Package 'QLRM'

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Type Package

Title Improved Inference Methods Based on Quasi-
Likelihood Ratio Statistics for Modified Poisson and Least-Squares Regressions

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Description Modified Poisson and least-squares regression analyses for binary out-
comes of Zou (2004) <doi:10.1093/aje/kwh090> and Che-
ung (2007) <doi:10.1093/aje/kwm223> have been standard multivariate analysis methods to esti-
mate risk ratio and risk difference in clinical and epidemiological studies. Recent stud-
ies have shown the ordinary robust variance estimator possibly has serious bias un-
der small or moderate sample size situations for these methods. This package provides computa-
tional tools to calculate improved confidence intervals for the effect measures based on the quasi-
likelihood ratio statistics (Noma et al. (2024) <Forthcoming>).

Depends R (>= 3.5.0)

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R topics documented:

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QLRM-package	*The 'QLRM' package.*

Description

Modified Poisson and least-squares regression analyses for binary outcomes of Zou (2004) and Cheung (2007) have been standard multivariate analysis methods to estimate risk ratio and risk difference in clinical and epidemiological studies. Recent studies have shown the ordinary robust variance estimator possibly has serious bias under small or moderate sample size situations for these methods. This package provides computational tools to calculate improved confidence intervals for the effect measures based on the quasi-likelihood ratio statistics (Noma et al. (2024) <Forthcoming>).

References

Cheung, Y. B. (2007). A modified least-squares regression approach to the estimation of risk difference. *American Journal of Epidemiology* **166**, 1337-1344.

Noma, H. et al. (2024+). Quasi-likelihood ratio tests and Bartlett-type correction for improved confidence intervals of the modified Poisson and least-squares regressions for binary outcomes. Forthcoming.

Zou, G. (2004). A modified poisson regression approach to prospective studies with binary data. *American Journal of Epidemiology* **159**, 702-706.

bsmqlrci.ls	*Calculating bootstrap confidence interval for modified least-squares regression based on the modified quasi-likelihood ratio test*

Description

Recent studies revealed the robust standard error estimates of the modified least-squares regression analysis are generally biased under small or moderate sample settings. To adjust the bias and to provide more accurate confidence intervals, confidence interval and P-value of the test for risk difference by modified least-squares regression are calculated based on the bootstrap approach of Noma et al. (2024).

Usage

```
bsmqlrci.ls(formula, data, x.name=NULL, B=1000, cl=0.95, C0=10^-5,
 digits=4, seed=527916)
```

Arguments

formula	An object of class "formula" (or one that can be coerced to that class): a symbolic description of the model to be fitted.
data	A data frame, list or environment (or object coercible by as.data.frame to a data frame) containing the variables in the model.
x.name	The variable name that the confidence interval is calculated for the regression coefficient; should be involved in formula as an explanatory variable. Specify as a character object.

B	The number of bootstrap resampling (default: 1000)
cl	Confidence level for calculating confidence intervals (default: 0.95)
C0	A tuning parameter to control the precisions of numerical computations of confidence limits (default: 10^-5).
digits	Number of decimal places in the output (default: 4).
seed	Seed to generate random numbers (default: 527916).

Value

Results of the modified least-squares analyses are presented. Three objects are provided: Results of the modified least-squares regression with the Wald-type approximation, the bootstrap-based confidence interval for the corresponding covariate, and P-value for the bootstrap test of RD=0.

References

Noma, H. et al. (2024+). Quasi-likelihood ratio tests and Bartlett-type correction for improved confidence intervals of the modified Poisson and least-squares regressions for binary outcomes. Forthcoming.

Examples

```
data(exdata01)

bsmqlrci.ls(y ~ x1 + x2 + x3 + x4, data=exdata01, "x3", B=10)
# For illustration. B should be >= 1000 (the number of bootstrap resampling).
```

---

bsmqlrci.pois	*Calculating bootstrap confidence interval for modified Poisson regression based on the modified quasi-likelihood ratio test*

Description

Recent studies revealed the risk ratio estimates and robust standard error estimates of the modified Poisson regression analysis are generally biased under small or moderate sample settings. To adjust the bias and to provide more accurate confidence intervals, confidence interval and P-value of the test for risk ratio by modified Poisson regression are calculated based on the bootstrap approach of Noma et al. (2024).

