Package 'netUtils'

August 27, 2022

Title Miscellaneous Functions for Network Analysis

Version 0.7.0

Description Provides a collection of network analytic (convenience) functions which are missing in other standard packages. This includes triad census with attributes <doi:10.1016/j.socnet.2019.04.003>, core-periphery models <doi:10.1016/S0378-8733(99)00019-2>, and several graph generators. Most functions are build upon 'igraph'.

URL https://github.com/schochastics/netUtils/

BugReports https://github.com/schochastics/netUtils/issues

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Encoding UTF-8

RoxygenNote 7.2.0

LinkingTo Rcpp, RcppArmadillo

Imports Rcpp, igraph, stats

Suggests covr, testthat (>= 3.0.0)

Config/testthat/edition 3

NeedsCompilation yes

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Repository CRAN

Date/Publication 2022-08-27 08:40:05 UTC

R topics documented:

`as_adj_list1` *Adjacency list*

Description

Create adjacency lists from a graph, either for adjacent edges or for neighboring vertices. This version is faster than the version of igraph but less general.

Usage

```
as_adj_list1(g)
```

Arguments

g	An igraph object

Details

The function does not have a mode parameter and only returns the adjacency list comparable to as_adj_list(g,mode="all)

Value

A list of numeric vectors.

Author(s)

David Schoch

Examples

```
library(igraph)
g <- make_ring(10)
as_adj_list1(g)
```

`as_adj_weighted` *weighted dense adjacency matrix*

Description

returns the weighted adjacency matrix in dense format

Usage

```
as_adj_weighted(g, attr = NULL)
```

Arguments

`g`	An igraph object
`attr`	Either NULL or a character string giving an edge attribute name. If NULL a traditional adjacency matrix is returned. If not NULL then the values of the given edge attribute are included in the adjacency matrix.

Details

This method is faster than as_adj from igraph if you need the weighted adjacency matrix in dense format

Value

Numeric matrix

Author(s)

David Schoch

Examples

```
library(igraph)
g <- sample_gnp(10, 0.2)
E(g)$weight <- runif(ecount(g))
as_adj_weighted(g, attr="weight")
```

as_multi_adj *Convert a list of graphs to an adjacency matrices*

Description

Convenience function that turns a list of igraph objects into adjacency matrices.

Usage

```
as_multi_adj(g_lst, attr = NULL, sparse = FALSE)
```

Arguments

g_lst	A list of igraph object
attr	Either NULL or a character string giving an edge attribute name. If NULL a binary adjacency matrix is returned.
sparse	Logical scalar, whether to create a sparse matrix. The 'Matrix' package must be installed for creating sparse matrices.

Value

List of numeric matrices

Author(s)

David Schoch

bipartite_from_data_frame *two-mode network from a data.frame*

Description

Create a two-mode network from a data.frame

Usage

```
bipartite_from_data_frame(d, type1, type2, attr = NULL)
```

Arguments

d	data.frame
type1	column name of mode 1
type2	column name of mode 2
attr	named list of edge attributes

Value

two mode network as igraph object

Author(s)

David Schoch

Examples

```
library(igraph)
edges <- data.frame(mode1=1:5,mode2=letters[1:5])
bipartite_from_data_frame(edges,"mode1","mode2")
```

`clique_vertex_mat` *Clique Vertex Matrix*

Description

Creates the clique vertex matrix with entries (i,j) equal to one if node j is in clique i

Usage

```
clique_vertex_mat(g)
```

Arguments

g	An igraph object

Value

Numeric matrix

Author(s)

David Schoch

Examples

```
library(igraph)
g <- sample_gnp(10,0.2)
clique_vertex_mat(g)
```

core_periphery *Discrete core-periphery model*

Description

Fits a discrete core-periphery model to a given network

Usage

```
core_periphery(graph, method = "rk1_dc", iter = 5000)
```

Arguments

graph	igraph object
method	algorithm to use (see details)
iter	number of iterations if method=SA

Details

The function fits the data to an optimal pattern matrix with simulated annealing (method="SA") or a rank 1 approximation, either with degree centrality (method="rk1_dc") or eigenvector centrality (method="rk1_ec") . The rank 1 approximation is computationally far cheaper but also more experimental. Best is to compare the results from both models.

Value

list with numeric vector with entries (k1,k2,...ki...) where ki assigns vertex i to either the core (ki=1) or periphery (ki=0), and the maximal correlation with an optimal pattern matrix

Author(s)

David Schoch

References

Borgatti, Stephen P., and Martin G. Everett. "Models of core/periphery structures." Social networks 21.4 (2000): 375-395.

Examples

```
set.seed(121)
#split graphs have a perfect core-periphery structure
sg <- split_graph(n = 20, p = 0.3,core = 0.5)
core_periphery(sg)
```

dyad_census_attr *dyad census with node attributes*

Description

dyad census with node attributes

Usage

```
dyad_census_attr(g, vattr)
```

Arguments

g	igraph object. should be a directed graph.
vattr	name of vertex attribute to be used.

