Package 'lmmen'

August 14, 2017

Title Linear Mixed Model Elastic Net

Version 1.0

Description Fits (Gaussian) linear mixed-effects models
for high-dimensional data (n<<p) using the linear mixed model elastic-net penalty.

Depends R (>= 3.3.2), lmmlasso

Imports quadprog, mvtnorm, glmnet, lme4, utils, stats, glmmLasso

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Encoding UTF-8

LazyData true

RoxygenNote 6.0.1

NeedsCompilation no

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Repository CRAN

Date/Publication 2017-08-14 19:18:45 UTC

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`cv.glmmLasso` *Cross Validation for glmmLasso package*

Description

Cross Validation for glmmLasso package as shown in example xxx

Usage

```
cv.glmmLasso(dat, form.fixed = NULL, form.rnd = NULL, lambda = seq(500, 0,
  by = -5), family = stats::gaussian(link = "identity"))
```

Arguments

`dat`	data.frame, containing y,X,Z and subject variables
`form.fixed`	formaula, fixed param formula, Default: NULL
`form.rnd`	list, named list containing random effect formula, Default: NULL
`lambda`	numeric, vector containing lasso penalty levels, Default: seq(500, 0, by = -5)
`family`	family, family function that defines the distribution link of the glmm, Default: gaussian(link = "identity")

Value

list of a fitted glmmLasso object and the cv BIC path

References

A. Groll and G. Tutz. Variable selection for generalized linear mixed models by L1-penalized estimation. Statistics and Computing, pages 1–18, 2014.

cv function is the generalized form of last example glmmLasso package demo file

See Also

`glmmLasso`

Examples

```
## Not run: cv.glmmLasso(initialize_example(seed=1))
```

cv.lmmlasso *Cross Validation for lmmlasso package*

Description

Cross Validation for lmmlasso package as shown in example xxx

Usage

```
cv.lmmlasso(dat, lambda = seq(0, 500, 5), ...)
```

Arguments

dat	matrix, containing y,X,Z and subject variables
lambda	numeric, path of positive regularization parameter, Default: seq(0, 500, 5)
...	parameters to pass to lmmlasso

Value

lmmlasso fit object

References

J. Schelldorfer, P. Buhlmann, and S. Van de Geer. Estimation for high-dimensional linear mixed-effects models using L1-penalization. Scandinavian Journal of Statistics, 38(2):197–214, 2011.

See Also

lmmlasso

Examples

```
## Not run: cv.lmmlasso(initialize_example(seed = 1))
```

golden_section *Golden section grid search on a lmmen penalty*

Description

Solve for local minimum with one dimensional golden section one of the regularization parameters of the lmmen penalty.

Usage

```
golden_section(dat, init.beta, pen.effect = "FE.L1", opt.lb = 0,
  opt.ub = 1, opt.maxiter = 100, opt.tol = 0.1, opt.tau = (sqrt(5) -
  1)/2)
```

Arguments

dat	matrix, matrix that includes y (response),X (population covariates), Z (random effects covariates (not incl random intercept))
init.beta	numeric, initial fixed effects estimates
pen.effect	character,which penalty to search on c('FE.L1','RE.L1',FE.L2","RE.L2'), Default: 'FE.L1'
opt.lb	numeric, start of search interval, Default: 0
opt.ub	numeric, end of search interval, Default: 1
opt.maxiter	numeric, maximum iterations to search, Default: 100
opt.tol	numeric, accuracy value, Default: 0.1
opt.tau	numeric, golden proportion coefficient (~0.618) Default: (sqrt(5) - 1)/2

Value

lmmen list object inluding lmmen fit object of min BIC solution and summary statistics from the grid searc

Examples

```
## Not run:
 dat <- initialize_example(n.i = 5,n = 30,q=4,seed=1)
 init <- init.beta(dat,method='glmnet')
 golden_section(dat,init,pen.effect = 'FE.L1')

## End(Not run)
```

---

golden_section_2d *Golden section two dimensional grid search on L1 lmmen penalties*

Description

Solve for local minimum with two dimensional golden section on L1 lmmen penalties.

Usage

```
golden_section_2d(dat, init.beta, l2 = c(1, 1), opt.lb = c(0, 0),
  opt.ub = c(1, 1), opt.maxiter = 100, opt.tol = 0.1, opt.tau = (sqrt(5)
  - 1)/2)
```

Arguments

dat	matrix, matrix that includes y (response),X (population covariates), Z (random effects covariates (not incl random intercept))
init.beta	numeric, initial fixed effects estimates
l2	numeric, L2 penalty levels Default: c(1, 1)
opt.lb	numeric, start of interval for L1 fixed and L1 random effects, Default: c(0, 0)
opt.ub	numeric, end of interval for L1 fixed and L1 random effects Default: c(1, 1)
opt.maxiter	numeric, maximum iterations to search, Default: 100
opt.tol	numeric, accuracy value, Default: 0.1
opt.tau	numeric, golden proportion coefficient (~0.618) Default: (sqrt(5) - 1)/2

Value

lmmen list object inluding lmmen fit object of min BIC solution and summary statistics from the grid search

Examples

```
## Not run:
 dat <- initialize_example(n.i = 5,n = 30,q=4,seed=1)
 init <- init.beta(dat,method='glmnet')
 golden_section_2d(dat,init)
## End(Not run)
```

---

init.beta *Evaluate fixed effects initial values for lmmen*

Description

Evaluate fixed effects initial values for lmmen via cv.glmnet or lme4.

