

Package ‘betaMC’

February 10, 2023

Title Monte Carlo Confidence Intervals for Standardized Regression Coefficients

Version 1.0.0.9000

Description Generates Monte Carlo confidence intervals for standardized regression coefficients for models fitted by `lm()`.
'betaMC' combines ideas from Monte Carlo confidence intervals for the indirect effect (Preacher and Selig, 2012 <[doi:10.1080/19312458.2012.679848](https://doi.org/10.1080/19312458.2012.679848)>) and the sampling covariance matrix of regression coefficients (Dudgeon, 2017 <[doi:10.1007/s11336-017-9563-z](https://doi.org/10.1007/s11336-017-9563-z)>) to generate confidence intervals for standardized regression coefficients.

URL <https://github.com/jeksterslab/betaMC>,
<https://jeksterslab.github.io/betaMC/>

BugReports <https://github.com/jeksterslab/betaMC/issues>

License MIT + file LICENSE

Encoding UTF-8

LazyData true

Roxygen list(markdown = TRUE)

Depends R (>= 3.5.0)

Imports stats, methods

Suggests knitr, rmarkdown, testthat

RoxygenNote 7.2.3

NeedsCompilation no

Author Ivan Jacob Agaloos Pesigan [aut, cre, cph]
(<<https://orcid.org/0000-0003-4818-8420>>)

Maintainer Ivan Jacob Agaloos Pesigan <r.jeksterslab@gmail.com>

R topics documented:

BetaMC	2
coef.betamc	4

coef.diffbetamc	5
coef.rsqbetamc	6
confint.betamc	6
confint.diffbetamc	7
confint.rsqbetamc	8
dif	9
DiffBetaMC	9
nas1982	10
print.betamc	11
print.diffbetamc	12
print.rsqbetamc	12
rsq	13
RSqBetaMC	14
summary.betamc	15
summary.diffbetamc	15
summary.rsqbetamc	16
vcov.betamc	17
vcov.diffbetamc	18
vcov.rsqbetamc	18
Index	20

BetaMC

Estimate Standardized Regression Coefficients and Generate Sampling Distributions Using the Monte Carlo Method

Description

Estimate Standardized Regression Coefficients and Generate Sampling Distributions Using the Monte Carlo Method

Usage

```
BetaMC(
  object,
  R = 20000L,
  type = "hc3",
  g1 = 1,
  g2 = 1.5,
  k = 0.7,
  decomposition = "eigen",
  pd = TRUE,
  tol = 1e-06
)
```

Arguments

object	Object of class <code>lm</code> .
R	Positive integer. Number of Monte Carlo replications.
type	Character string. Sampling covariance matrix type. Possible values are "mvn", "adf", "hc0", "hc1", "hc2", "hc3", "hc4", "hc4m", and "hc5". <code>type = "mvn"</code> uses the normal-theory sampling covariance matrix. <code>type = "adf"</code> uses the asymptotic distribution-free sampling covariance matrix. <code>type = "hc0"</code> through "hc5" uses different versions of heteroskedasticity-consistent sampling covariance matrix.
g1	Numeric. <code>g1</code> value for <code>type = "hc4m"</code> or <code>type = "hc5"</code> .
g2	Numeric. <code>g2</code> value for <code>type = "hc4m"</code> .
k	Numeric. Constant for <code>type = "hc5"</code>
decomposition	Character string. Matrix decomposition of the sampling variance-covariance matrix for the data generation. If <code>decomposition = "chol"</code> , use Cholesky decomposition. If <code>decomposition = "eigen"</code> , use eigenvalue decomposition. If <code>decomposition = "svd"</code> , use singular value decomposition.
pd	Logical. If <code>pd = TRUE</code> , check if the sampling variance-covariance matrix is positive definite using <code>tol</code> .
tol	Numeric. Tolerance used for <code>pd</code> .

