093/bib/bbv108

**References**

https://github.com/aedin/NCI60Example

---

**deflate_block_bl**

**Deflation via block loadings**

**Description**

Removes data from a data frame in the direction of a given block loadings vector.

**Usage**

deflate_block_bl(df, bl)

**Arguments**

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>df</td>
<td>a data frame in &quot;sample&quot; x &quot;variable&quot; format</td>
</tr>
<tr>
<td>bl</td>
<td>a block loadings vector in variable space</td>
</tr>
</tbody>
</table>

**Details**

Subtracts the component of each row in the direction of a given block loadings vector to yield a ‘deflated’ data matrix.

**Value**

the deflated data frame
Examples

```r
df <- matrix(rbinom(15, 1, prob = 0.3), ncol = 3)
block_loading <- rbinom(3, 1, prob = 0.3)
deflated_data <- deflate_block_bl(df, block_loading)
```

---

deflate_block_gs  
**Deflation via global scores**

Description

Removes data from a data frame in the direction of a given global scores vector.

Usage

```r
deflate_block_gs(df, gs)
```

Arguments

- `df`: a data frame in "sample" x "variable" format
- `gs`: a global scores vector in sample space

Details

Subtracts the component of each column in the direction of a given global scores vector to yield a ‘deflated’ data matrix.

Value

the deflated data frame

Examples

```r
df <- matrix(rbinom(15, 1, prob = 0.3), ncol = 3)
global_score <- rbinom(5, 1, prob = 0.3)
deflated_data <- deflate_block_gs(df, global_score)
```
**extract_from_mae**

*Extract a list of harmonized data matrices from an MAE object*

**Description**

Extract a list of harmonized data matrices for input into nipals_multiblock() from an MAE object.

**Usage**

```r
extract_from_mae(MAE_object, subset_data = "all")
```

**Arguments**

- **MAE_object**: an MAE object containing experiment data for extraction colData field optional
  experiments should either be SummarizedExperiment, SingleCellExperiment, or RangedSummarizedExperiment classes
- **subset_data**:  
  - 'all' use all experiments in MAE object
  - 'c(omic1,omic2,...)' list of omics from names(MAE_object)

**Value**

List of harmonized data matrices for input into nipals_multiblock()

**Examples**

```r
data(NCI60)
data_blocks_mae <- simple_mae(data_blocks, row_format="sample",
colData=metadata_NCI60)
NCI60_input = extract_from_mae(data_blocks_mae, subset='all')
```

---

**get_colors**

*Assigning colors to different omics*

**Description**

Assigning colors to different omics.

Creates a list of omics and associated colors for plotting. The default palette was chosen to be color-blindness friendly.

**Usage**

```r
color_pal = scales::viridis_pal,  
color_pal_params = list()
```

```r
color_pal = scales::viridis_pal,  
color_pal_params = list()
```

```r
color_pal = scales::viridis_pal,  
color_pal_params = list()
```

---

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**Usage**

```r
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color_pal_params = list()
```

```r
color_pal = scales::viridis_pal,  
color_pal_params = list()
```

```r
color_pal = scales::viridis_pal,  
color_pal_params = list()
```
get_metadata_colors

Arguments

mcia_results object returned from nipals_multiblock() function
color_pal a function which returns color palettes (e.g. scales)
color_pal_params list of parameters for the corresponding function

Value

List of omics with assigned colors

Examples

data(NCI60)
data_blocks_mae <- simple_mae(data_blocks, row_format="sample",
colData=metadata_NCI60)
mcia_results <- nipals_multiblock(data_blocks_mae, num_PCs = 10,
plots = "none", tol = 1e-12)
colors_omics <- get_colors(mcia_results)

Description

Assigning colors to different values of a metadata column

creates a list of metadata columns and associated colors for plotting. The default palette was chosen to be color-blindness friendly.

