Package ‘rbridge’

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Description Bridge Regression estimation with linear restrictions de-
fined in Yuzbasi et al. (2019) <arXiv:1910.03660>. Special cases of this approach fit the re-
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Description
Fit a bridge penalized maximum likelihood. It is computed the regularization path which is consisted of lasso or ridge penalty at the a grid values for lambda.

Usage
bridge(X, y, q = 1, lambda.min = ifelse(n > p, 0.001, 0.05),
      nlambda = 100, lambda, eta = 1e-07, converge = 10^10)

Arguments
X       Design matrix.
y       Response vector.
q       is the degree of norm which includes ridge regression with q=2 and lasso estimates with q=1 as special cases
lambda.min       The smallest value for lambda if n>p is 0.001 and 0.05 otherwise.
nlambda       The number of lambda values - default is 100
lambda       A user supplied lambda sequence. By default, the program compute a sequence of values the length of nlambda.
etta       is a preselected small positive threshold value. It is deleted jth variable to make the algorithm stable and also is excluded jth variable from the final model. Default is 1e-07.
converge       is the value of converge. Defaults is 10^10. In each iteration, it is calculated by sum of square the change in linear predictor for each coefficient. The algorithm iterates until converge > eta.

Details
Computes bridge estimation

Value
An object of class rbridge, a list with entries
betas       Coefficients computed over the path of lambda
lambda       The lambda values which is given at the function
coef.bridge

Author(s)
Bahadir Yuzbasi, Mohammad Arashi and Fikri Akdeniz
Maintainer: Bahadir Yuzbasi <b.yzb@hotmail.com>

See Also
cv.bridge

Examples
set.seed(2019)
beta <- c(3, 1.5, 0, 0, 2, 0, 0, 0)
p <- length(beta)
beta <- matrix(beta, nrow = p, ncol = 1)

n = 100
X = matrix(rnorm(n*p),n,p)
y = X %*% beta + rnorm(n)

model1 <- bridge(X, y, q = 1)
print(model1)

model2 <- bridge(X, y, q = 2)
print(model2)

---

coef.bridge  
Extract coefficients from a 'bridge' object

Description
Extract coefficients from a 'bridge' object.

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

Arguments
object  
A 'bridge' object.
s  
Value(s) of the penalty parameter lambda at which predictions are required.
...  
Additional arguments for compatibility.

Value
A vector of coefficients
**Author(s)**
Bahadir Yuzbasi, Mohammad Arashi and Fikri Akdeniz
Maintainer: Bahadir Yuzbasi <b.yzb@hotmail.com>

**See Also**
predict.bridge

**Examples**
```
set.seed(2019)
beta <- c(3, 1.5, 0, 0, 2, 0, 0, 0)
p <- length(beta)
beta <- matrix(beta, nrow = p, ncol = 1)

n = 100
X = matrix(rnorm(n*p),n,p)
y = X%*%beta + rnorm(n)
model1 <- bridge(X, y, q = 1)
coef(model1,s='lambda.min')
```

---

**coef.cv.bridge**

Extract coefficients from a 'cv.bridge' object

**Description**
Extract coefficients from a 'cv.bridge' object.

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

**Arguments**
- **object** A 'cv.bridge' object.
- **s** Value(s) of the penalty parameter lambda at which predictions are required.
- **...** Additional arguments for compatibility.

**Value**
A vector of coefficients

**Author(s)**
Bahadir Yuzbasi, Mohammad Arashi and Fikri Akdeniz
Maintainer: Bahadir Yuzbasi <b.yzb@hotmail.com>
See Also

`predict.cv.rbridge`

Examples

```r
set.seed(2019)
beta <- c(3, 1.5, 0, 0, 2, 0, 0, 0)
p <- length(beta)
beta <- matrix(beta, nrow = p, ncol = 1)

n = 100
X = matrix(rnorm(n*p),n,p)
y = X%*%beta + rnorm(n)

model1 <- cv.bridge(X, y, q = 1)
coef(model1,s='lambda.min')
```

Description

Extract coefficients from a 'cv.rbridge' object.

