

# Package ‘stepSplitReg’

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**Type** Package

**Title** Stepwise Split Regularized Regression

**Version** 1.0.3

**Date** 2022-11-21

**Description** Functions to perform stepwise split regularized regression. The approach first uses a stepwise algorithm to split the variables into the models with a goodness of fit criterion, and then regularization is applied to each model. The weights of the models in the ensemble are determined based on a criterion selected by the user.

**License** GPL (>= 2)

**Biarch** true

**Imports** Rcpp (>= 1.0.7), SplitGLM, npls

**Suggests** testthat, mvnfast

**LinkingTo** Rcpp, RcppArmadillo

**RoxygenNote** 7.1.1

**NeedsCompilation** yes

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coef.cv.stepSplitReg *Coefficients for cv.stepSplitReg Object*

---

### Description

coef.cv.stepSplitReg returns the coefficients for a cv.stepSplitReg object.

### Usage

```
## S3 method for class 'cv.stepSplitReg'  
coef(object, group_index = NULL, ...)
```

### Arguments

object	An object of class cv.stepSplitReg
group_index	Groups included in the ensemble. Default setting includes all the groups.
...	Additional arguments for compatibility.

### Value

The coefficients for the cv.stepSplitReg object.

### Author(s)

Anthony-Alexander Christidis, <anthony.christidis@stat.ubc.ca>

### See Also

[cv.stepSplitReg](#)

### Examples

```
# Required Libraries  
library(mvnfast)  
  
# Setting the parameters  
p <- 100  
n <- 30  
n.test <- 500  
sparsity <- 0.2  
rho <- 0.5  
SNR <- 3  
  
# Generating the coefficient  
p.active <- floor(p*sparsity)  
a <- 4*log(n)/sqrt(n)  
neg.prob <- 0.2
```

```

nonzero.betas <- (-1)^(rbinom(p.active, 1, neg.prob))*(a + abs(rnorm(p.active)))

# Correlation structure
Sigma <- matrix(0, p, p)
Sigma[1:p.active, 1:p.active] <- rho
diag(Sigma) <- 1
true.beta <- c(nonzero.betas, rep(0, p - p.active))

# Computing the noise parameter for target SNR
sigma.epsilon <- as.numeric(sqrt((t(true.beta) %% Sigma %% true.beta)/SNR))

# Simulate some data
set.seed(1)
x.train <- mvnfast::rmvn(n, mu=rep(0,p), sigma=Sigma)
y.train <- 1 + x.train %% true.beta + rnorm(n=n, mean=0, sd=sigma.epsilon)
x.test <- mvnfast::rmvn(n.test, mu=rep(0,p), sigma=Sigma)
y.test <- 1 + x.test %% true.beta + rnorm(n.test, sd=sigma.epsilon)

# Stepwise Split Regularized Regression
step.out <- cv.stepSplitReg(x.train, y.train, n_models = c(2, 3), max_variables = NULL, keep = 4/4,
  model_criterion = c("F-test", "RSS")[1],
  stop_criterion = c("F-test", "pR2", "aR2", "R2", "Fixed")[1],
  stop_parameter = 0.05,
  shrinkage = TRUE, alpha = 4/4, include_intercept = TRUE,
  n_lambda = 50, tolerance = 1e-2, max_iter = 1e5, n_folds = 5,
  model_weights = c("Equal", "Proportional", "Stacking")[1],
  n_threads = 1)
step.coefficients <- coef(step.out, group_index = 1:step.out$n_models_optimal)
step.predictions <- predict(step.out, x.test, group_index = 1:step.out$n_models_optimal)
mspe.step <- mean((step.predictions-y.test)^2)/sigma.epsilon^2

```

---

coef.stepSplitReg

*Coefficients for stepSplitReg Object*


---

## Description

coef.stepSplitReg returns the coefficients for a stepSplitReg object.

## Usage

```

## S3 method for class 'stepSplitReg'
coef(object, group_index = NULL, ...)

```

## Arguments

object	An object of class stepSplitReg
group_index	Groups included in the ensemble. Default setting includes all the groups.
...	Additional arguments for compatibility.

**Value**

The coefficients for the stepSplitReg object.