Details

The empirical sampling distribution of parameter estimates for the unstandardized regression model is generated using the Monte Carlo method, that is, random values of parameter estimates are sampled from the multivariate normal distribution using the estimated parameter vector as the mean vector and the specified sampling covariance matrix using the `type` argument as the covariance matrix. The standardized regression coefficients are derived from each randomly generated vector of parameters to generate the empirical sampling distribution of estimates of standardized slopes. Confidence intervals are generated by obtaining percentiles corresponding to $100(1 - \alpha)\%$ from the generated sampling distribution of standardized slopes, where α is the significance level.

Value

Returns an object of class `betamc` which is a list with the following elements:

call Function call.
lm Object of class `lm`.
lm_process Pre-processed object of class `lm`.
type Standard error type.
thetahatstar Sampling distribution of standardized estimates.
vcov Sampling distribution of standardized estimates.
est Vector of standardized slopes.

Author(s)

Ivan Jacob Agaloos Pesigan

References

- Dudgeon, P. (2017). Some improvements in confidence intervals for standardized regression coefficients. *Psychometrika*, 82(4), 928–951. doi:10.1007/s113360179563z
- Preacher, K. J., & Selig, J. P. (2012). Advantages of Monte Carlo confidence intervals for indirect effects. *Communication Methods and Measures*, 6(2), 77-98. doi:10.1080/19312458.2012.679848

See Also

Other Beta Monte Carlo Functions: [DiffBetaMC\(\)](#), [RSqBetaMC\(\)](#)

Examples

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaMC(object, R = 100)
# use a large R, for example, R = 20000 for actual research
# Methods -----
print(std)
summary(std)
coef(std)
vcov(std)
confint(std, level = 0.95)
```

coef.betamc

Standardized Regression Slopes

Description

Standardized Regression Slopes

Usage

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

Arguments

object	Object of class betamc.
...	additional arguments.

Value

Returns a vector of standardized regression slopes.

Author(s)

Ivan Jacob Agaloos Pesigan

Examples

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
out <- BetaMC(object, R = 100)
# use a large R, for example, R = 20000 for actual research
coef(out)
```

coef.diffbetamc

*Differences of Standardized Regression Slopes***Description**

Differences of Standardized Regression Slopes

Usage

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

Arguments

object	Object of class diffbetamc.
...	additional arguments.

Value

Returns a vector of differences of standardized regression slopes.

Author(s)

Ivan Jacob Agaloos Pesigan

Examples

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaMC(object)
diff <- DiffBetaMC(std)
coef(diff)
```

`coef.rsqbetamc`
Differences of Standardized Regression Slopes

Description

Differences of Standardized Regression Slopes

Usage

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

Arguments

`object` Object of class `rsqbetamc`.
`...` additional arguments.

Value

Returns a vector of multiple correlation.

Author(s)

Ivan Jacob Agaloos Pesigan

Examples

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaMC(object)
rsq <- RSqBetaMC(std)
coef(rsq)
```

`confint.betamc`
Confidence Intervals for Standardized Regression Slopes

Description

Confidence Intervals for Standardized Regression Slopes

Usage

```
## S3 method for class 'betamc'
confint(object, parm = NULL, level = 0.95, ...)
```

Arguments

object	Object of class betamc.
parm	a specification of which parameters are to be given confidence intervals, either a vector of numbers or a vector of names. If missing, all parameters are considered.
level	the confidence level required.
...	additional arguments.

Value

Returns a matrix of confidence intervals.

Author(s)

Ivan Jacob Agaloos Pesigan

Examples

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
out <- BetaMC(object, R = 100)
# use a large R, for example, R = 20000 for actual research
confint(out, level = 0.95)
```

confint.diffbetamc	<i>Confidence Intervals for Differences of Standardized Regression Slopes</i>
--------------------	---

Description

Confidence Intervals for Differences of Standardized Regression Slopes

Usage

