Package 'MLGL'

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Type Package

Title Multi-Layer Group-Lasso

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Description It implements a new procedure of variable selection in the context of redundancy between explanatory variables, which holds true with high dimensional data (Grimonprez et al. (2023) <doi:10.18637/jss.v106.i03>).

BugReports https://github.com/modal-inria/MLGL/issues

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Imports gglasso, MASS, Matrix, fastcluster, FactoMineR, parallelDist

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Contents

`MLGL-package` *MLGL*

Description

This package presents a method combining Hierarchical Clustering and Group-lasso. Usually, a single partition of the covariates is used in the group-lasso. Here, we provide several partitions from the hierarchical tree.

A post-treatment method based on statistical test (with FWER and FDR control) for selecting the regularization parameter and the optimal group for this value is provided. This method can be applied for the classical group-lasso and our method.

Details

The MLGL function performs the hierarchical clustering and the group-lasso. The post-treatment method can be performed with hierarchicalFWER and selFWER functions. The whole process can be run with the fullProcess function.

Author(s)

Quentin Grimonprez

References

Grimonprez Q, Blanck S, Celisse A, Marot G (2023). "MLGL: An R Package Implementing Correlated Variable Selection by Hierarchical Clustering and Group-Lasso." Journal of Statistical Software, 106(3), 1-33. doi:10.18637/jss.v106.i03.

See Also

MLGL, cv.MLGL, fullProcess, hierarchicalFWER

Examples

```
# Simulate gaussian data with block-diagonal variance matrix containing 12 blocks of size 5
X <- simuBlockGaussian(50, 12, 5, 0.7)
# Generate a response variable
y <- X[, c(2, 7, 12)] %*% c(2, 2, -2) + rnorm(50, 0, 0.5)
# Apply MLGL method
res <- MLGL(X, y)
```

`bootstrapHclust` *Hierarchical Clustering with distance matrix computed using bootstrap replicates*

Description

Hierarchical Clustering with distance matrix computed using bootstrap replicates

Usage

```
bootstrapHclust(X, frac = 1, B = 50, method = "ward.D2", nCore = NULL)
```

Arguments

`X`	data
`frac`	fraction of sample used at each replicate
`B`	number of replicates
`method`	desired method: "single", "complete", "average", "mcquitty", "ward.D", "ward.D2", "centroid", "median".
`nCore`	number of cores

Value

An object of class hclust

Examples

```
hc <- bootstrapHclust(USArrests, nCore = 1)
```

---

coef.cv.MLGL *Get coefficients from a* cv.MLGL *object*

Description

Get coefficients from a cv.MLGL object

Usage

```
## S3 method for class 'cv.MLGL'
coef(object, s = c("lambda.1se", "lambda.min"), ...)
```

Arguments

object	cv.MLGL object
s	Either "lambda.1se" or "lambda.min"
...	Not used. Other arguments to predict.

Value

A matrix with estimated coefficients for given values of s.

Author(s)

Quentin Grimonprez

See Also

cv.MLGL, predict.cv.MLGL

coef.MLGL *Get coefficients from a MLGL object*

Description

Get coefficients from a MLGL object

Usage

```
## S3 method for class 'MLGL'
coef(object, s = NULL, ...)
```

Arguments

object	MLGL object
s	values of lambda. If NULL, use values from object
...	Not used. Other arguments to predict.

Value

A matrix with estimated coefficients for given values of s.

Author(s)

Quentin Grimonprez

See Also

MLGL, predict.MLGL

computeGroupSizeWeight *Compute the group size weight vector with an authorized maximal size*

Description

Compute the group size weight vector with an authorized maximal size

Usage

```
computeGroupSizeWeight(hc, sizeMax = NULL)
```

Arguments

hc	output of hclust
sizeMax	maximum size of cluster to consider

Value

the weight vector

Examples

```
set.seed(42)
# Simulate gaussian data with block-diagonal variance matrix containing 12 blocks of size 5
X <- simuBlockGaussian(50, 12, 5, 0.7)
# Generate a response variable
y <- X[, c(2, 7, 12)] %*% c(2, 2, -2) + rnorm(50, 0, 0.5)
# use 20 as the maximal number of group
hc <- hclust(dist(t(X)))
w <- computeGroupSizeWeight(hc, sizeMax = 20)
# Apply MLGL method
res <- MLGL(X, y, hc = hc, weightSizeGroup = w)
```

---

cv.MLGL *Multi-Layer Group-Lasso with cross V-fold validation*

Description

V-fold cross validation for MLGL function

Usage

```
cv.MLGL(
  X,
  y,
  nfolds = 5,
  lambda = NULL,
  hc = NULL,
  weightLevel = NULL,
  weightSizeGroup = NULL,
  loss = c("ls", "logit"),
  intercept = TRUE,
  sizeMaxGroup = NULL,
  verbose = FALSE,
  ...
)
```

Arguments

X	matrix of size n*p
y	vector of size n. If loss = "logit", elements of y must be in {-1,1}
nfolds	number of folds
lambda	lambda values for group lasso. If not provided, the function generates its own values of lambda

hc	output of hclust function. If not provided, hclust is run with ward.D2 method
weightLevel	a vector of size p for each level of the hierarchy. A zero indicates that the level will be ignored. If not provided, use 1/(height between 2 successive levels)
weightSizeGroup	a vector
loss	a character string specifying the loss function to use, valid options are: "ls" least squares loss (regression) and "logit" logistic loss (classification)
intercept	should an intercept be included in the model ?
sizeMaxGroup	maximum size of selected groups. If NULL, no restriction
verbose	print some information
...	Others parameters for cv.gglasso function

Details

Hierarchical clustering is performed with all the variables. Then, the partitions from the different levels of the hierarchy are used in the different run of MLGL for cross validation.

