Package ‘wast’

September 27, 2022

Type Package

Title Change-plane testing in the generalized estimating equations

Version 1.0.1

Author Xu Liu [aut,cre]

Maintainer Xu Liu <liu.xu@sufe.edu.cn>

Description Provide a method to calculate p-value of the test statistic for subgroup detecting in in the framework of general estimating equation (EE). In the paper Liu (2022), we propose a novel U-like statistic by taking the weighted average over the nuisance parametric space. The proposed test statistics not only improve power, but also save dramatically computational time. Many common and useful models are considered, including models with change point or change plane. We propose a novel U-like test statistic to detect multiple change planes in the framework of EE.

License GPL (>= 2)

Depends R (>= 3.2.0)

LazyData true

NeedsCompilation yes

Repository github

URL https://github.com/xliusufe/wast

Encoding UTF-8

Archs i386, x64

R topics documented:

`wast-package` *Change-plane testing in the generalized estimating equations*

Description

Provide a method to calculate p-value of the test statistic for subgroup detecting in in the framework of general estimating equation (EE). In the paper Liu (2022), we propose a novel U-like statistic by taking the weighted average over the nuisance parametric space. The proposed test statistics not only improve power, but also save dramatically computational time. Many common and useful models are considered, including models with change point or change plane. We propose a novel U-like test statistic to detect multiple change planes in the framework of EE.

Details

Package:	wast
Type:	Package
Version:	1.0.1
Date:	2022-05-5
License:	GPL (>= 2)

References

Andrews, D. W. K. and Ploberger, W. (1994). Optimal tests when a nuisance parameter is present only under the alternative. Econometrica, 62(6):1383-1414.

Fan, A., Rui, S., and Lu, W. (2017). Change-plane analysis for subgroup detection and sample size calculation. Journal of the American Statistical Association, 112(518):769-778.

Huang, Y., Cho, J., and Fong, Y. (2021). Threshold-based subgroup testing in logistic regression models in two phase sampling designs. Journal of the Royal Statistical Society: Series C. 291-311.

Liu, X. (2022). Change-plane testing in the generalized estimating equations. Manuscript.

`estglm` *Estimation in Generalized Linear Models with subgroups*

Description

Provide estimators of coefficients in generalized linear models with subgroups.

Usage

```
estglm(data, family = "gaussian", h = NULL, smooth = "sigmoid", maxIter = 100, tol = 0.0001)
```

Arguments

`data` A list, including Y (response), X (baseline variable), Z (grouping difference variable), and U (grouping variable).

`family` Family for generalized linear models, including 'gaussian', 'binomial', and 'poisson'.

`h` A numeric number, which is the bandwidth in the smooth function. Default is `h = log(n)/sqrt(n)`.

`smooth` The smooth function. Either "sigmoid" (the default), "pnorm", or "mixnorm", see details below.

`maxIter` An integer, the maximum number of iterations. Default is `maxIter = 100`.

`tol` Convergence threshhold. Default is `tol = 0.0001`.

Details

Generalized linear models

$$f(\boldsymbol{V}_i;\boldsymbol{\alpha},\boldsymbol{\beta},\boldsymbol{\gamma}) = \exp\left\{\frac{y_i\mu_i - c(\mu_i)}{a(\phi)}\right\}h(y_i),$$

where

$$\mu_i = \boldsymbol{X}_i^T\boldsymbol{\alpha} + \boldsymbol{Z}_i^T\boldsymbol{\beta}\mathbf{1}(\boldsymbol{U}_i^T\boldsymbol{\gamma} \geq 0).$$

The smooth functioms:

- (a) sigmoid function ("sigmoid")

$$S(u) = 1/(1+e^{-u});$$

- (b) norm CDF ("pnorm")

$$S(u) = \Phi(u);$$

- (c) mixture of norm CDF and density ("mixnorm")

$$S(u) = \Phi(u) + u\phi(u),$$

where $\Phi(u)$ and $\phi(u)$ are the CDF and density of starndard norm distribution, that is,

$$\Phi(u) = \int_{-\infty}^{u}\frac{1}{2\pi}\exp\left(-\frac{s^2}{2}\right)ds,$$

and

$$\phi(u) = \frac{1}{2\pi}\exp\left(-\frac{u^2}{2}\right).$$

Value

`alpha` Estimator of the baseline parameter $\boldsymbol{\alpha}$.

