Package 'shrink'

June 25, 2018

Type Package

Title Shrinking characteristics of precision matrix estimators

Version 2.0

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Description This package is an implementation of the methods described in ``Shrinking Characteristics of Precision Matrix Estimators". https://arxiv.org/pdf/1704.04820.pdf

URL https://github.com/MGallow/shrink

BugReports https://github.com/MGallow/shrink/issues

License GPL (>= 2)

ByteCompile TRUE

NeedsCompilation yes

Encoding UTF-8

LazyData true

RoxygenNote 6.0.1

Imports stats,
parallel,
foreach,
ggplot2,
dplyr

Depends Rcpp (>= 0.12.10),
RcppProgress (>= 0.1),
doParallel

LinkingTo Rcpp,
RcppArmadillo,
RcppProgress

Suggests testthat,
knitr,
rmarkdown,
microbenchmark,
glasso,
pkgdown

SystemRequirements GNU make

VignetteBuilder knitr

R topics documented:

`plot.shrink` *Plot shrink object*

Description

Produces a plot for the cross validation errors, if available.

Usage

```
## S3 method for class 'shrink'
plot(x, type = c("line", "heatmap"), footnote = TRUE, ...)
```

Arguments

`x`	class object shrink.
`type`	produce either 'heatmap' or 'line' graph
`footnote`	option to print footnote of optimal values. Defaults to TRUE.
`...`	additional arguments.

Examples

```
# NEED TO COMPLETE
```

`shrink` *Shrinking characteristics of precision matrix estimators*

Description

Shrinking characteristics of precision matrix estimators. Penalized precision matrix estimation using the ADMM algorithm. Consider the case where $X_1, ..., X_n$ are iid $N_p(\mu, \Sigma)$ and we are tasked with estimating the precision matrix, denoted $\Omega \equiv \Sigma^{-1}$. This function solves the following optimization problem:

Objective: $\hat{\Omega}_\lambda = \arg\min_{\Omega \in S_+^p} \{Tr(S\Omega) - \log\det(\Omega) + \lambda \|A\Omega B - C\|_1\}$

where $\lambda > 0$ and we define $\|A\|_1 = \sum_{i,j} |A_{ij}|$.

Usage

```
shrink(X = NULL, S = NULL, Y = NULL, A = diag(ncol(S)),
  B = diag(ncol(S)), C = diag(ncol(S)), nlam = 10, lam.min.ratio = 0.01,
  lam = NULL, path = FALSE, rho = 2, mu = 10, tau.inc = 2,
  tau.dec = 2, crit = c("ADMM", "loglik"), tol.abs = 1e-04,
  tol.rel = 1e-04, maxit = 10000, adjmaxit = NULL, K = 5,
  crit.cv = c("MSE", "loglik", "AIC", "BIC"), start = c("warm", "cold"),
  cores = 1, trace = c("progress", "print", "none"))
```