Value

a cv.MLGL object containing:

lambda values of lambda.

cvm the mean cross-validated error.

cvsd estimate of standard error of cvm

cvupper upper curve = cvm+cvsd

cvlower lower curve = cvm-cvsd

lambda.min The optimal value of lambda that gives minimum cross validation error cvm.

lambda.1se The largest value of lambda such that error is within 1 standard error of the minimum.

time computation time

Author(s)

Quentin Grimonprez

See Also

MLGL, stability.MLGL, predict.cv.gglasso, coef.cv.MLGL, plot.cv.MLGL

Examples

```
set.seed(42)
# Simulate gaussian data with block-diagonal variance matrix containing 12 blocks of size 5
X <- simuBlockGaussian(50, 12, 5, 0.7)
# Generate a response variable
y <- X[, c(2, 7, 12)] %*% c(2, 2, -2) + rnorm(50, 0, 0.5)
# Apply cv.MLGL method
res <- cv.MLGL(X, y)
```

Ftest *F-test*

Description

Perform a F-test

Usage

```
Ftest(X, y, varToTest)
```

Arguments

X	design matrix of size n*p
y	response vector of length n
varToTest	vector containing the index of the column of X to test

Details

y = X * beta + epsilon

null hypothesis: beta[varToTest] = 0 alternative hypothesis: it exists an index k in varToTest such that beta[k] != 0

The test statistic is based on a full and a reduced model. full: y = X * beta[varToTest] + epsilon reduced: the null model

Value

a vector of the same length as varToTest containing the p-values of the test.

See Also

partialFtest

fullProcess *Full process of MLGL*

Description

Run hierarchical clustering following by a group-lasso on all the different partition and a hierarchical testing procedure. Only for linear regression problem.

Usage

```
fullProcess(X, ...)

## Default S3 method:
fullProcess(
  X,
  y,
  control = c("FWER", "FDR"),
  alpha = 0.05,
  test = partialFtest,
  hc = NULL,
  fractionSampleMLGL = 1/2,
  BHclust = 50,
  nCore = NULL,
  addRoot = FALSE,
  Shaffer = FALSE,
  ...
)

## S3 method for class 'formula'
fullProcess(
  formula,
  data,
  control = c("FWER", "FDR"),
  alpha = 0.05,
  test = partialFtest,
  hc = NULL,
  fractionSampleMLGL = 1/2,
  BHclust = 50,
  nCore = NULL,
  addRoot = FALSE,
  Shaffer = FALSE,
  ...
)
```

Arguments

X	matrix of size n*p
...	Others parameters for MLGL
y	vector of size n.
control	either "FDR" or "FWER"
alpha	control level for testing procedure
test	test used in the testing procedure. Default is partialFtest
hc	output of hclust function. If not provided, hclust is run with ward.D2 method. User can also provide the desired method: "single", "complete", "average", "mcquitty", "ward.D", "ward.D2", "centroid", "median".

`fractionSampleMLGL`
: a real between 0 and 1: the fraction of individuals to use in the sample for MLGL (see Details).

`BHclust`
: number of replicates for computing the distance matrix for the hierarchical clustering tree

`nCore`
: number of cores used for distance computation. Use all cores by default.

`addRoot`
: If TRUE, add a common root containing all the groups

`Shaffer`
: If TRUE, a Shaffer correction is performed (only if control = "FWER")

`formula`
: an object of class "formula" (or one that can be coerced to that class): a symbolic description of the model to be fitted.

`data`
: an optional data frame, list or environment (or object coercible by as.data.frame to a data frame) containing the variables in the model. If not found in data, the variables are taken from environment (formula)

Details

Divide the n individuals in two samples. Then the three following steps are done: 1) Bootstrap Hierarchical Clustering of the variables of X 2) MLGL on the second sample of individuals 3) Hierarchical testing procedure on the first sample of individuals.

