Package 'rqlm'

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Type Package

Title Modified Poisson and Least-Squares Regressions for Binary
Outcome

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Description Modified Poisson and least-squares regression analyses for binary outcomes of Zou (2004) <doi:10.1093/aje/kwh090> and Cheung (2007) <doi:10.1093/aje/kwm223> have been standard multivariate analysis methods to estimate risk ratio and risk difference in clinical and epidemiological studies. This R package involves an easy-to-handle function to implement these analyses by simple commands. Also, 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 also provides computational tools to calculate alternative accurate confidence intervals (Noma and Gosho (2024) <Forthcoming>).

Depends R (>= 3.5.0)

Imports stats, MASS, sandwich

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rqlm-package   *The 'rqlm' package.*

Description

Modified Poisson and least-squares regression analyses for binary outcomes have been standard multivariate analysis methods to estimate risk ratio and risk difference in clinical and epidemiological studies. This R package involves an easy-to-handle function to implement these analyses by simple commands. Also, 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 also provides computational tools to calculate accurate confidence intervals (Noma and Gosho, 2024).

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. and Gosho, M. (2024). Bootstrap confidence intervals based on quasi-likelihood estimating functions for 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.

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bsci.ls   *Calculating bootstrap confidence interval for modified least-squares regression based on the quasi-score statistic*

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 and Gosho (2024).

Usage

```
bsci.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 by rqlm, the bootstrap-based confidence interval for the corresponding covariate, and P-value for the bootstrap test of RD=0.

References

Noma, H. and Gosho, M. (2024). Bootstrap confidence intervals based on quasi-likelihood estimating functions for the modified Poisson and least-squares regressions for binary outcomes. Forthcoming.

Examples

```
data(exdata01)

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

---

bsci.pois	*Calculating bootstrap confidence interval for modified Poisson regression based on the quasi-score statistic*

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 and Gosho (2024).

Usage

```
bsci.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 by rqlm, the bootstrap confidence interval for the corresponding covariate, and P-value for the bootstrap test of RR=1.

References

Noma, H. and Gosho, M. (2024). Bootstrap confidence intervals based on quasi-likelihood estimating functions for the modified Poisson and least-squares regressions for binary outcomes. Forthcoming.

Examples

```
data(exdata01)

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

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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).

---

qesci.ls	*Calculating confidence interval for modified least-squares regression based on the quasi-score 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 quasi-score test of Noma and Gosho (2024).

Usage

```
qesci.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 by rqlm, quasi-score confidence interval for the corresponding covariate, and P-value for the quasi-score test of RD=0.

References

Noma, H. and Gosho, M. (2024). Bootstrap confidence intervals based on quasi-likelihood estimating functions for the modified Poisson and least-squares regressions for binary outcomes. Forthcoming.

Examples

```
data(exdata01)

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

---

qesci.pois	*Calculating confidence interval for modified Poisson regression based on the quasi-score 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 quasi-score test of Noma and Gosho (2024).

Usage

```
qesci.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 by rqlm, quasi-score confidence interval for the corresponding covariate, and P-value for the quasi-score test of RR=1.

References

Noma, H. and Gosho, M. (2024). Bootstrap confidence intervals based on quasi-likelihood estimating functions for the modified Poisson and least-squares regressions for binary outcomes. Forthcoming.

Examples

```
data(exdata01)

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

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rqlm   *Modified Poisson and least-squares regression analyses for binary out-*
                             comes

Description

Modified Poisson and least-squares regression analyses for binary outcomes are performed. This
function is handled by a similar way with `lm` or `glm`. The model fitting to the binary data can
be specified by `family`. Also, the resultant coefficients and confidence limits can be transformed
to exponential scales by specifying `eform`. The standard error estimates are calculated using the
standard robust variance estimator by `sandwich` package.

Usage

```
rqlm(formula, data, family=poisson, eform=FALSE, cl=0.95, 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.
family	A description of the error distribution and link function to be used in the model. gaussian: Modified least-squares regression. poisson: Modified Poisson regression.
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)
digits	Number of decimal places in the output (default: 4).

Value

Results of the modified Poisson and least-squares regression analyses.

- `coef`: Coefficient estimates; transformed to the exponential scale if `eform=TRUE`.
- `SE`: Robust standard error estimates for `coef`.
- `CL`: Lower limits of confidence intervals.
- `CU`: Upper limits of confidence intervals.
- `P-value`: P-values for the coefficient tests.

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. and Gosho, M. (2024). Bootstrap confidence intervals based on quasi-likelihood estimating functions for the modified Poisson and least-squares regressions for binary outcomes. Forthcoming.

White, H. (1982). Maximum likelihood estimation of misspecified models. *Econometrica*, **50**, 1-25.

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

Examples

```
data(exdata02)

rqlm(y ~ x1 + x2 + x3 + x4, data=exdata02, family=poisson, eform=TRUE)
# Modifed Poisson regression analysis
# Coefficient estimates are translated to risk ratio scales

rqlm(y ~ x1 + x2 + x3 + x4, data=exdata02, family=gaussian)
# Modifed least-squares regression analysis

rqlm(y ~ x1 + x2 + x3 + x4, data=exdata02, family=gaussian, digits=3)
# Modifed least-squares regression analysis
# Number of decimal places can be changed by specifying "digits"
```

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