

Package ‘concorR’

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Type Package

Title CONCOR and Supplemental Functions

Version 0.2.1

Description Contains the CONCOR (CONvergence of iterated CORrelations) algorithm and a series of supplemental functions for easy running, plotting, and blockmodeling. The CONCOR algorithm is used on social network data to identify network positions based off a definition of structural equivalence; see Breiger, Boorman, and Arabie (1975) [doi:10.1016/0022-2496\(75\)90028-0](https://doi.org/10.1016/0022-2496(75)90028-0) and Wasserman and Faust's book Social Network Analysis: Methods and Applications (1994). This version allows multiple relationships for the same set of nodes and uses both incoming and outgoing ties to find positions.

Imports igraph, sna, stats, graphics

License GPL (>= 2)

Encoding UTF-8

LazyData true

URL <https://github.com/ATraxLab/concorR>

BugReports <https://github.com/ATraxLab/concorR/issues>

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concor	<i>Find CONCOR partition for a graph</i>
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Description

Use the CONCOR (CONvergence of iterated CORrelations) algorithm to identify roles within social network data.

Usage

```
concor(m_list, nsplit = 1, self_ties = FALSE, cutoff = .9999999, max_iter = 50)
```

Arguments

<code>m_list</code>	A list of adjacency matrices. Matrices must be square, of the same dimensions, and have row/column names (node names). Each matrix represents a different relationship of the same nodes. If there is only one relationship of interest, <code>m_list</code> is a list of that single matrix.
<code>nsplit</code>	The number of times the input matrices will be partitioned. Each split divides a partition in two, resulting in 2^{nsplit} roles identified.
<code>self_ties</code>	A Boolean representing whether self-ties can be present in the data. TRUE allows for self-ties; FALSE does not.
<code>cutoff</code>	The cutoff point of the iterated correlations. Both this and <code>max_iter</code> can be lowered slightly to improve speed.
<code>max_iter</code>	The maximum number of times the correlation will be run for a split. Both this and <code>cutoff</code> can be lowered slightly to improve speed.

Details

This version works for multiple relationships, assuming they all are for the same data (same size of input matrices), and can be used with isolates present. It requires further testing on weighted networks (but appears to successfully split such networks). It will attempt to split the network `nsplit` times, causing there to be 2^{nsplit} partitions, plus one for isolated nodes (if they exist), unless a structurally equivalent node group or singular node group is present. If the algorithm attempts to split such a node group the function will ignore that group and continue to split all other blocks until specified. If a higher number of splits, `nsplit`, are requested than are possible to apply to the specified data (due to structurally equivalent node groups being present or all blocks being singular nodes) the code will warn the user that split `nsplit` was the same as split `i`, the final possible split, and stop.

Value

A data frame with two columns: `block` is the block or role identified by CONCOR, and `vertex` is the node names.

References

R. L. Breiger, S. A. Boorman, P. Arabie, An algorithm for clustering relational data with applications to social network analysis and comparison with multidimensional scaling. *J. of Mathematical Psychology*. **12**, 328 (1975). doi: [10.1016/00222496\(75\)900280](https://doi.org/10.1016/00222496(75)900280)

S. Wasserman and K. Faust, *Social Network Analysis: Methods and Applications* (Cambridge University Press, 1994).

Examples

```
a <- matrix(c(0, 0, 0, 1, 1, 0, 1, 0, 1, 1, 0, 1, 1, 0, 1, 0), ncol = 4)
rownames(a) <- c("a", "b", "c", "d")
colnames(a) <- c("a", "b", "c", "d")

concor(list(a))
```

concor1

Find +1/-1 convergence points of an input matrix

Description

A subfunction of `concor`.

Runs the Pearson correlation on the matrix stack repeatedly until a square matrix consisting of only +1 and -1 is formed.

Usage

```
concor1(m_stack, cutoff = .9999999, max_iter = 50)
```

Arguments

<code>m_stack</code>	The stack of input matrices, which must include all transposes and relations.
<code>cutoff</code>	The absolute value of the convergence threshold for each matrix element.
<code>max_iter</code>	Maximum number of times to run the correlation while seeking convergence.

Details

For network data with R relations, the input matrix "stack" is a $(2 \times N \times R) \times N$ matrix, consisting of each relation's adjacency matrix, then the transpose of that matrix, appended to each other vertically. The correlation is run until either all matrix entries have absolute values greater than `cutoff` or the maximum number of iterations `max_iter` is reached. On its own, this function does not execute the whole CONCOR method, but is listed separately from `concor` to demonstrate the core step.

Value

A square matrix, with number of rows/columns equal to the number of columns of `m_stack`, where the values are either +1 or -1. The input matrix can later be split into two "positions" based off the locations of the positive/negative values.