**Author(s)**

Anthony-Alexander Christidis, <anthony.christidis@stat.ubc.ca>

**See Also**

[stepSplitReg](#)

**Examples**

```
# Required Libraries
library(mvnfast)

# Setting the parameters
p <- 100
n <- 30
n.test <- 1000
sparsity <- 0.2
rho <- 0.5
SNR <- 3

# Generating the coefficient
p.active <- floor(p*sparsity)
a <- 4*log(n)/sqrt(n)
neg.prob <- 0.2
nonzero.betas <- (-1)^(rbinom(p.active, 1, neg.prob))*(a + abs(rnorm(p.active)))

# Correlation structure
Sigma <- matrix(0, p, p)
Sigma[1:p.active, 1:p.active] <- rho
diag(Sigma) <- 1
true.beta <- c(nonzero.betas, rep(0, p - p.active))

# Computing the noise parameter for target SNR
sigma.epsilon <- as.numeric(sqrt((t(true.beta) %*% Sigma %*% true.beta)/SNR))

# Simulate some data
set.seed(1)
x.train <- mvnfast::rmvn(n, mu=rep(0,p), sigma=Sigma)
y.train <- 1 + x.train %*% true.beta + rnorm(n=n, mean=0, sd=sigma.epsilon)
x.test <- mvnfast::rmvn(n.test, mu=rep(0,p), sigma=Sigma)
y.test <- 1 + x.test %*% true.beta + rnorm(n.test, sd=sigma.epsilon)

# Stepwise Split Regularized Regression
step.out <- stepSplitReg(x.train, y.train, n_models = 3, max_variables = NULL, keep = 4/4,
  model_criterion = c("F-test", "RSS")[1],
  stop_criterion = c("F-test", "pR2", "aR2", "R2", "Fixed")[1],
  stop_parameter = 0.05,
  shrinkage = TRUE, alpha = 4/4, include_intercept = TRUE,
```

```

n_lambda = 50, tolerance = 1e-2, max_iter = 1e5, n_folds = 5,
model_weights = c("Equal", "Proportional", "Stacking")[1])
step.coefficients <- coef(step.out, group_index = 1:step.out$n_models)
step.predictions <- predict(step.out, x.test, group_index = 1:step.out$n_models)
mspe.step <- mean((step.predictions-y.test)^2)/sigma.epsilon^2

```

---

cv.stepSplitReg

*Cross Validation - Stepwise Split Regularized Regression*


---

## Description

cv.stepSplitReg performs the CV procedure for stepwise split regularized regression.

## Usage

```

cv.stepSplitReg(
  x,
  y,
  n_models = NULL,
  max_variables = NULL,
  keep = 1,
  model_criterion = c("F-test", "RSS")[1],
  stop_criterion = c("F-test", "pR2", "aR2", "R2", "Fixed")[1],
  stop_parameter = 0.05,
  shrinkage = TRUE,
  alpha = 3/4,
  include_intercept = TRUE,
  n_lambda = 100,
  tolerance = 0.001,
  max_iter = 1e+05,
  n_folds = 10,
  model_weights = c("Equal", "Proportional", "Stacking")[1],
  n_threads = 1
)

```

## Arguments

x	Design matrix.
y	Response vector.
n_models	Number of models into which the variables are split.
max_variables	Maximum number of variables that a model can contain.
keep	Proportion of models to keep based on their individual cross-validated errors. Default is 1.
model_criterion	Criterion for adding a variable to a model. Must be one of c("F-test", "RSS"). Default is "F-test".

stop_criterion	Criterion for determining when a model is saturated. Must be one of c("F-test", "pR2", "aR2", "R2", "Fixed"). Default is "F-test".
stop_parameter	Parameter value for the stopping criterion. Default is 0.05 for "F-test".
shrinkage	TRUE or FALSE parameter for shrinkage of the final models. Default is TRUE.
alpha	Elastic net mixing parameter for model shrinkage. Default is 3/4.
include_intercept	TRUE or FALSE parameter for the inclusion of an intercept term.
n_lambda	Number of candidates for the sparsity penalty parameter. Default is 100.
tolerance	Convergence criteria for the coefficients. Default is 1e-3.
max_iter	Maximum number of iterations in the algorithm. Default is 1e5.
n_folds	Number of cross-validation folds. Default is 10.
model_weights	Criterion to determine the weights of the model for prediction. Must be one of c("Equal", "Proportional", "Stacking"). Default is "Equal".
n_threads	Number of threads. Default is 1.