Arguments

X	option to provide a nxp data matrix. Each row corresponds to a single observation and each column contains n observations of a single feature/variable.
S	option to provide a pxp sample covariance matrix (denominator n). If argument is NULL and X is provided instead then S will be computed automatically.
Y	option to provide nxr response matrix. Each row corresponds to a single response and each column contains n response of a single feature/response.
A	option to provide user-specified matrix for penalty term. This matrix must have p columns. Defaults to identity matrix.
B	option to provide user-specified matrix for penalty term. This matrix must have p rows. Defaults to identity matrix.
C	option to provide user-specified matrix for penalty term. This matrix must have nrow(A) rows and ncol(B) columns. Defaults to identity matrix.
nlam	number of lam tuning parameters for penalty term generated from lam.min.ratio and lam.max (automatically generated). Defaults to 10.
lam.min.ratio	smallest lam value provided as a fraction of lam.max. The function will automatically generate nlam tuning parameters from lam.min.ratio*lam.max to lam.max in log10 scale. lam.max is calculated to be the smallest lam such that all off-diagonal entries in Omega are equal to zero (alpha = 1). Defaults to 1e-2.
lam	option to provide positive tuning parameters for penalty term. This will cause nlam and lam.min.ratio to be disregarded. If a vector of parameters is provided, they should be in increasing order. Defaults to NULL.
path	option to return the regularization path. This option should be used with extreme care if the dimension is large. If set to TRUE, cores must be set to 1 and errors and optimal tuning parameters will based on the full sample. Defaults to FALSE.
rho	initial step size for ADMM algorithm.
mu	factor for primal and residual norms in the ADMM algorithm. This will be used to adjust the step size rho after each iteration.
tau.inc	factor in which to increase step size rho
tau.dec	factor in which to decrease step size rho
crit	criterion for convergence (ADMM or loglik). If crit = loglik then iterations will stop when the relative change in log-likelihood is less than tol.abs. Default is ADMM and follows the procedure outlined in Boyd, et al.
tol.abs	absolute convergence tolerance. Defaults to 1e-4.
tol.rel	relative convergence tolerance. Defaults to 1e-4.
maxit	maximum number of iterations. Defaults to 1e4.
adjmaxit	adjusted maximum number of iterations. During cross validation this option allows the user to adjust the maximum number of iterations after the first lam tuning parameter has converged (for each alpha). This option is intended to be paired with warm starts and allows for 'one-step' estimators. Defaults to NULL.
K	specify the number of folds for cross validation.
crit.cv	cross validation criterion (MSE, loglik, AIC, or BIC). Defaults to MSE.
start	specify warm or cold start for cross validation. Default is warm.
cores	option to run CV in parallel. Defaults to cores = 1.

`trace`	option to display progress of CV. Choose one of `progress` to print a progress bar, `print` to print completed tuning parameters, or `none`.
`alpha`	elastic net mixing parameter contained in [0, 1]. `0 = ridge, 1 = lasso`. If a vector of parameters is provided, they should be in increasing order. Defaults to grid of values `seq(0, 1, 0.2)`.

Details

For details on the implementation of 'shrink', see the vignette https://mgallow.github.io/shrink/.

Value

returns class object `ADMMsigma` which includes:

`Call`	function call.
`Iterations`	number of iterations.
`Tuning`	optimal tuning parameter.
`Lambdas`	grid of lambda values for CV.
`maxit`	maximum number of iterations.
`Omega`	estimated penalized precision matrix.
`Sigma`	estimated covariance matrix from the penalized precision matrix (inverse of Omega).
`Path`	array containing the solution path. Solutions will be ordered in ascending alpha values for each lambda.
`Z`	final sparse update of estimated penalized precision matrix.
`Y`	final dual update.
`rho`	final step size.
`Loglik`	penalized log-likelihood for Omega
`MIN.error`	minimum average cross validation error (cv.crit) for optimal parameters.
`AVG.error`	average cross validation error (cv.crit) across all folds.
`CV.error`	cross validation errors (cv.crit).

Author(s)

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References

- Boyd, Stephen, Neal Parikh, Eric Chu, Borja Peleato, Jonathan Eckstein, and others. 2011. 'Distributed Optimization and Statistical Learning via the Alternating Direction Method of Multipliers.' *Foundations and Trends in Machine Learning* 3 (1). Now Publishers, Inc.: 1-122. https://web.stanford.edu/~boyd/papers/pdf/admm_distr_stats.pdf
- Hu, Yue, Chi, Eric C, amd Allen, Genevera I. 2016. 'ADMM Algorithmic Regularization Paths for Sparse Statistical Machine Learning.' *Splitting Methods in Communication, Imaging, Science, and Engineering*. Springer: 433-459.
- Molstad, Aaron J., and Adam J. Rothman. (2017). 'Shrinking Characteristics of Precision Matrix Estimators. *arXiv preprint arXiv: 1704.04820.*. https://arxiv.org/pdf/1704.04820.pdf
- Rothman, Adam. 2017. 'STAT 8931 notes on an algorithm to compute the Lasso-penalized Gaussian likelihood precision matrix estimator.'

See Also

plot.shrink

Examples

```
# NEED TO COMPLETE
```

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