See Also

[concor](#)

Examples

```
a <- matrix(c(0, 0, 0, 1, 1, 0, 1, 0, 1, 1, 0, 1, 1, 0, 1, 0), ncol = 4)
b <- rbind(a, t(a))

concor1(b)
```

concorR

The concorR Package

Description

concorR implements the CONCOR (CONvergence of iterated CORrelations) algorithm as introduced by Breiger, Boorman, and Arabie (1975) and detailed by Wasserman and Faust (1994). This package includes the [concor](#) algorithm itself, and some useful functions for plotting and interpreting the outputs. The plotting methods included are: plotting the overall network with the [concor](#) partitions as colors (using the [igraph](#) package), plotting a blockmodel using the [concor](#) partitions (using the [sna](#) package), and plotting reduced network graphs showing the connections between [concor](#) partitions (again using [igraph](#)).

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References

R. L. Breiger, S. A. Boorman, P. Arabie, An algorithm for clustering relational data with applications to social network analysis and comparison with multidimensional scaling. *J. of Mathematical Psychology*. **12**, 328 (1975). doi: [10.1016/00222496\(75\)900280](https://doi.org/10.1016/00222496(75)900280)

S. Wasserman and K. Faust, *Social Network Analysis: Methods and Applications* (Cambridge University Press, 1994).

concor_igraph_apply *Find CONCOR partition and add to a list of **igraph** objects*

Description

Takes a list of **igraph** objects, runs `concor` until the desired number of splits, and adds the final split to each object as a vertex attribute.

Usage

```
concor_igraph_apply(igraph_list, nsplit = 1)
```

Arguments

<code>igraph_list</code>	The list of igraph objects for use in <code>concor</code> .
<code>nsplit</code>	Number of times to split each network.

Details

This function is a wrapper for a common task: Running `concor` on one or more **igraph** objects and adding the resulting partition to each object as a vertex attribute. If multiple **igraph** objects are included in the input list, they should be multiple relations for the same nodes.

If all of the input graphs are weighted, edge weights will be used by `concor`.

Value

Returns a list of **igraph** objects, each with a vertex attribute `csplitn` (where `n` is `nsplit`) that contains the block assignment obtained from `concor`.

See Also

[concor](#), [concor_make_igraph](#)

Examples

```
a <- matrix(c(0, 0, 0, 1, 1, 0, 1, 0, 1, 1, 0, 1, 1, 0, 1, 0), ncol = 4)
rownames(a) <- c("a", "b", "c", "d")
colnames(a) <- c("a", "b", "c", "d")
a.igraph <- igraph::graph_from_adjacency_matrix(a)
concor_igraph_apply(list(a.igraph))

b <- matrix(c(0, 0, 0, 4, 1, 0, 3, 0, 2, 1, 0, 1, 1, 0, 2, 0), ncol = 4)
rownames(b) <- c("a", "b", "c", "d")
colnames(b) <- c("a", "b", "c", "d")
b.igraph <- igraph::graph_from_adjacency_matrix(b, weighted = "weight")
concor_igraph_apply(list(b.igraph))

concor_igraph_apply(list(a.igraph, b.igraph))
```

concor_make_igraph *Find CONCOR partition and create a list of **igraph** objects*

Description

Run `concor` on a list of adjacency matrices and create a list of **igraph** objects with a specific CONCOR split added as a vertex attribute.

Usage

```
concor_make_igraph(adj_list, nsplit = 1)
```

Arguments

<code>adj_list</code>	A list of adjacency matrices, each representing a different relation for the same nodes.
<code>nsplit</code>	The total number of splits CONCOR will (attempt to) perform.

Details

This function is a wrapper for a common task: Running `concor` on one or more adjacency matrices, then saving the networks as **igraph** objects with the CONCOR partition as a vertex attribute. If multiple adjacency matrices are included in the input list, they should be multiple relations for the same nodes.

If any of the input matrices have entries other than 0 and 1, all are treated as weighted (a weight edge attribute is added to each output graph).

Value

Returns a list of **igraph** objects with a vertex attribute `csplitn`, where `n` is `nsplit` that contains the block assignment obtained from `concor`.

See Also

[concor](#), [concor_igraph_apply](#)

Examples

```
a <- matrix(c(0, 0, 0, 1, 1, 0, 1, 0, 1, 1, 0, 1, 1, 0, 1, 0), ncol = 4)
rownames(a) <- c("a", "b", "c", "d")
colnames(a) <- c("a", "b", "c", "d")
concor_make_igraph(list(a))

b <- matrix(c(0, 0, 0, 4, 1, 0, 3, 0, 2, 1, 0, 1, 1, 0, 2, 0), ncol = 4)
rownames(b) <- c("a", "b", "c", "d")
colnames(b) <- c("a", "b", "c", "d")
concor_make_igraph(list(b))

concor_make_igraph(list(a, b))
```

krack_advice

Krackhardt High-Tech Managers data

Description

A network of connections between 21 managers at a manufacturing company taken by David Krackhardt in 1987. The three networks available are advice, friendship, and report structure.