`beta` Estimator of the grouping difference parameter $\boldsymbol{\beta}$.

`gamma` Estimator of the grouping parameter $\boldsymbol{\gamma}$.

`delta` A vector with length n. Estimator of the indicator function $I(\boldsymbol{U}^T\boldsymbol{\gamma} \geq 0)$.

References

Andrews, D. W. K. and Ploberger, W. (1994). Optimal tests when a nuisance parameter is present only under the alternative. Econometrica, 62(6):1383-1414.

Fan, A., Rui, S., and Lu, W. (2017). Change-plane analysis for subgroup detection and sample size calculation. Journal of the American Statistical Association, 112(518):769-778.

Huang, Y., Cho, J., and Fong, Y. (2021). Threshold-based subgroup testing in logistic regression models in two phase sampling designs. Journal of the Royal Statistical Society: Series C. 291-311.

Liu, X. (2022). Change-plane testing in the generalized estimating equations. Manuscript.

Examples

```
data(simulatedData_gaussian)
fit <- estglm(data = data_gaussian, family = "gaussian")
fit$alpha

data(simulatedData_binomial)
fit <- estglm(data = data_binomial, family = "binomial")
fit$beta

data(simulatedData_poisson)
fit <- estglm(data = data_poisson, family = "poisson")
fit$alpha
fit$beta
```

`estglmBoot` *Estimating standard deviation of parameters by bootstrap method in Generalized Linear Models with subgroups*

Description

Provide estimators of standard deviation of coefficients by bootstrap method in generalized linear models with subgroups.

Usage

```
estglmBoot(data, family = "gaussian", h = NULL, smooth = "sigmoid",
           weights = "exponential", B = 1000, maxIter = 100, tol = 0.0001)
```

Arguments

`data`	A list, including Y (response), X (baseline variable), Z (grouping difference variable), and U (grouping variable).
`family`	Family for generalized linear models, including 'gaussian', 'binomial', and 'poisson'.
`h`	A numeric number, which is the bandwidth in the smooth function. Default is `h = log(n)/sqrt(n)`.
`smooth`	The smooth function. Either "sigmoid" (the default), "pnorm", or "mixnorm", see details below.
`weights`	The weights. Either "exponential" (the default), "norm", or "bernoulli", see details below.

`B`	An integer, the number of bootstrap samples. Default is `B = 1000`.
`maxIter`	An integer, the maximum number of iterations. Default is `maxIter = 100`.
`tol`	Convergence threshhold. Default is `tol = 0.0001`.

Details

Generalized linear models

$$f(\boldsymbol{V}_i; \boldsymbol{\alpha}, \boldsymbol{\beta}, \boldsymbol{\gamma}) = \exp\left\{\frac{y_i\mu_i - c(\mu_i)}{a(\phi)}\right\} h(y_i),$$

where

$$\mu_i = \boldsymbol{X}_i^T\boldsymbol{\alpha} + \boldsymbol{Z}_i^T\boldsymbol{\beta}\mathbf{1}(\boldsymbol{U}_i^T\boldsymbol{\gamma} \geq 0).$$

The smooth functioms:

- (a) sigmoid function ("sigmoid")
$$S(u) = 1/(1+e^{-u});$$
- (b) norm CDF ("pnorm")
$$S(u) = \Phi(u);$$
- (c) mixture of norm CDF and density ("mixnorm")
$$S(u) = \Phi(u) + u\phi(u),$$

where $\Phi(u)$ and $\phi(u)$ are the CDF and density of starndard norm distribution, that is,

$$\Phi(u) = \int_{-\infty}^{u} \frac{1}{2\pi} \exp\left(-\frac{s^2}{2}\right) ds,$$

and

$$\phi(u) = \frac{1}{2\pi} \exp\left(-\frac{u^2}{2}\right).$$

The weights from:

(a) exponential distribution with unit rate parameter ("exponential");

(b) normal distribution with unit mean and unit variance ("norm");

(c) bernoulli distribution, of which value is 0 with probability 0.5 and 2 with probability 0.5.