Usage

get_metadata_colors(
    mcia_results,
color_col,
color_pal = scales::viridis_pal,
color_pal_params = list()
)

Arguments

mcia_results object returned from nipals_multiblock() function
color_col an integer or string specifying the column that will be used for color_col
color_pal a function which returns color palettes (e.g. scales)
color_pal_params list of parameters for the corresponding function

Value

List of metadata columns with assigned colors
**get_tv**

Computes the total variance of a multi-omics dataset

**Description**

Computes the total variances of all data blocks in a multi-omics dataset, intended for datasets that do not use 'CCpreproc'.

**Usage**

```r
get_tv(ds)
```

**Arguments**

- `ds`: a list of multi-omics dataframes/matrices in "sample x variable" format

**Value**

the total variance of the dataset (i.e. sum of block variances)

**Examples**

```r
data(NCI60)
tot_var <- get_tv(data_blocks)
```

---

**global_scores_eigenvalues_plot**

**Description**

Function to plot eigenvalues of scores up to `num_PCs`

**Usage**

```r
global_scores_eigenvalues_plot(mcia_results)
```
Arguments

mcia_results MCIA results object returned from `nipals_multiblock`

Details

Plotting function for eigenvalues of scores up to num_PCs

Value

Displays the contribution plot using eigenvalues

Examples

data(NCI60)
data_blocks_mae <- simple_mae(data_blocks, row_format="sample", colData=metadata_NCI60)
mcia_results <- nipals_multiblock(data_blocks_mae, num_PCs = 10, plots = "none", tol=1e-12)
global_scores_eigenvalues_plot(mcia_results)

global_scores_heatmap  Plotting a heatmap of global factors scores (sample v. factors)

Description

Plots a heatmap of MCIA global scores

Usage

global_scores_heatmap(
  mcia_results,
  color_col = NULL,
  color_pal = scales::viridis_pal,
  color_pal_params = list(option = "D")
)

Arguments

mcia_results the mcia object matrix after running MCIA, must also contain metadata with columns corresponding to color_col
color_col an integer or string specifying the column that will be used for color_col
color_pal a list of colors or function which returns a list of colors
color_pal_params a list of parameters for the color function

Value

ComplexHeatmap object
gsea_report  

Perform biological annotation-based comparison

Description

Runs fgsea for the input gene vector

Usage

```r
gsea_report(
    metagenes,
    path.database,
    factors = NULL,
    pval.thr = 0.05,
    nproc = 4
)
```

Arguments

- `metagenes`: Vector of gene scores where the row names are HUGO symbols
- `path.database`: path to a GMT annotation file
- `factors`: vector of factors which should be analyzed
- `pval.thr`: p-value threshold (default to 0.05)
- `nproc`: number of processors to utilize

Value

data frame with the most significant p-value number of significant pathways
the selectivity scores across the given factors

metadata_NCI60  

NCI-60 Multi-Omics Metadata

Description

Metadata for the included multi-omics dataset, denoting the cancer type associated with each of the 21 cell lines.

Value

List with 21 elements

Source

Meng et. al, 2016 supplementary materials https://doi.org/10.1093/bib/bbv108
NipalsResult-class

An S4 class to contain results computed with ‘nipals_multiblock()’

Description

An S4 class to contain results computed with ‘nipals_multiblock()’

Value

A NipalsResult object.

Slots

global_scores  A matrix containing global scores as columns.
global_loadings  A matrix containing global loadings as columns.
block_score_weights  A matrix containing block weights as columns.
block_scores  A list of matrices. Each matrix contains the scores as columns for a given block.
block_loadings  A list of matrices. Each matrix contains the loadings as columns for a given block.
eigvals  A list of singular values of the data matrix at each deflation step.
col_preproc_method  character for the column-level preprocessing method used. See ‘col_preproc()’.
block_preproc_method  character for the block-level preprocessing method used. See ‘block_preproc()’.
block_variances  A list of variances for each block.
metadata  A data frame of metadata originally passed into ‘nipals_multiblock()’.

nipals_iter

NIPALS Iteration

Description

Applies one iteration stage/loop of the NIPALS algorithm.