Usage

```
bsmqlrci.pois(formula, data, x.name=NULL, B=1000, eform=FALSE, cl=0.95, C0=10^-5,
 digits=4, seed=527916)
```

Arguments

formula	An object of class "formula" (or one that can be coerced to that class): a symbolic description of the model to be fitted.
data	A data frame, list or environment (or object coercible by as.data.frame to a data frame) containing the variables in the model.

x.name	The variable name that the confidence interval is calculated for the regression coefficient; should be involved in `formula` as an explanatory variable. Specify as a character object.
B	The number of bootstrap resampling (default: 1000)
eform	A logical value that specify whether the outcome should be transformed by exponential function (default: `FALSE`)
cl	Confidence level for calculating confidence intervals (default: 0.95)
C0	A tuning parameter to control the precisions of numerical computations of confidence limits (default: 10^{-5}).
digits	Number of decimal places in the output (default: 4).
seed	Seed to generate random numbers (default: 527916).

Value

Results of the modified Poisson analyses are presented. Three objects are provided: Results of the modified Poisson regression with the Wald-type approximation, the bootstrap confidence interval for the corresponding covariate, and P-value for the bootstrap test of RR=1.

References

Noma, H. et al. (2024+). Quasi-likelihood ratio tests and Bartlett-type correction for improved confidence intervals of the modified Poisson and least-squares regressions for binary outcomes. Forthcoming.

Examples

```
data(exdata01)

bsmqlrci.pois(y ~ x1 + x2 + x3 + x4, data=exdata01, "x3", B=10, eform=TRUE)
# For illustration. B should be >= 1000 (the number of bootstrap resampling).
```

---

bsqlrci.ls	*Calculating bootstrap confidence interval for modified least-squares regression based on the quasi-likelihood ratio test*

Description

Recent studies revealed the robust standard error estimates of the modified least-squares regression analysis are generally biased under small or moderate sample settings. To adjust the bias and to provide more accurate confidence intervals, confidence interval and P-value of the test for risk difference by modified least-squares regression are calculated based on the bootstrap approach of Noma et al. (2024).

Usage

```
bsqlrci.ls(formula, data, x.name=NULL, B=1000, cl=0.95, C0=10^-5,
 digits=4, seed=527916)
```

Arguments

formula	An object of class "formula" (or one that can be coerced to that class): a symbolic description of the model to be fitted.
data	A data frame, list or environment (or object coercible by as.data.frame to a data frame) containing the variables in the model.
x.name	The variable name that the confidence interval is calculated for the regression coefficient; should be involved in formula as an explanatory variable. Specify as a character object.
B	The number of bootstrap resampling (default: 1000)
cl	Confidence level for calculating confidence intervals (default: 0.95)
C0	A tuning parameter to control the precisions of numerical computations of confidence limits (default: 10^-5).
digits	Number of decimal places in the output (default: 4).
seed	Seed to generate random numbers (default: 527916).

Value

Results of the modified least-squares analyses are presented. Three objects are provided: Results of the modified least-squares regression with the Wald-type approximation, the bootstrap-based confidence interval for the corresponding covariate, and P-value for the bootstrap test of RD=0.

References

Noma, H. et al. (2024+). Quasi-likelihood ratio tests and Bartlett-type correction for improved confidence intervals of the modified Poisson and least-squares regressions for binary outcomes. Forthcoming.

Examples

```
data(exdata01)

bsqlrci.ls(y ~ x1 + x2 + x3 + x4, data=exdata01, "x3", B=10)
# For illustration. B should be >= 1000 (the number of bootstrap resampling).
```

---

bsqlrci.pois	*Calculating bootstrap confidence interval for modified Poisson regression based on the quasi-likelihood ratio test*

Description

Recent studies revealed the risk ratio estimates and robust standard error estimates of the modified Poisson regression analysis are generally biased under small or moderate sample settings. To adjust the bias and to provide more accurate confidence intervals, confidence interval and P-value of the test for risk ratio by modified Poisson regression are calculated based on the bootstrap approach of Noma et al. (2024).

Usage

```
bsqlrci.pois(formula, data, x.name=NULL, B=1000, eform=FALSE, cl=0.95, C0=10^-5,
 digits=4, seed=527916)
```

Arguments

formula	An object of class "formula" (or one that can be coerced to that class): a symbolic description of the model to be fitted.
data	A data frame, list or environment (or object coercible by as.data.frame to a data frame) containing the variables in the model.
x.name	The variable name that the confidence interval is calculated for the regression coefficient; should be involved in formula as an explanatory variable. Specify as a character object.
B	The number of bootstrap resampling (default: 1000)
eform	A logical value that specify whether the outcome should be transformed by exponential function (default: FALSE)
cl	Confidence level for calculating confidence intervals (default: 0.95)
C0	A tuning parameter to control the precisions of numerical computations of confidence limits (default: 10^-5).
digits	Number of decimal places in the output (default: 4).
seed	Seed to generate random numbers (default: 527916).