Value

a list containing:

res output of MLGL function

lambdaOpt lambda values maximizing the number of rejects

var A vector containing the index of selected variables for the first `lambdaOpt` value

group A vector containing the values index of selected groups for the first `lambdaOpt` value

selectedGroups Selected groups for the first `lambdaOpt` value

reject Selected groups for all lambda values

alpha Control level

test Test used in the testing procedure

control "FDR" or "FWER"

time Elapsed time

Author(s)

Quentin Grimonprez

See Also

MLGL, hierarchicalFDR, hierarchicalFWER, selFDR, selFWER

Examples

```
# least square loss
set.seed(42)
X <- simuBlockGaussian(50, 12, 5, 0.7)
y <- X[, c(2, 7, 12)] %*% c(2, 2, -2) + rnorm(50, 0, 0.5)
res <- fullProcess(X, y)
```

`hierarchicalFDR` *Hierarchical testing with FDR control*

Description

Apply hierarchical test for each hierarchy, and test external variables for FDR control at level alpha

Usage

```
hierarchicalFDR(X, y, group, var, test = partialFtest, addRoot = FALSE)
```

Arguments

`X`	original data
`y`	associated response
`group`	vector with index of groups. group[i] contains the index of the group of the variable var[i].
`var`	vector with the variables contained in each group. group[i] contains the index of the group of the variable var[i].
`test`	function for testing the nullity of a group of coefficients in linear regression. The function has 3 arguments: `X`, the design matrix, `y`, response, and `varToTest`, a vector containing the indices of the variables to test. The function returns a p-value
`addRoot`	If TRUE, add a common root containing all the groups

Details

Version of the hierarchical testing procedure of Yekutieli for MLGL output. You can use th selFDR function to select groups at a desired level alpha.

Value

a list containing:

pvalues pvalues of the different test (without correction)

adjPvalues adjusted pvalues

groupId Index of the group

hierMatrix Matrix describing the hierarchical tree.

References

Yekutieli, Daniel. "Hierarchical False Discovery Rate-Controlling Methodology." Journal of the American Statistical Association 103.481 (2008): 309-16.

See Also

selFDR, hierarchicalFWER

Examples

```
set.seed(42)
X <- simuBlockGaussian(50, 12, 5, 0.7)
y <- X[, c(2, 7, 12)] %*% c(2, 2, -2) + rnorm(50, 0, 0.5)
res <- MLGL(X, y)
test <- hierarchicalFDR(X, y, res$group[[20]], res$var[[20]])
```

---

hierarchicalFWER *Hierarchical testing with FWER control*

Description

Apply hierarchical test for each hierarchy, and test external variables for FWER control at level alpha

Usage

```
hierarchicalFWER(
  X,
  y,
  group,
  var,
  test = partialFtest,
  Shaffer = FALSE,
  addRoot = FALSE
)
```

Arguments

X	original data
y	associated response
group	vector with index of groups. group[i] contains the index of the group of the variable var[i].
var	vector with the variables contained in each group. group[i] contains the index of the group of the variable var[i].

`test`	function for testing the nullity of a group of coefficients in linear regression. The function has 3 arguments: `X`, the design matrix, `y`, response, and `varToTest`, a vector containing the indices of the variables to test. The function returns a p-value
`Shaffer`	boolean, if TRUE, a Shaffer correction is performed
`addRoot`	If TRUE, add a common root containing all the groups

Details

Version of the hierarchical testing procedure of Meinshausen for MLGL output. You can use th selFWER function to select groups at a desired level alpha

Value

a list containing:

pvalues pvalues of the different test (without correction)

adjPvalues adjusted pvalues

groupId Index of the group

hierMatrix Matrix describing the hierarchical tree.

References

Meinshausen, Nicolai. "Hierarchical Testing of Variable Importance." Biometrika 95.2 (2008): 265-78.

See Also

selFWER, hierarchicalFDR

Examples

```
set.seed(42)
X <- simuBlockGaussian(50, 12, 5, 0.7)
y <- X[, c(2, 7, 12)] %*% c(2, 2, -2) + rnorm(50, 0, 0.5)
res <- MLGL(X, y)
test <- hierarchicalFWER(X, y, res$group[[20]], res$var[[20]])
```

`HMT` *Hierarchical Multiple Testing procedure*

Description

Apply Hierarchical Multiple Testing procedure on a `MLGL` object

Usage

```
HMT(
  res,
  X,
  y,
  control = c("FWER", "FDR"),
  alpha = 0.05,
  test = partialFtest,
  addRoot = FALSE,
  Shaffer = FALSE,
  ...
)
```

Arguments

res	MLGL object
X	matrix of size n*p
y	vector of size n.
control	either "FDR" or "FWER"
alpha	control level for testing procedure
test	test used in the testing procedure. Default is partialFtest
addRoot	If TRUE, add a common root containing all the groups
Shaffer	If TRUE, a Shaffer correction is performed (only if control = "FWER")
...	extra parameters for selFDR

Value

a list containing:

lambdaOpt lambda values maximizing the number of rejects

var A vector containing the index of selected variables for the first `lambdaOpt` value

group A vector containing the values index of selected groups for the first `lambdaOpt` value

selectedGroups Selected groups for the first `lambdaOpt` value

indLambdaOpt indices associated with optimal lambdas

reject Selected groups for all lambda values

alpha Control level

test Test used in the testing procedure

control "FDR" or "FWER"

time Elapsed time

hierTest list containing the output of the testing function for each lambda. Each element can be used with the selFWER or selFDR functions.

