Package ‘biclustermd’

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Type Package
Title Biclustering with Missing Data
Version 0.2.3
Maintainer John Reisner <johntreisner@gmail.com>
Description Biclustering is a statistical learning technique that simultaneously
partitions and clusters rows and columns of a data matrix. Since the solution
space of biclustering is in infeasible to completely search with current
computational mechanisms, this package uses a greedy heuristic. The algorithm
featured in this package is, to the best our knowledge, the first biclustering
algorithm to work on data with missing values. Li, J., Reisner, J., Pham, H.,
Sciences, 510, 304–316.
URL https://github.com/jreisner/biclustermd
BugReports https://github.com/jreisner/biclustermd/issues
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Author John Reisner [cre, aut, cph],
Hieu Pham [ctb, cph],
Jing Li [ctb, cph]
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# biclustermd-package

**biclustermd** is a package to bicluster data with missing values.

## Description

The main function is `biclustermd()`. Results can be plotted with `autoplot()` and `as.Biclust()` converts results to Biclust objects.
as.Biclust

Convert a biclustermd object to a Biclust object

Description

Convert a biclustermd object to a Biclust object

Usage

as.Biclust(object)

Arguments

object The biclustermd object to convert to a Biclust object

Value

Returns an object of class Biclust.

Examples

data("synthetic")

bc <- biclustermd(synthetic, col_clusters = 3, row_clusters = 2,
  miss_val = mean(synthetic, na.rm = TRUE),
  miss_val_sd = sd(synthetic, na.rm = TRUE),
  col_min_num = 2, row_min_num = 2,
  col_num_to_move = 1, row_num_to_move = 1,
  max.iter = 10)

bc

as.Biclust(bc)

# biclust::drawHeatmap won't work since it doesn't exclude NAs
## Not run: biclust::drawHeatmap(synthetic, as.Biclust(bc), 6)

# bicluster 6 is in the top right-hand corner here:
autoplot(bc)
# compare with bicust::drawHeatmap2:
biclust::drawHeatmap2(synthetic, as.Biclust(bc), 6)

# bicluster 3 is in the bottom right-hand corner here:
autoplot(bc)
# compare with bicust::drawHeatmap2:
biclust::drawHeatmap2(synthetic, as.Biclust(bc), 3)
autoplot.biclustermd  Make a heatmap of sparse biclustering results

Description
Make a heatmap of sparse biclustering results

Usage
## S3 method for class 'biclustermd'
autoplot(  
  object,  
  axis.text = NULL,  
  reorder = FALSE,  
  transform_colors = FALSE,  
  c = 1/6,  
  cell_alpha = 1/5,  
  col_clusts = NULL,  
  row_clusts = NULL,  
  ...  
)

Arguments

object    An object of class "biclustermd".
axis.text A character vector specifying for which axes text should be drawn. Can be any of "x", "col" for columns, "y", "row" for rows, or any combination of the four. By default this is NULL; no axis text is drawn.
reorder   A logical. If TRUE, heatmap will be sorted according to the cell-average matrix, A.
transform_colors  If equals TRUE then the data is scaled by c and run through a standard normal cdf before plotting. If FALSE (default), raw data values are used in the heat map.
c    Value to scale the data by before running it through a standard normal CDF. Default is 1/6.
cell_alpha A scalar defining the transparency of shading over a cell and by default this equals 1/5. The color corresponds to the cell mean.
col_clusts A vector of column cluster indices to display. If NULL (default), all are displayed.
row_clusts A vector of row cluster indices to display. If NULL (default), all are displayed.
... Arguments to be passed to geom_vline() and geom_hline().