Usage

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

Arguments

- `object`: A 'cv.rbridge' object.
- `s`: Value(s) of the penalty parameter lambda at which predictions are required.
- `...`: Additional arguments for compatibility.

Value

A vector of coefficients

Author(s)

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Maintainer: Bahadir Yuzbasi <b.yzb@hotmail.com>

See Also

`predict.cv.rbridge`
Examples

```r
set.seed(2019)
beta <- c(3, 1.5, 0, 0, 2, 0, 0, 0)
p <- length(beta)
beta <- matrix(beta, nrow = p, ncol = 1)

### Restricted Matrix and vector
c1 <- c(1,1,0,0,1,0,0,0)
R1.mat <- matrix(c1,nrow = 1, ncol = p)
r1.vec <- as.matrix(c(6.5),1,1)

n = 100
X = matrix(rnorm(n*p),n,p)
y = X%*%beta + rnorm(n)

######## Model 1 based on first restrictions
model1 <- cv.rbridge(X, y, q = 1, R1.mat, r1.vec)
coef(model1, s="lambda.min")
```

---

**coef.rbridge**

*Extract coefficients from a 'rbridge' object*

---

**Description**

Makes predictions from a cross-validated 'rbridge' model

**Usage**

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

**Arguments**

- `object`: A 'rbridge' object.
- `s`: Value(s) of the penalty parameter lambda at which predictions are required.
- `...`: Additional arguments for compatibility.

**Value**

Among a matrix with predictions, a vector non-zero indexing or a vector of coefficients

**Author(s)**

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**See Also**

`predict.rbridge`
Examples

```r
set.seed(2019)
beta <- c(3, 1.5, 0, 0, 2, 0, 0, 0)
p <- length(beta)
beta <- matrix(beta, nrow = p, ncol = 1)

### Restricted Matrix and vector
c1 <- c(1,1,0,0,1,0,0,0)
R1.mat <- matrix(c1,nrow = 1, ncol = p)
r1.vec <- as.matrix(c(6.5),1,1)

n = 100
X = matrix(rnorm(n*p),n,p)
y = X%*%beta + rnorm(n)

##### Model 1 based on first restrictions
model1 <- rbridge(X, y, q = 1, R1.mat, r1.vec)
coef(model1,s='lambda.min')
```

---

cv.bridge

Cross-validation for bridge

Description

Does k-fold cross-validation for bridge, produces a plot, and returns a value for lambda.

Usage

```r
cv.bridge(X, y, q, lambda, nfolds = 10, lambda.min = ifelse(n > p, 0.001, 0.05), nlambda = 100, eta = 1e-07, converge = 10^10, num_threads = 10)
```

Arguments

- `X` X matrix as in bridge.
- `y` response y as in bridge.
- `q` is the degree of norm which includes ridge regression with q=2 and lasso estimates with q=1 as special cases.
- `lambda` lambda sequence; default is NULL. It is given by user or cv.rbridge chooses its own sequence.
- `nfolds` number of folds - default is 10.
- `lambda.min` The smallest value for lambda if n>p is 0.001 and 0.05 otherwise.
- `nlambda` The number of lambda values - default is 100.
- `eta` is a preselected small positive threshold value. It is deleted jth variable to make the algorithm stable and also is excluded jth variable from the final model. Default is 1e-07.
converge is the value of converge. Defaults is $10^{10}$. In each iteration, it is calculated by sum of square the change in linear predictor for each coefficient. The algorithm iterates until converge > eta.

num_threads Number of threads used for parallel computation over the folds.