lambda lambda path

nGroup Number of groups before testing

nSelectedGroup Number of groups after testing

See Also

hierarchicalFWER hierarchicalFDR selFWER selFDR

Examples

```
set.seed(42)
X <- simuBlockGaussian(50, 12, 5, 0.7)
y <- X[, c(2, 7, 12)] %*% c(2, 2, -2) + rnorm(50, 0, 0.5)
res <- MLGL(X, y)

# perform hierarchical testing with FWER control
out <- HMT(res, X, y, alpha = 0.05)

# test a new value of alpha for a specific lambda
selFWER(out$hierTest[[60]], alpha = 0.1)
```

---

listToMatrix *Obtain a sparse matrix of the coefficients of the path*

Description

Obtain a sparse matrix of the coefficients of the path

Usage

```
listToMatrix(x, row = c("covariates", "lambda"))
```

Arguments

x	MLGL object
row	"lambda" or "covariates". If row="covariates", each row of the output matrix represents a covariate else if row="lambda", it represents a value of lambda.

Details

This function can be used with a MLGL object to obtain a matrix with all estimated coefficients for the p original variables. In case of overlapping groups, coefficients from repeated variables are summed.

Value

a sparse matrix containing the estimated coefficients for different lambdas

See Also

MLGL, overlapgglasso

Examples

```
# Simulate gaussian data with block-diagonal variance matrix containing 12 blocks of size 5
X <- simuBlockGaussian(50, 12, 5, 0.7)
# Generate a response variable
y <- X[, c(2, 7, 12)] %*% c(2, 2, -2) + rnorm(50, 0, 0.5)
# Apply MLGL method
res <- MLGL(X, y)
# Convert output in sparse matrix format
beta <- listToMatrix(res)
```

MLGL *Multi-Layer Group-Lasso*

Description

Run hierarchical clustering following by a group-lasso on all the different partitions.

Usage

```
MLGL(X, ...)

## Default S3 method:
MLGL(
  X,
  y,
  hc = NULL,
  lambda = NULL,
  weightLevel = NULL,
  weightSizeGroup = NULL,
  intercept = TRUE,
  loss = c("ls", "logit"),
  sizeMaxGroup = NULL,
  verbose = FALSE,
  ...
)

## S3 method for class 'formula'
MLGL(
  formula,
  data,
  hc = NULL,
  lambda = NULL,
  weightLevel = NULL,
  weightSizeGroup = NULL,
  intercept = TRUE,
  loss = c("ls", "logit"),
  verbose = FALSE,
```

```
  ...
)
```

Arguments

X	matrix of size n*p
...	Others parameters for gglasso function
y	vector of size n. If loss = "logit", elements of y must be in {-1,1}
hc	output of hclust function. If not provided, hclust is run with ward.D2 method. User can also provide the desired method: "single", "complete", "average", "mcquitty", "ward.D", "ward.D2", "centroid", "median".
lambda	lambda values for group lasso. If not provided, the function generates its own values of lambda
weightLevel	a vector of size p for each level of the hierarchy. A zero indicates that the level will be ignored. If not provided, use 1/(height between 2 successive levels). Only if hc is provided
weightSizeGroup	a vector of size 2*p-1 containing the weight for each group. Default is the square root of the size of each group. Only if hc is provided
intercept	should an intercept be included in the model ?
loss	a character string specifying the loss function to use, valid options are: "ls" least squares loss (regression) and "logit" logistic loss (classification)
sizeMaxGroup	maximum size of selected groups. If NULL, no restriction
verbose	print some information
formula	an object of class "formula" (or one that can be coerced to that class): a symbolic description of the model to be fitted.
data	an optional data.frame, list or environment (or object coercible by as.data.frame to a data.frame) containing the variables in the model. If not found in data, the variables are taken from environment (formula)

Value

a MLGL object containing:

lambda lambda values

b0 intercept values for lambda

beta A list containing the values of estimated coefficients for each values of lambda

var A list containing the index of selected variables for each values of lambda

group A list containing the values index of selected groups for each values of lambda

nVar A vector containing the number of non zero coefficients for each values of lambda

nGroup A vector containing the number of non zero groups for each values of lambda

structure A list containing 3 vectors. var: all variables used. group: associated groups. weight: weight associated with the different groups. level: for each group, the corresponding level of the hierarchy where it appears and disappears. 3 indicates the level with a partition of 3 groups.

time computation time

dim dimension of `X`

hc Output of hierarchical clustering

call Code executed by user

Author(s)

Quentin Grimonprez

See Also

cv.MLGL, stability.MLGL, listToMatrix, predict.MLGL, coef.MLGL, plot.cv.MLGL

Examples

```
set.seed(42)
# Simulate gaussian data with block-diagonal variance matrix containing 12 blocks of size 5
X <- simuBlockGaussian(50, 12, 5, 0.7)
# Generate a response variable
y <- X[, c(2, 7, 12)] %*% c(2, 2, -2) + rnorm(50, 0, 0.5)
# Apply MLGL method
res <- MLGL(X, y)
```