Value
An object of class ggplot.
Examples

data("synthetic")

bc <- biclustermd(synthetic, col_clusters = 3, row_clusters = 2,
     miss_val = mean(synthetic, na.rm = TRUE),
     miss_val_sd = sd(synthetic, na.rm = TRUE),
     col_min_num = 2, row_min_num = 2,
     col_num_to_move = 1, row_num_to_move = 1,
     max.iter = 10)

bc
autoplot(bc)

autoplot(bc, axis.text = c('x', 'row')) +
ggplot2::scale_fill_distiller(palette = "Spectral", na.value = "white")

# Complete shading
autoplot(bc, axis.text = c('col', 'row'), cell_alpha = 1)

# Transformed values and no shading
autoplot(bc, transform_colors = TRUE, c = 1/20, cell_alpha = 0)

# Focus on row cluster 1 and column cluster 2
autoplot(bc, col_clusts = 2, row_clusts = 1)

autoplot.biclustermd_sim

Plot similarity measures between two consecutive biclusterings.

Description

Creates a ggplot of the three similarity measures used in biclustermd::bicluster() for both row and column dimensions.

Usage

## S3 method for class 'biclustermd_sim'
autoplot(object, similarity = NULL, facet = TRUE, ncol = NULL, ...)

Arguments

object
similarity
facet

Object of class "biclustermd_sim"
A character vector indicating which similarity measure to plot. Can be any of "Rand", "HA", "Jaccard", or "used". If "used", plot only the measure used as the stopping condition in the algorithm. By default (NULL) all three are plotted. When plotted, the used measure will have an asterisk.
If TRUE (default), each similarity measure will be in its own plot. if FALSE, all three similarity measures for rows and columns are given in one plot.
ncol
If faceting, the number of columns to arrange the plots in.

... Arguments to pass to ggplot2::geom_point()

Value
A ggplot object.

Examples

data("synthetic")

bc <- biclustermd(synthetic, col_clusters = 3, row_clusters = 2,
miss_val = mean(synthetic, na.rm = TRUE),
miss_val_sd = sd(synthetic, na.rm = TRUE),
col_min_num = 2, row_min_num = 2,
col_num_to_move = 1, row_num_to_move = 1,
max.iter = 10)

bc
autoplot(bc$Similarities, ncol = 1)
biclustermd

Examples
data("synthetic")

bc <- biclustermd(synthetic, col_clusters = 3, row_clusters = 2,
    miss_val = mean(synthetic, na.rm = TRUE),
    miss_val_sd = sd(synthetic, na.rm = TRUE),
    col_min_num = 2, row_min_num = 2,
    col_num_to_move = 1, row_num_to_move = 1,
    max.iter = 10)

bc
data bc$SSE

biclustermd

Bicluster data with non-random missing values

Description
Bicluster data with non-random missing values

Usage
biclustermd(
    data,
    row_clusters = floor(sqrt(nrow(data)));
    col_clusters = floor(sqrt(ncol(data)));
    miss_val = mean(data, na.rm = TRUE),
    miss_val_sd = 1,
    similarity = "Rand",
    row_min_num = floor(nrow(data)/row_clusters),
    col_min_num = floor(ncol(data)/col_clusters),
    row_num_to_move = 1,
    col_num_to_move = 1,
    row_shuffles = 1,
    col_shuffles = 1,
    max.iter = 100,
    verbose = FALSE
)

Arguments
data Dataset to bicluster. Must to be a data matrix with only numbers and missing
values in the data set. It should have row names and column names.
row_clusters The number of clusters to partition the rows into. The default is floor(sqrt(nrow(data))).
col_clusters The number of clusters to partition the columns into. The default is floor(sqrt(ncol(data))).
mis_val Value or function to put in empty cells of the prototype matrix. If a value,
a random normal variable with sd = miss_val_sd is used each iteration. By
default, this equals the mean of data.
miss_val_sd  Standard deviation of the normal distribution miss_val follows if miss_val is a number. By default this equals 1.
similarity  The metric used to compare two successive clusterings. Can be "Rand" (default), "HA" for the Hubert and Arabie adjusted Rand index or "Jaccard". See RRand for details.
row_min_num  Minimum row prototype size in order to be eligible to be chosen when filling an empty row prototype. Default is floor(nrow(data) / row_clusters).
col_min_num  Minimum column prototype size in order to be eligible to be chosen when filling an empty row prototype. Default is floor(ncol(data) / col_clusters).
row_num_to_move  Number of rows to remove from the sampled prototype to put in the empty row prototype. Default is 1.
col_num_to_move  Number of columns to remove from the sampled prototype to put in the empty column prototype. Default is 1.
row_shuffles  Number of times to shuffle rows in each iteration. Default is 1.
col_shuffles  Number of times to shuffle columns in each iteration. Default is 1.
max.iter  Maximum number of iterations to let the algorithm run for.
verbose  Logical. If TRUE, will report progress.