Usage

nipals_iter(ds, tol = 1e-12, maxIter = 1000, isCentered = FALSE)
Arguments

- **ds**: a list of data matrices, each in "sample" x "variable" format
- **tol**: a number for the tolerance on the stopping criterion for NIPALS
- **maxIter**: a number for the maximum number of times NIPALS should iterate
- **isCentered**: TRUE if data blocks have feature mean zero, FALSE otherwise

Details

Follows the NIPALS algorithm as described by Hanafi et. al. (2010). Starts with a random vector in sample space and repeatedly projects it onto the variable vectors and block scores to generate block and global loadings/scores/weights. The loop stops when either the stopping criterion is low enough, or the maximum number of iterations is reached. Intended as a utility function for `nipals_multiblock` to be used between deflation steps.

Value

a list containing the global/block scores, loadings and weights for a given order

Examples

```r
data(NCI60)
data_blocks <- lapply(data_blocks, as.matrix)
nipals_results <- nipals_iter(data_blocks, tol = 1e-7, maxIter = 1000)
```

Description

Applies the full adjusted NIPALS algorithm to generate block and global scores/loadings with the desired deflation method.

Usage

```r
nipals_multiblock(
  data_blocks_mae,
  col_preproc_method = "colprofile",
  block_preproc_method = "unit_var",
  num_PCs = 10,
  tol = 1e-09,
  max_iter = 1000,
  color_col = NULL,
  deflationMethod = "block",
  plots = "all"
)
```
**Arguments**

`data_blocks_mae`  
a MultiAssayExperiment class object (with sample metadata as a dataframe in the colData attribute).

`col_preproc_method`  
an option for the desired column-level data pre-processing, either:
- ‘colprofile’ applies column-centering, row and column weighting by contribution to variance.
- ‘standardized’ centers each column and divides by its standard deviation.
- ‘centered_only’ ONLY centers data

`block_preproc_method`  
an option for the desired block-level data pre-processing, either:
- ‘unit_var’ FOR CENTERED MATRICES ONLY - divides each block by the square root of its variance
- ‘num_cols’ divides each block by the number of variables in the block.
- ‘largest_sv’ divides each block by its largest singular value.
- ‘none’ performs no preprocessing

`num_PCs`  
the maximum order of scores/loadings

`tol`  
a number for the tolerance on the stopping criterion for NIPALS

`max_iter`  
a number for the maximum number of times NIPALS should iterate

`color_col`  
Optional argument with the column name of the ‘metadata’ data frame used to define plotting colors

`deflationMethod`  
an option for the desired deflation method, either:
- ‘block’ deflation via block loadings (for MCIA, default)
- ‘global’ deflation via global scores (for CPCA)

`plots`  
an option to display various plots of results:
- ‘all’ displays plots of block scores, global scores, and eigenvalue scree plot
- ‘global’ displays only global score projections and eigenvalue scree plot
- ‘none’ does not display plots

**Details**

Follows the NIPALS algorithm as described by Hanafi et. al. (2010). For each order of scores/loadings, the vectors are computed via the `nipals_iter` function, then used to deflate the data matrix according to the desired deflation method. This process is repeated up to the desired maximum order of scores/loadings.

**Value**

a ‘nipalsResult’ object with the following fields:

- ‘global_scores’ a matrix containing global scores as columns (NOT normalized to unit variance)
• ‘global_loadings’ a matrix containing global loadings as columns
• ‘global_score_weights’ a matrix of weights to express global scores as a combination of block scores. Has dimensions "num_Blocks" by "num_PCs"
• ‘eigvals’ a matrix containing the eigenvalue for each computed global score.
• ‘block_scores’ a list of matrices, each contains the scores for one block
• ‘block loadings’ a list of matrices, each contains the loadings for one block (w/ unit length)
• ‘block score weights’ a matrix containing weights for each block score of each order used to construct the global scores.
• ‘col_preproc_method’ the column preprocessing method used on the data.
• ‘block_variances’ a list of variances of each block AFTER NORMALIZATION OPTION APPLIED
• ‘metadata’ the metadata dataframe supplied with the ‘metadata’ argument. Note: overrides metadata present in any MAE class object.

