Package 'FLAG'

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Title Flexible and Accurate Gaussian Graphical Models

Version 0.1

Description In order to achieve accurate estimation without sparsity assumption on the precision matrix, element-wise inference on the precision matrix, and joint estimation of multiple Gaussian graphical models, a novel method is proposed and efficient algorithm is implemented. FLAG() is the main function given a data matrix, and FlagOneEdge() will be used when one pair of random variables are interested where their indices should be given.
Flexible and Accurate Methods for Estimation and Inference of Gaussian Graphical Models with Applications, see Qian Y (2023) <doi:10.14711/thesis-991013223054603412>, Qian Y, Hu X, Yang C (2023) <doi:10.48550/arXiv.2306.17584>.

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RoxygenNote 7.1.2

Imports stats, MASS

URL https://github.com/YangLabHKUST/FLAG

BugReports https://github.com/YangLabHKUST/FLAG/issues

NeedsCompilation no

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Contents

FLAG *FLAG is the main function to fulfill the whole process.*

Description

FLAG is the main function to fulfill the whole process.

Usage

```
FLAG(
  data,
  scale.var = TRUE,
  low.rank = NULL,
  infer = "llr",
  eps = 1e-07,
  crit.loglik = 1e-04
)
```

Arguments

data	Matrix, with size n*p.
scale.var	Logical, whether to scale the variance of X to 1/p, default to be T(RUE).
low.rank	Logical, whether to use low rank update to shrink the time of eigen-decomposition of XX^T, default to be TRUE when sample size larger than 1000.
infer	Character, option of different tests of inference where 'llr' for likelihood ratio test and 'wald' for Wald test based on Fisher Information Matrix.
eps	Numeric, a small term to avoid numerical problems, default to be 1e-7.
crit.loglik	Numeric, the criteria of the change ratio of log likelihood to stop.

Value

List, the estimated precision matrix, the p-value of precision matrix estimation, the edge existence using Bonferroni correction, the edge existence using false discovery rate, the matrix of estimated eta, the standard error or estimated eta, the matrix of estimated partial correlation rho, the standard error or estimated partial correlation rho, the p-value of partial correlation matrix estimation, the matrix of estimated sigma_a^2, the standard error or estimated sigma_b^2, the execution time.

Examples

```
N = 20
P = 10
pi = 0.2
Pre = matrix(sample(c(0.2, 0.4), P*P, replace = TRUE) * rbinom(P*P, 1, pi), nrow = P, ncol = P )
Pre[lower.tri(Pre)] = t(Pre)[lower.tri(Pre)]
diag(Pre) = 1
```

```
vals <- eigen(Pre)$values
Sigma = solve(Pre)
Z = MASS::mvrnorm(N, rep(0, P), Sigma)
Z.c = scale(Z, center = TRUE, scale = FALSE)
results = FLAG(Z.c)
```

FlagOneEdge *Use FLAG to infer one edge. Given n*p data matrix, when we only interest in the conditional dependence between i-th and j-th variables.*

Description

Use FLAG to infer one edge. Given n*p data matrix, when we only interest in the conditional dependence between i-th and j-th variables.

Usage

```
FlagOneEdge(data, i, j, scale.var = TRUE, infer = "llr", eps = 1e-07)
```

Arguments

data	Matrix, with size n*p.
i	integer, the index of one element.
j	integer, the index of another element.
scale.var	Logical, whether to scale the variance of X to 1/p, default to be T(RUE).
infer	Character, option of different tests of inference where 'llr' for likelihood ratio test and 'wald' for Wald test based on Fisher Information Matrix.
eps	Numeric, a small term to avoid numerical problems, default to be 1e-7.

Value

List, the list of log likelihood during iterations, the estimated precision value, the p-value of precision value estimation, the estimated Gamma_beta matrix with size 2*2, in the random effects model, the estimated Gamma_epsilon matrix with size 2*2*, in the random effects model, the estimated off-diagonal element eta in the matrix Gamma_epsilon, the standard error of eta, the estimated partial correlation rho, the standard error of rho, the p-value of rho, the execution time.