Value
A list of class biclustermd:

params  a list of all arguments passed to the function, including defaults.
data  the inputted two way table of data.
P0  the initial column partition matrix.
Q0  the initial row partition matrix.
InitialSSE  the SSE of the original partitioning.
P  the final column partition matrix.
Q  the final row partition matrix.
SSE  a matrix of class biclustermd_sse detailing the SSE recorded at the end of each iteration.
Similarities  a data frame of class biclustermd_sim detailing the value of row and column similarity measures recorded at the end of each iteration. Contains information for all three similarity measures. This carries an attribute "used" which provides the similarity measure used as the stopping condition for the algorithm.
iteration  the number of iterations the algorithm ran for, whether max.iter was reached or convergence was achieved.
A  the final prototype matrix which gives the average of each bicluster.

References
See Also

rep_biclustermd, tune_biclustermd

Examples

data("synthetic")
# default parameters
bc <- biclustermd(synthetic)
bc
autoplot(bc)

# providing the true number of row and column clusters
bc <- biclustermd(synthetic, col_clusters = 3, row_clusters = 2)
bc
autoplot(bc)

# an example with the nycflights13::flights dataset
library(nycflights13)
data("flights")
library(dplyr)
flights_bcd <- flights %>%
  select(month, dest, arr_delay)

flights_bcd <- flights_bcd %>%
  group_by(month, dest) %>%
  summarise(mean_arr_delay = mean(arr_delay, na.rm = TRUE)) %>%
  spread(dest, mean_arr_delay) %>%
  as.data.frame()

rownames(flights_bcd) <- flights_bcd$month
flights_bcd <- as.matrix(flights_bcd[, -1])

flights_bc <- biclustermd(data = flights_bcd, col_clusters = 6, row_clusters = 4,
                          row_min_num = 3, col_min_num = 5,
                          max.iter = 20, verbose = TRUE)

flights_bc

binary_vector_gen

Make a binary vector with all values equal to zero except for one

Description

Make a binary vector with all values equal to zero except for one

Usage

binary_vector_gen(n, i)
cell_heatmap

Arguments

  n  Desired vector length.
  i  Index whose value is one.

Value

A vector

Description

Make a heat map of bicluster cell sizes.

Usage

  cell_heatmap(x, ...)

Arguments

  x  An object of class biclustermd.
  ... Arguments to pass to geom_tile()

Examples

  data("synthetic")
  bc <- biclustermd(synthetic, col_clusters = 3, row_clusters = 2,
                   miss_val = mean(synthetic, na.rm = TRUE),
                   miss_val_sd = sd(synthetic, na.rm = TRUE),
                   col_min_num = 2, row_min_num = 2,
                   col_num_to_move = 1, row_num_to_move = 1,
                   max.iter = 10)
  cell_heatmap(bc)
  cell_heatmap(bc) + ggplot2::scale_fill_viridis_c()
cell_mse

Make a data frame containing the MSE for each bicluster cell

Description

Make a data frame containing the MSE for each bicluster cell

Usage

cell_mse(x)

Arguments

x

An object of class biclustermd.

Value

A data frame giving the row cluster, column cluster, the number of data points in each row and column cluster, the number of data points missing in the cell, and the cell MSE.