Details

Computes bridge

Value

An object of class rbridge, a list with entries

cve the mean cross-validated error.
cvse estimate of standard error of cvm.
cvup upper curve = cvm+cvsd.
cvlo lower curve = cvm-cvsd.
lambda the values of lambda used in the fits
nz number of non-zero coefficients at each lambda.
betas estimated coefficient at each lambda.
lambda.min value of lambda that gives minimum cve
lambda.1se largest value of lambda such that error is within 1 standard error of the minimum

Author(s)

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See Also

bridge

Examples

set.seed(2019)
beta <- c(3, 1.5, 0, 0, 2, 0, 0, 0)
p <- length(beta)
beta <- matrix(beta, nrow = p, ncol = 1)

n = 100
X = matrix(rnorm(n*p),n,p)
y = X%*%beta + rnorm(n)

####### Model 1
model1 <- cv.bridge(X, y, q = 1)
print(model1)
coef(model1,s='lambda.min')
predict(model1,newx=X[1:5,], s="lambda.min", type="response")
cv.rbridge

predict(model1, s="lambda.min", type="coefficient")

## Model 2
model2 <- cv.bridge(X, y, q = 2)
print(model2)
coef(model2, s='lambda.min')
predict(model2, newx=X[1:5,], s="lambda.min", type="response")
predict(model2, s="lambda.min", type="coefficient")

cv.rbridge

Cross-validation for rbridge

Description

Does k-fold cross-validation for rbridge, produces a plot, and returns a value for lambda

Usage

cv.rbridge(X, y, q, R, r, lambda, nfolds = 10, lambda.min = ifelse(n > p, 0.001, 0.05), nlambda = 100, eta = 1e-07, converge = 10^10, num_threads = 10)

Arguments

X       X matrix as in rbridge.
y       response y as in rbridge.
q       is the degree of norm which includes ridge regression with q=2 and lasso estimates with q=1 as special cases
R       is m by p (m<p) matrix of constants.
r       is a m-vector of known prespecified constants. If it is given true restriction, then
                    r - Rβ = 0.

lambda is a preselected small positive threshold value. It is deleted jth variable to make
the algorithm stable and also is excluded jth variable from the final model. Default is 1e-07.
	nfolds number of folds - default is 10.

lambda.min The smallest value for lambda if n>p is 0.001 and 0.05 otherwise.
nlambda The number of lambda values - default is 100
eta is the value of converge. Defaults is 10^10. In each iteration, it is calculated by
sum of square the change in linear predictor for each coefficient. The algorithm
iterates until converge > eta.

num_threads Number of threads used for parallel computation over the folds,
Details

Computes cv.rbridge

Value

An object of class rbridge, a list with entries
- `cve`: the mean cross-validated error.
- `cvse`: estimate of standard error of `cvm`.
- `cvup`: upper curve = `cvm+cvsd`.
- `cvlo`: lower curve = `cvm-cvsd`.
- `lambda`: the values of lambda used in the fits.
- `nz`: number of non-zero coefficients at each `lambda`.
- `betas`: estimated coefficient at each `lambda`.
- `lambda.min`: value of lambda that gives minimum `cve`.
- `lambda.1se`: largest value of lambda such that error is within 1 standard error of the minimum.

Author(s)

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See Also

rbridge

Examples

```r
set.seed(2019)
beta <- c(3, 1.5, 0, 0, 2, 0, 0, 0)
p <- length(beta)
beta <- matrix(beta, nrow = p, ncol = 1)
p.active <- which(beta != 0)

### Restricted Matrix and vector
### Res 1
c1 <- c(1, 1, 0, 0, 1, 0, 0, 0)
R1.mat <- matrix(c1, nrow = 1, ncol = p)
r1.vec <- as.matrix(c(6.5), 1, 1)

### Res 2
c2 <- c(-1, 1, 0, 0, 1, 0, 0, 0)
R2.mat <- matrix(c2, nrow = 1, ncol = p)
r2.vec <- matrix(c(0.5), nrow = 1, ncol = 1)

### Res 3
R3.mat <- t(matrix(c(c1, c2), nrow = p, ncol = 2))
r3.vec <- matrix(c(6.5, 0.5), nrow = 2, ncol = 1)

### Res 4
R4.mat = diag(1, p, p)[-p.active,]
```
r4.vec <- matrix(rep(0,p-length(p.active)),nrow = p-length(p.active), ncol = 1)

n = 100
X = matrix(rnorm(n*p),n,p)
y = X%*%beta + rnorm(n)