Details

The node attribute should be integers from 1 to max(attr). Currently only works for 2

Value

dyad census with node attributes.

Author(s)

David Schoch

fast_cliques *Find Cliques, maximal or not, fast*

Description

Enumerates all (maximal) cliques using MACE. Can be faster than igraph in some circumstances

Usage

```
fast_cliques(g, what = "M", min = NULL, max = NULL, outfile = NA)
```

Arguments

g	An igraph object
what	either "M" for maximal cliques or "C" for all cliques
min	Numeric constant, lower limit on the size of the cliques to find. NULL means no limit, ie. it is the same as 0
max	Numeric constant, upper limit on the size of the cliques to find. NULL means no limit
outfile	character. If not NA, cliques are written to file

Details

C Code downloaded from http://research.nii.ac.jp/~uno/codes.htm. Download the code and run make and then point an environment variable called MACE_PATH to the binary. See http://research.nii.ac.jp/~uno/code/mace for more details. MACE is faster than igraph for dense graphs.

Value

a list containing numeric vectors of vertex ids. Each list element is a clique. If outfile!=NA, the output is written to the specified file

Author(s)

David Schoch

References

Kazuhisa Makino, Takeaki Uno, "New Algorithms for Enumerating All Maximal Cliques", Lecture Notes in Computer Science 3111 (Proceedings of SWAT 2004), Springer, pp.260-272, 2004

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graph_cartesian *Cartesian product of two graphs*

Description

Compute the Cartesian product of two graphs

Usage

```
graph_cartesian(g, h)
```

Arguments

g	An igraph object
h	An igraph object

Details

See https://en.wikipedia.org/wiki/Cartesian_product_of_graphs

Value

Cartesian product as igraph object

Author(s)

David Schoch

Examples

```
library(igraph)
g <- make_ring(4)
h <- make_full_graph(2)
graph_cartesian(g,h)
```

---

graph_cor *Graph correlation*

Description

This function computes the correlation between networks. Implemented methods expect the graph to be an adjacency matrix, an igraph, or a network object.

Usage

```
graph_cor(object1, object2)

## Default S3 method:
graph_cor(object1, object2)

## S3 method for class 'igraph'
graph_cor(object1, object2, ...)

## S3 method for class 'matrix'
graph_cor(object1, object2)

## S3 method for class 'array'
graph_cor(object1, object2)
```

Arguments

object1	igraph object or adjacency matrix
object2	igraph object or adjacency matrix over the same vertex set as object1
...	additional arguments

Value

correlation between graphs

graph_direct *Direct product of two graphs*

Description

Compute the direct product of two graphs

Usage

```
graph_direct(g, h)
```

Arguments

g	An igraph object
h	An igraph object

Details

See https://en.wikipedia.org/wiki/Tensor_product_of_graphs

Value

Direct product as igraph object

Author(s)

David Schoch

Examples

```
library(igraph)
g <- make_ring(4)
h <- make_full_graph(2)
graph_direct(g,h)
```

graph_from_multi_edgelist *Multiple networks from a single edgelist with a typed attribute*

Description

Create a list of igraph objects from an edgelist according to a type attribute

Usage

```
graph_from_multi_edgelist(
  d,
  from = NULL,
  to = NULL,
  type = NULL,
  weight = NULL,
  directed = FALSE
)
```

Arguments

d	data frame.
from	column name of sender. If NULL, defaults to first column.
to	column of receiver. If NULL, defaults to second column.
type	type attribute to split the edgelist. If NULL, defaults to third column.
weight	optional column name of edge weights. Ignored if NULL.
directed	logical scalar, whether or not to create a directed graph.

Value

list of igraph objects.

Author(s)

David Schoch

Examples

```
library(igraph)
d <- data.frame(from=rep(c(1,2,3),3),to=rep(c(2,3,1),3),
                type=rep(c("a","b","c"),each=3),weight=1:9)
graph_from_multi_edgelist(d,"from","to","type","weight")
```

---

graph_kpartite *k partite graphs*

Description

Create a random k-partite graph.