Examples

data(NCI60)

data_blocks_mae <- simple_mae(data_blocks,row_format="sample",
                           colData=metadata_NCI60)

NIPALS_results <- nipals_multiblock(data_blocks_mae, num_PCs = 10,
                            tol = 1e-12, max_iter = 1000,
                            col_preproc_method = "colprofile",
                            deflationMethod = "block")

MCIA_results <- nipals_multiblock(data_blocks_mae, num_PCs = 4)

CPCA_results <- nipals_multiblock(data_blocks_mae, num_PCs = 4,
                             deflationMethod = "global")

nmb_get_bl          Accessor function for block loadings

Description

Retrieves the block loadings as a list of matrices from a ‘NipalsResult’ object, typically output from ‘nipals_multiblock()’.

Usage

nmb_get_bl(nmb_object)

Arguments

nmb_object        A ‘NipalsResult’ object.

Value

a list of matrices containing block loadings.
Examples

```r
data("NCI60")
data_blocks_mae <- simple_mae(data_blocks, row_format="sample",
  colData=metadata_NCI60)
mcia_out <- nipals_multiblock(data_blocks_mae, num_PCs = 10)
block_loadings <- nmb_get_bl(mcia_out)
```

nmb_get_bs

**Accessor function for block scores**

Description

Retrieves the block scores as a list of matrices from a ‘NipalsResult’ object, typically output from ‘nipals_multiblock()’.

Usage

```
nmb_get_bs(nmb_object)
```

Arguments

- `nmb_object` A ‘NipalsResult’ object.

Value

A list of matrices containing block scores.

Examples

```r
data("NCI60")
data_blocks_mae <- simple_mae(data_blocks, row_format="sample",
  colData=metadata_NCI60)
mcia_out <- nipals_multiblock(data_blocks_mae, num_PCs = 10)
block_scores <- nmb_get_bs(mcia_out)
```

nmb_get_bs_weights

**Accessor function for block score weights**

Description

Retrieves the block score weights from a ‘NipalsResult’ object, typically output from ‘nipals_multiblock()’.

Usage

```
nmb_get_bs_weights(nmb_object)
```
Arguments

nmb_object A ‘NipalsResult’ object.

Value

A matrix containing the block score weights.

Examples

```r
data("NCI60")
data_blocks_mae <- simple_mae(data_blocks, row_format="sample",
   colData=metadata_NCI60)
mcia_out <- nipals_multiblock(data_blocks_mae, num_PCs = 10)
block_score_weights <- nmb_get_bs_weights(mcia_out)
```

nmb_get_eigs

**Accessor function for eigenvalues**

Description

Retrieves the eigenvalues from a ‘NipalsResult’ object, typically output from `nipals_multiblock()`.

Usage

```r
nmb_get_eigs(nmb_object)
```

Arguments

nmb_object A ‘NipalsResult’ object.

Value

A matrix containing the eigenvalues for all global scores.

Examples

```r
data("NCI60")
data_blocks_mae <- simple_mae(data_blocks, row_format="sample",
   colData=metadata_NCI60)
mcia_out <- nipals_multiblock(data_blocks_mae, num_PCs = 10)
nipals_eigvals <- nmb_get_eigs(mcia_out)
```
nmb_get_gl  

Accessor function for global loadings

Description
Retrieves the global loadings as a matrix from a ‘NipalsResult’ object, typically output from ‘nipals_multiblock()’.  

Usage
nmb_get_gl(nmb_object)

Arguments
nmb_object  A ‘NipalsResult’ object.

Value
a matrix containing global loadings.

Examples
```r
data("NCI60")
data_blocks_mae <- simple_mae(data_blocks,row_format="sample",colData=metadata_NCI60)
mcia_out <- nipals_multiblock(data_blocks_mae, num_PCs = 10)
global_loadings <- nmb_get_gl(mcia_out)
```

nmb_get_gs  

Accessor function for global scores

Description
Retrieves the global scores as a matrix from a ‘NipalsResult’ object, typically output from ‘nipals_multiblock()’.