######## Model 1 based on first restrictions
model1 <- cv.rbridge(X, y, q = 1, R1.mat, r1.vec)
print(model1)
coef(model1,s='lambda.min')
coef(model1,s='lambda.1se')
predict(model1,newx=X[1:5,], s="lambda.min", type="response")
predict(model1, s="lambda.min",type="coefficient")
predict(model1, s="lambda.1se",type="coefficient")

######## Model 2 based on second restrictions
model2 <- cv.rbridge(X, y, q = 1, R2.mat, r2.vec)
print(model2)
coef(model2,s='lambda.min')
coef(model2,s='lambda.1se')
predict(model2,newx=X[1:5,], s="lambda.min", type="response")
predict(model2, s="lambda.min",type="coefficient")
predict(model2, s="lambda.1se",type="coefficient")

######## Model 3 based on third restrictions
model3 <- cv.rbridge(X, y, q = 1, R3.mat, r3.vec)
print(model3)
coef(model3,s='lambda.min')
coef(model3,s='lambda.1se')
predict(model3,newx=X[1:5,], s="lambda.min", type="response")
predict(model3, s="lambda.min",type="coefficient")
predict(model3, s="lambda.1se",type="coefficient")

######## Model 4 based on fourth restrictions
model4 <- cv.rbridge(X, y, q = 1, R4.mat, r4.vec)
print(model4)
coef(model4,s='lambda.min')
coef(model4,s='lambda.1se')
predict(model4,newx=X[1:5,], s="lambda.min", type="response")
predict(model4, s="lambda.min",type="coefficient")
predict(model4, s="lambda.1se",type="coefficient")

plot.cv.bridge

plot a 'cv.bridge' object function

Description

Plots the cross-validation curve, and upper and lower standard deviation curves, as a function of the lambda values used.
plot.cv.rbridge

**Usage**

```r
## S3 method for class 'cv.bridge'
plot(x, sign.lambda = 1, ...)
```

**Arguments**

- `x` Design matrix.
- `sign.lambda` Either plot against `log(lambda)` (default) or its negative if `sign.lambda=-1`.
- `...` Other graphical parameters to plot

**Author(s)**

Bahadir Yuzbasi, Mohammad Arashi and Fikri Akdeniz
Maintainer: Bahadir Yuzbasi <b.yzb@hotmail.com>

---

**Description**

Plots the cross-validation curve, and upper and lower standard deviation curves, as a function of the lambda values used.

**Usage**

```r
## S3 method for class 'cv.rbridge'
plot(x, sign.lambda = 1, ...)
```

**Arguments**

- `x` Design matrix.
- `sign.lambda` Either plot against `log(lambda)` (default) or its negative if `sign.lambda=-1`.
- `...` Other graphical parameters to plot

**Author(s)**

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predict.bridge

**Description**

Makes predictions from a cross-validated 'bridge' model

**Usage**

```r
## S3 method for class 'bridge'
predict(object, newx, s = c("lambda.min", "lambda.1se"),
         type = c("response", "nonzero", "coefficients"), ...)
```

**Arguments**

- **object**: A 'bridge' object.
- **newx**: Matrix of new values for x at which predictions are to be made.
- **s**: Value(s) of the penalty parameter lambda at which predictions are required.
- **type**: It should one of "response", "nonzero" or "coefficients". The "response" is for predicted values, the "nonzero" is for exacting non-zero coefficients and the "coefficients" is for the estimated coefficients.
- **...**: Additional arguments for compatibility.