Value

`alpha`	Estimator of the baseline parameter $\boldsymbol{\alpha}$.
`beta`	Estimator of the grouping difference parameter $\boldsymbol{\beta}$.
`gamma`	Estimator of the grouping parameter $\boldsymbol{\gamma}$.
`delta`	A vector with length n. Estimator of the indicator function $I(\boldsymbol{U}^T\boldsymbol{\gamma} \geq 0)$.
`std`	A vector with length $p+q+r-1$. The standard deviation (`sd`) of parameter $(\boldsymbol{\alpha}^T, \boldsymbol{\beta}^T, \boldsymbol{\gamma}_{-1}^T)^T$, where $\boldsymbol{\gamma}_{-1} = (\gamma_2, \cdots, \gamma_r)^T$.

References

Andrews, D. W. K. and Ploberger, W. (1994). Optimal tests when a nuisance parameter is present only under the alternative. Econometrica, 62(6):1383-1414.

Fan, A., Rui, S., and Lu, W. (2017). Change-plane analysis for subgroup detection and sample size calculation. Journal of the American Statistical Association, 112(518):769-778.

Huang, Y., Cho, J., and Fong, Y. (2021). Threshold-based subgroup testing in logistic regression models in two phase sampling designs. Journal of the Royal Statistical Society: Series C. 291-311.

Liu, X. (2022). Change-plane testing in the generalized estimating equations. Manuscript.

Examples

```
data(simulatedData_gaussian)
fit <- estglmBoot(data = data_gaussian, family = "gaussian")
fit$alpha
fit$beta
fit$gamma
fit$std

data(simulatedData_binomial)
fit <- estglmBoot(data = data_binomial, family = "binomial")
fit$alpha
fit$beta
fit$gamma
fit$std

data(simulatedData_poisson)
fit <- estglmBoot(data = data_poisson, family = "poisson")
fit$alpha
fit$beta
fit$gamma
fit$std
```

`estglmBootMult` *Estimating standard deviation of parameters by bootstrap method in Generalized Linear Models with multiple change-planes*

Description

Provide estimators of standard deviation of coefficients by bootstrap method in generalized linear models with multiple change-planes.

Usage

```
estglmBootMult(data, family = "gaussian", ng = 2, h = NULL, smooth = "sigmoid",
               weights = "exponential", B = 1000, maxIter = 100, tol = 0.0001)
```

Arguments

`data`	A list, including Y (response), X (baseline variable), Z (grouping difference variable), and U (grouping variable).
`family`	Family for generalized linear models, including 'gaussian', 'binomial', and 'poisson'.

ng	An integer, which is the number of change-planes. Default is ng = 2.
h	A numeric number, which is the bandwidth in the smooth function. Default is h = log(n)/sqrt(n).
smooth	The smooth function. Either "sigmoid" (the default), "pnorm", or "mixnorm", see details below.
weights	The weights. Either "exponential" (the default), "norm", or "bernoulli", see details below.
B	An integer, the number of bootstrap samples. Default is B = 1000.
maxIter	An integer, the maximum number of iterations. Default is maxIter = 100.
tol	Convergence threshhold. Default is tol = 0.0001.

Details

Generalized linear models

$$f(\boldsymbol{V}_i; \boldsymbol{\alpha}, \boldsymbol{\beta}, \boldsymbol{\gamma}) = \exp\left\{\frac{y_i\mu_i - c(\mu_i)}{a(\phi)}\right\} h(y_i),$$

where

$$\mu_i = \boldsymbol{X}_i^T\boldsymbol{\alpha} + \boldsymbol{Z}_i^T\sum_{s=1}^{S}\boldsymbol{\beta}_s\mathbf{1}(U_i + \boldsymbol{U}_{2i}^T\boldsymbol{\gamma}_{-1} \geq a_s),$$

with the identifiable restraint that $a_1 < a_2 < \cdots < a_S$.

The smooth functioms:

- (a) sigmoid function ("sigmoid")

$$S(u) = 1/(1 + e^{-u});$$

- (b) norm CDF ("pnorm")

$$S(u) = \Phi(u);$$

- (c) mixture of norm CDF and density ("mixnorm")

$$S(u) = \Phi(u) + u\phi(u),$$

where $\Phi(u)$ and $\phi(u)$ are the CDF and density of starndard norm distribution, that is,

$$\Phi(u) = \int_{-\infty}^{u}\frac{1}{2\pi}\exp\left(-\frac{s^2}{2}\right)ds,$$

and

$$\phi(u) = \frac{1}{2\pi}\exp\left(-\frac{u^2}{2}\right).$$

The weights from:

(a) exponential distribution with unit rate parameter ("exponential");

(b) normal distribution with unit mean and unit variance ("norm");

(c) bernoulli distribution, of which value is 0 with probability 0.5 and 2 with probability 0.5.