**Value**

An object of class cv.stepSplitReg.

**Author(s)**

Anthony-Alexander Christidis, <anthony.christidis@stat.ubc.ca>

**See Also**

[coef.cv.stepSplitReg](#), [predict.cv.stepSplitReg](#)

**Examples**

```
# Required Libraries
library(mvnfast)

# Setting the parameters
p <- 100
n <- 30
n.test <- 500
sparsity <- 0.2
rho <- 0.5
SNR <- 3

# Generating the coefficient
p.active <- floor(p*sparsity)
a <- 4*log(n)/sqrt(n)
neg.prob <- 0.2
nonzero.betas <- (-1)^(rbinom(p.active, 1, neg.prob))*(a + abs(rnorm(p.active)))

# Correlation structure
Sigma <- matrix(0, p, p)
```

```

Sigma[1:p.active, 1:p.active] <- rho
diag(Sigma) <- 1
true.beta <- c(nonzero.betas, rep(0, p - p.active))

# Computing the noise parameter for target SNR
sigma.epsilon <- as.numeric(sqrt((t(true.beta) %*% Sigma %*% true.beta)/SNR))

# Simulate some data
set.seed(1)
x.train <- mvnfast::rmvn(n, mu=rep(0,p), sigma=Sigma)
y.train <- 1 + x.train %*% true.beta + rnorm(n=n, mean=0, sd=sigma.epsilon)
x.test <- mvnfast::rmvn(n.test, mu=rep(0,p), sigma=Sigma)
y.test <- 1 + x.test %*% true.beta + rnorm(n.test, sd=sigma.epsilon)

# Stepwise Split Regularized Regression
step.out <- cv.stepSplitReg(x.train, y.train, n_models = c(2, 3), max_variables = NULL, keep = 4/4,
                           model_criterion = c("F-test", "RSS")[1],
                           stop_criterion = c("F-test", "pR2", "aR2", "R2", "Fixed")[1],
                           stop_parameter = 0.05,
                           shrinkage = TRUE, alpha = 4/4, include_intercept = TRUE,
                           n_lambda = 50, tolerance = 1e-2, max_iter = 1e5, n_folds = 5,
                           model_weights = c("Equal", "Proportional", "Stacking")[1],
                           n_threads = 1)
step.coefficients <- coef(step.out, group_index = 1:step.out$n_models_optimal)
step.predictions <- predict(step.out, x.test, group_index = 1:step.out$n_models_optimal)
mspe.step <- mean((step.predictions-y.test)^2)/sigma.epsilon^2

```

---

predict.cv.stepSplitReg

*Predictions for cv.stepSplitReg Object*

---

## Description

predict.cv.stepSplitReg returns the predictions for a cv.stepSplitReg object.

## Usage

```

## S3 method for class 'cv.stepSplitReg'
predict(object, newx, group_index = group_index, ...)

```

## Arguments

object	An object of class cv.stepSplitReg
newx	New data for predictions.
group_index	Groups included in the ensemble. Default setting includes all the groups.
...	Additional arguments for compatibility.

**Value**

The predictions for the `cv.stepSplitReg` object.

**Author(s)**

Anthony-Alexander Christidis, <anthony.christidis@stat.ubc.ca>

**See Also**

[cv.stepSplitReg](#)