Examples

data("synthetic")
bc <- biclustermd(synthetic, col_clusters = 3, row_clusters = 2,
                 miss_val = mean(synthetic, na.rm = TRUE),
                 miss_val_sd = sd(synthetic, na.rm = TRUE),
                 col_min_num = 2, row_min_num = 2,
                 col_num_to_move = 1, row_num_to_move = 1,
                 max.iter = 10)
cell_mse(bc)

cluster_iteration_sum_sse

Calculate the sum cluster SSE in each iteration

Description

Calculate the sum cluster SSE in each iteration

Usage

cluster_iteration_sum_sse(data, P, Q)
Arguments

data The data being biclustered. Must be a data matrix with only numbers and missing values in the data set. It should have row names and column names.
P Matrix for column prototypes.
Q Matrix for row prototypes.

Value

The SSE for the parameters specified.

col.names A generic to gather column names

Description

A generic to gather column names

Usage

col.names(x)

Arguments

x an object to retrieve column names from

col.names.biclustermd Get data matrix column names and their corresponding column cluster membership

Description

Get data matrix column names and their corresponding column cluster membership

Usage

## S3 method for class 'biclustermd'
col.names(x)

Arguments

x an object of class biclustermd

Value

a data frame with column names of the shuffled matrix and corresponding column cluster names.
Examples

data("synthetic")
# default parameters
bc <- biclustermd(synthetic)
bc
col.names(bc)
# this is a simplified version of the output for gather(bc):
library(dplyr)
gather(bc) %>% distinct(col_cluster, col_name)

col_cluster_names 
Get column names in each column cluster

Description

Get column names in each column cluster

Usage

col_cluster_names(x, data)

Arguments

x Biclustering object to extract column cluster designation from
data Data that contains the column names

Value

A data frame with two columns: cluster corresponds to the column cluster and name gives the column names in each cluster.

Examples

data("synthetic")
rownames(synthetic) <- letters[1:nrow(synthetic)]
colnames(synthetic) <- letters[1:ncol(synthetic)]
bc <- biclustermd(synthetic, col_clusters = 3, row_clusters = 2,
miss_val = mean(synthetic, na.rm = TRUE),
miss_val_sd = sd(synthetic, na.rm = TRUE),
col_min_num = 2, row_min_num = 2,
col_num_to_move = 1, row_num_to_move = 1,
max.iter = 10)
bc
**compare_biclusters**  
*Compare two biclusterings or a pair of partition matrices*

**Description**

Compare two biclusterings or a pair of partition matrices

**Usage**

```r
compare_biclusters(bc1, bc2)
```

**Arguments**

- `bc1`: the first biclustering or partition matrix. Must be either of class `biclustermd` or `matrix`.
- `bc2`: the second biclustering or partition matrix. Must be either of class `biclustermd` or `matrix`.

**Value**

If comparing a pair of biclusterings, a list containing the column similarity indices and the row similarity indices, in that order. If a pair of matrices, a vector of similarity indices.

**Examples**

```r
data("synthetic")
bc <- biclustermd(synthetic, col_clusters = 3, row_clusters = 2)
bc2 <- biclustermd(synthetic, col_clusters = 3, row_clusters = 2)

# compare the two biclusterings
compare_biclusters(bc, bc2)

# determine the similarity between initial and final row clusterings
compare_biclusters(bc$Q0, bc$Q)
```

**fill_empties_P**  
*Randomly select a column prototype to fill an empty column prototype with*

**Description**

Randomly select a column prototype to fill an empty column prototype with

**Usage**

```r
fill_empties_P(data, obj, col_min_num = 10, col_num_to_move = 5)
```
**Arguments**

- **data**: The data being biclustered. Must be a data matrix with only numbers and missing values in the data set. It should have row names and column names.
- **obj**: A matrix for column clusters, typically named P.
- **col_min_num**: Minimum column prototype size in order to be eligible to be chosen when filling an empty column prototype. Default is 10.
- **col_num_to_move**: Number of columns to remove from the sampled prototype to put in the empty column prototype. Default is 5.

**Value**

A matrix for column clusters, i.e., a P matrix.