---

overlapgglasso *Group-lasso with overlapping groups*

Description

Group-lasso with overlapping groups

Usage

```
overlapgglasso(
  X,
  y,
  var,
  group,
  lambda = NULL,
  weight = NULL,
  loss = c("ls", "logit"),
  intercept = TRUE,
  ...
)
```

Arguments

X	matrix of size n*p
y	vector of size n. If loss = "logit", elements of y must be in {-1,1}
var	vector containing the variable to use
group	vector containing the associated groups
lambda	lambda values for group lasso. If not provided, the function generates its own values of lambda
weight	a vector the weight for each group. Default is the square root of the size of each group
loss	a character string specifying the loss function to use, valid options are: "ls" least squares loss (regression) and "logit" logistic loss (classification)
intercept	should an intercept be included in the model ?
...	Others parameters for gglasso function

Details

Use a group-lasso algorithm (see gglasso) to solve a group-lasso with overlapping groups. Each variable j of the original matrix X is paste k(j) times in a new dataset with k(j) the number of different groups containing the variable j. The new dataset is used to solve the group-lasso with overlapping groups running a group-lasso algorithm.

Value

a MLGL object containing:

lambda lambda values

b0 intercept values for lambda

beta A list containing the values of estimated coefficients for each values of lambda

var A list containing the index of selected variables for each values of lambda

group A list containing the values index of selected groups for each values of lambda

nVar A vector containing the number of non zero coefficients for each values of lambda

nGroup A vector containing the number of non zero groups for each values of lambda

structure A list containing 3 vectors. var: all variables used. group: associated groups. weight: weight associated with the different groups.

time computation time

dim dimension of X

Source

Laurent Jacob, Guillaume Obozinski, and Jean-Philippe Vert. 2009. Group lasso with overlap and graph lasso. In Proceedings of the 26th Annual International Conference on Machine Learning (ICML '09).

See Also

listToMatrix

Examples

```
# Least square loss
set.seed(42)
X <- simuBlockGaussian(50, 12, 5, 0.7)
y <- X[, c(2, 7, 12)] %*% c(2, 2, -2) + rnorm(50, 0, 0.5)
var <- c(1:60, 1:8, 7:15)
group <- c(rep(1:12, each = 5), rep(13, 8), rep(14, 9))
res <- overlapgglasso(X, y, var, group)

# Logistic loss
y <- 2 * (rowSums(X[, 1:4]) > 0) - 1
var <- c(1:60, 1:8, 7:15)
group <- c(rep(1:12, each = 5), rep(13, 8), rep(14, 9))
res <- overlapgglasso(X, y, var, group, loss = "logit")
```

---

partialFtest *Partial F-test*

Description

Perform a partial F-test

Usage

```
partialFtest(X, y, varToTest)
```

Arguments

X	design matrix of size n*p
y	response vector of length n
varToTest	vector containing the index of the column of X to test

Details

y = X * beta + epsilon

null hypothesis: beta[varToTest] = 0 alternative hypothesis: it exists an index k in varToTest such that beta[k] != 0

The test statistic is based on a full and a reduced model. full: y = X * beta + epsilon reduced: y = X * beta[-varToTest] + epsilon

Value

a vector of the same length as varToTest containing the p-values of the test.

See Also

Ftest

`plot.cv.MLGL` *Plot the cross-validation obtained from* `cv.MLGL` *function*

Description

Plot the cross-validation obtained from `cv.MLGL` function

Usage

```
## S3 method for class 'cv.MLGL'
plot(x, log.lambda = FALSE, ...)
```

Arguments

`x`	`cv.MLGL` object
`log.lambda`	If TRUE, use log(lambda) instead of lambda in abscissa
`...`	Other parameters for plot function

See Also

cv.MLGL

Examples

```
set.seed(42)
# Simulate gaussian data with block-diagonal variance matrix containing 12 blocks of size 5
X <- simuBlockGaussian(50, 12, 5, 0.7)
# Generate a response variable
y <- X[, c(2, 7, 12)] %*% c(2, 2, -2) + rnorm(50, 0, 0.5)
# Apply cv.MLGL method
res <- cv.MLGL(X, y)
# Plot the cv error curve
plot(res)
```

`plot.fullProcess` *Plot the path obtained from* `fullProcess` *function*

Description

Plot the path obtained from `fullProcess` function

Usage

```
## S3 method for class 'fullProcess'
plot(
  x,
  log.lambda = FALSE,
  lambda.lines = FALSE,
  lambda.opt = c("min", "max", "both"),
  ...
)
```

Arguments

`x`	`fullProcess` object
`log.lambda`	If TRUE, use log(lambda) instead of lambda in abscissa
`lambda.lines`	If TRUE, add vertical lines at lambda values
`lambda.opt`	If there is several optimal lambdas, which one to print "min", "max" or "both"
`...`	Other parameters for plot function

