

Package ‘ImpShrinkage’

July 21, 2025

Type Package

Title Improved Shrinkage Estimations for Multiple Linear Regression

Version 1.0.0

Maintainer Mina Norouzirad <mina.norouzirad@gmail.com>

Description

A variety of improved shrinkage estimators in the area of statistical analysis: unrestricted; restricted; preliminary test; improved preliminary test; Stein; and positive-rule Stein. More details can be found in chapter 7 of Saleh, A. K. Md. E. (2006) <ISBN: 978-0-471-56375-4>.

License GPL (>= 2)

URL <https://github.com/mnrzrad/ImpShrinkage>

Encoding UTF-8

LazyData false

RoxygenNote 7.2.3

Depends R (>= 2.10)

NeedsCompilation no

Author Mina Norouzirad [aut, cre] (ORCID:

<<https://orcid.org/0000-0003-0311-6888>>),

Danial Mazarei [aut] (ORCID: <<https://orcid.org/0000-0002-3633-9298>>),

Ricardo Moura [aut] (ORCID: <<https://orcid.org/0000-0002-3003-9235>>),

'FCT, I.P. [fnd] (under the scope of the projects UIDB/00297/2020 and

UIDP/00297/2020 (NovaMath))

Repository CRAN

Date/Publication 2023-06-21 19:50:02 UTC

Contents

cement	2
coefficients.improvedpreliminaryTest	3
coefficients.positivestein	4
coefficients.preliminaryTest	5
coefficients.restricted	6

coefficients.stein	7
coefficients.unrestricted	8
fitted.improvedpreliminaryTest	9
fitted.positivestein	10
fitted.preliminaryTest	11
fitted.restricted	12
fitted.stein	13
fitted.unrestricted	14
iptReg	15
predict.improvedpreliminaryTest	17
predict.positivestein	18
predict.preliminaryTest	19
predict.restricted	20
predict.stein	21
predict.unrestricted	22
prstReg	23
ptReg	25
residuals.improvedpreliminaryTest	27
residuals.positivestein	28
residuals.preliminaryTest	29
residuals.restricted	30
residuals.stein	30
residuals.unrestricted	31
resReg	32
simdata	34
stReg	35
teststat	37
unrReg	38

Index	41
--------------	-----------

cement

Hald's Cement Data

Description

Heat evolved (cals/gm) in the setting of 13 samples of Portland cement with different percentage weight of chemical components.

Format

A data.frame with 13 observations on the following 5 variables.

- x1** percentage weight in clinkers of $3\text{CaO} \cdot \text{Al}_2\text{O}_3$
- x2** percentage weight in clinkers of $3\text{CaO} \cdot \text{SiO}_2$
- x3** percentage weight in clinkers of $4\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot \text{Fe}_2\text{O}_3$
- x4** percentage weight in clinkers of $2\text{CaO} \cdot \text{SiO}_2$
- y** heat evolved (calories/gram)

Source

Woods, H., Steinour, H. H. and Starke, H. R. (1932) Effect of composition of Portland cement on heat evolved during hardening. Industrial Engineering and Chemistry, 24, 1207–1214.

Examples

```
data("cement")
cement
```

```
coefficients.improvedpreliminaryTest
```

Extract Model Coefficients

Description

Coefficients extracted from the model object improvedpreliminaryTest

Usage

```
## S3 method for class 'improvedpreliminaryTest'
coefficients(object, ...)

## S3 method for class 'improvedpreliminaryTest'
coef(object, ...)
```

Arguments

object	An object of class improvedpreliminaryTest.
...	Other arguments.

Value

A vector of coefficients.

See Also

[coefficients.unrestricted](#), [coefficients.restricted](#), [coefficients.preliminaryTest](#), [coefficients.stein](#), [coefficients.positivestein](#), [coef.unrestricted](#), [coef.restricted](#), [coef.positivestein](#), [coef.stein](#), [coef.positivestein](#).

Examples

```

n_obs <- 100
p_vars <- 5
beta <- c(2, 1, 3, 0, 5)
simulated_data <- simdata(n = n_obs, p = p_vars, beta)
X <- simulated_data$X
y <- simulated_data$y
p <- ncol(X)
# H beta = h
H <- matrix(c(1, 1, -1, 0, 0, 1, 0, 1, 0, -1, 0, 0, 0, 1, 0), nrow = 3, ncol = p, byrow = TRUE)
h <- rep(0, nrow(H))
model <- iptReg(X, y, H, h, alpha = 0.05)
coefficients(model)
coef(model)

```

coefficients.positivestain

Extract Model Coefficients

Description

Coefficients extracted from the model object positivestain

Usage

```

## S3 method for class 'positivestain'
coefficients(object, ...)

## S3 method for class 'positivestain'
coef(object, ...)

```

Arguments

object	An object of class positivestain.
...	Other arguments.

Value

A vector of coefficients.

See Also

[coefficients.unrestricted](#), [coefficients.restricted](#), [coefficients.preliminaryTest](#), [coefficients.improvedpreliminaryTest](#), [coefficients.stein](#), [coef.unrestricted](#), [coef.restricted](#), [coef.preliminaryTest](#), [coef.improvedpreliminaryTest](#), [coef.stein](#).

Examples

```

n_obs <- 100
p_vars <- 5
beta <- c(2, 1, 3, 0, 5)
simulated_data <- simdata(n = n_obs, p = p_vars, beta)
X <- simulated_data$X
y <- simulated_data$y
p <- ncol(X)
# H beta = h
H <- matrix(c(1, 1, -1, 0, 0, 1, 0, 1, 0, -1, 0, 0, 0, 1, 0), nrow = 3, ncol = p, byrow = TRUE)
h <- rep(0, nrow(H))
model <- prstReg(X, y, H, h)
coefficients(model)
coef(model)

```

```

coefficients.preliminaryTest
      Extract Model Coefficients

```

Description

Coefficients extracted from the model object preliminaryTest

Usage

```

## S3 method for class 'preliminaryTest'
coefficients(object, ...)

## S3 method for class 'preliminaryTest'
coef(object, ...)

```

Arguments

object	An object of class preliminaryTest.
...	Other arguments.

Value

A vector of coefficients.

See Also

[coefficients.unrestricted](#), [coefficients.restricted](#), [coefficients.improvedpreliminaryTest](#), [coefficients.stein](#), [coefficients.positivestein](#), [coef.unrestricted](#), [coef.restricted](#), [coef.improvedpreliminaryTest](#), [coef.stein](#), [coef.positivestein](#). #'

Examples

```

n_obs <- 100
p_vars <- 5
beta <- c(2, 1, 3, 0, 5)
simulated_data <- simdata(n = n_obs, p = p_vars, beta)
X <- simulated_data$X
y <- simulated_data$y
p <- ncol(X)
# H beta = h
H <- matrix(c(1, 1, -1, 0, 0, 1, 0, 1, 0, -1, 0, 0, 0, 1, 0), nrow = 3, ncol = p, byrow = TRUE)
h <- rep(0, nrow(H))
model <- ptReg(X, y, H, h, alpha = 0.05)
coefficients(model)
coef(model)

```

coefficients.restricted

Extract Model Coefficients

Description

Coefficients extracted from the model object restrctited.

Usage

```

## S3 method for class 'restricted'
coefficients(object, ...)

## S3 method for class 'restricted'
coef(object, ...)

```

Arguments

object	An object of class restricted.
...	Other arguments.