**Value**

Among a matrix with predictions, a vector non-zero indexing or a vector of coefficients

**Author(s)**

Bahadir Yuzbasi, Mohammad Arashi and Fikri Akdeniz
Maintainer: Bahadir Yuzbasi <b.yzb@hotmail.com>

**See Also**

- `coef.bridge`

**Examples**

```r
set.seed(2019)
beta <- c(3, 1.5, 0, 2, 0, 0, 0, 0)
p <- length(beta)
beta <- matrix(beta, nrow = p, ncol = 1)

n = 100
X = matrix(rnorm(n*p),n,p)
y = X%*%beta + rnorm(n)
```
predict.cv.bridge

Make predictions from a 'cv.bridge' object

Description

Makes predictions from a cross-validated 'cv.bridge' model

Usage

## S3 method for class 'cv.bridge'
predict(object, newx, s = c("lambda.min", "lambda.1se"), type = c("response", "nonzero", "coefficients"), ...)

Arguments

object A 'cv.bridge' object.
newx Matrix of new values for x at which predictions are to be made.
s Value(s) of the penalty parameter lambda at which predictions are required.
type It should one of "response", "nonzero" or "coefficients". The "response" is for predicted values, the "nonzero" is for exacting non-zero coefficients and the "coefficients" is for the estimated coefficients.
... Additional arguments for compatibility.

Value

Among a matrix with predictions, a vector non-zero indexing or a vector of coefficients

Author(s)

Bahadir Yuzbasi, Mohammad Arashi and Fikri Akdeniz  
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See Also

ccoef.cv.bridge
Examples

```r
set.seed(2019)
beta <- c(3, 1.5, 0, 0, 2, 0, 0, 0)
p <- length(beta)
beta <- matrix(beta, nrow = p, ncol = 1)

n = 100
X = matrix(rnorm(n*p), n, p)
y = X%*%beta + rnorm(n)

model1 <- cv.bridge(X, y, q = 1)
coef(model1, s='lambda.min')
predict(model1,newx=X[1:5,], s="lambda.min", type="response")
predict(model1, s="lambda.min",type="coefficient")
```

---

**predict.cv.rbridge**  
Make predictions from a 'cv.rbridge' object

### Description

Makes predictions from a cross-validated 'cv.rbridge' model

### Usage

```r
## S3 method for class 'cv.rbridge'
predict(object, newx, s = c("lambda.min", "lambda.1se"), type = c("response", "nonzero", "coefficients"), ...)  
```

### Arguments

- **object** A 'cv.rbridge' object.
- **newx** Matrix of new values for x at which predictions are to be made.
- **s** Value(s) of the penalty parameter lambda at which predictions are required.
- **type** It should one of "response", "nonzero" or "coefficients". The "response" is for predicted values, the "nonzero" is for exacting non-zero coefficients and the "coefficients" is for the estimated coefficients.
- **...** Additional arguments for compatibility.

### Value

Among a matrix with predictions, a vector non-zero indexing or a vector of coefficients

### Author(s)

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Bahadir Yuzbasi maintainer Baha
predict.rbridge

Make predictions from a 'rbridge' object

Description

Makes predictions from a cross-validated 'rbridge' model

Usage

## S3 method for class 'rbridge'
predict(object, newx, s = c("lambda.min", "lambda.1se"), type = c("response", "nonzero", "coefficients"), ...)

Arguments

- **object**: A 'rbridge' object.
- **newx**: Matrix of new values for x at which predictions are to be made.
- **s**: Value(s) of the penalty parameter lambda at which predictions are required.
- **type**: It should one of "response", "nonzero" or "coefficients". The "response" is for predicted values, the "nonzero" is for exacting non-zero coefficients and the "coefficients" is for the estimated coefficients.
- **...**: Additional arguments for compatibility.
Value

Among a matrix with predictions, a vector non-zero indexing or a vector of coefficients

Author(s)

Bahadir Yuzbasi, Mohammad Arashi and Fikri Akdeniz
Maintainer: Bahadir Yuzbasi <b.yzb@hotmail.com>

