Package 'graphonmix'

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Type Package

Title Generates Dense and Sparse Graphs using Graphon Extensions

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Description Generates dense or sparse graphs using graphon mixtures and graphettes. Graphon mixtures uses two graphons U and W to generate graphs. Sparse graphs are generated in this case using the inverse line graph (root) operation. Graphettes have 3 components, the graphon W, a real-valued sequence and a graph edit function. Both techniques can generate dense or sparse graphs. Kandanaarachchi and Ong (2026) <doi:10.48550/arXiv.2505.13864>, Wijesinghe et al (2026) <doi:10.48550/arXiv.2602.23566>.

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Imports ggplot2, igraph, imager, stats

Suggests gridExtra, knitr, rmarkdown

VignetteBuilder knitr

URL https://sevvandi.github.io/graphonmix/

NeedsCompilation no

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`autoplot.extract_sparse` *Plots the output of extract_sparse function.*

Description

Plots the two lines fitted to the unique, sorted log degrees of the graph.

Usage

```
## S3 method for class 'extract_sparse'
autoplot(object, ...)
```

Arguments

`object`	The output of the function 'extract_sparse'
`...`	Other arguments currently ignored

Value

A ggplot object.

Examples

```
library(igraph)
gr <- sample_pa(10000, power = 1.2, directed = FALSE)
sparse <- extract_sparse(gr)
autoplot(sparse)
```

`autoplot.separate_dense_and_sparse` *Plots the output of separate_dense_and_sparse.*

Description

Plots the three lines fitted to the unique, sorted log degrees of the graph.

Usage

```
## S3 method for class 'separate_dense_and_sparse'
autoplot(object, ...)
```

Arguments

`object`	The output of the function 'separate_dense_and_sparse.'
`...`	Other arguments currently ignored

Value

A ggplot object.

Examples

```
library(igraph)
W <- matrix(0.1, nrow = 100, ncol = 100)
wts <- c(0.5, 0.3, 0.2)
ns <- 200
nd <- 100
p <- 0.5
gr <- sample_mixed_graph(W, wts, nd, ns, p = 0.1, option = 2)
out <- separate_dense_and_sparse(gr)
separate <- separate_dense_and_sparse(gr)
autoplot(separate)
```

create_exp_matrix *Creates an exponential graphon*

Description

Creates an nxn matrix where the (i,j)th entry is exp(-(i+j)/scalar)

Usage

```
create_exp_matrix(nrow, scalar)
```

Arguments

nrow	The dimension of the matrix
scalar	The scalar in exp(-(i+j)/scalar)

Value

An nxn matrix

Examples

```
W <- create_exp_matrix(100, 100)
```

empirical_graphon *Computes empirical graphon from graph*

Description

Computes empirical graphon given a graph

Usage

```
empirical_graphon(gr, n = NULL)
```

Arguments

gr	A graph
n	Dimension of the graphon matrix

Value

The empirical graphon

Examples

```
library(igraph)
gr <- sample_gnp(1000, p=0.2)
emp <-  empirical_graphon(gr, n = 100)
```

`extract_sparse` *Extracts the sparse part from a (U,W) graphon mixture*

Description

This function extracts the sparse component from a (U,W) mixture graph by fitting two lines to the unique sorted log degree values. The first line gives the number of hubs in the sparse part and the remaining line fits the degrees of the dense part.

Usage

```
extract_sparse(gr)
```

Arguments

`gr`	The input graph

Value

a list with the following components:

`num_hubs`	The number of hubs in the sparse component.
`phat`	The probability vector of the sparse component. This is also known as the mass partition.
`segment_sizes`	The sizes of the two line segments.
`line_equations`	The two equations of the lines.
`cutoff`	The best cut off for the two lines.
`models`	The models of the fitted lines.
`mse`	The mean squared error
`data`	The degree data.

Examples

```
library(igraph)
gr <- sample_pa(10000, power = 1.2, directed = FALSE)
sparse <- extract_sparse(gr)
sparse$phat
```

generate_star_union *Generates a sparse graph of star graphs*

Description

Generates a union of star graphs given the weights

Usage

```
generate_star_union(wts, n)
```

Arguments

wts	The proportion of the hub degrees
n	The number of nodes in the new graph

Value

A disjoint union of star graphs

Examples

```
library(igraph)
wts <- c(0.5, 0.3, 0.2)
gr <- generate_star_union(wts, n = 100)
gr
```

graph_join *Joins two graphs*

Description

Joins two graphs randomly connecting vertices

Usage

```
graph_join(gr1, gr2, p = 0.5, option = 2)
```

Arguments

gr1	The first graph to join
gr2	The second graph to join
p	The proportion of edges in gr1 to be added as part of the joining
option	Two options. 1 does the disjoint union, 2 does the random edges union.