Value

A vector of coefficients.

See Also

[coefficients.unrestricted](#), [coefficients.preliminaryTest](#), [coefficients.improvedpreliminaryTest](#), [coefficients.stein](#), [coefficients.positivestein](#), [coef.unrestricted](#), [coef.preliminaryTest](#), [coef.improvedpreliminaryTest](#) [coef.stein](#), [coef.positivestein](#).

Examples

```

n_obs <- 100
p_vars <- 5
beta <- c(2, 1, 3, 0, 5)
simulated_data <- simdata(n = n_obs, p = p_vars, beta)
X <- simulated_data$X
y <- simulated_data$y
p <- ncol(X)
# H beta = h
H <- matrix(c(1, 1, -1, 0, 0, 1, 0, 1, 0, -1, 0, 0, 0, 1, 0), nrow = 3, ncol = p, byrow = TRUE)
h <- rep(0, nrow(H))
model <- resReg(X, y, H, h)
coefficients(model)
coef(model)

```

coefficients.stein	<i>Extract Model Coefficients</i>
--------------------	-----------------------------------

Description

Coefficients extracted from the model object `stein`

Usage

```

## S3 method for class 'stein'
coefficients(object, ...)

## S3 method for class 'stein'
coef(object, ...)

```

Arguments

<code>object</code>	An object of class <code>stein</code> .
<code>...</code>	Other arguments.

Value

A vector of coefficients.

See Also

[coefficients.unrestricted](#), [coefficients.restricted](#), [coefficients.preliminaryTest](#), [coefficients.improvedpreliminaryTest](#), [coefficients.positivestein](#), [coef.unrestricted](#), [coef.restricted](#), [coef.preliminaryTest](#), [coef.improvedpreliminaryTest](#), [coef.positivestein](#).

Examples

```

n_obs <- 100
p_vars <- 5
beta <- c(2, 1, 3, 0, 5)
simulated_data <- simdata(n = n_obs, p = p_vars, beta)
X <- simulated_data$X
y <- simulated_data$y
p <- ncol(X)
# H beta = h
H <- matrix(c(1, 1, -1, 0, 0, 1, 0, 1, 0, -1, 0, 0, 0, 1, 0), nr = 3, nc = p, byrow = TRUE)
h <- rep(0, nrow(H))
model <- stReg(X, y, H, h)
coefficients(model)
coef(model)

```

coefficients.unrestricted

Extract Model Coefficients

Description

Coefficients extracted from the model object unrestricted.

Usage

```

## S3 method for class 'unrestricted'
coefficients(object, ...)

## S3 method for class 'unrestricted'
coef(object, ...)

```

Arguments

object	An object of class unrestricted.
...	Other arguments.

Value

A vector of coefficients.

See Also

[coefficients.restricted](#), [coefficients.preliminaryTest](#), [coefficients.improvedpreliminaryTest](#), [coefficients.stein](#), [coefficients.positivestein](#), [coef.restricted](#), [coef.preliminaryTest](#), [coef.improvedpreliminaryTest](#), [coef.stein](#), [coef.positivestein](#).

Examples

```

n_obs <- 100
p_vars <- 5
beta <- c(2, 1, 3, 0, 5)
simulated_data <- simdata(n = n_obs, p = p_vars, beta)
X <- simulated_data$X
y <- simulated_data$y
model <- unrReg(X, y)
coefficients(model)
coef(model)

```

fitted.improvedpreliminaryTest

Extract Model Fitted Values

Description

Fitted values based on object improvedpreliminaryTest.

Usage

```

## S3 method for class 'improvedpreliminaryTest'
fitted(object, ...)

```

Arguments

object	An object of class improvedpreliminaryTest.
...	Other arguments.

Value

A vector of fitted values.

See Also

[fitted.unrestricted](#), [fitted.restricted](#), [fitted.preliminaryTest](#), [fitted.stein](#), [fitted.positivestein](#).

Examples

```

n_obs <- 100
p_vars <- 5
beta <- c(2, 1, 3, 0, 5)
simulated_data <- simdata(n = n_obs, p = p_vars, beta)
X <- simulated_data$X
y <- simulated_data$y
p <- ncol(X)
# H beta = h
H <- matrix(c(1, 1, -1, 0, 0, 1, 0, 1, 0, -1, 0, 0, 0, 1, 0), nrow = 3, ncol = p, byrow = TRUE)
h <- rep(0, nrow(H))

```

```
model <- iptReg(X, y, H, h, alpha = 0.05)
fitted(model)
```

fitted.positivestein *Extract Model Fitted Values*

Description

Fitted values based on object positivestein.

Usage

```
## S3 method for class 'positivestein'
fitted(object, ...)
```

Arguments

object	An object of class positivestein.
...	Other arguments.

Value

A vector of fitted values.

See Also

[fitted.unrestricted](#), [fitted.restricted](#), [fitted.preliminaryTest](#), [fitted.improvedpreliminaryTest](#), [fitted.stein](#).

Examples

```
n_obs <- 100
p_vars <- 5
beta <- c(2, 1, 3, 0, 5)
simulated_data <- simdata(n = n_obs, p = p_vars, beta)
X <- simulated_data$X
y <- simulated_data$y
p <- ncol(X)
# H beta = h
H <- matrix(c(1, 1, -1, 0, 0, 1, 0, 1, 0, -1, 0, 0, 0, 1, 0), nrow = 3, ncol = p, byrow = TRUE)
h <- rep(0, nrow(H))
model <- prstReg(X, y, H, h)
fitted(model)
```

fitted.preliminaryTest*Extract Model Fitted Values*

Description

Fitted values based on object preliminaryTest.

Usage

```
## S3 method for class 'preliminaryTest'  
fitted(object, ...)
```

Arguments

object	An object of class preliminaryTest.
...	Other arguments.

Value

A vector of fitted values.

See Also

[fitted.unrestricted](#), [fitted.restricted](#), [fitted.improvedpreliminaryTest](#), [fitted.stein](#),
[fitted.positivestein](#)

Examples

```
n_obs <- 100  
p_vars <- 5  
beta <- c(2, 1, 3, 0, 5)  
simulated_data <- simdata(n = n_obs, p = p_vars, beta)  
X <- simulated_data$X  
y <- simulated_data$y  
p <- ncol(X)  
# H beta = h  
H <- matrix(c(1, 1, -1, 0, 0, 1, 0, 1, 0, -1, 0, 0, 0, 1, 0), nrow = 3, ncol = p, byrow = TRUE)  
h <- rep(0, nrow(H))  
model <- ptReg(X, y, H, h, alpha = 0.05)  
fitted(model)
```

fitted.restricted	<i>Extract Model Fitted Values</i>
-------------------	------------------------------------

Description

Fitted values based on object restrcited.

Usage

```
## S3 method for class 'restricted'  
fitted(object, ...)
```

Arguments

object	An object of class restricted.
...	Other arguments.

Value

Fitted values extracted from the object restricted.

See Also

[fitted.unrestricted](#), [fitted.preliminaryTest](#), [fitted.improvedpreliminaryTest](#), [fitted.stein](#),
[fitted.positivestein](#)

Examples

```
n_obs <- 100  
p_vars <- 5  
beta <- c(2, 1, 3, 0, 5)  
simulated_data <- simdata(n = n_obs, p = p_vars, beta)  
X <- simulated_data$X  
y <- simulated_data$y  
p <- ncol(X)  
# H beta = h  
H <- matrix(c(1, 1, -1, 0, 0, 1, 0, 1, 0, -1, 0, 0, 0, 1, 0), nrow = 3, ncol = p, byrow = TRUE)  
h <- rep(0, nrow(H))  
model <- resReg(X, y, H, h)  
fitted(model)
```

fitted.stein	<i>Extract Model Fitted Values</i>
--------------	------------------------------------

Description

Fitted values based on object `stein`.