Usage

```
graph_kpartite(n = 10, grp = c(5, 5))
```

Arguments

n	number of nodes
grp	vector of partition sizes

Value

igraph object

Author(s)

David Schoch

Examples

```
#3-partite graph with equal sized groups
graph_kpartite(n = 15, grp = c(5,5,5))
```

---

graph_to_sage *convert igraph object to sage format*

Description

convert igraph object to sage format to be read in SAGE

Usage

```
graph_to_sage(g)
```

Arguments

g	igraph object

Value

sage string

Author(s)

David Schoch

helpers *helper function*

Description

small functions to deal with typical network problems

Usage

```
biggest_component(g)

delete_isolates(g)
```

Arguments

g	igraph object

Value

igraph object

Author(s)

David Schoch

sample_coreseq *Generate random graphs with a given coreness sequence*

Description

Similar to sample_degseq just with coreness

Usage

```
sample_coreseq(cores)
```

Arguments

cores	coreness sequence

Details

The code is an adaption of the python code from https://github.com/ktvank/Random-Graphs-with-Prescribed-K-Core-Sequences/

Value

igraph object of graph with the same coreness sequence as the input

Author(s)

David Schoch

References

Van Koevering, Katherine, Austin R. Benson, and Jon Kleinberg. 2021. 'Random Graphs with Prescribed K-Core Sequences: A New Null Model for Network Analysis'. ArXiv:2102.12604. https://doi.org/10.1145/3442381.3450001.

Examples

```
library(igraph)
g1 <- make_graph("Zachary")
kcores1 <- coreness(g1)
g2 <- sample_coreseq(kcores1)
kcores2 <- coreness(g2)

#the sorted arrays are the same
all(sort(kcores1)==sort(kcores2))
```

---

sample_pa_homophilic *Homophilic random graph using BA preferential attachment model*

Description

A graph of n nodes is grown by attaching new nodes each with m edges that are preferentially attached to existing nodes with high degree, depending on the homophily parameters.

Usage

```
sample_pa_homophilic(
  n,
  m,
  minority_fraction,
  h_ab,
  h_ba = NULL,
  directed = FALSE
)
```

Arguments

n	number of nodes
m	number of edges a new node is connected to
minority_fraction	fraction of nodes that belong to the minority group
h_ab	probability to connect a node from group a with groub b
h_ba	probability to connect a node from group b with groub a. If NULL, h_ab is used.
directed	should a directed network be created

Details

The code is an adaption of the python code from https://github.com/gesiscss/HomophilicNtwMinorities/

Value

igraph object

Author(s)

David Schoch #maximally heterophilic network sample_pa_homophilic(n = 50, m = 2,minority_fraction = 0.2,h_ab = 1) #maximally homophilic network sample_pa_homophilic(n = 50, m = 2,minority_fraction = 0.2,h_ab = 0)

References

Karimi, F., Génois, M., Wagner, C., Singer, P., & Strohmaier, M. (2018). Homophily influences ranking of minorities in social networks. Scientific reports, 8(1), 1-12. (https://www.nature.com/articles/s41598-018-29405-7)

Espín-Noboa, L., Wagner, C., Strohmaier, M., & Karimi, F. (2022). Inequality and inequity in network-based ranking and recommendation algorithms. Scientific reports, 12(1), 1-14. (https://www.nature.com/articles/s41
022-05434-1)

---

split_graph *split graph*

Description

Create a random split graph with a perfect core-periphery structure.

Usage

```
split_graph(n, p, core)
```

Arguments

n	number of nodes
p	probability of peripheral nodes to connect to the core nodes
core	fraction of nodes in the core

Value

igraph object

Author(s)

David Schoch

Examples

```
#split graph with 20 nodes and a core size of 10
split_graph(n = 20, p = 0.4, 0.5)
```

---

str.igraph *Print graphs to terminal*

Description

Prints an igraph object to terminal (different than the standard igraph method)

Usage

```
## S3 method for class 'igraph'
str(object, ...)
```

Arguments

object	An igraph object
...	additional arguments to print (ignored)

Value

str does not return anything. The obvious side effect is output to the terminal.

Author(s)

David Schoch

structural_equivalence *Maximal Structural Equivalence*

Description

Calculates structural equivalence for an undirected graph

Usage

```
structural_equivalence(g)
```

Arguments

g	An igraph object

Details

Two nodes u and v are structurally equivalent if they have exactly the same neighbors. The equivalence classes produced with this function are either cliques or empty graphs.

Value

vector of equivalence classes

Author(s)

David Schoch

triad_census_attr *triad census with node attributes*

Description

triad census with node attributes

Usage

```
triad_census_attr(g, vattr)
```

Arguments

g	igraph object. should be a directed graph
vattr	name of vertex attribute to be used

Details

The node attribute should be integers from 1 to max(attr). The output is a named vector where the names are of the form Txxx-abc, where xxx corresponds to the standard triad census notation and "abc" are the attributes of the involved nodes.

The implemented algorithm is comparable to the algorithm in Lienert et al.

Value

triad census with node attributes

Author(s)

David Schoch

References

Lienert, J., Koehly, L., Reed-Tsochas, F., & Marcum, C. S. (2019). An efficient counting method for the colored triad census. Social Networks, 58, 136-142.

Examples

```
library(igraph)
set.seed(112)
g <- sample_gnp(20,p = 0.3,directed = TRUE)
# add a vertex attribute
V(g)$type <- rep(1:2,each = 10)
triad_census_attr(g,"type")
```

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