Value

The joined graph

Examples

```
W <- create_exp_matrix(100, 100)
# create the sparse part - a disjoint set of stars
wts <- c(0.5, 0.3, 0.2)
grdense <- sample_graphon(W, 100)
grsparse <- generate_star_union(wts, 200)
gr <- graph_join(grdense, grsparse, opt = 2)
```

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line_graphon *Creates a line graphon from a sequence of probabilities*

Description

Creates a line graphon, which is a disjoint clique graphon from a sequence of probability values

Usage

```
line_graphon(probs)
```

Arguments

probs	The list of probabilities starting from the largest.

Value

The line graphon

Examples

```
library(ggplot2)
wts <- c(0.5, 0.3, 0.2)
U <- line_graphon(wts)
plot_graphon(U)
```

plot_graphon *Plots graphon*

Description

Plots graphon

Usage

```
plot_graphon(W, cols = c("white", "black"))
```

Arguments

W	A graphon given by an nxn matrix
cols	Colors, by default white and black

Value

A ggplot object.

Examples

```
W <- create_exp_matrix(100, 100)
plot_graphon(W)
```

predict_hubs *Predicts the degree of hubs of an new graph*

Description

Predicts the degree of hubs of an unseen graph given a graph generated from the same process.

Usage

```
predict_hubs(gr, n, k = NULL)
```

Arguments

gr	The input graph
n	The number of nodes in the new graph
k	The number of hubs. Default is NULL

Value

A vector of hub degrees

Examples

```
library(igraph)
gr <- sample_pa(10000, power = 1.2, directed = FALSE)
predict_hubs(gr, n = 11000)
```

`ring_graphon` *Creates a ring graphon*

Description

Creates an graphon which can generate ring graphs.

Usage

```
ring_graphon(n, alpha = 0.1)
```

Arguments

`n`	The dimension of the matrix
`alpha`	A scaling factor used in the graphon. Default set to 0.1

Value

An nxn matrix

Examples

```
# example code
W <- ring_graphon(100)
plot_graphon(W)
```

`sample_graphette` *Samples a graph from a graphette*

Description

Samples a graph from a graphette given by (W, a_n, f), where W is the graphon, a_n is generally a sequence converging to zero and f is a graph edit funcion.

Usage

```
sample_graphette(
  W,
  rho_n = NULL,
  graph_edit_f = NULL,
  n = 100,
  t_or_p = 0.5,
  ring_sizes = c(5, 6)
)
```

Arguments

W	The graphon. This is a symmetric matrix with values in [0,1]
rho_n	A function. Default is 1.
graph_edit_f	The graph edit function. For star functions it can be one of 'star_f1', 'star_f2', 'star_f3', 'star_f4' or 'star_f5'. To add rings, it needs to be 'add_rings'. The function 'remove_cycles' removes cycles.
n	The number of nodes in the graph to sample
t_or_p	The parameter for star function or the ring function. For the ring function it needs to be between 0 and 1.
ring_sizes	The size of rings to add if the graph edit function is the ring function. default values set to c(5,6).

Value

gr A graph sampled from rho_n W.

Examples

```
library(igraph)
# Example 1
f1 <- function(n) 10/n
W <- matrix(0.2, nrow = 100, ncol = 100)
gr <- sample_graphette(W, rho_n = f1, graph_edit_f = 'add_rings', n = 100, t_or_p = 0.5)
gr

# Example 2
gr <- sample_graphette(W, rho_n = f1, graph_edit_f = 'star_f1', n = 100, t_or_p = 3)
gr
```

---

sample_graphon *Generates a graph given a graphon*

Description

Generates a graph given a dense graphon W.

Usage

```
sample_graphon(W, n)
```

Arguments

W	A graphon given by a matrix
n	The number of nodes of the sampled graph

Value

A graph sampled from the graphon W with n nodes

Examples

```
library(igraph)
W <- matrix(0.2, nrow = 100, ncol = 100)
gr <- sample_graphon(W, n= 100)
```

`sample_mixed_graph` *Generate a (U,W) mixture graph*

Description

Generate a (U,W) mixture graph from a dense graphon W and a mass partition corresponding to a line graph graphon U.

Usage

```
sample_mixed_graph(W, wts, nd, ns, p = 0.5, option = 2)
```

Arguments

`W`	The dense graphon. This is a symmetric matrix with values in [0,1]
`wts`	The degree proportions of the hub degrees. Need to add up to 1. This is the mass partition corresponding to the line graph graphon U.
`nd`	The number of nodes in the dense part of the graph
`ns`	The number of nodes in the sparse part of the graph
`p`	The nodes to be added as a proportion of the edges in the dense part
`option`	Graph joining option. If `option == 1` then a disjoit union is considered. If `option == 2` the two graphs are joined randomly with the number of edges specified by `p`.