Usage

```
## S3 method for class 'stein'  
fitted(object, ...)
```

Arguments

<code>object</code>	An object of class <code>stein</code> .
<code>...</code>	Other arguments.

Value

A vector of fitted values.

See Also

[fitted.unrestricted](#), [fitted.restricted](#), [fitted.preliminaryTest](#), [fitted.improvedpreliminaryTest](#), [fitted.positivestein](#)

Examples

```
n_obs <- 100  
p_vars <- 5  
beta <- c(2, 1, 3, 0, 5)  
simulated_data <- simdata(n = n_obs, p = p_vars, beta)  
X <- simulated_data$X  
y <- simulated_data$y  
p <- ncol(X)  
# H beta = h  
H <- matrix(c(1, 1, -1, 0, 0, 1, 0, 1, 0, -1, 0, 0, 0, 1, 0), nr = 3, nc = p, byrow = TRUE)  
h <- rep(0, nrow(H))  
model <- stReg(X, y, H, h)  
fitted(model)
```

fitted.unrestricted	<i>Extract Model Fitted Values</i>
---------------------	------------------------------------

Description

Fitted values based on object unrestricted.

Usage

```
## S3 method for class 'unrestricted'  
fitted(object, ...)
```

Arguments

object	An object of class unrestricted.
...	Other arguments.

Value

A vector of fitted values.

See Also

[fitted.restricted](#), [fitted.preliminaryTest](#), [fitted.improvedpreliminaryTest](#), [fitted.stein](#),
[fitted.positivestein](#).

Examples

```
n_obs <- 100  
p_vars <- 5  
beta <- c(2, 1, 3, 0, 5)  
simulated_data <- simdata(n = n_obs, p = p_vars, beta)  
X <- simulated_data$X  
y <- simulated_data$y  
model <- unrReg(X, y)  
fitted(model)
```

iptReg

*The improved preliminary test estimator***Description**

This function calculates the improved preliminary test estimator. When the error has a normal distribution, this estimator can be calculated by

$$\hat{\beta}^{iPT} = \hat{\beta}^{PT} - d(\hat{\beta}^U - \hat{\beta}^R)\mathcal{L}^{-1}I(\mathcal{L} > F_{q,n-p}(\alpha))$$

and, when the error has a non-normal distribution, by

$$\hat{\beta}^{iPT} = \hat{\beta}^{PT} - d(\hat{\beta}^U - \hat{\beta}^R)\mathcal{L}^{-1}I(\mathcal{L} > \chi_q^2(\alpha))$$

where $I(A)$ denotes an indicator function and

- $\hat{\beta}^{PT}$ is the preliminary test estimator; See [ptReg](#)
- $\hat{\beta}^U$ is the unrestricted estimator; See [unrReg](#).
- $\hat{\beta}^R$ is the restricted estimator; See [resReg](#).
- $\mathcal{L}$ is the test statistic. See [teststat](#);
- $F_{q,n-p}(\alpha)$ is the upper α level critical value of F -distribution with $(q, n - p)$ degrees of freedom, calculated using [qf](#);
- $\chi_q^2(\alpha)$ is the upper α level critical value of χ^2 -distribution with q degree of freedom, calculated using [qchisq](#);
- d is the shrinkage factor;
- α is the significance level.

Usage

```
iptReg(X, y, H, h, alpha, d = NULL, is_error_normal = FALSE)
```

Arguments

X	Matrix with input observations, of dimension $n \times p$; each row is an observation vector.
y	Vector with response observations of size n .
H	A given $q \times p$ matrix.
h	A given $q \times 1$ vector.
alpha	A given significance level.
d	(optional) If not provided (or set to NULL), it will be calculated using $\frac{(q-2) \cdot (n-p)}{q \cdot (n-p+2)}$.
is_error_normal	logical value indicating whether the errors follow a normal distribution. If <code>is_error_normal</code> is TRUE, the distribution of the test statistics for the null hypothesis is F distribution (FDist). On the other hand, if the errors have a non-normal distribution, the asymptotic distribution of the test statistics is χ^2 distribution (Chisquare). By default, <code>is_error_normal</code> is set to FALSE.

Details

The corresponding estimator of σ^2 is

$$s^2 = \frac{1}{n-p} (y - X\hat{\beta}^{iPT})^\top (y - X\hat{\beta}^{iPT}).$$

Value

An object of class `improvedpreliminaryTest` is a list containing at least the following components:

`coef` A named vector of coefficients.

`residuals` The residuals, that is, the response values minus fitted values.

`s2` The estimated variance.

`fitted.values` The fitted values.

References

Saleh, A. K. Md. Ehsanes. (2006). *Theory of Preliminary Test and Stein-Type Estimation With Applications*, Wiley.

Kaciranlar, S., Akdeniz, S. S. F., Styan, G. P. & Werner, H. J. (1999). A new biased estimators in linear regression and detailed analysis of the widely-analysed dataset on portland cement. *Sankhya, Series B*, 61(3), 443-459.

Kibria, B. M. Golam (2005). Applications of Some Improved Estimators in Linear Regression, *Journal of Modern Applied Statistical Methods*, 5(2), 367- 380.

Examples

```
n_obs <- 100
p_vars <- 5
beta <- c(2, 1, 3, 0, 5)
simulated_data <- simdata(n = n_obs, p = p_vars, beta)
X <- simulated_data$X
y <- simulated_data$y
p <- ncol(X)
# H beta = h
H <- matrix(c(1, 1, -1, 0, 0, 1, 0, 1, 0, -1, 0, 0, 0, 1, 0), nrow = 3, ncol = p, byrow = TRUE)
h <- rep(0, nrow(H))
iptReg(X, y, H, h, alpha = 0.05)

# H beta != h
p <- ncol(X)
H <- matrix(c(1, 1, -1, 0, 0, 1, 0, 1, 0, -1, 0, 0, 0, 1, 0), nrow = 3, ncol = p, byrow = TRUE)
h <- rep(1, nrow(H))
iptReg(X, y, H, h, alpha = 0.05)

data(cement)
X <- as.matrix(cbind(1, cement[, 1:4]))
y <- cement$y
# Based on Kaciranlar et al. (1999)
```

```
H <- matrix(c(0, 1, -1, 1, 0), nrow = 1, ncol = 5, byrow = TRUE)
h <- rep(0, nrow(H))
iptReg(X, y, H, h, alpha = 0.05)
# Based on Kibria (2005)
H <- matrix(c(0, 1, -1, 1, 0, 0, 0, 1, -1, -1, 0, 1, -1, 0, -1), nrow = 3, ncol = 5, byrow = TRUE)
h <- rep(0, nrow(H))
iptReg(X, y, H, h, alpha = 0.05)
```

```
predict.improvedpreliminaryTest
```

Extract Model Predictions Values

Description

Predicted values based on object improvedpreliminaryTest.

Usage

```
## S3 method for class 'improvedpreliminaryTest'
predict(object, newdata, ...)
```

Arguments

object	An object of class "improvedpreliminaryTest".
newdata	An optional data frame in which to look for variables with which to predict. If omitted, the fitted values are used.
...	Other arguments.