Value

Results of the modified Poisson analyses are presented. Three objects are provided: Results of the modified Poisson regression with the Wald-type approximation, the bootstrap confidence interval for the corresponding covariate, and P-value for the bootstrap test of RR=1.

References

Noma, H. et al. (2024+). Quasi-likelihood ratio tests and Bartlett-type correction for improved confidence intervals of the modified Poisson and least-squares regressions for binary outcomes. Forthcoming.

Examples

```
data(exdata01)

bsqlrci.pois(y ~ x1 + x2 + x3 + x4, data=exdata01, "x3", B=10, eform=TRUE)
# For illustration. B should be >= 1000 (the number of bootstrap resampling).
```

---

exdata01	*A simulated example dataset*

Description

A simulated cohort data with binomial outcome.

- y: Dichotomous outcome variable.
- x1: Continuous covariate.
- x2: Binary covariate.
- x3: Binary covariate.
- x4: Binary covariate.

Usage

```
data(exdata01)
```

Format

A simulated cohort data with binomial outcome (n=40).

---

exdata02 *A simulated example dataset*

Description

A simulated cohort data with binomial outcome.

- y: Dichotomous outcome variable.
- x1: Continuous covariate.
- x2: Binary covariate.
- x3: Binary covariate.
- x4: Binary covariate.

Usage

```
data(exdata02)
```

Format

A simulated cohort data with binomial outcome (n=1200).

---

mqlrci.ls *Calculating confidence interval for modified least-squares regression based on the modified quasi-likelihood ratio test*

Description

Recent studies revealed the robust standard error estimates of the modified least-squares regression analysis are generally biased under small or moderate sample settings. To adjust the bias and to provide more accurate confidence intervals, confidence interval and P-value of the test for risk difference by modified least-squares regression are calculated based on the modified quasi-likelihood ratio test of Noma et al. (2024+).

Usage

```
mqlrci.ls(formula, data, x.name=NULL, cl=0.95, C0=10^-5, digits=4)
```

Arguments

formula	An object of class "formula" (or one that can be coerced to that class): a symbolic description of the model to be fitted.
data	A data frame, list or environment (or object coercible by as.data.frame to a data frame) containing the variables in the model.
x.name	The variable name that the confidence interval is calculated for the regression coefficient; should be involved in formula as an explanatory variable. Specify as a character object.
cl	Confidence level for calculating confidence intervals (default: 0.95)
C0	A tuning parameter to control the precisions of numerical computations of confidence limits (default: 10^-5).
digits	Number of decimal places in the output (default: 4).

Value

Results of the modified least-squares analyses are presented. Three objects are provided: Results of the modified least-squares regression with the Wald-type approximation, modified quasi-likelihood ratio confidence interval for the corresponding covariate, and P-value for the modified quasi-likelihood ratio test of RD=0.

References

Noma, H. et al. (2024+). Quasi-likelihood ratio tests and Bartlett-type correction for improved confidence intervals of the modified Poisson and least-squares regressions for binary outcomes. Forthcoming.

Examples

```
data(exdata01)

mqlrci.ls(y ~ x1 + x2 + x3 + x4, data=exdata01, "x3")
```

---

mqlrci.pois	*Calculating confidence interval for modified Poisson regression based on the modified quasi-likelihood ratio test*

Description

Recent studies revealed the risk ratio estimates and robust standard error estimates of the modified Poisson regression analysis are generally biased under small or moderate sample settings. To adjust the bias and to provide more accurate confidence intervals, confidence interval and P-value of the test for risk ratio by modified Poisson regression are calculated based on the modified quasi-likelihood ratio test of Noma et al. (2024+).

Usage

```
mqlrci.pois(formula, data, x.name=NULL, eform=FALSE, cl=0.95, C0=10^-5, digits=4)
```

Arguments

formula	An object of class "formula" (or one that can be coerced to that class): a symbolic description of the model to be fitted.
data	A data frame, list or environment (or object coercible by as.data.frame to a data frame) containing the variables in the model.
x.name	The variable name that the confidence interval is calculated for the regression coefficient; should be involved in formula as an explanatory variable. Specify as a character object.
eform	A logical value that specify whether the outcome should be transformed by exponential function (default: FALSE)
cl	Confidence level for calculating confidence intervals (default: 0.95)
C0	A tuning parameter to control the precisions of numerical computations of confidence limits (default: 10^{-5}).
digits	Number of decimal places in the output (default: 4).