Value

A graph sampled from the (U,W) mixture.

Examples

```
library(igraph)
W <- matrix(0.1, nrow = 100, ncol = 100)
wts <- c(0.5, 0.3, 0.2)
ns <- 200
nd <- 100
p <- 0.5
gr <- sample_mixed_graph(W, wts, nd, ns, p, option = 2)
gr
```

sample_sparse_graphon *Samples a graph from a sparsified graphon*

Description

Samples a graph from a sparsified graphon given by a_n W, where W is the graphon and a_n is generally a sequence converging to zero.

Usage

```
sample_sparse_graphon(W, rho_n = NULL, n)
```

Arguments

W	The graphon. This is a symmetric matrix with values in [0,1]
rho_n	A function. Default is 1.
n	The number of nodes in the graph to sample

Value

gr A graph sampled from rho_n W.

Examples

```
library(igraph)
f1 <- function(n) 10/n
W <- matrix(0.2, nrow = 100, ncol = 100)
gr <- sample_sparse_graphon(W, f1, n = 100)
gr
```

sbm_graphon *Creates a Stochastic Block Model graphon*

Description

Creates an graphon representing a Stochastic Block Model (SBM).

Usage

```
sbm_graphon(mat, n)
```

Arguments

mat	The matrix representing the SBM
n	The dimension of the matrix

Value

An nxn matrix

Examples

```
# example code
mat <- matrix(c(0.9, 0.01, 0.02,
0.01, 0.8, 0.03,
0.02, 0.03, 0.7), nrow = 3, byrow = TRUE)
W <- sbm_graphon(mat, 100)
plot_graphon(W)
```

---

scale_graphon *Scales a graphon to an nxn matrix*

Description

Scales a graphon to an nxn matrix suitable for large adjacency matrices

Usage

```
scale_graphon(W, n)
```

Arguments

W	A graphon given as a symmetric square matrix
n	The dimension of the output matrix

Value

Scaled nxn graphon

Examples

```
library(igraph)
gr <- sample_gnp(1000, p=0.2)
adj <- as_adjacency_matrix(gr)
W <- scale_graphon(adj, 100)
```

separate_dense_and_sparse

Separates the dense and sparse part from a (U,W) graphon mixture

Description

This function breaks a (U,W) mixture graph into a dense and sparse component.

Usage

```
separate_dense_and_sparse(grmix)
```

Arguments

grmix	The input graph

Value

a list with the following components:

gr_dense	The dense component.
gr_sparse	The sparse component.
data	The original graph.

Examples

```
library(igraph)
W <- matrix(0.1, nrow = 100, ncol = 100)
wts <- c(0.5, 0.3, 0.2)
ns <- 200
nd <- 100
p <- 0.5
gr <- sample_mixed_graph(W, wts, nd, ns, p = 0.1, option = 2)
out <- separate_dense_and_sparse(gr)
out
```

star_f1

Adds stars to nodes

Description

Adds stars to nodes

Usage

```
star_f1(xvals, t)
```

Arguments

xvals	Values between 0 and 1 from the graphon
t	A parameter indicating the strength of hubs

Value

a vector of values

Examples

```
# example code
st <- star_f1(runif(10), 3)
st
```

---

star_f2 *Adds stars to nodes*

Description

Adds stars to nodes

Usage

```
star_f2(xvals, t)
```

Arguments

xvals	Values between 0 and 1 from the graphon
t	A parameter indicating the strength of hubs

Value

a vector of values

Examples

```
# example code
st <- star_f2(runif(10), 3)
st
```

star_f3 *Adds stars to nodes*

Description

Adds stars to nodes

Usage

```
star_f3(xvals, t)
```

Arguments

xvals	Values between 0 and 1 from the graphon
t	A parameter indicating the strength of hubs

Value

a vector of values

Examples

```
# example code
st <- star_f3(runif(10), 3)
st
```

star_f4 *Adds stars to nodes*

Description

Adds stars to nodes

Usage

```
star_f4(xvals, t)
```

Arguments

xvals	Values between 0 and 1 from the graphon
t	A parameter indicating the strength of hubs

Value

a vector of values

Examples

```
# example code
st <- star_f4(runif(10), 3)
st
```

`star_f5` *Adds stars to nodes*

Description

Adds stars to nodes

Usage

```
star_f5(xvals, t)
```

Arguments

`xvals`	Values between 0 and 1 from the graphon
`t`	A parameter indicating the strength of hubs

Value

a vector of values

Examples

```
# example code
st <- star_f5(runif(10), 3)
st
```

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