Value

A vector of predictions.

See Also

[predict.unrestricted](#), [predict.restricted](#), [predict.preliminaryTest](#), [predict.stein](#), [predict.positivestein](#).

Examples

```
n_obs <- 100
p_vars <- 5
beta <- c(2, 1, 3, 0, 5)
simulated_data <- simdata(n = n_obs, p = p_vars, beta)
X <- simulated_data$X
y <- simulated_data$y
p <- ncol(X)
# H beta = h
H <- matrix(c(1, 1, -1, 0, 0, 1, 0, 1, 0, -1, 0, 0, 0, 1, 0), nrow = 3, ncol = p, byrow = TRUE)
h <- rep(0, nrow(H))
model <- iptReg(X, y, H, h, alpha = 0.05)
```

```
predict(model, X)
```

`predict.positivestein` *Extract Model Predictions Values*

Description

Predicted values based on object `positivestein`.

Usage

```
## S3 method for class 'positivestein'
predict(object, newdata, ...)
```

Arguments

<code>object</code>	An object of class "positivestein".
<code>newdata</code>	An optional data frame in which to look for variables with which to predict. If omitted, the fitted values are used.
<code>...</code>	Other arguments.

Value

A vector of predictions.

See Also

[predict.unrestricted](#), [predict.restricted](#), [predict.preliminaryTest](#), [predict.improvedpreliminaryTest](#), [predict.stein](#).

Examples

```
n_obs <- 100
p_vars <- 5
beta <- c(2, 1, 3, 0, 5)
simulated_data <- simdata(n = n_obs, p = p_vars, beta)
X <- simulated_data$X
y <- simulated_data$y
p <- ncol(X)
# H beta = h
H <- matrix(c(1, 1, -1, 0, 0, 1, 0, 1, 0, -1, 0, 0, 0, 1, 0), nrow = 3, ncol = p, byrow = TRUE)
h <- rep(0, nrow(H))
model <- prstReg(X, y, H, h)
predict(model, X)
```

`predict.preliminaryTest`*Extract Model Predictions Values*

Description

Predicted values based on object `preliminaryTest`.

Usage

```
## S3 method for class 'preliminaryTest'
predict(object, newdata, ...)
```

Arguments

<code>object</code>	An object of class "preliminaryTest".
<code>newdata</code>	An optional data frame in which to look for variables with which to predict. If omitted, the fitted values are used.
<code>...</code>	Other arguments.

Value

A vector of predictions.

See Also

[predict.unrestricted](#), [predict.restricted](#), [predict.improvedpreliminaryTest](#), [predict.stein](#), [predict.positivestein](#).

Examples

```
n_obs <- 100
p_vars <- 5
beta <- c(2, 1, 3, 0, 5)
simulated_data <- simdata(n = n_obs, p = p_vars, beta)
X <- simulated_data$X
y <- simulated_data$y
p <- ncol(X)
# H beta = h
H <- matrix(c(1, 1, -1, 0, 0, 1, 0, 1, 0, -1, 0, 0, 0, 1, 0), nrow = 3, ncol = p, byrow = TRUE)
h <- rep(0, nrow(H))
model <- ptReg(X, y, H, h, alpha = 0.05)
predict(model, X)
```

predict.restricted *Extract Model Predictions Values*

Description

Predicted values based on object restrcited.

Usage

```
## S3 method for class 'restricted'
predict(object, newdata, ...)
```

Arguments

object	An object of class restricted.
newdata	An optional data frame in which to look for variables with which to predict. If omitted, the fitted values are used.
...	Other arguments.

Value

A vector of predictions.

See Also

[predict.unrestricted](#), [predict.preliminaryTest](#), [predict.improvedpreliminaryTest](#), [predict.stein](#), [predict.positivestein](#).

Examples

```
n_obs <- 100
p_vars <- 5
beta <- c(2, 1, 3, 0, 5)
simulated_data <- simdata(n = n_obs, p = p_vars, beta)
X <- simulated_data$X
y <- simulated_data$y
p <- ncol(X)
# H beta = h
H <- matrix(c(1, 1, -1, 0, 0, 1, 0, 1, 0, -1, 0, 0, 0, 1, 0), nrow = 3, ncol = p, byrow = TRUE)
h <- rep(0, nrow(H))
model <- resReg(X, y, H, h)
predict(model, X)
```

predict.stein	<i>Extract Model Predictions Values</i>
---------------	---

Description

Predicted values based on object stein.

Usage

```
## S3 method for class 'stein'
predict(object, newdata, ...)
```

Arguments

object	An object of class "stein".
newdata	An optional data frame in which to look for variables with which to predict. If omitted, the fitted values are used.
...	Other arguments.

Value

A vector of predictions.

See Also

[predict.unrestricted](#), [predict.restricted](#), [predict.preliminaryTest](#), [predict.improvedpreliminaryTest](#), [predict.positivestein](#).

Examples

```
n_obs <- 100
p_vars <- 5
beta <- c(2, 1, 3, 0, 5)
simulated_data <- simdata(n = n_obs, p = p_vars, beta)
X <- simulated_data$X
y <- simulated_data$y
p <- ncol(X)
# H beta = h
H <- matrix(c(1, 1, -1, 0, 0, 1, 0, 1, 0, -1, 0, 0, 0, 1, 0), nr = 3, nc = p, byrow = TRUE)
h <- rep(0, nrow(H))
model <- stReg(X, y, H, h)
predict(model, X)
```

predict.unrestricted *Extract Model Predictions Values*

Description

Predicted values based on object unrestricted.

Usage

```
## S3 method for class 'unrestricted'  
predict(object, newdata, ...)
```

Arguments

object	An object of class unrestricted.
newdata	An optional data frame in which to look for variables with which to predict. If omitted, the fitted values are used.
...	Other arguments.

Value

A vector of predictions.

See Also

[predict.restricted](#), [predict.preliminaryTest](#), [predict.improvedpreliminaryTest](#), [predict.stein](#), [predict.positivestein](#).

Examples

```
n_obs <- 100  
p_vars <- 5  
beta <- c(2, 1, 3, 0, 5)  
simulated_data <- simdata(n = n_obs, p = p_vars, beta)  
X <- simulated_data$X  
y <- simulated_data$y  
model <- unrReg(X, y)  
predict(model, X)
```

prstReg

*The positive-rule Stein estimator***Description**

This function calculates the positive-rule Stein estimator. This estimator is an improved version of the Stein estimator, where only the positive part of the shrinking factor is considered. It may be calculated by

$$\hat{\beta}^{S+} = \hat{\beta}^S + (1 + d\mathcal{L}^{-1})I(\mathcal{L} > d)(\hat{\beta}^U - \hat{\beta}^R)$$

where $I(A)$ denotes an indicator function and

- $\hat{\beta}^S$ is the Stein estimator; See [stReg](#).
- $\hat{\beta}^U$ is the unrestricted estimator; See [unrReg](#).
- $\hat{\beta}^R$ is the restricted estimator; See [resReg](#).
- $\mathcal{L}$ is the test statistic. See [teststat](#);
- d is the shrinkage factor.