---

**Description**

Randomly select a row prototype to fill an empty row prototype with

**Usage**

```
fill_empties_Q(data, obj, row_min_num = 10, row_num_to_move = 5)
```

**Arguments**

- **data**: The data being biclustered. Must be a data matrix with only numbers and missing values in the data set. It should have row names and column names.
- **obj**: A matrix for row clusters, typically named Q.
- **row_min_num**: Minimum row prototype size in order to be eligible to be chosen when filling an empty row prototype. Default is 10.
- **row_num_to_move**: Number of rows to remove from the sampled prototype to put in the empty row prototype. Default is 5.

**Value**

A matrix for row clusters, i.e., a Q matrix.
format_partition  Format a partition matrix

Description

Formats a partition matrix so that subsets in a partition will be ordered by the value of the smallest in each subset

Usage

format_partition(P1)

Arguments

P1  A partition matrix.

Value

A formatted partition matrix.

gather.biclustermd  Gather a biclustermd object

Description

Gather a biclustermd object

Usage

## S3 method for class 'biclustermd'
gather(
data,
key = NULL,
value = NULL,
...,  
na.rm = FALSE,
convert = FALSE,
factor_key = FALSE
)
**Arguments**

- **data**: a `biclustermd` object to gather.
- **key**: unused; included for consistency with `tidyr` generic
- **value**: unused; included for consistency with `tidyr` generic
- **...**: unused; included for consistency with `tidyr` generic
- **na.rm**: unused; included for consistency with `tidyr` generic
- **convert**: unused; included for consistency with `tidyr` generic
- **factor_key**: unused; included for consistency with `tidyr` generic

**Value**

A data frame containing the row names and column names of both the two-way table of data biclustered and the cell-average matrix.

**Examples**

data("synthetic")

bc <- biclustermd(synthetic, col_clusters = 3, row_clusters = 2,
                   miss_val = mean(synthetic, na.rm = TRUE),
                   miss_val_sd = sd(synthetic, na.rm = TRUE),
                   col_min_num = 2, row_min_num = 2,
                   col_num_to_move = 1, row_num_to_move = 1,
                   max.iter = 10)

gather(bc)

# bicluster 6 is in the top right-hand corner here:
autoplot(bc)

# bicluster 3 is in the bottom right-hand corner here:
autoplot(bc)

---

**jaccard_similarity**

*Compute the Jaccard similarity coefficient for two clusterings*

**Description**

Compute the Jaccard similarity coefficient for two clusterings.

**Usage**

```r
jaccard_similarity(clus1, clus2)
```

**Arguments**

- **clus1**: vector giving the first set of clusters
- **clus2**: vector giving the second set of clusters
Value

a numeric

References


Description

Make a heatmap of cell MSEs

Usage

mse_heatmap(x, ...)

Arguments

x An object of class biclustermd.
...
Arguments to pass to geom_tile()

Value

A ggplot object.

Examples

data("synthetic")
bc <- biclustermd(synthetic, col_clusters = 3, row_clusters = 2,
null_val = mean(synthetic, na.rm = TRUE),
miss_val_sd = sd(synthetic, na.rm = TRUE),
col_min_num = 2, row_min_num = 2,
col_num_to_move = 1, row_num_to_move = 1,
max.iter = 10)

mse_heatmap(bc)
mse_heatmap(bc) + ggplot2::scale_fill_viridis_c()
partition_gen

Generate an initial, random partition matrix with \( N \) objects into \( K \) subsets/groups.

**Description**

This function is used to randomly generate a partition matrix and assign rows or columns to prototypes. Must be the case that \( N > K \).

**Usage**

```r
partition_gen(N, K)
```

**Arguments**

- **N**
  - Number of objects/rows in a partition matrix

- **K**
  - Desired number of partitions

**Value**

A partition matrix.

---

partition_gen_by_p

Create a partition matrix with a partition vector \( p \)

**Description**

Create a partition matrix with a partition vector \( p \)

**Usage**

```r
partition_gen_by_p(N, K, p)
```

**Arguments**

- **N**
  - Rows in a partition matrix

- **K**
  - Number of prototypes to create

- **p**
  - Integer vector containing the cluster each row in a partition matrix is to be assigned to.