```
## S3 method for class 'diffbetamc'
confint(object, parm = NULL, level = 0.95, ...)
```

Arguments

object	Object of class diffbetamc.
parm	a specification of which parameters are to be given confidence intervals, either a vector of numbers or a vector of names. If missing, all parameters are considered.
level	the confidence level required.
...	additional arguments.

Value

Returns a matrix of confidence intervals.

Author(s)

Ivan Jacob Agaloos Pesigan

Examples

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaMC(object)
diff <- DiffBetaMC(std)
confint(diff, level = 0.95)
```

confint.rsqbetamc	<i>Confidence Intervals for Differences of Standardized Regression Slopes</i>
-------------------	---

Description

Confidence Intervals for Differences of Standardized Regression Slopes

Usage

```
## S3 method for class 'rsqbetamc'
confint(object, parm = NULL, level = 0.95, ...)
```

Arguments

object	Object of class rsqbetamc.
parm	a specification of which parameters are to be given confidence intervals, either a vector of numbers or a vector of names. If missing, all parameters are considered.
level	the confidence level required.
...	additional arguments.

Value

Returns a matrix of confidence intervals.

Author(s)

Ivan Jacob Agaloos Pesigan

Examples

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaMC(object)
rsq <- RSqBetaMC(std)
confint(rsq, level = 0.95)
```

dif	<i>Differences of Regression Slopes</i>
-----	---

Description

Differences of Regression Slopes

Usage

```
dif(object, ...)
```

Arguments

object	Object used to select a method.
...	additional arguments.

Author(s)

Ivan Jacob Agaloos Pesigan

DiffBetaMC	<i>Estimate Differences of Standardized Slopes and Sampling Covariance Matrix</i>
------------	---

Description

Estimate Differences of Standardized Slopes and Sampling Covariance Matrix

Usage

```
DiffBetaMC(object)
```

Arguments

object	Object of class betamc, that is, the output of the BetaMC() function.
--------	---

Value

Returns an object of class `diffbetamc` which is a list with the following elements:

fit The argument object.

thetahatstar Sampling distribution.

vcov Sampling covariance matrix of differences of standardized slopes.

est Vector of differences of standardized slopes.

Author(s)

Ivan Jacob Agaloos Pesigan

See Also

Other Beta Monte Carlo Functions: [BetaMC\(\)](#), [RSqBetaMC\(\)](#)

Examples

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaMC(object)
diff <- DiffBetaMC(std)
# Methods -----
print(diff)
summary(diff)
coef(diff)
vcov(diff)
confint(diff, level = 0.95)
```

nas1982

1982 National Academy of Sciences Doctoral Programs Data

Description

1982 National Academy of Sciences Doctoral Programs Data

Usage

nas1982

Format

Ratings of 46 doctoral programs in psychology in the USA with the following variables:

QUALITY Program quality ratings.

NFACUL Number of faculty members in the program.

NGRADES Number of program graduates.

PCTSUPP Percentage of program graduates who received support.

PCTGRT Percent of faculty members holding research grants.

NARTIC Number of published articles attributed to program faculty member.

PCTPUB Percent of faculty with one or more published article.

References

National Research Council. (1982). *An assessment of research-doctorate programs in the United States: Social and behavioral sciences*. doi:10.17226/9781. Reproduced with permission from the National Academy of Sciences, Courtesy of the National Academies Press, Washington, D.C.

print.betamc	<i>Print Method for an Object of Class betamc</i>
--------------	---

Description

Print Method for an Object of Class betamc

Usage

```
## S3 method for class 'betamc'
print(x, alpha = c(0.05, 0.01, 0.001), digits = 4, ...)
```

Arguments

x	Object of Class betamc.
alpha	Significance level.
digits	Digits to print.
...	additional arguments.

Value

Returns a matrix of standardized regression slopes, standard errors, number of Monte Carlo replications, and confidence intervals.