See Also

fullProcess

Examples

```
set.seed(42)
# Simulate gaussian data with block-diagonal variance matrix containing 12 blocks of size 5
X <- simuBlockGaussian(50, 12, 5, 0.7)
# Generate a response variable
y <- X[, c(2, 7, 12)] %*% c(2, 2, -2) + rnorm(50, 0, 0.5)
# Apply MLGL method
res <- fullProcess(X, y)
# Plot the solution path
plot(res)
```

plot.HMT *Plot the path obtained from* HMT *function*

Description

Plot the path obtained from HMT function

Usage

```
## S3 method for class 'HMT'
plot(
  x,
  log.lambda = FALSE,
  lambda.lines = FALSE,
  lambda.opt = c("min", "max", "both"),
  ...
)
```

Arguments

x	fullProcess object
log.lambda	If TRUE, use log(lambda) instead of lambda in abscissa
lambda.lines	If TRUE, add vertical lines at lambda values
lambda.opt	If there is several optimal lambdas, which one to print "min", "max" or "both"
...	Other parameters for plot function

See Also

HMT

Examples

```
set.seed(42)
# Simulate gaussian data with block-diagonal variance matrix containing 12 blocks of size 5
X <- simuBlockGaussian(50, 12, 5, 0.7)
# Generate a response variable
y <- X[, c(2, 7, 12)] %*% c(2, 2, -2) + rnorm(50, 0, 0.5)
# Apply MLGL method
res <- MLGL(X, y)

out <- HMT(res, X, y)
plot(out)
```

`plot.MLGL` *Plot the path obtained from* `MLGL` *function*

Description

Plot the path obtained from `MLGL` function

Usage

```
## S3 method for class 'MLGL'
plot(x, log.lambda = FALSE, lambda.lines = FALSE, ...)
```

Arguments

`x`	`MLGL` object
`log.lambda`	If TRUE, use log(lambda) instead of lambda in abscissa
`lambda.lines`	if TRUE, add vertical lines at lambda values
`...`	Other parameters for plot function

See Also

MLGL

Examples

```
# Simulate gaussian data with block-diagonal variance matrix containing 12 blocks of size 5
set.seed(42)
X <- simuBlockGaussian(50, 12, 5, 0.7)
# Generate a response variable
y <- X[, c(2, 7, 12)] %*% c(2, 2, -2) + rnorm(50, 0, 0.5)
# Apply MLGL method
res <- MLGL(X, y)
# Plot the solution path
plot(res)
```

`plot.stability.MLGL` *Plot the stability path obtained from* `stability.MLGL` *function*

Description

Plot the stability path obtained from `stability.MLGL` function

Usage

```
## S3 method for class 'stability.MLGL'
plot(x, log.lambda = FALSE, threshold = 0.75, ...)
```

Arguments

x	stability.MLGL object
log.lambda	If TRUE, use log(lambda) instead of lambda in abscissa
threshold	Threshold for selection frequency
...	Other parameters for plot function

Value

A list containing:

var Index of selected variables for the given threshold.

group Index of the associated group.

threshold Value of threshold

See Also

stability.MLGL

Examples

```
set.seed(42)
# Simulate gaussian data with block-diagonal variance matrix containing 12 blocks of size 5
X <- simuBlockGaussian(50, 12, 5, 0.7)

# Generate a response variable
y <- X[, c(2, 7, 12)] %*% c(2, 2, -2) + rnorm(50, 0, 0.5)

# Apply stability.MLGL method
res <- stability.MLGL(X, y)
selected <- plot(res)
print(selected)
```

---

predict.cv.MLGL *Predict fitted values from a cv.MLGL object*

Description

Predict fitted values from a cv.MLGL object

Usage

```
## S3 method for class 'cv.MLGL'
predict(
  object,
  newx = NULL,
  s = c("lambda.1se", "lambda.min"),
  type = c("fit", "coefficients"),
  ...
)
```

Arguments

object	cv.MLGL object
newx	matrix with new individuals for prediction. If type="coefficients", the parameter has to be NULL
s	Either "lambda.1se" or "lambda.min"
type	if "fit", return the fitted values for each values of s, if "coefficients", return the estimated coefficients for each s
...	Not used. Other arguments to predict.

Value

A matrix with fitted values or estimated coefficients for given values of s.

Author(s)

Quentin Grimonprez

See Also

cv.MLGL

---

predict.MLGL *Predict fitted values from a MLGL object*

Description

Predict fitted values from a MLGL object

Usage

```
## S3 method for class 'MLGL'
predict(object, newx = NULL, s = NULL, type = c("fit", "coefficients"), ...)
```

Arguments

object	MLGL object
newx	matrix with new individuals for prediction. If type="coefficients", the parameter has to be NULL
s	values of lambda. If NULL, use values from object
type	if "fit", return the fitted values for each values of s, if "coefficients", return the estimated coefficients for each s
...	Not used. Other arguments to predict.

Value

A matrix with fitted values or estimated coefficients for given values of s.

Author(s)

original code from **gglasso** package Author: Yi Yang <yiyang@umn.edu>, Hui Zou <hzou@stat.umn.edu>

function inspired from predict function from gglasso package by Yi Yang and Hui Zou.