Usage

```
prstReg(X, y, H, h, d = NULL, is_error_normal = FALSE)
```

Arguments

X	Matrix with input observations, of dimension $n \times p$; each row is an observation vector.
y	Vector with response observations of size n .
H	A given $q \times p$ matrix.
h	A given $q \times 1$ vector.
d	(optional) If not provided (or set to NULL), it will be calculated using $\frac{(q-2) \cdot (n-p)}{q \cdot (n-p+2)}$.
is_error_normal	logical value indicating whether the errors follow a normal distribution. If <code>is_error_normal</code> is TRUE, the distribution of the test statistics for the null hypothesis is F distribution (FDist). On the other hand, if the errors have a non-normal distribution, the asymptotic distribution of the test statistics is χ^2 distribution (Chisquare). By default, <code>is_error_normal</code> is set to FALSE.

Details

The corresponding estimator of σ^2 is given by

$$s^2 = \frac{1}{n-p}(y - X\hat{\beta}^{S+})^\top (y - X\hat{\beta}^{S+}).$$

Value

An object of class `pst` is a list containing at least the following components:

`coef` A named vector of coefficients.

`residuals` The residuals, that is, the response values minus fitted values.

`s2` The estimated variance.

`fitted.values` The fitted values.

References

Saleh, A. K. Md. Ehsanes. (2006). *Theory of Preliminary Test and Stein-Type Estimation With Applications*, Wiley.

Kaciranlar, S., Akdeniz, S. S. F., Styan, G. P. & Werner, H. J. (1999). A new biased estimators in linear regression and detailed analysis of the widely-analysed dataset on portland cement. *Sankhya, Series B*, 61(3), 443-459.

Kibria, B. M. Golam (2005). Applications of Some Improved Estimators in Linear Regression, *Journal of Modern Applied Statistical Methods*, 5(2), 367- 380.

Examples

```
n_obs <- 100
p_vars <- 5
beta <- c(2, 1, 3, 0, 5)
simulated_data <- simdata(n = n_obs, p = p_vars, beta)
X <- simulated_data$X
y <- simulated_data$y
p <- ncol(X)
# H beta = h
H <- matrix(c(1, 1, -1, 0, 0, 1, 0, 1, 0, -1, 0, 0, 0, 1, 0), nr = 3, nc = p, byrow = TRUE)
h <- rep(0, nrow(H))
prstReg(X, y, H, h)

# H beta != h
H <- matrix(c(1, 1, -1, 0, 0, 1, 0, 1, 0, -1, 0, 0, 0, 1, 0), nr = 3, nc = p, byrow = TRUE)
h <- rep(1, nrow(H))
prstReg(X, y, H, h)

data(cement)
X <- as.matrix(cbind(1, cement[, 1:4]))
y <- cement$y
# Based on Kaciranlar et al. (1999)
H <- matrix(c(0, 1, -1, 1, 0), nrow = 1, ncol = 5, byrow = TRUE)
h <- rep(0, nrow(H))
prstReg(X, y, H, h)
# Based on Kibria (2005)
H <- matrix(c(0, 1, -1, 1, 0, 0, 0, 1, -1, -1, 0, 1, -1, 0, -1), nrow = 3, ncol = 5, byrow = TRUE)
h <- rep(0, nrow(H))
prstReg(X, y, H, h)
```

Description

This function calculates the preliminary test. When the error has a normal distribution, the test statistic is given by

$$\hat{\beta}^{PT} = \hat{\beta}^U - (\hat{\beta}^U - \hat{\beta}^R)I(\mathcal{L} \leq F_{q,n-p}(\alpha))$$

and, if the error has a non-normal distribution, is given by

$$\hat{\beta}^{PT} = \hat{\beta}^U - (\hat{\beta}^U - \hat{\beta}^R)I(\mathcal{L} \leq \chi_q^2(\alpha))$$

where $I(A)$ denotes an indicator function and

- $\hat{\beta}^U$ is the unrestricted estimator; See [unrReg](#).
- $\hat{\beta}^R$ is the restricted estimator; See [resReg](#).
- $\mathcal{L}$ is the test statistic. See [teststat](#);
- $F_{q,n-p}(\alpha)$ is the upper α level critical value of F -distribution with $(q, n - p)$ degrees of freedom, calculated using [qf](#);
- $\chi_q^2(\alpha)$ is the upper α level critical value of χ^2 -distribution with q degree of freedom, calculated using [qchisq](#);
- α : the significance level.

Usage

```
ptReg(X, y, H, h, alpha, is_error_normal = FALSE)
```

Arguments

X	Matrix with input observations, of dimension $n \times p$; each row is an observation vector.
y	Vector with response observations of size n .
H	A given $q \times p$ matrix.
h	A given $q \times 1$ vector.
alpha	A given significance level.
is_error_normal	logical value indicating whether the errors follow a normal distribution. If <code>is_error_normal</code> is TRUE, the distribution of the test statistics for the null hypothesis is F distribution (FDist). On the other hand, if the errors have a non-normal distribution, the asymptotic distribution of the test statistics is χ^2 distribution (Chisquare). By default, <code>is_error_normal</code> is set to FALSE.

Details

The corresponding estimator of σ^2 is

$$s^2 = \frac{1}{n-p}(y - X\hat{\beta}^{PT})^\top (y - X\hat{\beta}^{PT}).$$

Value

An object of class `preliminaryTest` is a list containing at least the following components:

`coef` A named vector of coefficients.

`residuals` The residuals, that is, the response values minus fitted values.

`s2` The estimated variance.

`fitted.values` The fitted values.

References

Saleh, A. K. Md. Ehsanes. (2006). *Theory of Preliminary Test and Stein-Type Estimation With Applications*, Wiley.

Kaciranlar, S., Akdeniz, S. S. F., Styan, G. P. & Werner, H. J. (1999). A new biased estimators in linear regression and detailed analysis of the widely-analysed dataset on portland cement. *Sankhya, Series B*, 61(3), 443-459.

Kibria, B. M. Golam (2005). Applications of Some Improved Estimators in Linear Regression, *Journal of Modern Applied Statistical Methods*, 5(2), 367- 380.

Examples

```
n_obs <- 100
p_vars <- 5
beta <- c(2, 1, 3, 0, 5)
simulated_data <- simdata(n = n_obs, p = p_vars, beta)
X <- simulated_data$X
y <- simulated_data$y
p <- ncol(X)
# H beta = h
H <- matrix(c(1, 1, -1, 0, 0, 1, 0, 1, 0, -1, 0, 0, 0, 1, 0), nrow = 3, ncol = p, byrow = TRUE)
h <- rep(0, nrow(H))
ptReg(X, y, H, h, alpha = 0.05)

# H beta != h
p <- ncol(X)
H <- matrix(c(1, 1, -1, 0, 0, 1, 0, 1, 0, -1, 0, 0, 0, 1, 0), nrow = 3, ncol = p, byrow = TRUE)
h <- rep(1, nrow(H))
ptReg(X, y, H, h, alpha = 0.05)

data(cement)
X <- as.matrix(cbind(1, cement[, 1:4]))
y <- cement$y
# Based on Kaciranlar et al. (1999)
H <- matrix(c(0, 1, -1, 1, 0), nrow = 1, ncol = 5, byrow = TRUE)
```

```

h <- rep(0, nrow(H))
ptReg(X, y, H, h, alpha = 0.05)
# Based on Kibria (2005)
H <- matrix(c(0, 1, -1, 1, 0, 0, 0, 1, -1, -1, 0, 1, -1, 0, -1), nrow = 3, ncol = 5, byrow = TRUE)
h <- rep(0, nrow(H))
ptReg(X, y, H, h, alpha = 0.05)

```

```

residuals.improvedpreliminaryTest
      Extract Model Residuals

```

Description

Residuals values based on model object improvedpreliminaryTest.

