Package ‘motifcluster’

August 11, 2020

Title  Motif-Based Spectral Clustering of Weighted Directed Networks

Version  0.1.1


URL  https://github.com/wgunderwood/motifcluster

Language  en-US

BugReports  https://github.com/wgunderwood/motifcluster/issues

License  GPL-3

Encoding  UTF-8

LazyData  true

RoxygenNote  7.1.0

Depends  R (>= 3.6.0)

Imports  igraph (>= 1.2.5), LICORS (>= 0.2.0), Matrix (>= 1.2), RSpectra (>= 0.16.0)

Suggests  covr (>= 3.5.0), knitr (>= 1.28), mclust (>= 5.4.6), rmarkdown (>= 2.1), testthat (>= 2.3.2)

VignetteBuilder knitr

NeedsCompilation  no

Author  William George Underwood [aut, cre]

Maintainer  William George Underwood <wgu2@princeton.edu>

Repository  CRAN

Date/Publication  2020-08-11 14:30:09 UTC
build_laplacian

R topics documented:

- `build_laplacian` ............................................................... 2
- `build_motif_adjacency_matrix` .......................................... 3
- `get_largest_component` .................................................... 4
- `get_motif_names` ............................................................. 4
- `random_sparse_matrix` ...................................................... 5
- `run_laplace_embedding` ..................................................... 5
- `run_motif_clustering` ....................................................... 6
- `run_motif_embedding` ....................................................... 7
- `sample_bsbm` ................................................................. 9
- `sample_dsbm` ................................................................. 10

Index

---

| build_laplacian | Build a Laplacian matrix |

Description

Build a Laplacian matrix (combinatorial Laplacian or random-walk Laplacian) from a symmetric (weighted) graph adjacency matrix.

Usage

```
build_laplacian(adj_mat, type_lap = c("comb", "rw"))
```

Arguments

- `adj_mat` Symmetric adjacency matrix from which to build the Laplacian.
- `type_lap` Type of Laplacian to build. One of "comb" (combinatorial) or "rw" (random-walk).

Value

The specified Laplacian matrix.

Examples

```
adj_mat <- matrix(c(1:9), nrow = 3)
build_laplacian(adj_mat, "rw")
```
**build_motif_adjacency_matrix**

*Build a motif adjacency matrix*

---

**Description**

Build a motif adjacency matrix from an adjacency matrix.

**Usage**

```r
build_motif_adjacency_matrix(
  adj_mat,
  motif_name,
  motif_type = c("struc", "func"),
  mam_weight_type = c("unweighted", "mean", "poisson"),
  mam_method = c("sparse", "dense")
)
```

**Arguments**

- `adj_mat`: Adjacency matrix from which to build the motif adjacency matrix.
- `motif_name`: Motif used for the motif adjacency matrix.
- `motif_type`: Type of motif adjacency matrix to build. One of "func" or "struc".
- `mam_weight_type`: The weighting scheme to use. One of "unweighted", "mean" or "product".
- `mam_method`: Which formulation to use. One of "dense" or "sparse". The sparse formulation avoids generating large dense matrices so tends to be faster for large sparse graphs.

**Details**

Entry \((i, j)\) of a motif adjacency matrix is the sum of the weights of all motifs containing both nodes \(i\) and \(j\). The motif is specified by name and the type of motif instance can be one of:

- **Functional**: motifs should appear as subgraphs.
- **Structural**: motifs should appear as induced subgraphs.

The weighting scheme can be one of:

- **Unweighted**: the weight of any motif instance is one.
- **Mean**: the weight of any motif instance is the mean of its edge weights.
- **Product**: the weight of any motif instance is the product of its edge weights.

**Value**

A motif adjacency matrix.
Examples

```r
adj_mat <- matrix(c(1:9), nrow = 3)
build_motif_adjacency_matrix(adj_mat, "M1", "func", "mean")
```

---

**get_largest_component**  
*Get largest connected component*

**Description**

Get the indices of the vertices in the largest connected component of a graph from its adjacency matrix.

**Usage**

```r
get_largest_component(adj_mat)
```

**Arguments**

- `adj_mat`: An adjacency matrix of a graph.

**Value**

A vector of indices corresponding to the vertices in the largest connected component.

**Examples**

```r
adj_mat <- matrix(c(0, 1, 0, 0, 0, 0, 0, 0, 0), nrow = 3)
get_largest_component(adj_mat)
```

---

**get_motif_names**  
*Get common motif names*

**Description**

Get the names of some common motifs as strings.

**Usage**

```r
get_motif_names()
```

**Value**

A vector of names (strings) of common motifs.
random_sparse_matrix

Build a random sparse matrix

Description

Build a sparse matrix of size \(m \times n\) with non-zero probability \(p\). Edge weights can be unweighted, constant-weighted or Poisson-weighted.