**Value**

A partition matrix.
**part_matrix_to_vector**  
*Convert a partition matrix to a vector*

**Description**
For each row in a partition matrix, this function gets the column index for which the row is equal to one. That is, for row i, this function returns the index of the row entry that is equal to one.

**Usage**
```r
part_matrix_to_vector(P0)
```

**Arguments**
- **P0**  
  A partition matrix

**Value**
An integer vector

---

**position_finder**  
*Find the index of the first nonzero value in a vector*

**Description**
Find the index of the first nonzero value in a vector

**Usage**
```r
position_finder(vec)
```

**Arguments**
- **vec**  
  A binary vector

**Value**
Position of the first nonzero value in a vector.
print.biclustermd

Print an object of class biclustermd

Description

Print an object of class biclustermd

Usage

## S3 method for class 'biclustermd'
print(x, ...)

Arguments

x  
a biclustermd object.
...
arguments passed to or from other methods

reorder_biclust

Reorder a bicluster object for making a heat map

Description

Reorder a bicluster object for making a heat map

Usage

reorder_biclust(x)

Arguments

x  
A bicluster object.

Value

A list containing the two partition matrices used by gg_bicluster.
Replicate a biclustering to achieve a minimum SSE solution.

**Description**

Repeat a biclustering to achieve a minimum SSE solution.

**Usage**

```r
rep_biclustermd(
  data,
  nrep = 10,
  parallel = FALSE,
  ncores = 2,
  col_clusters = floor(sqrt(ncol(data))),
  row_clusters = floor(sqrt(nrow(data))),
  miss_val = mean(data, na.rm = TRUE),
  miss_val_sd = 1,
  similarity = "Rand",
  row_min_num = 5,
  col_min_num = 5,
  row_num_to_move = 1,
  col_num_to_move = 1,
  row_shuffles = 1,
  col_shuffles = 1,
  max.iter = 100
)
```

**Arguments**

- **data**: Dataset to bicluster. Must be a data matrix with only numbers and missing values in the data set. It should have row names and column names.
- **nrep**: The number of times to repeat the biclustering. Default 10.
- **parallel**: Logical indicating if the user would like to utilize the `foreach` parallel backend. Default is FALSE.
- **ncores**: The number of cores to use if parallel computing. Default 2.
- **col_clusters**: The number of clusters to partition the columns into.
- **row_clusters**: The number of clusters to partition the rows into.
- **miss_val**: Value or function to put in empty cells of the prototype matrix. If a value, a random normal variable with sd = `miss_val_sd` is used each iteration.
- **miss_val_sd**: Standard deviation of the normal distribution `miss_val` follows if `miss_val` is a number. By default this equals 1.
- **similarity**: The metric used to compare two successive clusterings. Can be "Rand" (default), "HA" for the Hubert and Arabie adjusted Rand index or "Jaccard". See `RRand` and for details.
rep_biclustermd

row_min_num  Minimum row prototype size in order to be eligible to be chosen when filling an empty row prototype. Default is 5.

col_min_num  Minimum column prototype size in order to be eligible to be chosen when filling an empty row prototype. Default is 5.

row_num_to_move  Number of rows to remove from the sampled prototype to put in the empty row prototype. Default is 1.

col_num_to_move  Number of columns to remove from the sampled prototype to put in the empty column prototype. Default is 1.

row_shuffles  Number of times to shuffle rows in each iteration. Default is 1.

col_shuffles  Number of times to shuffle columns in each iteration. Default is 1.

max.iter  Maximum number of iterations to let the algorithm run for.

Value

A list of the minimum SSE biclustering, a vector containing the final SSE of each repeat, and the time it took the function to run.