**Examples**

```
# Required Libraries
library(mvnfast)

# Setting the parameters
p <- 100
n <- 30
n.test <- 500
sparsity <- 0.2
rho <- 0.5
SNR <- 3

# Generating the coefficient
p.active <- floor(p*sparsity)
a <- 4*log(n)/sqrt(n)
neg.prob <- 0.2
nonzero.betas <- (-1)^(rbinom(p.active, 1, neg.prob))*(a + abs(rnorm(p.active)))

# Correlation structure
Sigma <- matrix(0, p, p)
Sigma[1:p.active, 1:p.active] <- rho
diag(Sigma) <- 1
true.beta <- c(nonzero.betas, rep(0, p - p.active))

# Computing the noise parameter for target SNR
sigma.epsilon <- as.numeric(sqrt((t(true.beta) %*% Sigma %*% true.beta)/SNR))

# Simulate some data
set.seed(1)
x.train <- mvnfast::rmvn(n, mu=rep(0,p), sigma=Sigma)
y.train <- 1 + x.train %*% true.beta + rnorm(n=n, mean=0, sd=sigma.epsilon)
x.test <- mvnfast::rmvn(n.test, mu=rep(0,p), sigma=Sigma)
y.test <- 1 + x.test %*% true.beta + rnorm(n.test, sd=sigma.epsilon)

# Stepwise Split Regularized Regression
step.out <- cv.stepSplitReg(x.train, y.train, n_models = c(2, 3), max_variables = NULL, keep = 4/4,
  model_criterion = c("F-test", "RSS")[1],
  stop_criterion = c("F-test", "pR2", "aR2", "R2", "Fixed")[1],
  stop_parameter = 0.05,
  shrinkage = TRUE, alpha = 4/4, include_intercept = TRUE,
```



```
      n_lambda = 50, tolerance = 1e-2, max_iter = 1e5, n_folds = 5,
      model_weights = c("Equal", "Proportional", "Stacking")[1],
      n_threads = 1)
step.coefficients <- coef(step.out, group_index = 1:step.out$n_models_optimal)
step.predictions <- predict(step.out, x.test, group_index = 1:step.out$n_models_optimal)
mspe.step <- mean((step.predictions-y.test)^2)/sigma.epsilon^2
```

---

predict.stepSplitReg *Predictions for stepSplitReg Object*

---

### Description

predict.stepSplitReg returns the predictions for a stepSplitReg object.

### Usage

```
## S3 method for class 'stepSplitReg'
predict(object, newx, group_index = NULL, ...)
```

### Arguments

object	An object of class stepSplitReg
newx	New data for predictions.
group_index	Groups included in the ensemble. Default setting includes all the groups.
...	Additional arguments for compatibility.

### Value

The predictions for the stepSplitReg object.

### Author(s)

Anthony-Alexander Christidis, <anthony.christidis@stat.ubc.ca>

### See Also

[stepSplitReg](#)

### Examples

```
# Required Libraries
library(mvnfast)

# Setting the parameters
p <- 100
n <- 30
n.test <- 1000
```

```

sparsity <- 0.2
rho <- 0.5
SNR <- 3

# Generating the coefficient
p.active <- floor(p*sparsity)
a <- 4*log(n)/sqrt(n)
neg.prob <- 0.2
nonzero.betas <- (-1)^(rbinom(p.active, 1, neg.prob))*(a + abs(rnorm(p.active)))

# Correlation structure
Sigma <- matrix(0, p, p)
Sigma[1:p.active, 1:p.active] <- rho
diag(Sigma) <- 1
true.beta <- c(nonzero.betas, rep(0, p - p.active))

# Computing the noise parameter for target SNR
sigma.epsilon <- as.numeric(sqrt((t(true.beta) %*% Sigma %*% true.beta)/SNR))

# Simulate some data
set.seed(1)
x.train <- mvnfast::rmvn(n, mu=rep(0,p), sigma=Sigma)
y.train <- 1 + x.train %*% true.beta + rnorm(n=n, mean=0, sd=sigma.epsilon)
x.test <- mvnfast::rmvn(n.test, mu=rep(0,p), sigma=Sigma)
y.test <- 1 + x.test %*% true.beta + rnorm(n.test, sd=sigma.epsilon)

# Stepwise Split Regularized Regression
step.out <- stepSplitReg(x.train, y.train, n_models = 3, max_variables = NULL, keep = 4/4,
  model_criterion = c("F-test", "RSS")[1],
  stop_criterion = c("F-test", "pR2", "aR2", "R2", "Fixed")[1],
  stop_parameter = 0.05,
  shrinkage = TRUE, alpha = 4/4, include_intercept = TRUE,
  n_lambda = 50, tolerance = 1e-2, max_iter = 1e5, n_folds = 5,
  model_weights = c("Equal", "Proportional", "Stacking")[1])
step.coefficients <- coef(step.out, group_index = 1:step.out$n_models)
step.predictions <- predict(step.out, x.test, group_index = 1:step.out$n_models)
mspe.step <- mean((step.predictions-y.test)^2)/sigma.epsilon^2

```

---

stepSplitReg

*Stepwise Split Regularized Regression*


---

## Description

stepSplitReg performs stepwise split regularized regression.

