Package 'TRexSelector'

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Title T-Rex Selector: High-Dimensional Variable Selection & FDR Control

Version 0.0.1

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Description Performs fast variable selection in high-dimensional settings while controlling the false discovery rate (FDR) at a user-defined target level. The package is based on the paper Machkour, Muma, and Palomar (2021) <arXiv:2110.06048>.

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URL https://github.com/jasinmachkour/trex, https://arxiv.org/abs/2110.06048

BugReports https://github.com/jasinmachkour/trex/issues

License GPL (>= 3)

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R topics documented:

`add_dummies` *Add dummy predictors to the original predictor matrix*

Description

Sample num_dummies dummy predictors from the univariate standard normal distribution and append them to the predictor matrix X.

Usage

```
add_dummies(X, num_dummies)
```

Arguments

`X`	Real valued predictor matrix.
`num_dummies`	Number of dummies that are appended to the predictor matrix.

Value

Enlarged predictor matrix.

Examples

```
set.seed(123)
n <- 50
p <- 100
X <- matrix(stats::rnorm(n * p), nrow = n, ncol = p)
add_dummies(X = X, num_dummies = p)
```

`add_dummies_GVS` *Add dummy predictors to the original predictor matrix, as required by the T-Rex+GVS selector*

Description

Generate num_dummies dummy predictors as required for the T-Rex+GVS selector and append them to the predictor matrix X.

Usage

```
add_dummies_GVS(X, num_dummies, corr_max = 0.5)
```

Arguments

`X`	Real valued predictor matrix.
`num_dummies`	Number of dummies that are appended to the predictor matrix. Has to be a multiple of the number of original variables.
`corr_max`	Maximum allowed correlation between any two predictors from different clusters.

Value

Enlarged predictor matrix for the T-Rex+GVS selector.

Examples

```
set.seed(123)
n <- 50
p <- 100
X <- matrix(stats::rnorm(n * p), nrow = n, ncol = p)
add_dummies_GVS(X = X, num_dummies = p)
```

`FDP` *False discovery proportion (FDP)*

Description

Computes the FDP based on the estimated and the true regression coefficient vectors.

Usage

```
FDP(beta_hat, beta, eps = .Machine$double.eps)
```

Arguments

beta_hat	Estimated regression coefficient vector.
beta	True regression coefficient vector.
eps	Numerical zero.

Value

False discovery proportion (FDP).

Examples

```
data("Gauss_data")
X <- Gauss_data$X
y <- c(Gauss_data$y)
beta <- Gauss_data$beta

set.seed(1234)
res <- trex(X, y)
beta_hat <- res$selected_var

FDP(beta_hat = beta_hat, beta = beta)
```

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fdp_hat *Computes the conservative FDP estimate of the T-Rex selector*

Description

Computes the conservative FDP estimate of the T-Rex selector

Usage

```
fdp_hat(V, Phi, Phi_prime, T_stop, num_dummies, eps = .Machine$double.eps)
```

Arguments

V	Voting level grid.
Phi	Vector of relative occurrences.
Phi_prime	Vector of deflated relative occurrences.
T_stop	Number of included dummies after which the random experiments (i.e., forward selection processes) are stopped.
num_dummies	Number of dummies.
eps	Numerical zero.

Value

Vector of conservative FDP estimates for each value of the voting level grid.

Gauss_data *Toy data generated from a Gaussian linear model*

Description

A data set containing a predictor matrix X with n = 50 observations and p = 100 variables (predictors), and a sparse parameter vector beta with associated support vector.

Usage

```
Gauss_data
```

Format

A list containing a matrix X and vectors y, beta, and support:

X Predictor matrix, n = 50, p = 100.

y Response vector.

beta Parameter vector.

support Support vector.

Examples

```
# Generated as follows:
set.seed(789)
n <- 50
p <- 100
X <- matrix(stats::rnorm(n * p), nrow = n, ncol = p)
beta <- c(rep(5, times = 3), rep(0, times = 97))
support <- beta > 0
y <- X %*% beta + stats::rnorm(n)
Gauss_data <- list(
  X = X,
  y = y,
  beta = beta,
  support = support
)
```

lm_dummy *Perform one random experiment*

Description

Run one random experiment of the T-Rex selector, i.e., generates dummies, appends them to the predictor matrix, and runs the forward selection algorithm until it is terminated after T_stop dummies have been selected.