See Also

MLGL

Examples

```
X <- simuBlockGaussian(n = 50, nBlock = 12, sizeBlock = 5, rho = 0.7)
y <- drop(X[, c(2, 7, 12)] %*% c(2, 2, -1)) + rnorm(50, 0, 0.5)

m1 <- MLGL(X, y, loss = "ls")
predict(m1, newx = X)
predict(m1, s = 3, newx = X)
predict(m1, s = 1:3, newx = X)
```

---

print.fullProcess *Print Values*

Description

Print a fullProcess object

Usage

```
## S3 method for class 'fullProcess'
print(x, ...)
```

Arguments

x	fullProcess object
...	Not used.

See Also

fullProcess summary.fullProcess

Examples

```
set.seed(42)
# Simulate gaussian data with block-diagonal variance matrix containing 12 blocks of size 5
X <- simuBlockGaussian(50, 12, 5, 0.7)
# Generate a response variable
y <- X[, c(2, 7, 12)] %*% c(2, 2, -2) + rnorm(50, 0, 0.5)
# Apply MLGL method
res <- fullProcess(X, y)
print(res)
```

---

print.HMT *Print Values*

Description

Print a HMT object

Usage

```
## S3 method for class 'HMT'
print(x, ...)
```

Arguments

x	HMT object
...	Not used.

See Also

HMT summary.HMT

Examples

```
set.seed(42)
# Simulate gaussian data with block-diagonal variance matrix containing 12 blocks of size 5
X <- simuBlockGaussian(50, 12, 5, 0.7)
# Generate a response variable
y <- X[, c(2, 7, 12)] %*% c(2, 2, -2) + rnorm(50, 0, 0.5)
# Apply MLGL method
res <- MLGL(X, y)
out <- HMT(res, X, y)
print(out)
```

`print.MLGL` *Print Values*

Description

Print a MLGL object

Usage

```
## S3 method for class 'MLGL'
print(x, ...)
```

Arguments

x	MLGL object
...	Not used.

See Also

MLGL summary.MLGL

Examples

```
set.seed(42)
# Simulate gaussian data with block-diagonal variance matrix containing 12 blocks of size 5
X <- simuBlockGaussian(50, 12, 5, 0.7)
# Generate a response variable
y <- X[, c(2, 7, 12)] %*% c(2, 2, -2) + rnorm(50, 0, 0.5)
# Apply MLGL method
res <- MLGL(X, y)
print(res)
```

selFDR *Selection from hierarchical testing with FDR control*

Description

Select groups from hierarchical testing procedure with FDR control (hierarchicalFDR)

Usage

```
selFDR(out, alpha = 0.05, global = TRUE, outer = TRUE)
```

Arguments

out	output of hierarchicalFDR function
alpha	control level for test
global	if FALSE the provided alpha is the desired level control for each family.
outer	if TRUE, the FDR is controlled only on outer node (rejected groups without rejected children). If FALSE, it is controlled on the full tree.

Details

See the reference for mode details about the method.

If each family is controlled at a level alpha, we have the following control: FDR control of full tree: alpha * delta * 2 (delta = 1.44) FDR control of outer node: alpha * L * delta * 2 (delta = 1.44)

Value

a list containing:

toSel vector of boolean. TRUE if the group is selected

groupId Names of groups

local.alpha control level for each family of hypothesis

global.alpha control level for the tree (full tree or outer node)

References

Yekutieli, Daniel. "Hierarchical False Discovery Rate-Controlling Methodology." Journal of the American Statistical Association 103.481 (2008): 309-16.

See Also

hierarchicalFDR

Examples

```
set.seed(42)
X <- simuBlockGaussian(50, 12, 5, 0.7)
y <- X[, c(2, 7, 12)] %*% c(2, 2, -2) + rnorm(50, 0, 0.5)
res <- MLGL(X, y)
test <- hierarchicalFDR(X, y, res$group[[20]], res$var[[20]])
sel <- selFDR(test, alpha = 0.05)
```

---

selFWER *Selection from hierarchical testing with FWER control*

Description

Select groups from hierarchical testing procedure with FWER control (hierarchicalFWER)

Usage

```
selFWER(out, alpha = 0.05)
```

Arguments

out	output of hierarchicalFWER function
alpha	control level for test

Details

Only outer nodes (rejected groups without rejected children) are returned as TRUE.

Value

a list containing:

toSel vector of boolean. TRUE if the group is selected

groupId Names of groups

References

Meinshausen, Nicolai. "Hierarchical Testing of Variable Importance." Biometrika 95.2 (2008): 265-78.

See Also

hierarchicalFWER

Examples

```
set.seed(42)
X <- simuBlockGaussian(50, 12, 5, 0.7)
y <- X[, c(2, 7, 12)] %*% c(2, 2, -2) + rnorm(50, 0, 0.5)
res <- MLGL(X, y)
test <- hierarchicalFWER(X, y, res$group[[20]], res$var[[20]])
sel <- selFWER(test, alpha = 0.05)
```

---

simuBlockGaussian *Simulate multivariate Gaussian samples with block diagonal variance matrix*

Description

Simulate n samples from a gaussian multivariate law with 0 vector mean and block diagonal variance matrix with diagonal 1 and block of rho.