## Usage

```

stepSplitReg(
  x,

```

```

y,
n_models = NULL,
max_variables = NULL,
keep = 1,
model_criterion = c("F-test", "RSS")[1],
stop_criterion = c("F-test", "pR2", "aR2", "R2", "Fixed")[1],
stop_parameter = 0.05,
shrinkage = TRUE,
alpha = 3/4,
include_intercept = TRUE,
n_lambda = 100,
tolerance = 0.001,
max_iter = 1e+05,
n_folds = 10,
model_weights = c("Equal", "Proportional", "Stacking")[1]
)

```

### Arguments

x	Design matrix.
y	Response vector.
n_models	Number of models into which the variables are split.
max_variables	Maximum number of variables that a model can contain.
keep	Proportion of models to keep based on their individual cross-validated errors. Default is 1.
model_criterion	Criterion for adding a variable to a model. Must be one of c("F-test", "RSS"). Default is "F-test".
stop_criterion	Criterion for determining when a model is saturated. Must be one of c("F-test", "pR2", "aR2", "R2", "Fixed"). Default is "F-test".
stop_parameter	Parameter value for the stopping criterion. Default is 0.05 for "F-test".
shrinkage	TRUE or FALSE parameter for shrinkage of the final models. Default is TRUE.
alpha	Elastic net mixing parameter for model shrinkage. Default is 3/4.
include_intercept	TRUE or FALSE parameter for the inclusion of an intercept term.
n_lambda	Number of candidates for the sparsity penalty parameter. Default is 100.
tolerance	Convergence criteria for the coefficients. Default is 1e-3.
max_iter	Maximum number of iterations in the algorithm. Default is 1e5.
n_folds	Number of cross-validation folds. Default is 10.
model_weights	Criterion to determine the weights of the model for prediction. Must be one of c("Equal", "Proportional", "Stacking"). Default is "Equal".

### Value

An object of class stepSplitReg.

**Author(s)**

Anthony-Alexander Christidis, <anthony.christidis@stat.ubc.ca>

**See Also**

[coef.stepSplitReg](#), [predict.stepSplitReg](#)

**Examples**

```
# Required Libraries
library(mvnfast)

# Setting the parameters
p <- 100
n <- 30
n.test <- 1000
sparsity <- 0.2
rho <- 0.5
SNR <- 3

# Generating the coefficient
p.active <- floor(p*sparsity)
a <- 4*log(n)/sqrt(n)
neg.prob <- 0.2
nonzero.betas <- (-1)^(rbinom(p.active, 1, neg.prob))*(a + abs(rnorm(p.active)))

# Correlation structure
Sigma <- matrix(0, p, p)
Sigma[1:p.active, 1:p.active] <- rho
diag(Sigma) <- 1
true.beta <- c(nonzero.betas, rep(0, p - p.active))

# Computing the noise parameter for target SNR
sigma.epsilon <- as.numeric(sqrt((t(true.beta) %*% Sigma %*% true.beta)/SNR))

# Simulate some data
set.seed(1)
x.train <- mvnfast::rmvn(n, mu=rep(0,p), sigma=Sigma)
y.train <- 1 + x.train %*% true.beta + rnorm(n=n, mean=0, sd=sigma.epsilon)
x.test <- mvnfast::rmvn(n.test, mu=rep(0,p), sigma=Sigma)
y.test <- 1 + x.test %*% true.beta + rnorm(n.test, sd=sigma.epsilon)

# Stepwise Split Regularized Regression
step.out <- stepSplitReg(x.train, y.train, n_models = 3, max_variables = NULL, keep = 4/4,
  model_criterion = c("F-test", "RSS")[1],
  stop_criterion = c("F-test", "pR2", "aR2", "R2", "Fixed")[1],
  stop_parameter = 0.05,
  shrinkage = TRUE, alpha = 4/4, include_intercept = TRUE,
  n_lambda = 50, tolerance = 1e-2, max_iter = 1e5, n_folds = 5,
  model_weights = c("Equal", "Proportional", "Stacking")[1])
step.coefficients <- coef(step.out, group_index = 1:step.out$n_models)
step.predictions <- predict(step.out, x.test, group_index = 1:step.out$n_models)
```

```
mspe.step <- mean((step.predictions-y.test)^2)/sigma.epsilon^2
```

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