Usage

```
lm_dummy(
  X,
  y,
  model_tlars,
  T_stop = 1,
  num_dummies = ncol(X),
  method = "trex",
  type = "lar",
  corr_max = 0.5,
  lambda_2_lars = NULL,
  early_stop = TRUE,
  verbose = TRUE,
  intercept = FALSE,
  standardize = TRUE
)
```

Arguments

X	Real valued predictor matrix.
y	Response vector.
model_tlars	Object of the class tlars_cpp. It contains all state variables of the previous T-LARS step (necessary for warm-starts, i.e., restarting the forward selection process exactly where it was previously terminated).
T_stop	Number of included dummies after which the random experiments (i.e., forward selection processes) are stopped.
num_dummies	Number of dummies that are appended to the predictor matrix.
method	'trex' for the T-Rex selector and 'trex+GVS' for the T-Rex+GVS selector
type	'lar' for 'LARS' and 'lasso' for Lasso.
corr_max	Maximum allowed correlation between any two predictors from different clusters.
lambda_2_lars	lambda_2-value for LARS-based Elastic Net.
early_stop	Logical. If TRUE, then the forward selection process is stopped after T_stop dummies have been included. Otherwise the entire solution path is computed.
verbose	Logical. If TRUE progress in computations is shown when performing T-LARS steps on the created model.
intercept	Logical. If TRUE an intercept is included.
standardize	Logical. If TRUE the predictors are standardized and the response is centered.

Value

Object of the class tlars_cpp.

Examples

```
set.seed(123)
eps <- .Machine$double.eps
n <- 75
p <- 100
X <- matrix(stats::rnorm(n * p), nrow = n, ncol = p)
beta <- c(rep(3, times = 3), rep(0, times = 97))
y <- X %*% beta + rnorm(n)
res <- lm_dummy(X = X, y = y, T_stop = 1, num_dummies = 5 * p)
beta_hat <- res$get_beta()[seq(p)]
support <- abs(beta_hat) > eps
support
```

Phi_prime_fun *Computes the Deflated Relative Occurrences*

Description

Computes the matrix of deflated relative occurrences for all variables (i.e., j = 1,..., p) and for T = 1, ..., T_stop.

Usage

```
Phi_prime_fun(
  p,
  T_stop,
  num_dummies,
  phi_T_mat,
  Phi,
  eps = .Machine$double.eps
)
```

Arguments

p	Number of candidate variables.
T_stop	Number of included dummies after which the random experiments (i.e., forward selection processes) are stopped.
num_dummies	Number of dummies
phi_T_mat	Matrix of relative occurrences for all variables (i.e., j = 1,..., p) and for T = 1, ..., T_stop.
Phi	Vector of relative occurrences for all variables (i.e., j = 1,..., p) at T = T_stop.
eps	Numerical zero.

Value

Matrix of deflated relative occurrences for all variables (i.e., j = 1,..., p) and for T = 1, ..., T_stop.

`random_experiments` *Run K random experiments*

Description

Run K random experiments and compute the matrix of relative occurrences for all variables and all numbers of included variables before stopping.

Usage

```
random_experiments(
  X,
  y,
  K = 20,
  T_stop = 1,
  num_dummies = ncol(X),
  method = "trex",
  type = "lar",
  corr_max = 0.5,
  lambda_2_lars = NULL,
  early_stop = TRUE,
  lars_state_list,
  verbose = TRUE,
  intercept = FALSE,
  standardize = TRUE,
  parallel_process = FALSE,
  parallel_max_cores = min(K, max(1, parallel::detectCores(logical = FALSE))),
  seed = NULL,
  eps = .Machine$double.eps
)
```

Arguments

`X`	Real valued predictor matrix.
`y`	Response vector.
`K`	Number of random experiments.
`T_stop`	Number of included dummies after which the random experiments (i.e., forward selection processes) are stopped.
`num_dummies`	Number of dummies that are appended to the predictor matrix.
`method`	'trex' for the T-Rex selector and 'trex+GVS' for the T-Rex+GVS selector
`type`	'lar' for 'LARS' and 'lasso' for Lasso.
`corr_max`	Maximum allowed correlation between any two predictors from different clusters.
`lambda_2_lars`	lambda_2-value for LARS-based Elastic Net.

early_stop	Logical. If TRUE, then the forward selection process is stopped after T_stop dummies have been included. Otherwise the entire solution path is computed.
lars_state_list	If parallel_process = TRUE: List of state variables of the previous T-LARS steps of the K random experiments (necessary for warm-starts, i.e., restarting the forward selection process exactly where it was previously terminated). If parallel_process = FALSE: List of objects of the class tlars_cpp associated with the K random experiments (necessary for warm-starts, i.e., restarting the forward selection process exactly where it was previously terminated).
verbose	Logical. If TRUE progress in computations is shown.
intercept	Logical. If TRUE an intercept is included.
standardize	Logical. If TRUE the predictors are standardized and the response is centered.
parallel_process	Logical. If TRUE random experiments are executed in parallel.
parallel_max_cores	Maximum number of cores to be used for parallel processing (default: minimumNumber of random experiments K, number of physical cores).
seed	Seed for random number generator (ignored if parallel_process = FALSE).
eps	Numerical zero.