Author(s)

Ivan Jacob Agaloos Pesigan

Examples

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
out <- BetaMC(object, R = 100)
# use a large R, for example, R = 20000 for actual research
print(out)
```

print.diffbetamc	<i>Print Method for an Object of Class diffbetamc</i>
------------------	---

Description

Print Method for an Object of Class diffbetamc

Usage

```
## S3 method for class 'diffbetamc'
print(x, alpha = c(0.05, 0.01, 0.001), digits = 4, ...)
```

Arguments

x	Object of class diffbetamc.
alpha	Significance level.
digits	Digits to print.
...	additional arguments.

Value

Returns a matrix of differences of standardized regression slopes, standard errors, number of Monte Carlo replications, and confidence intervals.

Author(s)

Ivan Jacob Agaloos Pesigan

Examples

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaMC(object)
diff <- DiffBetaMC(std)
print(diff)
```

print.rsqbetamc	<i>Print Method for an Object of Class rsqbetamc</i>
-----------------	--

Description

Print Method for an Object of Class rsqbetamc

Usage

```
## S3 method for class 'rsqbetamc'
print(x, alpha = c(0.05, 0.01, 0.001), digits = 4, ...)
```

Arguments

<code>x</code>	Object of class <code>rsqbetamc</code> .
<code>alpha</code>	Significance level.
<code>digits</code>	Digits to print.
<code>...</code>	additional arguments.

Value

Returns a matrix of multiple correlation (R-squared and adjusted R-squared), standard errors, number of Monte Carlo replications, and confidence intervals.

Author(s)

Ivan Jacob Agaloos Pesigan

Examples

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaMC(object)
rsq <- RSqBetaMC(std)
print(rsq)
```

<code>rsq</code>	<i>Estimate Coefficient of Determination (R-Squared and Adjusted R-Squared) and Sampling Covariance Matrix</i>
------------------	--

Description

Estimate Coefficient of Determination (R-Squared and Adjusted R-Squared) and Sampling Covariance Matrix

Usage

```
rsq(object, ...)
```

Arguments

<code>object</code>	Object used to select a method.
<code>...</code>	additional arguments.

Author(s)

Ivan Jacob Agaloos Pesigan

RSqBetaMC

Estimate Differences of Standardized Slopes and Sampling Covariance Matrix

Description

Estimate Differences of Standardized Slopes and Sampling Covariance Matrix

Usage

```
RSqBetaMC(object)
```

Arguments

object Object of class `betamc`, that is, the output of the `BetaMC()` function.

Value

Returns an object of class `rsqbetamc` which is a list with the following elements:

fit The argument object.

thetahatstar Sampling distribution.

vcov Sampling covariance matrix of differences of standardized slopes.

est Vector of differences of standardized slopes.

Author(s)

Ivan Jacob Agaloos Pesigan

See Also

Other Beta Monte Carlo Functions: [BetaMC\(\)](#), [DiffBetaMC\(\)](#)

Examples

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaMC(object)
rsq <- RSqBetaMC(std)
# Methods -----
print(rsq)
summary(rsq)
coef(rsq)
vcov(rsq)
confint(rsq, level = 0.95)
```

summary.betamc	<i>Summary Method for an Object of Class betamc</i>
----------------	---

Description

Summary Method for an Object of Class betamc

Usage

```
## S3 method for class 'betamc'
summary(object, alpha = c(0.05, 0.01, 0.001), digits = 4, ...)
```

Arguments

object	Object of class betamc.
alpha	Significance level.
digits	Digits to print.
...	additional arguments.

Value

Returns a matrix of standardized regression slopes, standard errors, number of Monte Carlo replications, and confidence intervals.

Author(s)

Ivan Jacob Agaloos Pesigan

Examples

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
out <- BetaMC(object, R = 100)
# use a large R, for example, R = 20000 for actual research
summary(out)
```

summary.diffbetamc	<i>Summary Method for an Object of Class diffbetamc</i>
--------------------	---

Description

Summary Method for an Object of Class diffbetamc

Usage

```
## S3 method for class 'diffbetamc'
summary(object, alpha = c(0.05, 0.01, 0.001), digits = 4, ...)
```

Arguments

object	Object of class diffbetamc.
alpha	Significance level.
digits	Digits to print.
...	additional arguments.

Value

Returns a matrix of differences of standardized regression slopes, standard errors, number of Monte Carlo replications, and confidence intervals.

Author(s)

Ivan Jacob Agaloos Pesigan

Examples

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaMC(object)
diff <- DiffBetaMC(std)
summary(diff)
```

summary.rsqbetamc	<i>Summary Method for an Object of Class rsqbetamc</i>
-------------------	--

Description

Summary Method for an Object of Class rsqbetamc

Usage

```
## S3 method for class 'rsqbetamc'
summary(object, alpha = c(0.05, 0.01, 0.001), digits = 4, ...)
```

Arguments

object	Object of class rsqbetamc.
alpha	Significance level.
digits	Digits to print.
...	additional arguments.

