Package ‘DensParcorr’

Type Package
Title Dens-Based Method for Partial Correlation Estimation in Large Scale Brain Networks
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Description Provide a Dens-based method for estimating functional connection in large scale brain networks using partial correlation.
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Description

This function is to conduct the Dens-based approach for partial correlation estimation in large scale brain network study.

DensParcorr is the main function in this package. prec2dens and prec2part are sub-functions called by DensParcorr.
Usage

DensParcorr(data, select=FALSE, dens.level="plateau", plateau.thresh=0.01,
            Parcorr.est=NULL, directory=NULL, lambda=NULL)

Arguments

data         Input data matrix with dimension of TxM where T is the number of observations
              and M is the number of nodes. For example, in fMRI data the T is the number
              of scans.
select       Whether to conduct the Dens-based selection. If FALSE, output will only con-
              tain the estimated partial correlation list and precision matrix list correponding
              to the default tuning parameter series ranging from 1e-8 to 0.6. If TRUE, the
              output will include the previous results and the selected partial correlation ma-
              trix and precision matrix corresponding to the specified density level. Default is
              FALSE.
dens.level   Specify the density level in Dens-based tuning parameter selection method, in-
              cluding the plateau based density selection (dens.level = "plateau") and p per-
              centage density selection (dens.level = p, 0<p<1). This option is valid only
              when select=TRUE. See Details. Default is "plateau".
plateau.thresh The criterion to select the plateau. This option is valid only when select=TRUE.
                 See Details. Default value is 0.01.
Parcorr.est   Previous output from DensParcorr function.
directory    The directory to output the figures and precision matrices and the partial correla-
              tion matrices. The default (directory=NULL) is to output in the current working
              directory.
lambda       The lambda value for estimating the precision matrix ranging from 0 to 1. The
              default is NULL. If specified, no extra Dens-based step will be conducted.

Details

This function implements the statistical method proposed in Wang et al. (2016) to estimate partial
 correlation matrix for studying direct connectivity in large-scale brain network. The method de-
 rives partial correlation based on the precision matrix estimated via Constrained L1-minimization
 Approach (CLIME) (Cai et al., 2011). This function applies the Dens-based tuning parameter se-
 lection method in Wang et al. (2016) to help select an appropriate tuning parameter for sparsity
 control in the network estimation. Below is the breif step of Dens-based approach.

First, we specify a series of tuning parameters \{\lambda_n\}. Then, based on \{\lambda_n\} we estime a list of
 precision matices \Omega(\lambda_n) and and evaluate the density level of each precision matrix based on the
 Dens criterion function in equation (5) of Wang et al. (2016). This will provide the users the pro-
 file of the density level corresponding to the series of tuning parameters in \{\lambda_n\}. Users can use
 the dens.level option to specify the desired density level in the precision matrix estimation. If
 dens.level="plateau", the function will select the plateau point \lambda_{platu} in the density profile based
 on the plateau.thresh and output the precision matrix \Omega(\lambda_{platu}). If dens.level=p and 0<p<1,
 the function will select the tuning parameter \lambda_p to achieve p percentage density and output the pre-
 cision matrix \Omega(\lambda_p). Then, the partial correlation matrix will be derived from the precision matrix.
Further details can be found in the Reference.

The density profile and the heatmaps of precision matrices and partial correlation matrices will be saved in directory, and the estimated list of precision matrices and partial correlation matrices will also be saved in directory.

When users would like to run the function multiple times on the same input data for different dens.level, it is computationally more efficient to read in the previous output from DensParcorr to Parcorr.est so that the function won’t need to re-estimate the partial correlations based on the previous tuning parameters.

Value

An R list from DensParcorr containing the following terms:

- selected.partial.corr
  - Selected Partial Correlation matrix corresponding to dens.level. Only when select=TRUE.
- selected.precision
  - Selected Precision matrix corresponding to dens.level. Only when select=TRUE.
- selected.lambda
  - Selected tuning parameter corresponding to dens.level. Only when select=TRUE.
- lambda.list
  - The series of tuning parameters used for estimation and density profile.
- partial.corr.list
  - Estimated Partial Correlation matrix list corresponding to lambda.list.
- precision.list
  - Estimated Precision matrix list corresponding to lambda.list.
- Dens
  - Actual density levels for estimated precision matrix list.
- Dens.Percentage
  - Actual percentage density levels for estimated precision matrix list.
- selection.method
  - The method used for tuning parameter selection. For percentage Dens selection, this value will include the actual Dens percentage and the nominal Dens percentage. Only when select=TRUE.

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References


Examples

```r
# require(gplots)
# require(clime)

## simulated the data to use.
# data = matrix(rnorm(200),ncol=20)

##### example 1: estimate the partial correlation matrices for the
##### default series of tuning parameters.
# t0 = proc.time()[3]
# dens.est = DensParcorr(data,select=FALSE)
# proc.time()[3]-t0

##### Example 2: Estimate the network that reaches 40% density level.
# partial.dens.est = DensParcorr(data,dens.level = .4,select=TRUE)

##### Example 3: Now, estimate the 60% density level network based
##### on the same data. To speed up computation, we read in the
##### previous output from Example 2 into Parcorr.est
# t0 = proc.time()[3]
# partial.dens.est2 = DensParcorr(data, Parcorr.est = partial.dens.est,
# # dens.level=.6,select=TRUE)
# proc.time()[3]-t0
```

prec2dens

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**Calculate Dens value from Precision Matrix**

**Description**

This function evaluates the density level of a precision matrix based on the Dens criterion function in equation (5) of Wang et al. (2016).

**Usage**

`prec2dens(precision)`

**Arguments**

- `precision` Input precision matrix (symmetric and positive definite).

**Value**

Density level from Precision matrix.

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References


prec2part

**Calculate Partial Correlation Matrix from Precision Matrix**

Description

This function is to derive the partial correlation matrix from the precision matrix.

Usage

```
prec2part(Precision)
```

Arguments

- **Precision**
  
  Input precision matrix (symmetric and positive definite).

Value

Calculated partial correlation matrix.

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