Value

List containing the results of the K random experiments.

Examples

```
set.seed(123)
data("Gauss_data")
X <- Gauss_data$X
y <- c(Gauss_data$y)
res <- random_experiments(X = X, y = y)
relative_occurrences_matrix <- res$phi_T_mat
relative_occurrences_matrix
```

---

select_var_fun *Compute set of selected variables*

Description

Computes the set of selected variables and returns the estimated support vector for the T-Rex selector.

Usage

```
select_var_fun(p, tFDR, T_stop, FDP_hat_mat, Phi_mat, V)
```

Arguments

p	Number of candidate variables.
tFDR	Target FDR level (between 0 and 1, i.e., 0% and 100%).
T_stop	Number of included dummies after which the random experiments (i.e., forward selection processes) are stopped.
FDP_hat_mat	Matrix whose rows are the vectors of conservative FDP estimates for each value of the voting level grid.
Phi_mat	Matrix of relative occurrences as determined by the T-Rex calibration algorithm.
V	Voting level grid.

Value

Estimated support vector.

TPP *True positive proportion (TPP)*

Description

Computes the TPP based on the estimated and the true regression coefficient vectors.

Usage

```
TPP(beta_hat, beta, eps = .Machine$double.eps)
```

Arguments

beta_hat	Estimated regression coefficient vector.
beta	True regression coefficient vector.
eps	Numerical zero.

Value

True positive proportion (TPP).

Examples

```
data("Gauss_data")
X <- Gauss_data$X
y <- c(Gauss_data$y)
beta <- Gauss_data$beta

set.seed(1234)
res <- trex(X, y)
beta_hat <- res$selected_var

TPP(beta_hat = beta_hat, beta = beta)
```

`trex` *Run the T-Rex selector*

Description

Run the T-Rex selector The T-Rex selector performs fast variable selection in high-dimensional settings while controlling the false discovery rate (FDR) at a user-defined target level.

Usage

```
trex(
  X,
  y,
  tFDR = 0.2,
  K = 20,
  max_num_dummies = 10,
  max_T_stop = TRUE,
  method = "trex",
  type = "lar",
  corr_max = 0.5,
  lambda_2_lars = NULL,
  parallel_process = FALSE,
  parallel_max_cores = min(K, max(1, parallel::detectCores(logical = FALSE))),
  seed = NULL,
  eps = .Machine$double.eps,
  verbose = TRUE
)
```

Arguments

`X`	Real valued predictor matrix.
`y`	Response vector.
`tFDR`	Target FDR level (between 0 and 1, i.e., 0% and 100%).
`K`	Number of random experiments.
`max_num_dummies`	Integer factor determining the maximum number of dummies as a multiple of the number of original variables p (i.e., num_dummies = max_num_dummies * p).
`max_T_stop`	If TRUE the maximum number of dummies that can be included before stopping is set to ceiling(n / 2), where n is the number of data points/observations.
`method`	'trex' for the T-Rex selector and 'trex+GVS' for the T-Rex+GVS selector.
`type`	'lar' for 'LARS' and 'lasso' for Lasso.
`corr_max`	Maximum allowed correlation between any two predictors from different clusters.

lambda_2_lars	lambda_2-value for LARS-based Elastic Net.
parallel_process	Logical. If TRUE random experiments are executed in parallel.
parallel_max_cores	Maximum number of cores to be used for parallel processing (default: minimumNumber of random experiments K, number of physical cores).
seed	Seed for random number generator (ignored if parallel_process = FALSE).
eps	Numerical zero.
verbose	Logical. If TRUE progress in computations is shown.

Value

A list containing the estimated support vector and additional information, including the number of used dummies and the number of included dummies before stopping.

Examples

```
data("Gauss_data")
X <- Gauss_data$X
y <- c(Gauss_data$y)
set.seed(1234)
res <- trex(X = X, y = y)
selected_var <- res$selected_var
selected_var
```

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