See Also

coef.cv.bridge

Examples

```r
set.seed(2019)
beta <- c(3, 1.5, 0, 0, 2, 0, 0, 0)
p <- length(beta)
beta <- matrix(beta, nrow = p, ncol = 1)

### Restricted Matrix and vector
c1 <- c(1, 1, 0, 0, 1, 0, 0, 0)
R1.mat <- matrix(c1, nrow = 1, ncol = p)
r1.vec <- as.matrix(c(6.5), 1, 1)

n = 100
X = matrix(rnorm(n*p), n, p)
y = X%*%beta + rnorm(n)

######## Model 1 based on first restrictions
model1 <- rbridge(X, y, q = 1, R1.mat, r1.vec)
predict(model1, newx = X[1:5, ], type = "response")
predict(model1, s = "lambda.min", type = "coefficient")
```

---

**rbridge**

*Fit a Restricted Bridge Estimation*

**Description**

Fit a restricted linear model via bridge penalized maximum likelihood. It is computed the regularization path which is consisted of lasso or ridge penalty at the a grid values for lambda

**Usage**

```r
rbridge(X, y, q = 1, R, r, lambda.min = ifelse(n > p, 0.001, 0.05),
        nlambda = 100, lambda, eta = 1e-07, converge = 10^10)
```
Arguments

X  Design matrix.
y  Response vector.
q  is the degree of norm which includes ridge regression with q=2 and lasso estimates with q=1 as special cases
R  is a \( m \times p \) (\( m<p \)) matrix of constants.
r  is a \( m \)-vector of known prespecified constants. If it is given true restriction, then
\[ r - R\beta = 0. \]
Values for \( r \) should be given as a matrix. See "Examples''.

lambda.min  The smallest value for lambda if \( n>p \) is 0.001 and 0.05 otherwise.
nlambda  The number of lambda values - default is 100
lambda  A user supplied lambda sequence. By default, the program compute a sequence of values the length of nlambda.
eta  is a preselected small positive threshold value. It is deleted \( j \)-th variable to make the algorithm stable and also is excluded \( j \)-th variable from the final model. Default is \( 1e^{-07} \).
converge  is the value of converge. Defaults is \( 10^{10} \). In each iteration, it is calculated by sum of square the change in linear predictor for each coefficient. The algorithm iterates until converge > eta.

Details

In order to couple the bridge estimator with the restriction \( R \beta = r \), we solve the following optimization problem
\[ \min RSS w.r.t \| \beta \|_q \text{and} R\beta = r. \]

Value

An object of class rbridge, a list with entries

betas  Coefficients computed over the path of lambda
lambda  The lambda values which is given at the function

Author(s)

Bahadir Yuzbasi, Mohammad Arashi and Fikri Akdeniz
Maintainer: Bahadir Yuzbasi <b.yzb@hotmail.com>

See Also
cv.rbridge
Examples

```r
set.seed(2019)
beta <- c(3, 1.5, 0, 0, 2, 0, 0, 0)
p <- length(beta)
beta <- matrix(beta, nrow = p, ncol = 1)
p.active <- which(beta != 0)

### Restricted Matrix and vector
### Res 1
c1 <- c(1,1,0,0,1,0,0,0)
R1.mat <- matrix(c1,nrow = 1, ncol = p)
r1.vec <- as.matrix(c(6.5),1,1)

### Res 2
c2 <- c(-1,1,0,0,1,0,0,0)
R2.mat <- matrix(c2,nrow = 1, ncol = p)
r2.vec <- as.matrix(c(0.5),1,1)

### Res 3
R3.mat <- t(matrix(c(c1,c2),nrow = p, ncol = 2))
r3.vec <- matrix(c(6.5,0.5),nrow = 2, ncol = 1)

### Res 4
R4.mat = diag(1,p,p)[-p.active,]
r4.vec <- matrix(rep(0,p-length(p.active)),nrow = p-length(p.active), ncol = 1)

n = 100
X = matrix(rnorm(n*p),n,p)
y = X%*%beta + rnorm(n)

model1 <- rbridge(X, y, q = 1, R1.mat, r1.vec)
print(model1)

model2 <- rbridge(X, y, q = 1, R2.mat, r2.vec)
print(model2)

model3 <- rbridge(X, y, q = 1, R3.mat, r3.vec)
print(model3)

model4 <- rbridge(X, y, q = 1, R4.mat, r4.vec)
print(model4)
```
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