Examples

```
FlagOneEdge(matrix, i, j)
```

`FlagOnePair` *FLAG for one pair of random variables, using random effects model. This is a repeated function for FLAG.*

Description

FLAG for one pair of random variables, using random effects model. This is a repeated function for FLAG.

Usage

```
FlagOnePair(
  Y,
  X,
  Gamma_beta = NULL,
  Gamma_e = NULL,
  infer = "llr",
  fix.eta = FALSE,
  eps = 1e-07,
  max.iter = 5000,
  crit.loglik = 1e-04
)
```

Arguments

`Y`	Matrix, with size n*2.
`X`	Matrix, with size n*(p-2).
`Gamma_beta`	Matrix, with size 2*2.
`Gamma_e`	Matrix, with size 2*2.
`infer`	Character, option of different tests of inference where 'llr' for likelihood ratio test and 'wald' for Wald test based on Fisher Information Matrix.
`fix.eta`	Logical, whether to fix eta, default to be FALSE.
`eps`	Numeric, a small term to avoid numerical problems, default to be 1e-7.
`max.iter`	Integer, the maximum number of iterations, default to be 5000.
`crit.loglik`	Numeric, the criteria of the change ratio of log likelihood to stop.

Value

List, the list of log likelihood during iterations, the estimated Gamma_beta matrix with size 2*2, *in the random effects model, the estimated Gamma_epsilon matrix with size 2*2, in the random effects model, the estimated 2*2 submatrix of the precision matrix, the covariance matrix, which is the inverse of the Fisher information matrix, inferred by the Wald test, the estimated off-diagonal element eta in the matrix Gamma_epsilon, the standard error of eta, the p-value of eta, the estimated partial correlation rho, the standard error of rho, the p-value of rho.

Examples

```
FlagOnePair(Y, X)
```

`FlagOnePairEta0` *FLAG for one pair of random variables fixing eta as zero, using likelihood-ratio test.*

Description

FLAG for one pair of random variables fixing eta as zero, using likelihood-ratio test.

Usage

```
FlagOnePairEta0(
  Y,
  X,
  Gamma_beta,
  Gamma_e,
  eps = 1e-07,
  max.iter = 5000,
  crit.loglik = 1e-04
)
```

Arguments

`Y`	Matrix, with size n*2.
`X`	Matrix, with size n*(p-2).
`Gamma_beta`	Matrix, with size 2*2.
`Gamma_e`	Matrix, with size 2*2.
`eps`	Numeric, a small term to avoid numerical problems, default to be 1e-4.
`max.iter`	Integer, the maximum number of iterations, default to be 5000.
`crit.loglik`	Numeric, the criteria of the change ratio of log likelihood to stop.

Value

List, the list of log likelihood during iterations, Numeric, the log likelihood of the last iterations, the estimated Gamma_beta matrix with size 2*2, in the random effects model, the estimated 2*2* submatrix of the precision matrix.

Examples

```
FlagOnePairEta0(Y, X, Gamma_beta, Gamma_e)
```

GetSeRho *Get the standard error of rho.*

Description

Get the standard error of rho.

Usage

```
GetSeRho(Gamma_e, Gamma_e_cov)
```

Arguments

Gamma_e	Matrix, with size 2*2.
Gamma_e_cov	Matrix, with size 2*2.

Value

Numeric.

Examples

```
GetSeRho(Gamma_e,Gamma_e_cov)
```

InferWald *Infer by the Wald test.*

Description

Infer by the Wald test.

Usage

```
InferWald(Omega.inv, n, K, Y.vec, Gamma_e)
```

Arguments

Omega.inv	Matrix, with size (2n)*(2n).
n	Integer.
K	Matrix, with size n*n.
Y.vec	Matrix, with size (2*n)*1, the vectorized Y.
Gamma_e	Matrix, with size 2*2.

Value

List, the covariance matrix, which is the inverse of the Fisher information matrix, inferred by the Wald test, the estimated off-diagonal element eta in the matrix Gamma_epsilon, the standard error of eta, the p-value of eta, the estimated partial correlation rho, the standard error of rho, the p-value of rho.

Examples

```
InferWald(Omega.inv, n, K, Y.vec, Gamma_e)
```

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