Value

`alpha`	Estimator of the baseline parameter $\boldsymbol{\alpha}$.
`beta`	Estimator of the grouping difference parameter $\boldsymbol{\beta}$.
`gamma`	Estimator of the grouping parameter $\boldsymbol{\gamma}$.
`delta`	A vector with length n. Estimator of the indicator function $I(\boldsymbol{U}^T\boldsymbol{\gamma} \geq 0)$.
`ha`	Estimator of the threshholds $\{a_1, \cdots, a_S\}$, where S equals to `ng`.
`std`	A vector with length $p + S * q + r - 1$. The standard deviation (`sd`) of parameter $(\boldsymbol{\alpha}^T, \boldsymbol{\beta}^T, \boldsymbol{\gamma}_{-1}^T, a_1, \cdots, a_S)^T$, where S is the number of change-planes, and $\boldsymbol{\gamma}_{-1} = (\gamma_2, \cdots, \gamma_r)^T$.

References

Andrews, D. W. K. and Ploberger, W. (1994). Optimal tests when a nuisance parameter is present only under the alternative. Econometrica, 62(6):1383-1414.

Fan, A., Rui, S., and Lu, W. (2017). Change-plane analysis for subgroup detection and sample size calculation. Journal of the American Statistical Association, 112(518):769-778.

Huang, Y., Cho, J., and Fong, Y. (2021). Threshold-based subgroup testing in logistic regression models in two phase sampling designs. Journal of the Royal Statistical Society: Series C. 291-311.

Liu, X. (2022). Change-plane testing in the generalized estimating equations. Manuscript.

Examples

```
data(simulatedData_gaussian)
fit <- estglmBootMult(data = data_gaussian, family = "gaussian")
fit$alpha
fit$beta
fit$gamma
fit$std

data(simulatedData_binomial)
fit <- estglmBootMult(data = data_binomial, family = "binomial")
fit$alpha
fit$beta
fit$gamma
fit$std

data(simulatedData_poisson)
fit <- estglmBootMult(data = data_poisson, family = "poisson")
fit$alpha
fit$beta
fit$gamma
fit$std
```

`estglmMult` *Estimation in Generalized Linear Models with multiple change-planes*

Description

Provide estimators of coefficients in generalized linear models with multiple change-planes.

Usage

```
estglmMult(data, family = "gaussian", ng = 2, h = NULL, smooth = "sigmoid", maxIter = 100, tol = 0
```

Arguments

`data`	A list, including Y (response), X (baseline variable), Z (grouping difference variable), and U (grouping variable).
`family`	Family for generalized linear models, including 'gaussian', 'binomial', and 'poisson'.
`ng`	An integer, which is the number of change-planes. Default is `ng = 2`.
`h`	A numeric number, which is the bandwidth in the smooth function. Default is `h = log(n)/sqrt(n)`
`smooth`	The smooth function. Either "sigmoid" (the default), "pnorm", or "mixnorm", see details below.
`maxIter`	An integer, the maximum number of iterations. Default is `maxIter = 100`.
`tol`	Convergence threshhold. Default is `tol = 0.0001`.

Details

Generalized linear models

$$f(\boldsymbol{V}_i;\boldsymbol{\alpha},\boldsymbol{\beta},\boldsymbol{\gamma}) = \exp\left\{\frac{y_i\mu_i - c(\mu_i)}{a(\phi)}\right\} h(y_i),$$

where

$$\mu_i = \boldsymbol{X}_i^T\boldsymbol{\alpha} + \boldsymbol{Z}_i^T\sum_{s=1}^{S}\boldsymbol{\beta}_s\mathbf{1}(U_i + \boldsymbol{U}_{2i}^T\boldsymbol{\gamma}_{-1} \geq a_s),$$

with the identifiable restraint that $a_1 < a_2 < \cdots < a_S$.

