Package ‘clime’

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Type   Package
Title  Constrained L1-minimization for Inverse (covariance) Matrix Estimation
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Description A robust constrained L1 minimization method for estimating a large sparse inverse covariance matrix (aka precision matrix), and recovering its support for building graphical models. The computation uses linear programming.
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R topics documented:

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clime

solve for the inverse matrix

Description

Solve for a series of the inverse covariance matrix estimates at a grid of values for the constraint lambda.

Usage

clime(x, lambda=NULL, nlambda=ifelse(is.null(lambda), 100, length(lambda)),
lambda.max=0.8, lambda.min=ifelse(nrow(x)>ncol(x), 1e-4, 1e-2),
sigma=FALSE, perturb=TRUE, standardize=TRUE, logspaced=TRUE,
linsolver=c("primaldual", "simplex"), pdtol=1e-3, pdmaxiter=50)

Arguments

x Input matrix of size n (observations) times p (variables). Each column is a variable of length n. Alternatively, the sample covariance matrix may be set here with the next option sigma set to be TRUE. When the input is the sample covariance matrix, cv.clime can not be used for this object.

lambda Grid of non-negative values for the constraint parameter lambda. If missing, nlambda values from lambda.min to lambda.max will be generated.

standardize Whether the variables will be standardized to have mean zero and unit standard deviation. Default TRUE.

nlambda Number of values for program generated lambda. Default 100.

lambda.max Maximum value of program generated lambda. Default 0.8.

lambda.min Minimum value of program generated lambda. Default 1e-4(n > p) or 1e-2(n < p).

sigma Whether x is the sample covariance matrix. Default FALSE.

perturb Whether a perturbed Sigma should be used or the positive perturbation added if it is numerical. Default TRUE.

logspaced Whether program generated lambda should be log-spaced or linear spaced. Default TRUE.

linsolver Whether primaldual (default) or simplex method should be employed. Rule of thumb: primaldual for large p, simplex for small p.

pdtol Tolerance for the duality gap, ignored if simplex is employed.

pdmaxiter Maximum number of iterations for primaldual, ignored if simplex is employed.
Details

A constrained $\ell_1$ minimization approach for sparse precision matrix estimation (details in references) is implemented here using linear programming (revised simplex or primal-dual interior point method). It solves a sequence of $\lambda$ values on the following objective function

$$\min |\Omega|_1 \quad \text{subject to: } ||\Sigma_n \Omega - I||_\infty \leq \lambda$$

where $\Sigma_n$ is the sample covariance matrix and $\Omega$ is the inverse we want to estimate.

Value

An object with S3 class "clime". You can also use it as a regular R list with the following fields:

- Omega
  - List of estimated inverse covariance matrix for a grid of values for $\lambda$.
- lambda
  - Actual sequence of $\lambda$ used in the program
- perturb
  - Actual perturbation used in the program.
- standardize
  - Whether standardization is applied to the columns of $x$.
- x
  - Actual $x$ used in the program.
- lpfun
  - Linear programming solver used.

Author(s)

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References


Examples

```r
## trivial example
n <- 50
p <- 5
X <- matrix(rnorm(n*p), nrow=n)
re.clime <- clime(X)

## tridiagonal matrix example
bandMat <- function(p, k) {
  cM <- matrix(rep(1:p, each=p), nrow=p, ncol=p)
  return((abs(t(cM)-cM)<=k)*1)
}

## tridiagonal Omega with diagonal 1 and off-diagonal 0.5
Omega <- bandMat(p, 1)*0.5
diag(Omega) <- 1
Sigma <- solve(Omega)
X <- matrix(rnorm(n*p), nrow=n)*cholesky(Sigma)
re.clime <- clime(X, standardize=FALSE, linsolver="simplex")
```
clime-internal

### Description

Internal clime functions

### Usage

```r
likelihood(Sigma, Omega)
tracel2(Sigma, Omega)
```

### Arguments

- **Sigma**: Covariance matrix.
- **Omega**: Inverse covariance matrix.

### Details

There are not intended for use by users.

### Author(s)

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### References

cv.climedistance  

k-fold cross validation for clime object

Description

Perform a k-fold cross validation for selecting lambda

Usage

cv.climedistance(clime.obj, loss=c("likelihood", "tracel2"), fold=5)

Arguments

clime.obj clime object output from clime. Note that this requires that the input to clime is x instead of the sample covariance matrix.
loss loss to be used in cross validation. Currently, two losses are available: "likelihood" and "tracel2". Default "likelihood".
fold number of folds used in cross validation. Default 5.

Details

Perform a k-fold cross validation for selecting the tuning parameter lambda in clime. Two losses are implemented currently:

likelihood: $\text{Tr}[\Sigma \Omega] - \log |\Omega| - p$

tracel2: $\text{Tr}[\text{diag}(\Sigma \Omega - I)^2]$.

Value

An object with S3 class "cv.climedistance". You can use it as a regular R list with the following fields:

lambdaopt the lambda selected by cross validation to minimize the loss over the grid values of lambda.
loss the name of loss used in cross validation.
lambda sequence of lambda used in the program.
loss.mean average k-fold loss values for each grid value lambda.
loss.mean standard deviation of k-fold loss values for each grid value lambda.
lpfun Linear programming solver used.

Author(s)

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References


Examples

```r
## trivial example
n <- 50
p <- 5
X <- matrix(rnorm(n*p), nrow=n)
re.clime <- clime(X)
re.cv <- cv.clime(re.clime)
re.clime.opt <- clime(X, re.cv$lambdaopt)
```

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**print.clime**

*print a clime object*

**Description**

Print a summary of the clime object.

**Usage**

```r
## S3 method for class 'clime'
print(x, digits = max(3, getOption("digits") - 3), ...)
```

**Arguments**

- `x` clime object.
- `digits` significant digits in printout.
- `...` additional print options.

**Details**

This call simply outlines the options used for computing a clime object.

**Value**

The output above is invisibly returned.

**Author(s)**

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print.cv.clime

References


Examples

```r
## trivial example
n <- 50
p <- 5
X <- matrix(rnorm(n*p), nrow=n)
re.clime <- clime(X)
print(re.clime)
```

Description

Print a summary of the cv.clime object.

Usage

```r
## S3 method for class 'cv.clime'
print(x,digits = max(3, getOption("digits") - 3), ... )
```

Arguments

- `x` cv.clime object.
- `digits` significant digits in printout.
- `...` additional print options.

Details

This call outputs first a three column matrix with $\lambda$, mean and sd for the cross validation loss values. The actual loss used and the optimal $\lambda$ value picked by cv are printed.

Value

The output above is invisibly returned.

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References


Examples

```r
## trivial example
n <- 50
p <- 5
X <- matrix(rnorm(n*p), nrow=n)
re.clim <- clime(X)
re.cv <- cv.clim(re.clim)
print(re.cv)
```
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