Usage

```
random_sparse_matrix(m, n, p, sample_weight_type = "constant", w = 1)
```

Arguments

- **m, n**: Dimension of matrix to build is \((m,n)\).
- **p**: Probability that each entry is non-zero (before weighting).
- **sample_weight_type**: Type of weighting scheme.
- **w**: Weight parameter.

Value

A random sparse matrix.

run_laplace_embedding

Run Laplace embedding

Description

Run Laplace embedding on a symmetric (weighted) adjacency matrix with a specified number of eigenvalues and eigenvectors.

Usage

```
run_laplace_embedding(adj_mat, num_eigs, type_lap = c("comb", "rw"))
```

Arguments

- **adj_mat**: Symmetric adjacency matrix to be embedded.
- **num_eigs**: Number of eigenvalues and eigenvectors for the embedding.
- **type_lap**: Type of Laplacian for the embedding. One of "comb" (combinatorial) or "rw" (random-walk).
Value

A list with two entries: vals contains the length-num_eigs vector of the first few eigenvalues of the Laplacian, and vects contains an nrow(adj_mat) by num_eigs matrix of the associated eigenvectors.

Examples

```r
adj_mat <- matrix(c(1:9), nrow = 3)
run_laplace_embedding(adj_mat, 2, "rw")
```

run_motif_clustering  Run motif-based clustering

Description

Run motif-based clustering on the adjacency matrix of a (weighted directed) network, using a specified motif, motif type, weighting scheme, embedding dimension, number of clusters and Laplacian type.

Usage

```r
run_motif_clustering(
  adj_mat,
  motif_name,
  motif_type = c("struc", "func"),
  mam_weight_type = c("unweighted", "mean", "product"),
  mam_method = c("sparse", "dense"),
  num_eigs = 2,
  type_lap = c("comb", "rw"),
  restrict = TRUE,
  num_clusts = 2
)
```

Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>adj_mat</td>
<td>Adjacency matrix to be embedded.</td>
</tr>
<tr>
<td>motif_name</td>
<td>Motif used for the motif adjacency matrix.</td>
</tr>
<tr>
<td>motif_type</td>
<td>Type of motif adjacency matrix to use. One of &quot;func&quot; or &quot;struc&quot;.</td>
</tr>
<tr>
<td>mam_weight_type</td>
<td>Weighting scheme for the motif adjacency matrix. One of &quot;unweighted&quot;, &quot;mean&quot; or &quot;product&quot;.</td>
</tr>
<tr>
<td>mam_method</td>
<td>The method to use for building the motif adjacency matrix. One of &quot;sparse&quot; or &quot;dense&quot;.</td>
</tr>
<tr>
<td>num_eigs</td>
<td>Number of eigenvalues and eigenvectors for the embedding.</td>
</tr>
<tr>
<td>type_lap</td>
<td>Type of Laplacian for the embedding. One of &quot;comb&quot; or &quot;rw&quot;.</td>
</tr>
</tbody>
</table>
\texttt{run_motif_embedding}

\begin{itemize}
  \item \texttt{restrict} Whether or not to restrict the motif adjacency matrix to its largest connected component before embedding.
  \item \texttt{num_clusts} The number of clusters to find.
\end{itemize}

\textbf{Value}

A list with 8 entries:

- \texttt{adj.mat}: the original adjacency matrix.
- \texttt{motif_adj_mat}: the motif adjacency matrix.
- \texttt{comps}: the indices of the largest connected component of the motif adjacency matrix (if \texttt{restrict = TRUE}).
- \texttt{adj.mat_comps}: the original adjacency matrix restricted to the largest connected component of the motif adjacency matrix (if \texttt{restrict = TRUE}).
- \texttt{motif_adj_mat_comps}: the motif adjacency matrix restricted to its largest connected component (if \texttt{restrict = TRUE}).
- \texttt{vals}: a length-\texttt{num_eigs} vector containing the eigenvalues associated with the Laplace embedding of the (restricted) motif adjacency matrix.
- \texttt{vects}: a matrix containing the eigenvectors associated with the Laplace embedding of the (restricted) motif adjacency matrix.
- \texttt{clusts}: a vector containing integers representing the cluster assignment of each vertex in the (restricted) graph.

\textbf{Examples}

\begin{verbatim}
adj_mat <- matrix(c(1:9), nrow = 3)
run_motif_clustering(adj_mat, "M1", "func")
\end{verbatim}

\textbf{Description}

Calculate a motif adjacency matrix for a given motif and motif type, restrict it to its largest connected component, and then run Laplace embedding with specified Laplacian type and number of eigenvalues and eigenvectors.