The smooth functioms:

- (a) sigmoid function ("sigmoid")

$$S(u) = 1/(1 + e^{-u});$$

- (b) norm CDF ("pnorm")

$$S(u) = \Phi(u);$$

- (c) mixture of norm CDF and density ("mixnorm")

$$S(u) = \Phi(u) + u\phi(u),$$

where $\Phi(u)$ and $\phi(u)$ are the CDF and density of starndard norm distribution, that is,

$$\Phi(u) = \int_{-\infty}^{u}\frac{1}{2\pi}\exp\left(-\frac{s^2}{2}\right)ds,$$

and

$$\phi(u) = \frac{1}{2\pi}\exp\left(-\frac{u^2}{2}\right).$$

Value

`alpha`	Estimator of the baseline parameter $\boldsymbol{\alpha}$.
`beta`	Estimator of the grouping difference parameter $\boldsymbol{\beta}$.
`gamma`	Estimator of the grouping parameter $\boldsymbol{\gamma}$.
`delta`	A vector with length n. Estimator of the indicator function $I(\boldsymbol{U}^T\boldsymbol{\gamma} \geq 0)$.
`ha`	Estimator of the threshholds $\{a_1, \cdots, a_S\}$, where S equals to `ng`.

References

Andrews, D. W. K. and Ploberger, W. (1994). Optimal tests when a nuisance parameter is present only under the alternative. Econometrica, 62(6):1383-1414.

Fan, A., Rui, S., and Lu, W. (2017). Change-plane analysis for subgroup detection and sample size calculation. Journal of the American Statistical Association, 112(518):769-778.

Huang, Y., Cho, J., and Fong, Y. (2021). Threshold-based subgroup testing in logistic regression models in two phase sampling designs. Journal of the Royal Statistical Society: Series C. 291-311.

Liu, X. (2022). Change-plane testing in the generalized estimating equations. Manuscript.

Examples

```
data(simulatedData_gaussian)
fit <- estglmMult(data = data_gaussian, family = "gaussian")
fit$alpha

data(simulatedData_binomial)
fit <- estglmMult(data = data_binomial, family = "binomial")
fit$beta

data(simulatedData_poisson)
fit <- estglmMult(data = data_poisson, family = "poisson")
fit$alpha
fit$beta
```

`exams` *Examples for Subgroup Test in Generalized Linear Models*

Description

Examples for Family 'Gaussian', 'binomial', and 'Poisson'.

Usage

```
exams(family = "gaussian", method = "wast", M = 1000, K = 1000)
```

Arguments

`family`	Family for generalized linear models, including 'gaussian', 'binomial', and 'poisson'.
`method`	There are there methods, including the proposed 'wast', 'sst', and 'slrt'.
`M`	An integer, the number of bootstrap samples.
`K`	An integer, the number of threshold values for 'sst' and 'slrt'.

Value

pvals	P-value of the corresponding test statistic.

References

Andrews, D. W. K. and Ploberger, W. (1994). Optimal tests when a nuisance parameter is present only under the alternative. Econometrica, 62(6):1383-1414.

Fan, A., Rui, S., and Lu, W. (2017). Change-plane analysis for subgroup detection and sample size calculation. Journal of the American Statistical Association, 112(518):769-778.

Huang, Y., Cho, J., and Fong, Y. (2021). Threshold-based subgroup testing in logistic regression models in two phase sampling designs. Journal of the Royal Statistical Society: Series C. 291-311.

Liu, X. (2022). Change-plane testing in the generalized estimating equations. Manuscript.

Examples

```
pvals <- exams(family = "gaussian", method = "wast")
pvals

pvals <- exams(family = "binomial", method = "wast")
pvals

pvals <- exams(family = "poisson", method = "wast")
pvals
```

---

pvalglm — *P-value for Subgroup Test in Generalized Linear Models*

Description

Provide p-value for subgroup test in generalized linear models, including three methods 'wast', 'sst', and 'slrt'.

Usage

```
pvalglm(data, family = "gaussian", method = 'wast', M=1000, K = 2000)
```

Arguments

data	A list, including Y (response), X (baseline variable), Z (grouping difference variable), and U (grouping variable).
family	Family for generalized linear models, including 'gaussian', 'binomial', and 'poisson'.
method	There are there methods, including the proposed 'wast', 'sst', and 'slrt'.
M	An integer, the number of bootstrap samples.
K	An integer, the number of threshold values for 'sst' and 'slrt'.