Usage

```
init.beta(dat, method = c("glmnet", "lme4"))
```

Arguments

dat	data.frame, data to solve initial values
method	character, method to use, c('glmnet','lme4')

Details

cv.glmnet is set to ridge regression.

Value

numeric

See Also

cv.glmnet

Examples

```
dat <- initialize_example(n.i = 5,n = 30,q=4,seed=1)
init.beta(dat,method='glmnet')
init.beta(dat,method='lme4')
```

---

initialize_example *Initialize Scenario*

Description

Create a scenario to run the evaluation functions.

Usage

```
initialize_example(n.i = 5, n = 30, q = 4, total.beta = 9,
  true.beta = c(1, 1, 1), seed = NULL)
```

Arguments

n.i	integer, Observations per subject, Default: 5
n	integer, Number of subjects, Default: 30
q	integer, Number of random effects, Default: 4
total.beta	integer, Number of simulated fixed effects, Default: 9
true.beta	numeric, True of fixed effects indicies, Default: c(1,1,1)
seed	integer, set a seed for reproducibility, Default: NULL

Value

(n.i*n) x (1+total.beta+q) matrix containing where the subjects index are the matrix rownames

Description	Parameter	Dimension
Response	y	(n.i*n) x 1
Fixed	X	(n.i*n) x total.beta
Random	Z	(n.i*n) x q

See Also

rmvnorm

Examples

```
initialize_example(n.i = 5,n = 30,q=4,seed=1)
initialize_example(n.i = 10,n = 60,q=4,seed=1)
initialize_example(n.i = 5,n = 60,q=10,seed=1)
```

---

lmmen *linear mixed model Elastic Net*

Description

Regularize a linear mixed model with the linear mixed model Elastic Net penalty.

Usage

```
lmmen(data, init.beta, frac, eps = 10^(-4), verbose = FALSE)
```

Arguments

data	matrix, data
init.beta	numeric, initial values for fixed effects coefficients
frac	numeric, penalty levels for fixed and random effects expressed in ratios. c(L1.fixed,L2.fixed,L1.random,L
eps	numeric, tolerance level to pass to solve.QP, Default: 10^(-4)
verbose	boolean, show output during optimization Default: FALSE

Details

$y_i = x_{ij}^t \beta + z_{ij}^t b_i + \epsilon_i,$

$\epsilon_i \sim N(0, \sigma^2 I_{n_i})$

The lmmen function solves for the folloing problem.

$Q(\phi|y, b) = ||y - Z\Lambda\Gamma b - X\beta||^2 + \tilde{P}(\beta, d)$

$\tilde{P}(\beta, d) =$

$\lambda_2^f \sum_{i \in P} \beta_i^2 + \lambda_2^r \sum_{j \in Q} d_j^2 +$

$\lambda_1^f \sum_{i \in P} |\beta_i| + \lambda_1^r \sum_{j \in Q} |d_j|$

Where $\tilde{P}$ and $Q(\phi)$ denote the penalty applied to the likelihood and the penalized log-likelihood.

When the final model is not a mixed effects model, but either a fixed effects or random effects model then the original form of the Elastic Net penalty is applied.

Value

lmmen fit object including

fixed: estimated fixed effects coefficients

stddev: estimated random effects covariance matrix standard deviations

sigma.2: standard error of the model residual effect

lambda: estimated lower triangle of Λ (correlation of random effects)

Mean.est: model prediction $X^t\beta$

loglike: log likelihood

df: degrees of freedom

BIC: Minimum BIC penalty value

frac: ratio placed on the penalties corresponding to BIC

Gamma.Mat.RE: estimated Γ

Cov.Mat.RE: estimated random effect covariance matrix

Corr.Mat.RE: estimate random effects correlation matrix

solveQP: output of the call to solveQP corresponding to min BIC

References

Prepublished version of the lmmen paper.

See Also

solve.QP

Examples

```
dat <- initialize_example(n.i = 5,n = 30,q=4,seed=1)
init <- init.beta(dat,method='glmnet')
lmmen(data=dat,init.beta=init,frac=c(0.8,1,1,1))
```

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