Usage

krack_advice

krack_friend

krack_report

Format

A directed and unweighted **igraph** object.

Vertex attributes:

- Name: Vertex names (character; "v1", "v2", ..., "v21").
- x, y: A set of plotting coordinates, used if no other layout is supplied (numeric).
- Age: The age of each manager (integer).
- Tenure: The tenure of each manager (numeric).
- Level: The level in the corporate hierarchy (integer; 1 = CEO, 2 = Vice President, 3 = manager).
- Department: What department each manager is in (integer; 1, 2, 3, 4, or 0 for the CEO).

Details

Edges in the `krack_advice` and `krack_friend` networks come survey questions answered by all 21 managers. The `krack_report` network uses the formal organization chart to define connections between managers.

Source

The data was found at <http://vlado.fmf.uni-lj.si/pub/networks/data/WaFa/default.htm> and reformatted for use in R.

References

D. Krackhardt, Cognitive social structures. *Social Networks*. **9**, 104 (1987). doi: [10.1016/0378-8733\(87\)900098](https://doi.org/10.1016/0378-8733(87)900098)

S. Wasserman and K. Faust, *Social Network Analysis: Methods and Applications* (Cambridge University Press, 1994).

make_blk	<i>Make blockmodel objects using CONCOR partition</i>
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Description

Use the CONCOR algorithm to find network positions, continuing through a specified number of splits, and output `blockmodel` object(s).

Usage

```
make_blk(adj_list, nsplit = 1)
```

Arguments

<code>adj_list</code>	A list of adjacency matrices, each representing a different relation for the same nodes.
<code>nsplit</code>	The total number of splits CONCOR will (attempt to) perform.

Details

Runs `concor` to a specified number of splits (`nsplit`) and creates a `blockmodel` type object from each input matrix in `adj_list` using the membership vector generated by `concor`. This object holds summary information of interest, such as the reduced density matrix, as well as the permuted adjacency matrix that shows the blocked structure.

See the help file for `blockmodel` in the `sna` package for more details.

Value

A list of `blockmodel` type objects, one for each input adjacency matrix. Each `blockmodel` in the list corresponds to one relation.

See Also

[blockmodel](#), [concor](#)

Examples

```
g1 <- matrix(c(0, 0, 0, 1, 1, 0, 1, 0, 1, 1, 0, 1, 1, 0, 1, 0), ncol = 4)
rownames(g1) <- c("a", "b", "c", "d")
colnames(g1) <- c("a", "b", "c", "d")

g2 <- matrix(c(0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 1, 1, 0, 0), ncol = 4)
rownames(g2) <- c("a", "b", "c", "d")
colnames(g2) <- c("a", "b", "c", "d")

g1 <- list(g1, g2)
make_blk(g1)
```

make_reduced

Run CONCOR and output reduced adjacency matrices

Description

Takes a list of adjacency matrices, partitions using [concor](#), and returns a list of reduced adjacency matrices and their corresponding cutoff densities. Each reduced matrix corresponds to one input relation. The [sna](#) package must be installed, but does not need to be attached.

Usage

```
make_reduced(adj_list, nsplit = 1)
```

Arguments

adj_list	A list of adjacency matrices, each representing a different relation for the same nodes.
nsplit	The total number of splits CONCOR will (attempt to) perform.

Details

A reduced network represents each identified position in the network as a single node. Links (or self-links) exist if the density of ties in that block is greater than a threshold density. In this implementation, the density of the whole network is used as the threshold for each block.

In the list of input matrices `adj_list`, each should correspond to a different relation for the same nodes. Each adjacency matrix is partitioned with the CONCOR algorithm, continuing for `nsplit` divisions. After the threshold density is applied, each entry in the reduced matrix has values of 0 or 1.

Value

reduced_mat A list of reduced matrices, one for each input matrix.

dens A vector of the cut-off densities used (equal to the edge density of each entry in adj_list).

References

S. Wasserman and K. Faust, *Social Network Analysis: Methods and Applications* (Cambridge University Press, 1994).

See Also

[concor](#), [make_blk](#)

Examples

```
g1 <- matrix(c(0, 0, 0, 1, 1, 0, 1, 0, 1, 1, 0, 1, 1, 0, 1, 0), ncol = 4)
rownames(g1) <- c("a", "b", "c", "d")
colnames(g1) <- c("a", "b", "c", "d")

g2 <- matrix(c(0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 1, 1, 0, 0), ncol = 4)
rownames(g2) <- c("a", "b", "c", "d")
colnames(g2) <- c("a", "b", "c", "d")

make_reduced(list(g1, g2), nsplit = 1)
```

make_reduced_igraph *Build an igraph object for a reduced network*

Description

Turns a reduced adjacency matrix (usually output from [make_reduced](#)) into an igraph object. This function requires **igraph** to work.

