

Package ‘rMultiNet’

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Title Multi-Layer Networks Analysis

Version 0.1

Description Provides two general frameworks to generate a multi-layer network. This also provides several methods to reveal the embedding of both nodes and layers. The reference paper can be found from the URL mentioned below. Ting Li, Zhongyuan Lyu, Chenyu Ren, Dong Xia (2023) <[doi:10.48550/arXiv.2302.04437](https://doi.org/10.48550/arXiv.2302.04437)>.

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Imports dbscan, geigen, glmnet, graphics, Matrix, plotly, rTensor, stats

NeedsCompilation no

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Community_cluster_dbscan

Title

Description

Title

Usage

```
Community_cluster_dbscan(embedding, type, eps_value = 0.05, pts_value = 5)
```

Arguments

embedding	the embedding results from different methods
type	node embedding 'n' or network embedding 'N'
eps_value	parameters for DBSCAN
pts_value	parameters for DBSCAN

Value

the embedding results

Examples

```
tnsr = GenerateMMSBM(200, 3, 10, 2, d = NULL, r = NULL)
U_list = InitializationMMSBM(tnsr, 3, 2, rank = NULL)
embed_list = PowerIteration(tnsr, 3, 2, rank=NULL, type="TUCKER", U_0_list=U_list)
em = embed_list[[2]]
Community_cluster_dbscan(em, "N")
```

Community_cluster_km *Title*

Description

Title

Usage

```
Community_cluster_km(embedding, type, cluster_number)
```

Arguments

embedding	the embedding results from different methods
type	node embedding 'n' or network embedding 'N'
cluster_number	the number of clusters for Kmeans

Value

the embedding results

Examples

```
tnsr = GenerateMMSBM(200, 3, 10, 2, d = NULL, r = NULL)
U_list = InitializationMMSBM(tnsr, 3, 2, rank = NULL)
embed_list = PowerIteration(tnsr,3,2,rank=NULL,type="TUCKER",U_0_list=U_list)
em = embed_list[[2]]
Community_cluster_km(em,"N",5)
```

Embedding_network	<i>Title</i>
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Description

Title

Usage

```
Embedding_network(network_membership, L, paxis = 2)
```

Arguments

- network_membership the number of types of the network or the number of groups of vertices
- L the number of layers
- paxis the number of eigenvectors to use in the plot

Value

a plot table If the number of eigenvectors is more than two or plot the image

Examples

```
tnsr = GenerateMMSBM(200, 3, 10, 2, d = NULL, r = NULL)
U_list = InitializationMMSBM(tnsr, 3, 2, rank = NULL)
embed_list = PowerIteration(tnsr,3,2,rank=NULL,type="TUCKER",U_0_list=U_list)
Embedding_network(embed_list[[2]],10,2)
```

 GenerateMMLSM

Title

Description

Title

Usage

```

GenerateMMLSM(
  n,
  m,
  L,
  rank,
  U_mean = 0.5,
  cmax = 1,
  d,
  int_type = "Uniform",
  kernel_fun = "logit",
  scale_par = 1
)

```

Arguments

n	the number of vertices
m	the number of types of the network
L	the number of layers
rank	the rank of latent position matrix U
U_mean	the mean of the normal distribution of each entry of U
cmax	the entrywise upper bound of core tensor C
d	the average degree of the network
int_type	represents the ways of generating tensor C ('Uniform' or 'Norm')
kernel_fun	the link function of generating the adjacency tensor ('logit' or 'probit')
scale_par	the scaling factor of the parameter tensor

Value

a list including an adjacency tensor and the generating parameters

Examples

```
GenerateMMLSM(200, 3, 10, 2, d=NULL)
```

GenerateMMSBM	<i>Title</i>
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Description

Title

Usage

```
GenerateMMSBM(n, m, L, K, d = NULL, r = NULL)
```

Arguments

n	the number of vertices
m	the number of types of the network
L	the number of layers
K	the number of groups of vertices
d	the average degree of the network
r	the out-in ratio in each layer