Usage

```
simuBlockGaussian(n, nBlock, sizeBlock, rho)
```

Arguments

n	number of samples to simulate
nBlock	number of blocks
sizeBlock	size of blocks
rho	correlation within each block

Value

a matrix of size n * (nBlock * sizeBlock) containing the samples

Author(s)

Quentin Grimonprez

Examples

```
X <- simuBlockGaussian(50, 12, 5, 0.7)
```

stability.MLGL *Stability Selection for Multi-Layer Group-lasso*

Description

Stability selection for MLGL

Usage

```
stability.MLGL(
  X,
  y,
  B = 50,
  fraction = 0.5,
  hc = NULL,
  lambda = NULL,
  weightLevel = NULL,
  weightSizeGroup = NULL,
  loss = c("ls", "logit"),
  intercept = TRUE,
  verbose = FALSE,
  ...
)
```

Arguments

X	matrix of size n*p
y	vector of size n. If loss = "logit", elements of y must be in {-1,1}
B	number of bootstrap sample
fraction	Fraction of data used at each of the B sub-samples
hc	output of hclust function. If not provided, hclust is run with ward.D2 method
lambda	lambda values for group lasso. If not provided, the function generates its own values of lambda
weightLevel	a vector of size p for each level of the hierarchy. A zero indicates that the level will be ignored. If not provided, use 1/(height between 2 successive levels)
weightSizeGroup	a vector
loss	a character string specifying the loss function to use, valid options are: "ls" least squares loss (regression) and "logit" logistic loss (classification)
intercept	should an intercept be included in the model ?
verbose	print some information
...	Others parameters for gglasso function

Details

Hierarchical clustering is performed with all the variables. Then, the partitions from the different levels of the hierarchy are used in the different runs of MLGL for estimating the probability of selection of each group.

Value

a stability.MLGL object containing:

lambda sequence of `lambda`.

B Number of bootstrap samples.

stability A matrix of size length(lambda)*number of groups containing the probability of selection of each group

var vector containing the index of covariates

group vector containing the index of associated groups of covariates

time computation time

Author(s)

Quentin Grimonprez

References

Meinshausen and Buhlmann (2010). Stability selection. Journal of the Royal Statistical Society: Series B (Statistical Methodology) 72.4, p. 417-473.

See Also

cv.MLGL, MLGL

Examples

```
set.seed(42)
# Simulate gaussian data with block-diagonal variance matrix containing 12 blocks of size 5
X <- simuBlockGaussian(50, 12, 5, 0.7)

# Generate a response variable
y <- X[, c(2, 7, 12)] %*% c(2, 2, -2) + rnorm(50, 0, 0.5)

# Apply stability.MLGL method
res <- stability.MLGL(X, y)
```

summary.fullProcess *Object Summaries*

Description

Summary of a fullProcess object

Usage

```
## S3 method for class 'fullProcess'
summary(object, ...)
```

Arguments

object	fullProcess object
...	Not used.

See Also

fullProcess print.fullProcess

Examples

```
set.seed(42)
# Simulate gaussian data with block-diagonal variance matrix containing 12 blocks of size 5
X <- simuBlockGaussian(50, 12, 5, 0.7)
# Generate a response variable
y <- X[, c(2, 7, 12)] %*% c(2, 2, -2) + rnorm(50, 0, 0.5)
# Apply MLGL method
res <- fullProcess(X, y)
summary(res)
```

summary.HMT *Object Summaries*

Description

Summary of a HMT object

Usage

```
## S3 method for class 'HMT'
summary(object, ...)
```

Arguments

object	HMT object
...	Not used.

See Also

HMT print.HMT

Examples

```
set.seed(42)
# Simulate gaussian data with block-diagonal variance matrix containing 12 blocks of size 5
X <- simuBlockGaussian(50, 12, 5, 0.7)
# Generate a response variable
y <- X[, c(2, 7, 12)] %*% c(2, 2, -2) + rnorm(50, 0, 0.5)
# Apply MLGL method
res <- MLGL(X, y)
out <- HMT(res, X, y)
summary(out)
```

---

summary.MLGL *Object Summaries*

Description

Summary of a MLGL object

Usage

```
## S3 method for class 'MLGL'
summary(object, ...)
```

Arguments

object	MLGL object
...	Not used.

See Also

MLGL print.MLGL

Examples

```
set.seed(42)
# Simulate gaussian data with block-diagonal variance matrix containing 12 blocks of size 5
X <- simuBlockGaussian(50, 12, 5, 0.7)
# Generate a response variable
y <- X[, c(2, 7, 12)] %*% c(2, 2, -2) + rnorm(50, 0, 0.5)
# Apply MLGL method
res <- MLGL(X, y)
summary(res)
```

`uniqueGroupHclust` *Find all unique groups in* `hclust` *results*

Description

Find all unique groups in `hclust` results

Usage

```
uniqueGroupHclust(hc)
```

Arguments

hc	output of `hclust` function

Value

A list containing:

indexGroup Vector containing the index of variables.

varGroup Vector containing the index of the group of each variable.

Author(s)

Quentin Grimonprez

Examples

```
hc <- hclust(dist(USArrests), "average")
res <- uniqueGroupHclust(hc)
```

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