Usage

```

## S3 method for class 'improvedpreliminaryTest'
residuals(object, ...)

```

Arguments

object	An object of class improvedpreliminaryTest.
...	Other arguments.

Value

A vector of residuals.

See Also

[residuals.unrestricted](#), [residuals.restricted](#), [residuals.preliminaryTest](#), [residuals.stein](#), [residuals.positivestein](#),

Examples

```

n_obs <- 100
p_vars <- 5
beta <- c(2, 1, 3, 0, 5)
simulated_data <- simdata(n = n_obs, p = p_vars, beta)
X <- simulated_data$X
y <- simulated_data$y
p <- ncol(X)
# H beta = h
H <- matrix(c(1, 1, -1, 0, 0, 1, 0, 1, 0, -1, 0, 0, 0, 1, 0), nrow = 3, ncol = p, byrow = TRUE)
h <- rep(0, nrow(H))
model <- iptReg(X, y, H, h, alpha = 0.05)
residuals(model)

```

`residuals.positivestein`*Extract Model Residuals*

Description

Residuals values based on model object `positivestein`.

Usage

```
## S3 method for class 'positivestein'  
residuals(object, ...)
```

Arguments

<code>object</code>	An object of class <code>positivestein</code> .
<code>...</code>	Other arguments.

Value

A vector of residuals.

See Also

[residuals.unrestricted](#), [residuals.restricted](#), [residuals.preliminaryTest](#), [residuals.improvedpreliminary](#),
[residuals.stein](#).

Examples

```
n_obs <- 100  
p_vars <- 5  
beta <- c(2, 1, 3, 0, 5)  
simulated_data <- simdata(n = n_obs, p = p_vars, beta)  
X <- simulated_data$X  
y <- simulated_data$y  
p <- ncol(X)  
# H beta = h  
H <- matrix(c(1, 1, -1, 0, 0, 1, 0, 1, 0, -1, 0, 0, 0, 1, 0), nrow = 3, ncol = p, byrow = TRUE)  
h <- rep(0, nrow(H))  
model <- prstReg(X, y, H, h)  
residuals(model)
```

`residuals.preliminaryTest`*Extract Model Residuals*

Description

Residuals values based on model object `preliminaryTest`.

Usage

```
## S3 method for class 'preliminaryTest'  
residuals(object, ...)
```

Arguments

<code>object</code>	An object of class <code>preliminaryTest</code> .
<code>...</code>	Other arguments.

Value

A vector of residuals.

See Also

[residuals.unrestricted](#), [residuals.restricted](#), [residuals.improvedpreliminaryTest](#), [residuals.stein](#),
[residuals.positivestein](#).

Examples

```
n_obs <- 100  
p_vars <- 5  
beta <- c(2, 1, 3, 0, 5)  
simulated_data <- simdata(n = n_obs, p = p_vars, beta)  
X <- simulated_data$X  
y <- simulated_data$y  
p <- ncol(X)  
# H beta = h  
H <- matrix(c(1, 1, -1, 0, 0, 1, 0, 1, 0, -1, 0, 0, 0, 1, 0), nrow = 3, ncol = p, byrow = TRUE)  
h <- rep(0, nrow(H))  
model <- ptReg(X, y, H, h, alpha = 0.05)  
residuals(model)
```

residuals.restricted	<i>Extract Model Residuals</i>
----------------------	--------------------------------

Description

Residuals values based on model object restricted.

Usage

```
## S3 method for class 'restricted'
residuals(object, ...)
```

Arguments

object	An object of class restricted.
...	Other arguments.

Value

A vector of residuals.

[residuals.unrestricted](#), [residuals.preliminaryTest](#), [residuals.improvedpreliminaryTest](#),
[residuals.stein](#), [residuals.positivestein](#).

Examples

```
n_obs <- 100
p_vars <- 5
beta <- c(2, 1, 3, 0, 5)
simulated_data <- simdata(n = n_obs, p = p_vars, beta)
X <- simulated_data$X
y <- simulated_data$y
p <- ncol(X)
# H beta = h
H <- matrix(c(1, 1, -1, 0, 0, 1, 0, 1, 0, -1, 0, 0, 0, 1, 0), nrow = 3, ncol = p, byrow = TRUE)
h <- rep(0, nrow(H))
model <- resReg(X, y, H, h)
residuals(model)
```

residuals.stein	<i>Extract Model Residuals</i>
-----------------	--------------------------------

Description

Residuals values based on model object stein.

Usage

```
## S3 method for class 'stein'
residuals(object, ...)
```

Arguments

`object` An object of class `stein`.
`...` Other arguments.

Value

A vector of residuals.

See Also

[residuals.unrestricted](#), [residuals.restricted](#), [residuals.preliminaryTest](#), [residuals.improvedpreliminaryTest](#),
[residuals.positivestein](#),.

Examples

```
n_obs <- 100
p_vars <- 5
beta <- c(2, 1, 3, 0, 5)
simulated_data <- simdata(n = n_obs, p = p_vars, beta)
X <- simulated_data$X
y <- simulated_data$y
p <- ncol(X)
# H beta = h
H <- matrix(c(1, 1, -1, 0, 0, 1, 0, 1, 0, -1, 0, 0, 0, 1, 0), nr = 3, nc = p, byrow = TRUE)
h <- rep(0, nrow(H))
model <- stReg(X, y, H, h)
residuals(model)
```

```
residuals.unrestricted
```

Extract Model Residuals

Description

Residuals values based on model object `unrestricted`.

Usage

```
## S3 method for class 'unrestricted'
residuals(object, ...)
```

Arguments

object An object of class unrestricted.
 ... Other arguments.

Value

A vector of residuals.

See Also

[residuals.restricted](#), [residuals.preliminaryTest](#), [residuals.improvedpreliminaryTest](#)
[residuals.stein](#), [residuals.positivestein](#).

Examples

```
n_obs <- 100
p_vars <- 5
beta <- c(2, 1, 3, 0, 5)
simulated_data <- simdata(n = n_obs, p = p_vars, beta)
X <- simulated_data$X
y <- simulated_data$y
model <- unrReg(X, y)
residuals(model)
```

resReg

The restricted estimator

Description

This function calculates the restricted estimator using

$$\hat{\beta}^R = \hat{\beta}^U - (X^\top X)^{-1} H^\top (H(X^\top X)^{-1} H^\top)^{-1} (H \hat{\beta}^U - h)$$

where

- $\hat{\beta}^U$ is the unrestricted estimator; See [unrReg](#).
- $H\beta = h$ represents a subspace of the parameter space induced by the non-sample information. Here, H is a known $q \times p$ matrix, and h is a known q -vector.

Usage

```
resReg(X, y, H, h)
```

Arguments

X Matrix with input observations, of dimension $n \times p$; each row is an observation vector.
 y Vector with response observations of size n .
 H A given $q \times p$ matrix.
 h A given $q \times 1$ vector.

Details

The corresponding estimator of σ^2 is

$$s^2 = \frac{1}{n-p} (y - X\hat{\beta}^R)^\top (y - X\hat{\beta}^R).$$

Value

An object of class `restricted` is a list containing at least the following components:

`coef` A named vector of coefficients.

`residuals` The residuals, that is, the response values minus fitted values.

`s2` The estimated variance.