\textbf{Usage}

\begin{verbatim}
run_motif_embedding(
  adj.mat,
  motif_name,
  motif_type = c("struc", "func"),
  mam_weight_type = c("unweighted", "mean", "product"),
  mam_method = c("sparse", "dense"),
\end{verbatim}
run_motif_embedding

```r	num_eigs = 2,
type_lap = c("comb", "rw"),
restrict = TRUE
)
```

Arguments

- **adj_mat**: Adjacency matrix to be embedded.
- **motif_name**: Motif used for the motif adjacency matrix.
- **motif_type**: Type of motif adjacency matrix to use. One of "func" or "struc".
- **mam_weight_type**: Weighting scheme for the motif adjacency matrix. One of "unweighted", "mean" or "product".
- **mam_method**: The method to use for building the motif adjacency matrix. One of "sparse" or "dense".
- **num_eigs**: Number of eigenvalues and eigenvectors for the embedding.
- **type_lap**: Type of Laplacian for the embedding. One of "comb" or "rw".
- **restrict**: Whether or not to restrict the motif adjacency matrix to its largest connected component before embedding.

Value

A list with 7 entries:

- **adj_mat**: the original adjacency matrix.
- **motif_adj_mat**: the motif adjacency matrix.
- **comps**: the indices of the largest connected component of the motif adjacency matrix (if restrict = TRUE).
- **adj_mat_comps**: the original adjacency matrix restricted to the largest connected component of the motif adjacency matrix (if restrict = TRUE).
- **motif_adj_mat_comps**: the motif adjacency matrix restricted to its largest connected component (if restrict = TRUE).
- **vals**: a length-num_eigs vector containing the eigenvalues associated with the Laplace embedding of the (restricted) motif adjacency matrix.
- **vects**: a matrix containing the eigenvectors associated with the Laplace embedding of the (restricted) motif adjacency matrix.

Examples

```r
adj_mat <- matrix(c(1:9), nrow = 3)
run_motif_embedding(adj_mat, "M1", "func")
```
**sample_bsbm**

*Sample a bipartite stochastic block model (BSBM)*

**Description**

Sample the (weighted) adjacency matrix of a (weighted) bipartite stochastic block model (BSBM) with specified parameters.

**Usage**

```r
define_par <- sample_bsbm(
  source_block_sizes,
  dest_block_sizes,
  bipartite_connection_matrix,
  bipartite_weight_matrix = NULL,
  sample_weight_type = c("unweighted", "constant", "poisson")
)
```  

**Arguments**

- `source_block_sizes`  
  A vector containing the size of each block of source vertices.

- `dest_block_sizes`  
  A vector containing the size of each block of destination vertices.

- `bipartite_connection_matrix`  
  A matrix containing the source block to destination block connection probabilities.

- `bipartite_weight_matrix`  
  A matrix containing the source block to destination block weight parameters. Unused for `sample_weight_type = "constant"`. Defaults to NULL.

- `sample_weight_type`  
  The type of weighting scheme. One of "unweighted", "constant" or "poisson".

**Value**

A randomly sampled (weighted) adjacency matrix of a BSBM.

**Examples**

```r
source_block_sizes <- c(10, 10)
dest_block_sizes <- c(10, 10, 10)
bipartite_connection_matrix <- matrix(c(0.8, 0.5, 0.1, 0.1, 0.5, 0.8),
  nrow = 2, byrow = TRUE)
bipartite_weight_matrix = matrix(c(20, 10, 2, 2, 10, 20),
  nrow = 2, byrow = TRUE)
sample_bsbm(source_block_sizes, dest_block_sizes,
  bipartite_connection_matrix, bipartite_weight_matrix, "poisson")
```
Sample a directed stochastic block model (DSBM)

Description

Sample the (weighted) adjacency matrix of a (weighted) directed stochastic block model (DSBM) with specified parameters.

Usage

```r
sample_dsbm(
  block_sizes,
  connection_matrix,
  weight_matrix = NULL,
  sample_weight_type = c("unweighted", "constant", "poisson")
)
```

Arguments

- `block_sizes`: A vector containing the size of each block of vertices.
- `connection_matrix`: A matrix containing the block-to-block connection probabilities.
- `weight_matrix`: A matrix containing the block-to-block weight parameters. Unused for `sample_weight_type = "constant"`. Defaults to `NULL`.
- `sample_weight_type`: The type of weighting scheme. One of "unweighted", "constant" or "poisson".

Value

A randomly sampled (weighted) adjacency matrix of a DSBM.

Examples

```r
block_sizes <- c(10, 10)
connection_matrix <- matrix(c(0.8, 0.1, 0.1, 0.8), nrow = 2, byrow = TRUE)
weight_matrix <- matrix(c(10, 3, 3, 10), nrow = 2, byrow = TRUE)
sample_dsbm(block_sizes, connection_matrix, weight_matrix, "poisson")
```
Index

build_laplacian, 2
build_motif_adjacency_matrix, 3
get_largest_component, 4
get_motif_names, 4
random_sparse_matrix, 5
run_laplace_embedding, 5
run_motif_clustering, 6
run_motif_embedding, 7
sample_bsbm, 9
sample_dsbm, 10