Usage

```
make_reduced_igraph(reduced_mat)
```

Arguments

reduced_mat A reduced network adjacency matrix (typically outputted from [make_reduced](#) in the reduced_mat list)

Value

A directed and unweighted igraph object for the reduced matrix.

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

```
a <- matrix(c(0, 0, 0, 1, 1, 0, 1, 0, 1, 1, 0, 1, 1, 0, 1, 0), ncol = 4)
rownames(a) <- c("a", "b", "c", "d")
colnames(a) <- c("a", "b", "c", "d")

r_mat <- make_reduced(list(a), nsplit = 1)
make_reduced_igraph(r_mat$reduced_mat[[1]])
```

plot_blk

*Plot a blockmodel***Description**

Displays a plot of a blockmodel. Based on [plot.blockmodel](#) (**sna** must be installed), but reformats the plot to be square and removes the mandatory title.

Usage

```
plot_blk(x, labels = FALSE, ...)
```

Arguments

x	An object of class <code>blockmodel</code>
labels	If TRUE, vertex ids are displayed as row/column/diagonal labels. If FALSE, no node labels are shown.
...	Further arguments passed to or from other methods

Details

This is a modification of the [plot.blockmodel](#) function. The original displays vertex ids as row, column, and diagonal labels, which can be unreadable for larger networks. [plot.blockmodel](#) also adds a title of the form "Relation - 1", which this version omits.

Value

Returns NULL, invisibly.

Author(s)

Carter T. Butts (buttsc@uci.edu)

Modified by Tyme Suda

References

Carter T. Butts (2019). sna: Tools for Social Network Analysis. R package version 2.5. <https://CRAN.R-project.org/package=sna>

See Also

[plot.blockmodel](#)

Examples

```
g1 <- matrix(c(0, 0, 0, 1, 1, 0, 1, 0, 1, 1, 0, 1, 1, 0, 1, 0), ncol = 4)
rownames(g1) <- c("a", "b", "c", "d")
colnames(g1) <- c("a", "b", "c", "d")

g1 <- list(g1)
bm <- make_blk(g1, 1)[[1]]
plot_blk(bm)
```

plot_reduced

Plot a reduced network

Description

Plot a reduced network using **igraph**, with nodes colored by block number.

Usage

```
plot_reduced(iobject)
```

Arguments

`iobject` An igraph object representing the reduced network.

Details

Plots the reduced network, where each node represents all the nodes assigned to that position by CONCOR. Node colors on the reduced network plot are assigned by position, so if CONCOR is also used for vertex color on a sociogram (as in [plot_socio](#)), the node colors will align between the plots.

Value

Returns NULL, invisibly.

See Also

[make_reduced](#), [make_reduced_igraph](#), [plot_socio](#)

Examples

```

library(igraph)
g1 <- matrix(c(0, 0, 0, 1, 1, 0, 1, 0, 1, 1, 0, 1, 1, 0, 1, 0), ncol = 4)
rownames(g1) <- c("a", "b", "c", "d")
colnames(g1) <- c("a", "b", "c", "d")

r_mat <- make_reduced(list(g1), nsplit = 1)
r_igraph <- make_reduced_igraph(r_mat$reduced_mat[[1]])

plot_reduced(r_igraph)

```

plot_socio

*Plot sociogram colored by CONCOR partition***Description**

Plots a network of interest using CONCOR partition as vertex color. Uses an igraph object, normally created by [concor_make_igraph](#) or [concor_igraph_apply](#).

Usage

```
plot_socio(iobject, nsplit = NULL)
```

Arguments

iobject	An igraph object with <code>concor split</code> as appropriately-named vertex attribute.
nsplit	Split number to use as vertex color.

Details

This is a shortcut to plot an igraph object with usually-readable settings. It looks for the input `iobject` to have a vertex attribute called `csplit(nsplit)` that holds the CONCOR partition assignment (for example, if `nsplit = 2`, then `plot_socio` expects a vertex attribute named `csplit2`).

Value

Returns NULL, invisibly.

See Also

[concor](#), [concor_make_igraph](#), [concor_igraph_apply](#)

Examples

```

a <- matrix(c(0, 0, 0, 1, 1, 0, 1, 0, 1, 1, 0, 1, 1, 0, 1, 0), ncol = 4)
rownames(a) <- c("a", "b", "c", "d")
colnames(a) <- c("a", "b", "c", "d")

i_out <- concor_make_igraph(list(a))
plot_socio(i_out[[1]], 1)

```

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