`fitted.values` The fitted values.

References

Saleh, A. K. Md. Ehsanes. (2006). *Theory of Preliminary Test and Stein-Type Estimation With Applications*, Wiley.

Kaciranlar, S., Akdeniz, S. S. F., Styan, G. P. & Werner, H. J. (1999). A new biased estimators in linear regression and detailed analysis of the widely-analysed dataset on portland cement. *Sankhya, Series B*, 61(3), 443-459.

Kibria, B. M. Golam (2005). Applications of Some Improved Estimators in Linear Regression, *Journal of Modern Applied Statistical Methods*, 5(2), 367- 380.

Examples

```
n_obs <- 100
p_vars <- 5
beta <- c(2, 1, 3, 0, 5)
simulated_data <- simdata(n = n_obs, p = p_vars, beta)
X <- simulated_data$X
y <- simulated_data$y
p <- ncol(X)
# H beta = h
H <- matrix(c(1, 1, -1, 0, 0, 1, 0, 1, 0, -1, 0, 0, 0, 1, 0), nrow = 3, ncol = p, byrow = TRUE)
h <- rep(0, nrow(H))
resReg(X, y, H, h)

# H beta != h
H <- matrix(c(1, 1, -1, 0, 0, 1, 0, 1, 0, -1, 0, 0, 0, 1, 0), nrow = 3, ncol = p, byrow = TRUE)
h <- rep(1, nrow(H))
resReg(X, y, H, h)

data(cement)
X <- as.matrix(cbind(1, cement[, 1:4]))
y <- cement$y
# Based on Kaciranlar et al. (1999)
H <- matrix(c(0, 1, -1, 1, 0), nrow = 1, ncol = 5, byrow = TRUE)
```

```

h <- rep(0, nrow(H))
resReg(X, y, H, h)
# Based on Kibria (2005)
H <- matrix(c(0, 1, -1, 1, 0, 0, 0, 1, -1, -1, 0, 1, -1, 0, -1), nrow = 3, ncol = 5, byrow = TRUE)
h <- rep(0, nrow(H))
resReg(X, y, H, h)

```

simdata

Simulation data

Description

This function generates a toy example. The error term, ε , and the design matrix, X , are simulated from standard normal distributions, $\mathcal{N}(0, 1)$, using the `rnorm` function. Given the true parameter vector, β , the response vector, y , is calculated as

$$y = X\beta + \varepsilon.$$

Usage

```
simdata(n, p, beta, seed = NULL)
```

Arguments

<code>n</code>	Number of observations.
<code>p</code>	Number of variables.
<code>beta</code>	Regression parameter.
<code>seed</code>	(Optional) The random seed for reproducibility. Default is NULL.

Value

A list containing the following components:

X a matrix of dimensions $n \times p$.
y a numeric vector of length n .

References

Saleh, A. K. Md. Ehsanes. (2006). *Theory of Preliminary Test and Stein-Type Estimation With Applications*, Wiley.

Examples

```

simulated_data <- simdata(n = 100, p = 5, beta = c(2, 1, 3, 0, 5))
X <- simulated_data$X
y <- simulated_data$y
X
y

```

stReg

*The Stein estimator***Description**

This function can be used to calculate the Stein estimator using

$$\hat{\beta}^S = \hat{\beta}^U - d\mathcal{L}^{-1}(\hat{\beta}^U - \hat{\beta}^R)$$

where

- $\hat{\beta}^U$ is the unrestricted estimator; See [unrReg](#).
- $\hat{\beta}^R$ is the restricted estimator; See [resReg](#).
- $\mathcal{L}$ is the test statistic. See [teststat](#);
- d is the shrinkage factor.

Usage

```
stReg(X, y, H, h, d = NULL, is_error_normal = FALSE)
```

Arguments

X	Matrix with input observations, of dimension n x p; each row is an observation vector.
y	Vector with response observations of size n.
H	A given q x p matrix.
h	A given q x 1 vector.
d	(Optional) If not provided (or set to NULL), it will be set to be equal to $\frac{(q-2) \cdot (n-p)}{q \cdot (n-p+2)}$.
is_error_normal	logical value indicating whether the errors follow a normal distribution. If is_error_normal is TRUE, the distribution of the test statistics for the null hypothesis is FDist . On the other hand, if the errors have a non-normal distribution, the asymptotic distribution of the test statistics is Chisquare . By default, is_error_normal is set to FALSE.

Details

The corresponding estimator of σ^2 is

$$s^2 = \frac{1}{n-p} (y - X\hat{\beta}^S)^\top (y - X\hat{\beta}^S).$$

Value

An object of class `stein` is a list containing at least the following components:

`coef` A vector of coefficients.

`residuals` The residuals, that is, the response values minus the fitted values.

`s2` The estimated variance.

`fitted.values` The fitted values.

References

Saleh, A. K. Md. Ehsanes. (2006). *Theory of Preliminary Test and Stein-Type Estimation With Applications*, Wiley.

Kaciranlar, S., Akdeniz, S. S. F., Styan, G. P. & Werner, H. J. (1999). A new biased estimators in linear regression and detailed analysis of the widely-analysed dataset on portland cement. *Sankhya, Series B*, 61(3), 443-459.

Kibria, B. M. Golam (2005). Applications of Some Improved Estimators in Linear Regression, *Journal of Modern Applied Statistical Methods*, 5(2), 367- 380.

Examples

```
n_obs <- 100
p_vars <- 5
beta <- c(2, 1, 3, 0, 5)
simulated_data <- simdata(n = n_obs, p = p_vars, beta)
X <- simulated_data$X
y <- simulated_data$y
p <- ncol(X)
# H beta = h
H <- matrix(c(1, 1, -1, 0, 0, 1, 0, 1, 0, -1, 0, 0, 0, 1, 0), nrow = 3, ncol = p, byrow = TRUE)
h <- rep(0, nrow(H))
stReg(X, y, H, h)

# H beta != h
H <- matrix(c(1, 1, -1, 0, 0, 1, 0, 1, 0, -1, 0, 0, 0, 1, 0), nrow = 3, ncol = p, byrow = TRUE)
h <- rep(1, nrow(H))
stReg(X, y, H, h)

data(cement)
X <- as.matrix(cbind(1, cement[, 1:4]))
y <- cement$y
# Based on Kaciranlar et al. (1999)
H <- matrix(c(0, 1, -1, 1, 0), nrow = 1, ncol = 5, byrow = TRUE)
h <- rep(0, nrow(H))
stReg(X, y, H, h)
# Based on Kibria (2005)
H <- matrix(c(0, 1, -1, 1, 0, 0, 0, 1, -1, -1, 0, 1, -1, 0, -1), nrow = 3, ncol = 5, byrow = TRUE)
h <- rep(0, nrow(H))
stReg(X, y, H, h)
```

teststat	<i>Test-Statistics</i>
----------	------------------------

Description

This function calculates the test statistics, assuming $\mathcal{H}_0 : H\beta = h$. When the error has a normal distribution, it is defined as

$$\mathcal{L} = \frac{(H\hat{\beta}^U - h)^\top (H(X^\top X)^{-1}H^\top)^{-1}(H\hat{\beta}^U - h)}{qs_{unr}^2}$$

and when the error has a non-normal distribution, as

$$\mathcal{L} = \frac{(H\hat{\beta}^U - h)^\top (H(X^\top X)^{-1}H^\top)^{-1}(H\hat{\beta}^U - h)}{s_{unr}^2}$$

where

- $\hat{\beta}^U$ is the unrestricted estimator; See [unrReg](#).
- q is the number of restrictions, i.e., the number of rows of known matrix H ;
- s_{unr}^2 is the corresponding unrestricted estimator of σ^2 .