Details

Generalized linear models

$$f(\boldsymbol{V}_i;\boldsymbol{\alpha},\boldsymbol{\beta},\boldsymbol{\gamma}) = \exp\left\{\frac{y_i\mu_i - c(\mu_i)}{a(\phi)}\right\} h(y_i),$$

where

$$\mu_i = \boldsymbol{X}_i^T\boldsymbol{\alpha} + \boldsymbol{Z}_i^T\boldsymbol{\beta}\mathbf{1}(\boldsymbol{U}_i^T\boldsymbol{\gamma} \geq 0).$$

The hypothesis test problem is

$$H_0 : \boldsymbol{\beta} = \mathbf{0} \quad versus \quad H_1 : \boldsymbol{\beta} \neq \mathbf{0}.$$

Value

`pvals` P-value of the corresponding test statistic.

References

Andrews, D. W. K. and Ploberger, W. (1994). Optimal tests when a nuisance parameter is present only under the alternative. Econometrica, 62(6):1383-1414.

Fan, A., Rui, S., and Lu, W. (2017). Change-plane analysis for subgroup detection and sample size calculation. Journal of the American Statistical Association, 112(518):769-778.

Huang, Y., Cho, J., and Fong, Y. (2021). Threshold-based subgroup testing in logistic regression models in two phase sampling designs. Journal of the Royal Statistical Society: Series C. 291-311.

Liu, X. (2022). Change-plane testing in the generalized estimating equations. Manuscript.

Examples

```
data(simulatedData_gaussian)
pvals <- pvalglm(data = data_gaussian, family = "gaussian")
pvals

data(simulatedData_binomial)
pvals <- pvalglm(data = data_binomial, family = "binomial")
pvals

data(simulatedData_poisson)
pvals <- pvalglm(data = data_poisson, family = "poisson")
pvals
```

`pval_probit` *P-value for subgroup test in probit regression models*

Description

Provide p-value for subgroup test in probit regression models, including two methods 'wast' and 'sst'.

Usage

```
pval_probit(data, method = "wast", M = 1000, K = 2000,
                  isBeta = FALSE, shape1 = 1, shape2 = 1)
```

Arguments

`data`	A list, including Y (response), X (baseline variable), Z (grouping difference variable), and U (grouping variable).
`method`	There are two methods, including the proposed 'wast' and 'sst'.
`M`	An integer, the number of bootstrap samples.
`K`	An integer, the number of threshold values for 'sst'.
`isBeta`	A bool value. The weight $w(\gamma)$ is chosen to be Beta distribution if `isBeta=TRUE`, which can be used if the grouping difference variable is bounded in $[0, 1]$. Default is `FALSE`.
`shape1`	The first parameter of Best distribution if `isBeta = TRUE`.
`shape2`	The second parameter of Best distribution if `isBeta = TRUE`.

Details

Probit regression models

$$f(\boldsymbol{V}_i) = \Phi(h(\boldsymbol{V}_i, \boldsymbol{\alpha}, \boldsymbol{\beta}, \boldsymbol{\theta}))^{Y_i} + \Phi(-h(\boldsymbol{V}_i, \boldsymbol{\alpha}, \boldsymbol{\beta}, \boldsymbol{\theta}))^{1-Y_i},$$

where $\Phi(\cdot)$ is the cumulative distribution function of standard normal distribution, and

$$h(\boldsymbol{V}_i, \boldsymbol{\alpha}, \boldsymbol{\beta}, \boldsymbol{\theta}) = \boldsymbol{X}_i\boldsymbol{\alpha} + \boldsymbol{Z}_i^T\boldsymbol{\beta}\mathbf{1}(\boldsymbol{U}_i^T\boldsymbol{\theta} \geq 0).$$

The hypothesis test problem is

$$H_0 : \boldsymbol{\beta} = \mathbf{0} \quad versus \quad H_1 : \boldsymbol{\beta} \neq \mathbf{0}.$$

Value

`pvals`	P-value of the corresponding test statistic.

References

Andrews, D. W. K. and Ploberger, W. (1994). Optimal tests when a nuisance parameter is present only under the alternative. Econometrica, 62(6):1383-1414.

Fan, A., Rui, S., and Lu, W. (2017). Change-plane analysis for subgroup detection and sample size calculation. Journal of the American Statistical Association, 112(518):769-778.

Huang, Y., Cho, J., and Fong, Y. (2021). Threshold-based subgroup testing in logistic regression models in two phase sampling designs. Journal of the Royal Statistical Society: Series C. 291-311.

LEE, S., SEO, M. H. and SHIN, Y. (2011). Testing for Threshold Effects in Regression Models. Journal of the American Statistical Association 106, 220-231.