References


See Also

biclustermd, tune_biclustermd

Examples

data("synthetic")

# 20 repeats without parallelization
repeat_bc <- rep_biclustermd(synthetic, nrep = 20,
  col_clusters = 3, row_clusters = 2,
  miss_val = mean(synthetic, na.rm = TRUE),
  miss_val_sd = sd(synthetic, na.rm = TRUE),
  col_min_num = 2, row_min_num = 2,
  col_num_to_move = 1, row_num_to_move = 1,
  max.iter = 10)

repeat_bc
autoplot(repeat_bc$best_bc)
plot(repeat_bc$rep_sse, type = 'b', pch = 20)
repeat_bc$runtime

# 20 repeats with parallelization over 2 cores
repeat_bc <- rep_biclustermd(synthetic, nrep = 20, parallel = TRUE, ncores = 2,
  col_clusters = 3, row_clusters = 2,
  miss_val = mean(synthetic, na.rm = TRUE),
results_heatmap

```r
mis_val_sd = sd(synthetic, na.rm = TRUE),
col_min_num = 2, row_min_num = 2,
col_num_to_move = 1, row_num_to_move = 1,
max.iter = 10)
repeat_bc$runtime
```

---

**results_heatmap**

*Make a heatmap of sparse biclustering results*

**Description**

Make a heatmap of sparse biclustering results

**Usage**

```r
results_heatmap(
x, 
reorder = FALSE, 
transform_colors = FALSE, 
c = 1/6, 
cell_alpha = 1/5, 
col_clusts = NULL, 
row_clusts = NULL, 
...
)
```

**Arguments**

- **x** A biclustermd object.
- **reorder** A logical. If TRUE, heatmap will be sorted according to the cell-average matrix, A.
- **transform_colors** If equals TRUE then the data is scaled by c and run through a standard normal cdf before plotting. If FALSE (default), raw data values are used in the heat map.
- **c** Value to scale the data by before running it through a standard normal CDF. Default is 1/6.
- **cell_alpha** A scalar defining the transparency of shading over a cell and by default this equals 1/5. The color corresponds to the cell mean.
- **col_clusts** A vector of column cluster indices to display. If NULL (default), all are displayed.
- **row_clusts** A vector of row cluster indices to display. If NULL (default), all are displayed.
- **...** Arguments to be passed to geom_vline() and geom_hline().

**Value**

An object of class ggplot.
Get data matrix row names and their corresponding row cluster membership

## S3 method for class 'biclustermd'
row.names(x)

### Arguments

- **x**: an object of class biclustermd

### Value

A data frame with row names of the shuffled matrix and corresponding row cluster names.

### Examples

```r
data("synthetic")
# default parameters
bc <- biclustermd(synthetic)
bctransform(bc)
row.names(bc)
# this is a simplified version of the output for gather(bc):
library(dplyr)
gather(bc) %>% distinct(row_cluster, row_name)
```

Get row names in each row cluster

### Usage

`row_cluster_names(x, data)`

### Arguments

- **x**: Biclustering object to extract row cluster designation from
- **data**: Data that contains the row names
Value

A data frame with two columns: `cluster` corresponds to the row cluster and `name` gives the row names in each cluster.

Examples

data("synthetic")
rownames(synthetic) <- letters[1:nrow(synthetic)]
colnames(synthetic) <- letters[1:ncol(synthetic)]
bc <- biclustermd(synthetic, col_clusters = 3, row_clusters = 2,
                 miss_val = mean(synthetic, na.rm = TRUE),
                 miss_val_sd = sd(synthetic, na.rm = TRUE),
                 col_min_num = 2, row_min_num = 2,
                 col_num_to_move = 1, row_num_to_move = 1,
                 max.iter = 10)
bc

<table>
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<tr>
<th>runtimes</th>
<th>Algorithm run time data</th>
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Description

This dataset stems from the R journal article introducing biclustermd to R users. It describes the data attributes and run time for varying data sizes and structures.

Usage

runtimes

Format

An object of class `data.frame` with 2400 rows and 13 columns.

Details

A data frame of 2400 rows and 13 variables (defined range, inclusive):

- **combination_no**: Unique identifier of a combination of parameters.
- **rows**: Number of rows in the data matrix. (50, 1500)
- **cols**: Number of columns in the data matrix. (50, 1500)
- **N**: Product of the dimensions of the data. (2500, 2250000)
- **row_clusts**: Number of clusters to partition the rows into. (4, 300)
- **col_clusts**: Number of clusters to partition the columns into. (4, 300)
- **avg_row_clust_size**: Average row cluster size. rows / row_clusts
- **avg_col_clust_size**: Average column cluster size. cols / col_clusts
- **sparsity**: Percent of data values which are missing.
**user.self** CPU time used executing instructions to calls (from `proc.time`).