Usage

```
teststat(X, y, H, h, is_error_normal = FALSE)
```

Arguments

X	Matrix with input observations, of dimension n x p; each row is an observation vector.
y	Vector with response observations of size n.
H	A given q x p matrix.
h	A given q x 1 vector.
is_error_normal	logical value indicating whether the errors follow a normal distribution. If is_error_normal is TRUE, the distribution of the test statistics for the null hypothesis is the F distribution (FDist). On the other hand, if the errors have a non-normal distribution, the asymptotic distribution of the test statistics is the χ^2 distribution (Chisquare). By default, is_error_normal is set to FALSE.

Value

The value of the test statistic.

References

- Saleh, A. K. Md. Ehsanes. (2006). *Theory of Preliminary Test and Stein-Type Estimation With Applications*, Wiley.
- Kaciranlar, S., Akdeniz, S. S. F., Styan, G. P. & Werner, H. J. (1999). A new biased estimators in linear regression and detailed analysis of the widely-analysed dataset on portland cement. *Sankhya, Series B*, 61(3), 443-459.
- Kibria, B. M. Golam (2005). Applications of Some Improved Estimators in Linear Regression, *Journal of Modern Applied Statistical Methods*, 5(2), 367- 380.

Examples

```
n_obs <- 100
p_vars <- 5
beta <- c(2, 1, 3, 0, 5)
simulated_data <- simdata(n = n_obs, p_vars, beta)
X <- simulated_data$X
y <- simulated_data$y
p <- ncol(X)
# H beta = h
H <- matrix(c(1, 1, -1, 0, 0, 1, 0, 1, 0, -1, 0, 0, 0, 1, 0), nrow = 3, ncol = p, byrow = TRUE)
h <- rep(0, nrow(H))
teststat(X, y, H, h)

# H beta != h
H <- matrix(c(1, 1, -1, 0, 0, 1, 0, 1, 0, -1, 0, 0, 0, 1, 0), nrow = 3, ncol = p, byrow = TRUE)
h <- rep(1, nrow(H))
teststat(X, y, H, h)

data(cement)
X <- as.matrix(cbind(1, cement[, 1:4]))
y <- cement$y
# Based on Kaciranlar et al. (1999)
H <- matrix(c(0, 1, -1, 1, 0), nrow = 1, ncol = 5, byrow = TRUE)
h <- rep(0, nrow(H))
teststat(X, y, H, h)
# Based on Kibria (2005)
H <- matrix(c(0, 1, -1, 1, 0, 0, 0, 1, -1, -1, 0, 1, -1, 0, -1), nrow = 3, ncol = 5, byrow = TRUE)
h <- rep(0, nrow(H))
teststat(X, y, H, h)
```

unrReg

The Unrestricted estimator

Description

This function calculates the unrestricted estimator as

$$\hat{\beta}^U = (X^\top X)^{-1} X^\top y$$

where $^{\top}$ denotes the transpose of a matrix. It is important to note that the input matrices X and y should be standardized, for example, by using `scale`. Alternatively, the user can employ `lm` to obtain this estimator, but it is crucial to remember to set `intercept = FALSE`.

Usage

```
unrReg(X, y)
```

Arguments

<code>X</code>	Matrix with input observations, of dimension $n \times p$, where each row is an observation vector;
<code>y</code>	Vector with response observations of size n .

Details

The corresponding unrestricted estimator of σ^2 is

$$s^2 = \frac{1}{n-p} (y - X\hat{\beta}^U)^{\top} (y - X\hat{\beta}^U).$$

Value

An object of class `unrestricted` is a list containing at least the following components:

`coef` A named vector of coefficients.
`residuals` The residuals, that is, the response values minus fitted values.
`s2` The estimated variance.
`fitted.values` The fitted values.

References

Saleh, A. K. Md. Ehsanes. (2006). *Theory of Preliminary Test and Stein-Type Estimation With Applications*, Wiley.

Examples

```
data(cement)
n_obs <- 100
p_vars <- 5
beta <- c(2, 1, 3, 0, 5)
simulated_data <- simdata(n = n_obs, p = p_vars, beta)
X <- simulated_data$X
y <- simulated_data$y
unrReg(X, y)

data(cement)
X <- as.matrix(cbind(1, cement[, 1:4]))
y <- cement$y
# Based on Kaciranlar et al. (1999)
H <- matrix(c(0, 1, -1, 1, 0), nrow = 1, ncol = 5, byrow = TRUE)
```

```
h <- rep(0, nrow(H))  
unrReg(X, y)
```

```
H <- matrix(c(0, 1, -1, 1, 0, 0, 0, 1, -1, -1, 0, 1, -1, 0, -1), nrow = 3, ncol = 5, byrow = TRUE)  
h <- rep(0, nrow(H))  
unrReg(X, y)
```

Index

cement, 2
Chisquare, 15, 23, 25, 35, 37
coef.improvedpreliminaryTest, 4–8
coef.improvedpreliminaryTest
 (coefficients.improvedpreliminaryTest), 3
coef.positivestein, 3, 5–8
coef.positivestein
 (coefficients.positivestein), 4
coef.preliminaryTest, 4, 6–8
coef.preliminaryTest
 (coefficients.preliminaryTest), 5
coef.restricted, 3–5, 7, 8
coef.restricted
 (coefficients.restricted), 6
coef.stein, 3–6, 8
coef.stein(coefficients.stein), 7
coef.unrestricted, 3–7
coef.unrestricted
 (coefficients.unrestricted), 8
coefficients.improvedpreliminaryTest, 3, 4–8
coefficients.positivestein, 3, 4, 5–8
coefficients.preliminaryTest, 3, 4, 5, 6–8
coefficients.restricted, 3–5, 6, 7, 8
coefficients.stein, 3–6, 7, 8
coefficients.unrestricted, 3–7, 8

FDist, 15, 23, 25, 35, 37
fitted.improvedpreliminaryTest, 9, 10–14
fitted.positivestein, 9, 10, 11–14
fitted.preliminaryTest, 9, 10, 11, 12–14
fitted.restricted, 9–11, 12, 13, 14
fitted.stein, 9–12, 13, 14
fitted.unrestricted, 9–13, 14

iptReg, 15

lm, 39

predict.improvedpreliminaryTest, 17, 18–22
predict.positivestein, 17, 18, 19–22
predict.preliminaryTest, 17, 18, 19, 20–22
predict.restricted, 17–19, 20, 21, 22
predict.stein, 17–20, 21, 22
predict.unrestricted, 17–21, 22
prstReg, 23
ptReg, 15, 25

qchisq, 15, 25
qf, 15, 25

residuals.improvedpreliminaryTest, 27, 28–32
residuals.positivestein, 27, 28, 29–32
residuals.preliminaryTest, 27, 28, 29, 30–32
residuals.restricted, 27–29, 30, 31, 32
residuals.stein, 27–30, 30, 32
residuals.unrestricted, 27–31, 31
resReg, 15, 23, 25, 32, 35
rnorm, 34

scale, 39
simdata, 34
stReg, 23, 35

teststat, 15, 23, 25, 35, 37
unrReg, 15, 23, 25, 32, 35, 37, 38