

Package ‘fuser’

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Title Fused Lasso for High-Dimensional Regression over Groups

Version 1.0.0

Description Enables high-dimensional penalized regression across heterogeneous subgroups. Fusion penalties are used to share information about the linear parameters across subgroups. The underlying model is described in detail in Dondelinger and Mukherjee (2017) <arXiv:1611.00953>.

Depends R (>= 3.2.0)

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LazyData true

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Suggests testthat, ggplot2, knitr, rmarkdown

Imports Matrix, irlba, Rcpp, glmnet, RSpectra

LinkingTo Rcpp, RcppEigen

VignetteBuilder knitr

NeedsCompilation yes

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bigeigen	<i>Big eigenvalue calculation</i>
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Description

Calculate maximal eigenvalue of $t(X) \%* \% X$ for big matrices using singular value decomposition.

Usage

```
bigeigen(X, method = "RSpectra")
```

Arguments

X	matrix to be evaluated (can be a Matrix object).
method	One of 'irlba' or 'RSpectra'

Value

The maximal eigenvalue.

fusedL2DescentGLMNet	<i>Optimise the fused L2 model with glmnet (using transformed input data)</i>
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Description

Optimise the fused L2 model with glmnet (using transformed input data)

Usage

```
fusedL2DescentGLMNet(transformed.x, transformed.x.f, transformed.y, groups,
  lambda, gamma = 1, ...)
```

Arguments

transformed.x	Transformed covariates (output of generateBlockDiagonalMatrices)
transformed.x.f	Transformed fusion constraints (output of generateBlockDiagonalMatrices)
transformed.y	Transformed response (output of generateBlockDiagonalMatrices)
groups	Grouping factors for samples (a vector of size n, with K factor levels)
lambda	Sparsity penalty hyperparameter
gamma	Fusion penalty hyperparameter
...	Further options passed to glmnet.

Value

Matrix of fitted beta values.

A matrix with the linear coefficients for each group (p by k).

Examples

```
#' set.seed(123)

# Generate simple heterogeneous dataset
k = 4 # number of groups
p = 100 # number of covariates
n.group = 15 # number of samples per group
sigma = 0.05 # observation noise sd
groups = rep(1:k, each=n.group) # group indicators
# sparse linear coefficients
beta = matrix(0, p, k)
nonzero.ind = rbinom(p*k, 1, 0.025/k) # Independent coefficients
nonzero.shared = rbinom(p, 1, 0.025) # shared coefficients
beta[which(nonzero.ind==1)] = rnorm(sum(nonzero.ind), 1, 0.25)
beta[which(nonzero.shared==1),] = rnorm(sum(nonzero.shared), -1, 0.25)

X = lapply(1:k,
           function(k.i) matrix(rnorm(n.group*p),
                                n.group, p)) # covariates
y = sapply(1:k,
           function(k.i) X[[k.i]] %*% beta[,k.i] +
                        rnorm(n.group, 0, sigma)) # response
X = do.call('rbind', X)

# Pairwise Fusion strength hyperparameters (tau(k,k'))
# Same for all pairs in this example
G = matrix(1, k, k)

# Generate block diagonal matrices
transformed.data = generateBlockDiagonalMatrices(X, y, groups, G)

# Use L2 fusion to estimate betas (with near-optimal information
# sharing among groups)
beta.estimate = fusedL2DescentGLMNet(transformed.data$X,
                                     transformed.data$X.fused,
                                     transformed.data$Y, groups,
                                     lambda=c(0,0.001,0.1,1),
                                     gamma=0.001)
```

Description

Fused lasso optimisation with proximal-gradient method. (Chen et al. 2010)

Usage

```
fusedLassoProximal(X, Y, groups, lambda, gamma, G, mu = 1e-04, tol = 1e-06,
  num.it = 1000, lam.max = NULL, c.flag = FALSE, intercept = TRUE,
  penalty.factors = NULL, conserve.memory = p >= 10000)
```

Arguments

X	matrix of covariates (n by p)
Y	vector of responses (length n)
groups	vector of group indicators (length n)
lambda	Sparsity hyperparameter (accepts scalar value only)
gamma	Fusion hyperparameter (accepts scalar value only)
G	Matrix of pairwise group information sharing weights (K by K)
mu	Smoothness parameter for proximal optimization
tol	Tolerance for optimization
num.it	Number of iterations
lam.max	Maximal eigenvalue of $t(X) \%*\% X$ (will be calculate if not provided)
c.flag	Whether to use Rcpp for certain calculations (see Details).
intercept	Whether to include a (group-specific) intercept term.
penalty.factors	Weights for sparsity penalty.
conserve.memory	Whether to calculate XX and XY on the fly, conserving memory at the cost of speed. (True by default iff $p \geq 10000$)

Details

The proximal algorithm uses $t(X) \%*\% X$ and $t(X) \%*\% Y$. The function will attempt to pre-calculate these values to speed up computation. This may not always be possible due to memory restrictions; at present this is only done for $p < 10,000$. When $p > 10,000$, crossproducts are calculated explicitly; calculation can be speeded up by using Rcpp code (setting `c.flag=TRUE`).