Value

Results of the modified Poisson analyses are presented. Three objects are provided: Results of the modified Poisson regression with the Wald-type approximation, modified quasi-likelihood ratio confidence interval for the corresponding covariate, and P-value for the modified quasi-likelihood ratio test of RR=1.

References

Noma, H. et al. (2024+). Quasi-likelihood ratio tests and Bartlett-type correction for improved confidence intervals of the modified Poisson and least-squares regressions for binary outcomes. Forthcoming.

Examples

```
data(exdata01)

mqlrci.pois(y ~ x1 + x2 + x3 + x4, data=exdata01, "x3", eform=TRUE)
```

---

qlrci.ls	*Calculating confidence interval for modified least-squares regression based on the quasi-likelihood ratio test with mean calibration*

Description

Recent studies revealed the robust standard error estimates of the modified least-squares regression analysis are generally biased under small or moderate sample settings. To adjust the bias and to provide more accurate confidence intervals, confidence interval and P-value of the test for risk difference by modified least-squares regression are calculated based on the bootstrap approach of Noma et al. (2024).

Usage

```
qlrci.ls(formula, data, x.name=NULL, B=200, cl=0.95, C0=10^-5,
 digits=4, seed=527916)
```

Arguments

formula	An object of class "formula" (or one that can be coerced to that class): a symbolic description of the model to be fitted.
data	A data frame, list or environment (or object coercible by as.data.frame to a data frame) containing the variables in the model.
x.name	The variable name that the confidence interval is calculated for the regression coefficient; should be involved in formula as an explanatory variable. Specify as a character object.
B	The number of bootstrap resampling (default: 200)
cl	Confidence level for calculating confidence intervals (default: 0.95)
C0	A tuning parameter to control the precisions of numerical computations of confidence limits (default: 10^-5).
digits	Number of decimal places in the output (default: 4).
seed	Seed to generate random numbers (default: 527916).

Value

Results of the modified least-squares analyses are presented. Three objects are provided: Results of the modified least-squares regression with the Wald-type approximation, the confidence interval for the corresponding covariate, and P-value for the test of RD=0.

References

Noma, H. et al. (2024+). Quasi-likelihood ratio tests and Bartlett-type correction for improved confidence intervals of the modified Poisson and least-squares regressions for binary outcomes. Forthcoming.

Examples

```
data(exdata01)

qlrci.ls(y ~ x1 + x2 + x3 + x4, data=exdata01, "x3", B=10)
# For illustration. B should be >= 200 (the number of bootstrap resampling).
```

---

qlrci.pois	*Calculating confidence interval for modified Poisson regression based on the quasi-likelihood ratio test with mean calibration*

Description

Recent studies revealed the risk ratio estimates and robust standard error estimates of the modified Poisson regression analysis are generally biased under small or moderate sample settings. To adjust the bias and to provide more accurate confidence intervals, confidence interval and P-value of the test for risk ratio by modified Poisson regression are calculated based on the bootstrap approach of Noma et al. (2024).

Usage

```
qlrci.pois(formula, data, x.name=NULL, B=200, eform=FALSE, cl=0.95, C0=10^-5,
 digits=4, seed=527916)
```

Arguments

formula	An object of class "formula" (or one that can be coerced to that class): a symbolic description of the model to be fitted.
data	A data frame, list or environment (or object coercible by as.data.frame to a data frame) containing the variables in the model.
x.name	The variable name that the confidence interval is calculated for the regression coefficient; should be involved in formula as an explanatory variable. Specify as a character object.
B	The number of bootstrap resampling (default: 200)
eform	A logical value that specify whether the outcome should be transformed by exponential function (default: FALSE)
cl	Confidence level for calculating confidence intervals (default: 0.95)
C0	A tuning parameter to control the precisions of numerical computations of confidence limits (default: 10^{-5}).
digits	Number of decimal places in the output (default: 4).
seed	Seed to generate random numbers (default: 527916).

Value

Results of the modified Poisson analyses are presented. Three objects are provided: Results of the modified Poisson regression with the Wald-type approximation, the confidence interval for the corresponding covariate, and P-value for the test of RR=1.

References

Noma, H. et al. (2024+). Quasi-likelihood ratio tests and Bartlett-type correction for improved confidence intervals of the modified Poisson and least-squares regressions for binary outcomes. Forthcoming.

Examples

```
data(exdata01)

qlrci.pois(y ~ x1 + x2 + x3 + x4, data=exdata01, "x3", B=10, eform=TRUE)
# For illustration. B should be >= 200 (the number of bootstrap resampling).
```

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