Package: gclm (via r-universe)

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Type Package

Title Graphical Continuous Lyapunov Models

Version 0.0.1.9999

Description Estimation of covariance matrices as solutions of continuous time Lyapunov equations. Sparse coefficient matrix and diagonal noise are estimated with a proximal gradient method for an l1-penalized loss minimization problem. Varando G, Hansen NR (2020) <arXiv:2005.10483>.

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URL `https://github.com/gherardovarando/gclm`

BugReports `https://github.com/gherardovarando/gclm/issues`

Suggests testthat

Repository https://gherardovarando.r-universe.dev

RemoteUrl https://github.com/gherardovarando/gclm

RemoteRef HEAD

RemoteSha d20bd5d07d8b2f441b5f1a427b7b8ca154baa11f

Contents

B0 *Generate a naive stable matrix*

Description

Generate a naive stable matrix

Usage

```
B0(p)
```

Arguments

`p`	dimension of the matrix

Value

a stable matrix with off-diagonal entries equal to 1 and diagonal entries equal to `-p`

clyap *Solve continuous-time Lyapunov equations*

Description

`clyap` solve the continuous-time Lyapunov equations

$$BX + XB' + C = 0$$

Using the Bartels-Stewart algorithm with Hessenberg–Schur decomposition. Optionally the Hessenberg-Schur decomposition can be returned.

Usage

```
clyap(B, C, Q = NULL, all = FALSE)
```

Arguments

`B`	Square matrix
`C`	Square matrix
`Q`	Square matrix, the orthogonal matrix used to transform the original equation
`all`	logical

Details

If the matrix `Q` is set then the matrix `B` is assumed to be in upper quasi-triangular form (Hessenberg-Schur canonical form), as required by LAPACK subroutine `DTRSYL` and `Q` is the orthogonal matrix associated with the Hessenberg-Schur form of `B`. Usually the matrix `Q` and the appropriate form of `B` are obtained by a first call to `clyap(B, C, all = TRUE)`

`clyap` uses lapack subroutines:

- `DGEES`
- `DTRSYL`
- `DGEMM`

Value

The solution matrix `X` if `all = FALSE`. If `all = TRUE` a list with components `X`, `B` and `Q`. Where `B` and `Q` are the Hessenberg-Schur form of the original matrix `B` and the orthogonal matrix that performed the transformation.

Examples

```
B <- matrix(data = rnorm(9), nrow = 3)
## make B negative diagonally dominant, thus stable:
diag(B) <- - 3 * max(B)
C <- diag(runif(3))
X <- clyap(B, C)
## check X is a solution:
max(abs(B %*% X + X %*% t(B) + C))
```

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gclm *l1 penalized loss estimation for GCLM*

Description

Estimates a sparse continuous time Lyapunov parametrization of a covariance matrix using a lasso (L1) penalty.

Usage

```
gclm(
  Sigma,
  B = -0.5 * diag(ncol(Sigma)),
  C = rep(1, ncol(Sigma)),
  C0 = rep(1, ncol(Sigma)),
  loss = "loglik",
  eps = 0.01,
  alpha = 0.5,
  maxIter = 100,
  lambda = 0,
```

```
  lambdac = 0,
  job = 0
)

gclm.path(
  Sigma,
  lambdas = NULL,
  B = -0.5 * diag(ncol(Sigma)),
  C = rep(1, ncol(Sigma)),
  ...
)
```

Arguments

Sigma	covariance matrix
B	initial B matrix
C	diagonal of initial C matrix
C0	diagonal of penalization matrix
loss	one of "loglik" (default) or "frobenius"
eps	convergence threshold
alpha	parameter line search
maxIter	maximum number of iterations
lambda	penalization coefficient for B
lambdac	penalization coefficient for C
job	integer 0,1,10 or 11
lambdas	sequence of lambda
...	additional arguments passed to gclm

Details

gclm performs proximal gradient descent for the optimization problem

$$argminL(\Sigma(B,C)) + \lambda\rho(B) + \lambda_C||C - C0||_F^2$$

subject to B stable and C diagonal, where $\rho(B)$ is the l1 norm of the off-diagonal element of B.

gclm.path simply calls iteratively gclm with different lambda values. Warm start is used, that is in the i-th call to gclm the B and C matrices are initialized as the one obtained in the (i-1)th call.

Value

for gclm: a list with the result of the optimization

for gclm.path: a list of the same length of lambdas with the results of the optimization for the different lambda values

Examples

```
x <- matrix(rnorm(50*20),ncol=20)
S <- cov(x)

## l1 penalized log-likelihood
res <- gclm(S, eps = 0, lambda = 0.1, lambdac = 0.01)

## l1 penalized log-likelihood with fixed C
res <- gclm(S, eps = 0, lambda = 0.1, lambdac = -1)

## l1 penalized frobenius loss
res <- gclm(S, eps = 0, lambda = 0.1, loss = "frobenius")
```

`gclm.lowertri` *Recover lower triangular GCLM*

Description

Recover the only lower triangular stable matrix B such that `Sigma` (Σ) is the solution of the associated continuous Lyapunov equation:

$$B\Sigma + \Sigma B' + C = 0$$

Usage

```
gclm.lowertri(Sigma, P = solve(Sigma), C = diag(nrow = nrow(Sigma)))
```

Arguments

`Sigma`	covariance matrix
`P`	the inverse of the covariance matrix
`C`	symmetric positive definite matrix

Value

A stable lower triangular matrix

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