**sys.self** CPU time used executing calls (from `proc.time`).

**elapsed** Amount of time in seconds it took the algorithm to converge.

**iterations** Number of iterations to convergence.

---

**synthetic**

*Synthetic data for examples.*

---

**Description**

This simple dataset allows users to use data that are easy to understand while learning `biclustermd`. This is a matrix with 6 rows and 12 columns. 50% of values are missing.

**Usage**

```r
synthetic
```

**Format**

An object of class `matrix` with 6 rows and 12 columns.

---

**tune_biclustermd**

*Bicluster data over a grid of tuning parameters*

---

**Description**

Bicluster data over a grid of tuning parameters

**Usage**

```r
tune_biclustermd(
  data,
  nrep = 10,
  parallel = FALSE,
  ncores = 2,
  tune_grid = NULL
)
```
Arguments

data               Dataset to bicluster. Must to be a data matrix with only numbers and missing values in the data set. It should have row names and column names.
nrep               The number of times to repeat the biclustering for each set of parameters. Default 10.
parallel           Logical indicating if the user would like to utilize the foreach parallel backend. Default is FALSE.
ncores             The number of cores to use if parallel computing. Default 2.
tune_grid          A data frame of parameters to tune over. The column names of this must match the arguments passed to biclustermd().

Value

A list of:

- best_combn       The best combination of parameters,
- best_bc          The minimum SSE biclustering using the parameters in best_combn,
- grid             tune_grid with columns giving the minimum, mean, and standard deviation of the final SSE for each parameter combination, and
- runtime          CPU runtime & elapsed time.

References


See Also

biclustermd, rep_biclustermd

Examples

```r
library(dplyr)
library(ggplot2)
data("synthetic")
tg <- expand.grid( miss_val = fivenum(synthetic),
                   similarity = c("Rand", "HA", "Jaccard"),
                   col_min_num = 2,
                   row_min_num = 2,
                   col_clusters = 3:5,
                   row_clusters = 2 )
tg

# in parallel: two cores:
tbc <- tune_biclustermd(synthetic, nrep = 2, parallel = TRUE, ncores = 2, tune_grid = tg)
tbc
```
tbc$grid %>%
  group_by(miss_val, col_clusters) %>%
  summarise(avg_sd = mean(sd_sse)) %>%
  ggplot(aes(miss_val, avg_sd, color = col_clusters, group = col_clusters)) +
  geom_line() +
  geom_point()

tbc <- tune_biclustermd(synthetic, nrep = 2, tune_grid = tg)
tbc

boxplot(tbc$grid$mean_sse ~ tbc$grid$similarity)
boxplot(tbc$grid.sd_sse ~ tbc$grid$similarity)

# nycflights13::flights dataset
library(nycflights13)
data("flights")
library(dplyr)
flights_bcd <- flights %>%
  select(month, dest, arr_delay)
flights_bcd <- flights_bcd %>%
  group_by(month, dest) %>%
  summarise(mean_arr Delay = mean(arr_delay, na.rm = TRUE)) %>%
  spread(dest, mean_arr_delay) %>%
  as.data.frame()

# months as rows
rownames(flights_bcd) <- flights_bcd$month
flights_bcd <- as.matrix(flights_bcd[, -1])

flights_grid <- expand.grid(
  row_clusters = 4,
  col_clusters = c(6, 9, 12),
  miss_val = fivenum(flights_bcd),
  similarity = c("Rand", "Jaccard")
)

# RUN TIME: approximately 40 seconds across two cores.
flights_tune <- tune_biclustermd(
  flights_bcd,
  nrep = 10,
  parallel = TRUE,
  ncores = 2,
  tune_grid = flights_grid
)
flights_tune
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