Usage
nmb_get_gs(nmb_object)

Arguments
nmb_object  A ‘NipalsResult’ object.

Value
a matrix containing global scores.
Examples

data("NCI60")
data_blocks_mae <- simple_mae(data_blocks, row_format="sample",
                          colData=metadata_NCI60)
mcia_out <- nipals_multiblock(data_blocks_mae, num_PCs = 10)
global_scores <- nmb_get_gs(mcia_out)

default(nmb_get_metadata)

Accessor function for metadata

Description

Retrieves the metadata from a ‘NipalsResult’ object, typically output from ‘nipals_multiblock()’.

Usage

nmb_get_metadata(nmb_object)

Arguments

nmb_object A ‘NipalsResult’ object.

Value

da dataframe containing metadata associated with the ‘NipalsResult’ object.

Examples

data("NCI60")
data_blocks_mae <- simple_mae(data_blocks, row_format="sample",
                          colData=metadata_NCI60)
mcia_out <- nipals_multiblock(data_blocks_mae, num_PCs = 10)
nipals_metadata <- nmb_get_metadata(mcia_out)

ord_loadings

Ranked global loadings dataframe

Description

Creates a dataframe with ranked loadings for a given factor
predict_gs

Usage

ord_loadings(
  mcia_out,
  omic = "all",
  absolute = FALSE,
  descending = TRUE,
  factor = 1
)

Arguments

mcia_out object returned from nipals_multiblock() function
omic choose an omic to rank, or choose ‘all’ for all, ((omic = ”all”, omic = ”miRNA”, etc.))
absolute whether to rank by absolute value
descending whether to rank in descending or ascending order
factor choose a factor (numeric value from 1 to number of factors in mcia_out)

Value

ranked dataframe

Examples

data(NCI60)
data_blocks_mae <- simple_mae(data_blocks, row_format="sample",
colData=metadata_NCI60)
mcia_results <- nipals_multiblock(data_blocks_mae, num_PCs = 10,
plots = "none", tol = 1e-12)
all_pos_1 <- ord_loadings(mcia_out = mcia_results, omic = "all",
absolute = FALSE, descending = TRUE, factor = 1)

predict_gs Prediction of new global scores based on block loadings and weights

Description

Uses previously-computed block scores and weights to compute a global score for new data.

Usage

predict_gs(mcia_results, test_data)
Arguments

mcia_results  an mcia object output by nipals_multiblock() containing block scores, weights, and pre-processing identifier.

test_data  an MAE object with the same block types and features as the training dataset. Feature and omic order must match 'bl'.

Details

Projects the new observations onto each block loadings vector, then weights the projection according to the corresponding block weights.

Value

a matrix of predicted global scores for the training data

Examples

data(NCI60)
data_blocks_mae <- simple_mae(data_blocks, row_format="sample",
  colData=metadata_NCI60)
mcia_results <- nipals_multiblock(data_blocks_mae, num_PCs = 2)
new_data <- data_blocks_mae  # should update with a truly new dataset
preds <- predict_gs(mcia_results, new_data)

Description

Function to generate a projection plot of MCIA results.

Usage

projection_plot(
mcia_results,
projection,
orders = c(1, 2),
block_name = NULL,
color_col = NULL,
color_pal = scales::viridis_pal,
color_pal_params = list(option = "E"),
legend_loc = "bottomleft",
color_override = NULL,
cex = 0.5
)
**Arguments**

- `mcia_results`: MCIA results object returned from `nipals_multiblock`.
- `projection`: Options of plot, with the following options
  - `'all'`: scatter plot of two orders of global and block scores (aka factors).
  - `'global'`: scatter plot of two orders of global scores only (aka factors).
  - `'block'`: scatter plot of two orders of block scores only (aka factors) for given block.
- `orders`: Option to select orders of factors to plot against each other (for projection plots).
- `block_name`: Name of the block to be plotted (if `projection = block` argument used).
- `color_col`: An integer or string specifying the column that will be used for `color_col`.
- `color_pal`: A list of colors or function which returns a list of colors.
- `color_pal_params`: A list of parameters for the color function.
- `legend_loc`: Option for legend location, or "none" for no legend.
- `color_override`: Option to override colors when necessary, helpful for `projection = "global"` or "block".
- `cex`: Resizing parameter for drawing the points.