Value

A matrix with the linear coefficients for each group (p by k).

Examples

```

set.seed(123)
# Generate simple heterogeneous dataset
k = 4 # number of groups
p = 100 # number of covariates
n.group = 15 # number of samples per group
sigma = 0.05 # observation noise sd
groups = rep(1:k, each=n.group) # group indicators
# sparse linear coefficients
beta = matrix(0, p, k)
nonzero.ind = rbinom(p*k, 1, 0.025/k) # Independent coefficients
nonzero.shared = rbinom(p, 1, 0.025) # shared coefficients
beta[which(nonzero.ind==1)] = rnorm(sum(nonzero.ind), 1, 0.25)
beta[which(nonzero.shared==1),] = rnorm(sum(nonzero.shared), -1, 0.25)

X = lapply(1:k,
           function(k.i) matrix(rnorm(n.group*p),
                                n.group, p)) # covariates
y = sapply(1:k,
           function(k.i) X[[k.i]] %*% beta[,k.i] +
                        rnorm(n.group, 0, sigma)) # response
X = do.call('rbind', X)

# Pairwise Fusion strength hyperparameters (tau(k,k'))
# Same for all pairs in this example
G = matrix(1, k, k)

# Use L1 fusion to estimate betas (with near-optimal sparsity and
# information sharing among groups)
beta.estimate = fusedLassoProximal(X, y, groups, lambda=0.01, tol=3e-3,
                                  gamma=0.01, G, intercept=FALSE,
                                  num.it=500)

```

fusedLassoProximalIterationsTaken

Following a call to fusedLassoProximal, returns the actual number of iterations taken.

Description

Following a call to fusedLassoProximal, returns the actual number of iterations taken.

Usage

```
fusedLassoProximalIterationsTaken()
```

Value

Number of iterations performed in the previous call to fusedLassoProximal.

```
generateBlockDiagonalMatrices
```

Generate block diagonal matrices to allow for fused L2 optimization with glmnet.

Description

Generate block diagonal matrices to allow for fused L2 optimization with glmnet.

Usage

```
generateBlockDiagonalMatrices(X, Y, groups, G, intercept = FALSE,
  penalty.factors = rep(1, dim(X)[2]))
```

Arguments

X	covariates matrix (n by p).
Y	response vector (length n).
groups	vector of group indicators (ideally factors, length n)
G	matrix representing the fusion strengths between pairs of groups (K by K). Zero entries are assumed to be independent pairs.
intercept	whether to include an (per-group) intercept in the model
penalty.factors	vector of weights for the penalization of each covariate (length p)

Value

A list with components X, Y, X.fused and penalty, where X is a n by pK block-diagonal bigmatrix, Y is a re-arranged bigvector of length n, and X.fused is a choose(K,2)*p by pK bigmatrix encoding the fusion penalties.

Examples

```
set.seed(123)

# Generate simple heterogeneous dataset
k = 4 # number of groups
p = 100 # number of covariates
n.group = 15 # number of samples per group
sigma = 0.05 # observation noise sd
groups = rep(1:k, each=n.group) # group indicators
# sparse linear coefficients
beta = matrix(0, p, k)
nonzero.ind = rbinom(p*k, 1, 0.025/k) # Independent coefficients
nonzero.shared = rbinom(p, 1, 0.025) # shared coefficients
beta[which(nonzero.ind==1)] = rnorm(sum(nonzero.ind), 1, 0.25)
beta[which(nonzero.shared==1),] = rnorm(sum(nonzero.shared), -1, 0.25)
```

```
X = lapply(1:k,
           function(k.i) matrix(rnorm(n.group*p),
                                n.group, p)) # covariates
y = sapply(1:k,
           function(k.i) X[[k.i]] %% beta[,k.i] +
                        rnorm(n.group, 0, sigma)) # response
X = do.call('rbind', X)

# Pairwise Fusion strength hyperparameters (tau(k,k'))
# Same for all pairs in this example
G = matrix(1, k, k)

# Generate block diagonal matrices
transformed.data = generateBlockDiagonalMatrices(X, y, groups, G)
```

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