Liu, X. (2022). Change-plane testing in the generalized estimating equations. Manuscript.

Examples

```
data(simulatedData_probit)
pvals <- pval_probit(data = data_probit, method = "wast")
pvals

pvals <- pval_probit(data = data_probit, method = "sst")
pvals
```

`pval_quantile` *P-value for subgroup test in quantile regression models*

Description

Provide p-value for subgroup test in quantile regression models, including two methods 'wast' and 'sst'.

Usage

```
pval_quantile(data, method = "wast", tau = 0.5, M = 1000, K = 2000,
                              isBeta = FALSE, shape1 = 1, shape2 = 1)
```

Arguments

`data`	A list, including Y (response), X (baseline variable), Z (grouping difference variable), and U (grouping variable).
`method`	There are two methods, including the proposed 'wast' and 'sst'.
`tau`	The given quantile τ, a scale in the unit inteval. Default is `tau = 0.5`.
`M`	An integer, the number of bootstrap samples.
`K`	An integer, the number of threshold values for 'sst'.
`isBeta`	A bool value. The weight $w(\gamma)$ is chosen to be Beta distribution if `isBeta=TRUE`, which can be used if the grouping difference variable is bounded in $[0, 1]$. Default is `FALSE`.
`shape1`	The first parameter of Best distribution if `isBeta = TRUE`.
`shape2`	The second parameter of Best distribution if `isBeta = TRUE`.

Details

Quantile regression models

$$Q_{Y_i}(\tau|\boldsymbol{X}_i, \boldsymbol{Z}_i, \boldsymbol{U}_i) = \boldsymbol{X}_i^T\boldsymbol{\alpha}(\tau) + \boldsymbol{Z}_i^T\boldsymbol{\beta}(\tau)\mathbf{1}(\boldsymbol{U}_i^T\boldsymbol{\theta}(\tau) \geq 0).$$

The hypothesis test problem is

$$H_0 : \boldsymbol{\beta} = \mathbf{0} \quad versus \quad H_1 : \boldsymbol{\beta} \neq \mathbf{0}.$$

Value

`pvals`	P-value of the corresponding test statistic.

References

Andrews, D. W. K. and Ploberger, W. (1994). Optimal tests when a nuisance parameter is present only under the alternative. Econometrica, 62(6):1383-1414.

Fan, A., Rui, S., and Lu, W. (2017). Change-plane analysis for subgroup detection and sample size calculation. Journal of the American Statistical Association, 112(518):769-778.

Huang, Y., Cho, J., and Fong, Y. (2021). Threshold-based subgroup testing in logistic regression models in two phase sampling designs. Journal of the Royal Statistical Society: Series C. 291-311.

LEE, S., SEO, M. H. and SHIN, Y. (2011). Testing for Threshold Effects in Regression Models. Journal of the American Statistical Association 106, 220-231.

Liu, X. (2022). Change-plane testing in the generalized estimating equations. Manuscript.

Examples

```
data(simulatedData_quantile)
pvals <- pval_quantile(data = data_quantile, tau = 0.5, method = "wast")
pvals

pvals <- pval_quantile(data = data_quantile, tau = 0.3, method = "wast")
pvals
```

---

pval_semiparam *P-value for subgroup test in semiparamtric models*

Description

Provide p-value for subgroup test in semiparamtric models, including two methods 'wast' and 'sst'.

Usage

```
pval_semiparam(data, method = "wast", M = 1000, K = 2000,
               isBeta = FALSE, shape1 = 1, shape2 = 1)
```

Arguments

`data`	A list, including Y (response), A (treatment indicator), $X1$ and $X2$ (baseline variables), Z (grouping difference variable), and U (grouping variable).
`method`	There are two methods, including the proposed 'wast' and 'sst'.
`M`	An integer, the number of bootstrap samples.
`K`	An integer, the number of threshold values for 'sst'.
`isBeta`	A bool value. The weight $w(\gamma)$ is chosen to be Beta distribution if `isBeta=TRUE`, which can be used if the grouping difference variable is bounded in $[0, 1]$. Default is `FALSE`.
`shape1`	The first parameter of Best distribution if `isBeta = TRUE`.
`shape2`	The second parameter of Best distribution if `isBeta = TRUE`.