**Details**

Plotting function for a projection plot.

**Value**

Displays the desired plots.

**Examples**

```r
data(NCI60)
data_blocks_mae <- simple_mae(data_blocks, row_format="sample", colData=metadata_NCI60)
mcia_results <- nipals_multiblock(data_blocks_mae, num_PCs = 10, plots = "none", tol = 1e-12)
projection_plot(mcia_results, projection = "all", orders = c(1,2), color_col = "cancerType", legend_loc = "bottomright")
```

---

**simple_mae**

Create an MAE object from a list of data matrices and column data.

**Description**

Create an MAE object from a set of data matrices and column data.
Usage

```
simple_mae(matrix_list, row_format = "feature", colData_input = NULL)
```

Arguments

- `matrix_list` named list of data matrices
- `row_format` for lists of data frames, indicates whether rows of datasets denote 'feature' (default) or 'sample'.
- `colData_input` a data frame containing sample metadata; sample names in the rownames should correspond to samples names in ‘matrix_list’

Details

Requires that sample names match across experiments and are identical to primary names, will only convert data matrices to SummarizedExperiment class. If the data is more complex, please follow the guidelines for creating an MAE object outlined in ‘help(MultiAssayExperiment)’

Value

List of harmonized data matrices for input into nipals_multiblock()

Examples

```
data(NCI60)
data_blocks_mae <- simple_mae(data_blocks, row_format = "sample", colData = metadata_NCI60)
```

---

**vis_load_ord** Visualize ranked loadings

Description

Visualize a scree plot of loadings recovered from nipalsMCIA() output loadings matrix ranked using the ord_loadings() functions

Usage

```
vis_load_ord(gl_f_ord, omic_name, colors_omics, n_feat = 15)
```

Arguments

- `gl_f_ord` Ranked loading dataframe output from ord_loadings() function
- `omic_name` name of the given omic dataset
- `colors_omics` named list of colors associated with omics, output of get_colors() function
- `n_feat` number of features to visualize
**Value**

Plot in features for a factor by rank

**Examples**

```r
data(NCI60)
data_blocks_mae <- simple_mae(data_blocks, row_format="sample",
                               colData=metadata_NCI60)
mcia_results <- nipals_multiblock(data_blocks_mae, num_PCs = 10,
                                   plots = "none", tol = 1e-12)
all_pos_1 <- ord_loadings(mcia_out = mcia_results, omic = "all",
                          absolute = FALSE, descending = TRUE, factor = 1)
colors_omics <- get_colors(mcia_results)
vis_load_ord(all_pos_1, colors_omics = colors_omics)
```

---

**vis_load_plot**  
Visualize all loadings on two factor axes

**Description**

Visualize all loadings recovered from nipalsMCIA() output loadings matrix ranked using across two factor axes

**Usage**

```r
vis_load_plot(mcia_out, axes = c(1, 2), colors_omics)
```

**Arguments**

- `mcia_out`: object returned from nipals_multiblock() function
- `axes`: list of two numbers associated with two factors to visualize
- `colors_omics`: named list of colors associated with omics, output of get_colors() function

**Value**

Plot of MCIA feature loadings for chosen axes

**Examples**

```r
data(NCI60)
data_blocks_mae <- simple_mae(data_blocks, row_format="sample",
                               colData=metadata_NCI60)
mcia_results <- nipals_multiblock(data_blocks_mae, num_PCs = 10,
                                   plots = "none", tol = 1e-12)
colors_omics <- get_colors(mcia_results)
vis_load_plot(mcia_results, axes = c(1, 4), colors_omics = colors_omics)
```
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