Value

a list including an adjacency tensor and the generating parameters

Examples

```
GenerateMMSBM(200, 3, 10, 2, d = NULL, r = NULL)
```

InitializationLSM	<i>Title</i>
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Description

Title

Usage

```
InitializationLSM(
  gen_list,
  n,
  m,
  k,
  rank = NULL,
  perturb = 0.1,
  int_type = "warm"
)
```

Arguments

gen_list	a list including the adjacency tensor and the parameter of the mixture multilayer network
n	the number of nodes
m	the number of network types
k	the number of groups of vertices
rank	rank of U
perturb	the upper bound of Uniform distribution
int_type	the method to initialize U and W ('spec', 'rand' or 'warm')

Value

a list including the adjacency tensor, U0, W0 and tuning parameters

Examples

```
gen_list = GenerateMMLSM(200,3,10,2,d=NULL)
InitializationLSM(gen_list,200,3,2)
```

InitializationMMSBM *Title A function for initialization*

Description

Title A function for initialization

Usage

```
InitializationMMSBM(tnsr, m, k, rank = NULL)
```

Arguments

tnsr	the tensor of network
m	the number of types of the network
k	the number of groups of vertices
rank	the rank of the core tensor calculated by the equation

Value

U_list a list including the core tensor Z, network embedding and node embedding

Examples

```
tnsr = GenerateMMSBM(200, 3, 10, 2, d = NULL, r = NULL)
U_list = InitializationMMSBM(tnsr, 3, 2, rank = NULL)
```

PowerIteration	<i>Title</i>
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Description

Title

Usage

```
PowerIteration(
  tnsr,
  m,
  k,
  rank = NULL,
  type = "TWIST",
  U_0_list,
  delta1 = 1000,
  delta2 = 1000,
  max_iter = 5,
  tol = 1e-05
)
```

Arguments

tnsr	the adjacency tensor of the network
m	the number of types of the network
k	the number of groups of vertices
rank	the rank of the core tensor calculated by the equation
type	specifies the iterative algorithm to run 'TWIST' or 'Tucker'
U_0_list	InitializationMMSBM outputs
delta1	tuning parameters for regularization in mode1
delta2	tuning parameters for regularization in mode2
max_iter	the max times of iteration
tol	the convergence tolerance

Value

a list including the core tensor Z, network embedding and node embedding

Examples

```
tnsr = GenerateMMSBM(200, 3, 10, 2, d = NULL, r = NULL)
U_list = InitializationMMSBM(tnsr, 3, 2, rank = NULL)
embed_list = PowerIteration(tnsr, 3, 2, rank=NULL, type="TUCKER", U_0_list=U_list)
```

 ProjectedGD

*Title***Description**

Title

Usage

```

ProjectedGD(
  Ini_list,
  cmax = 1,
  eta_outer = 0.001,
  tmax_outer = 10,
  p_type = "logit",
  rd = "Non",
  show = TRUE,
  sigma = 1,
  sample_size = 500
)

```

Arguments

Ini_list	the output of function InitializationLSM
cmax	the upper limits for adding the coefficient constraint
eta_outer	the learning rate in gradient descent
tmax_outer	the number of iterations in gradient descent
p_type	the type of link function ('logit', 'probit' or 'poisson')
rd	whether to use stochastic sampling ('rand' or 'Non')
show	if print the iteration process
sigma	the link function parameter
sample_size	the size of sampling

Value

the embedding results of nodes and layers

Examples

```

gen_list = GenerateMMLSM(200,3,5,2,d=NULL)
Ini_list = InitializationLSM(gen_list,200,3,2)

```

SpecClustering	<i>Title</i>
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Description

Title

Usage

```
SpecClustering(tnsr, rank, embedding_type = "Layer")
```

Arguments

tnsr the adjacency tensor
rank the number of columns of the output matrix U
embedding_type SumAdj for 'Node' and M3SC for 'Layer'

Value

The embedding result can be applied in cluster methods like kmeans.

Examples

```
tnsr = GenerateMMSBM(200, 3, 10, 2, d = NULL, r = NULL)  
emb_result = SpecClustering(tnsr, 3)
```

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