Details

Semiparamtric models (see details in my paper Liu (2022))

$$Y_i = h(\boldsymbol{X}_{1i}) + A_i \boldsymbol{Z}_i^T \boldsymbol{\beta} \boldsymbol{1}(\boldsymbol{U}_i^T \boldsymbol{\theta} \geq 0) + \epsilon_i,$$

where $h(\boldsymbol{X}_1)$ is an unknown baseline mean function for patients in treatment $A = 0$ which can be set a linear function $h(\boldsymbol{X}_1) = X_1^T \boldsymbol{\alpha}_1$, and $P(A = 1|\boldsymbol{X}_2)$ can be modelled by a logistic regression model

$$P(A = 1|\boldsymbol{X}_2) = \pi(\boldsymbol{X}_2, \boldsymbol{\alpha}_2) = \frac{\exp\{\boldsymbol{X}_2^T \boldsymbol{\alpha}_2\}}{1 + \exp\{\boldsymbol{X}_2^T \boldsymbol{\alpha}_2\}}.$$

The hypothesis test problem is

$$H_0 : \boldsymbol{\beta} = \boldsymbol{0} \quad versus \quad H_1 : \boldsymbol{\beta} \neq \boldsymbol{0}.$$

Value

`pvals` P-value of the corresponding test statistic.

References

Andrews, D. W. K. and Ploberger, W. (1994). Optimal tests when a nuisance parameter is present only under the alternative. Econometrica, 62(6):1383-1414.

Fan, A., Rui, S., and Lu, W. (2017). Change-plane analysis for subgroup detection and sample size calculation. Journal of the American Statistical Association, 112(518):769-778.

Huang, Y., Cho, J., and Fong, Y. (2021). Threshold-based subgroup testing in logistic regression models in two phase sampling designs. Journal of the Royal Statistical Society: Series C. 291-311.

LEE, S., SEO, M. H. and SHIN, Y. (2011). Testing for Threshold Effects in Regression Models. Journal of the American Statistical Association 106, 220-231.

Liu, X. (2022). Change-plane testing in the generalized estimating equations. Manuscript.

Examples

```
data(simulatedData_semiparam)
pvals <- pval_semiparam(data = data_semiparam, method = "wast")
pvals

pvals <- pval_semiparam(data = data_semiparam, method = "sst")
pvals
```

---

simulatedData *Simulated data from generalized linear models*

Description

Simulated data from the framework of general estimating equations, including model

- 'Quantile regression' (`simulatedData_quantile`),
- 'Probit regression' (`simulatedData_probit`),
- 'Semiparamtric models' (`simulatedData_semiparam`),
- Simulated data from generalized linear models, including family 'gaussian' (`simulatedData_gaussian`), 'binomial' (`simulatedData_binomial`), and 'poisson' (`simulatedData_poisson`).

Usage

```
data(simulatedData_gaussian)
```

Details

We simulated data generated from generalized linear models

$$f(\boldsymbol{V}_i; \boldsymbol{\alpha}, \boldsymbol{\beta}, \boldsymbol{\gamma}) = \exp\left\{\frac{y_i\mu_i - c(\mu_i)}{a(\phi)}\right\} h(y_i),$$

where

$$\mu_i = \boldsymbol{X}_i^T\boldsymbol{\alpha} + \boldsymbol{Z}_i^T\boldsymbol{\beta}\mathbf{1}(\boldsymbol{U}_i^T\boldsymbol{\gamma} \geq 0).$$

- Y: the response, an n-vector
- X: the baseline variable with dimension $n \times p$
- Z: the grouping difference variable with dimension $n \times q$
- U: the grouping variable with dimension $n \times r$

References

Liu, X. (2022). Change-plane testing in the generalized estimating equations. Manuscript.

Examples

```
data(simulatedData_gaussian)

y <- data_gaussian$Y[1:5]
x <- dim(data_gaussian$X)
z <- dim(data_gaussian$Z)
u <- dim(data_gaussian$U)

data(simulatedData_probit)
y <- data_probit$Y[1:5]
x <- dim(data_probit$X)
z <- dim(data_probit$Z)
u <- dim(data_probit$U)

data(simulatedData_semiparam)
y <- data_semiparam$Y[1:5]
x1 <- dim(data_semiparam$X1)
x2 <- dim(data_semiparam$X2)
z <- dim(data_semiparam$Z)
u <- dim(data_semiparam$U)
```

Index