

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. (2018) <<https://hal.inria.fr/hal-01857242>>).

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

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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

"MLGL: An R package implementing correlated variable selection by hierarchical clustering and group-Lasso.", Quentin Grimonprez, Samuel Blanck, Alain Celisse, Guillemette Marot (2018). <https://hal.inria.fr/hal-01857242>

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	<i>Hierarchical Clustering with distance matrix computed using bootstrap replicates</i>
-----------------	---

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	<i>Get coefficients from a cv.MLGL object</i>
--------------	---

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 Grimouprez

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 <code>hclust</code>
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,
  nolds = 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
nolds	number of folds
lambda	lambda values for group lasso. If not provided, the function generates its own values of lambda

hc	output of <code>hclust</code> function. If not provided, <code>hclust</code> 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 informations
...	Others parameters for <code>cv.gglasso</code> 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.

cvstd estimate of standard error of cvm

cvupper upper curve = cvm+cvstd

cvlower lower curve = cvm-cvstd

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

$y = X * \text{beta} + \text{epsilon}$

null hypothesis: $\text{beta}[\text{varToTest}] = 0$ alternative hypothesis: it exists an index k in varToTest such that $\text{beta}[k] \neq 0$

The test statistic is based on a full and a reduced model. full: $y = X * \text{beta}[\text{varToTest}] + \text{epsilon}$
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", "mc-quitty", "ward.D", "ward.D2", "centroid", "median".

<code>fractionSampleMLGL</code>	a real between 0 and 1: the fraction of individuals to use in the sample for MLGL (see Details).
<code>BHclust</code>	number of replicates for computing the distance matrix for the hierarchical clustering tree
<code>nCore</code>	number of cores used for distance computation. Use all cores by default.
<code>addRoot</code>	If TRUE, add a common root containing all the groups
<code>Shaffer</code>	If TRUE, a Shaffer correction is performed (only if control = "FWER")
<code>formula</code>	an object of class "formula" (or one that can be coerced to that class): a symbolic description of the model to be fitted.
<code>data</code>	an optional data frame, list or environment (or object coercible by <code>as.data.frame</code> 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](#), [selfFDR](#), [selfFWER](#)

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	<i>Hierarchical testing with FDR control</i>
-----------------	--

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 the [selfFDR](#) 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].

<code>test</code>	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
<code>Shaffer</code>	boolean, if TRUE, a Shaffer correction is performed
<code>addRoot</code>	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 the [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 Apply Hierarchical Multiple Testing procedure on a [MLGL](#) object

Description

Hierarchical Multiple Testing procedure

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

<code>res</code>	MLGL object
<code>X</code>	matrix of size n*p
<code>y</code>	vector of size n.
<code>control</code>	either "FDR" or "FWER"
<code>alpha</code>	control level for testing procedure
<code>test</code>	test used in the testing procedure. Default is partialFtest
<code>addRoot</code>	If TRUE, add a common root containing all the groups
<code>Shaffer</code>	If TRUE, a Shaffer correction is performed (only if control = "FWER")
<code>...</code>	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 [selfFWER](#) or [selfFDR](#) functions.
lambda lambda path
nGroup Number of groups before testing
nSelectedGroup Numer of groups after testing

See Also

[hierarchicalFWER](#) [hierarchicalFDR](#) [selfFWER](#) [selfFDR](#)

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
selfFWER(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](#), [overlapglasso](#)

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

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

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)
```

overlappglasso

Group-lasso with overlapping groups

Description

Group-lasso with overlapping groups

Usage

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

Arguments

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

$$y = X * \text{beta} + \text{epsilon}$$

null hypothesis: $\text{beta}[\text{varToTest}] = 0$ alternative hypothesis: it exists an index k in varToTest such that $\text{beta}[k] \neq 0$

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

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

<code>x</code>	cv.MLGL object
<code>log.lambda</code>	If TRUE, use <code>log(lambda)</code> instead of <code>lambda</code> in abscissa
<code>...</code>	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

<code>x</code>	fullProcess object
<code>log.lambda</code>	If TRUE, use <code>log(lambda)</code> instead of <code>lambda</code> in abscissa
<code>lambda.lines</code>	If TRUE, add vertical lines at <code>lambda</code> values
<code>lambda.opt</code>	If there is several optimal lambdas, which one to print "min", "max" or "both"
<code>...</code>	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 Print a [fullProcess](#) object*

Description

Print Values

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 Print a [HMT](#) object

Description

Print Values

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 Print a [MLGL](#) object

Description

Print Values

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

<code>out</code>	output of hierarchicalFDR function
<code>alpha</code>	control level for test
<code>global</code>	if FALSE the provided alpha is the desired level control for each family.
<code>outer</code>	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 more 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	<i>Simulate multivariate Gaussian samples with block diagonal variance matrix</i>
-------------------	---

Description

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

Usage

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

Arguments

<code>n</code>	number of samples to simulate
<code>nBlock</code>	number of blocks
<code>sizeBlock</code>	size of blocks
<code>rho</code>	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 informations
...	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 $\text{length}(\text{lambda}) \times \text{number of groups}$ 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 Bühlmann (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 Summary of a [fullProcess](#) object*

Description

Object Summaries
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 Summary of a [HMT](#) object*

Description

Object Summaries
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 Summary of a [MLGL](#) object

Description

Object Summaries
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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