Value

Returns a matrix of multiple correlation (R-squared and adjusted R-squared), standard errors, number of Monte Carlo replications, and confidence intervals.

Author(s)

Ivan Jacob Agaloos Pesigan

Examples

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaMC(object)
rsq <- RSqBetaMC(std)
summary(rsq)
```

vcov.betamc

Sampling Covariance Matrix of the Standardized Regression Slopes

Description

Sampling Covariance Matrix of the Standardized Regression Slopes

Usage

```
## S3 method for class 'betamc'
vcov(object, ...)
```

Arguments

object Object of class betamc.
... additional arguments.

Value

Returns a matrix of the variance-covariance matrix of standardized slopes.

Author(s)

Ivan Jacob Agaloos Pesigan

Examples

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
out <- BetaMC(object, R = 100)
# use a large R, for example, R = 20000 for actual research
vcov(out)
```

vcov.diffbetamc	<i>Sampling Covariance Matrix of Differences of Standardized Regression Slopes</i>
-----------------	--

Description

Sampling Covariance Matrix of Differences of Standardized Regression Slopes

Usage

```
## S3 method for class 'diffbetamc'
vcov(object, ...)
```

Arguments

object	Object of class diffbetamc.
...	additional arguments.

Value

Returns a matrix of the variance-covariance matrix of differences of standardized regression slopes.

Author(s)

Ivan Jacob Agaloos Pesigan

Examples

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaMC(object)
diff <- DiffBetaMC(std)
vcov(diff)
```

vcov.rsqbetamc	<i>Sampling Covariance Matrix of Differences of Standardized Regression Slopes</i>
----------------	--

Description

Sampling Covariance Matrix of Differences of Standardized Regression Slopes

Usage

```
## S3 method for class 'rsqbetamc'
vcov(object, ...)
```

Arguments

<code>object</code>	Object of class <code>rsqbetamc</code> .
<code>...</code>	additional arguments.

Value

Returns a matrix of the variance-covariance matrix of multiple correlation.

Author(s)

Ivan Jacob Agaloos Pesigan

Examples

```
object <- lm(QUALITY ~ NARTIC + PCTGRT + PCTSUPP, data = nas1982)
std <- BetaMC(object)
rsq <- RSqBetaMC(std)
vcov(rsq)
```

Index

* Beta Monte Carlo Functions

BetaMC, [2](#)

DiffBetaMC, [9](#)

RSqBetaMC, [14](#)

* betaMC

BetaMC, [2](#)

DiffBetaMC, [9](#)

RSqBetaMC, [14](#)

* data

nas1982, [10](#)

* diff

DiffBetaMC, [9](#)

* methods

coef.betamc, [4](#)

coef.diffbetamc, [5](#)

coef.rsqbetamc, [6](#)

confint.betamc, [6](#)

confint.diffbetamc, [7](#)

confint.rsqbetamc, [8](#)

dif, [9](#)

print.betamc, [11](#)

print.diffbetamc, [12](#)

print.rsqbetamc, [12](#)

rsq, [13](#)

summary.betamc, [15](#)

summary.diffbetamc, [15](#)

summary.rsqbetamc, [16](#)

vcov.betamc, [17](#)

vcov.diffbetamc, [18](#)

vcov.rsqbetamc, [18](#)

* rsq

RSqBetaMC, [14](#)

BetaMC, [2](#), [10](#), [14](#)

coef.betamc, [4](#)

coef.diffbetamc, [5](#)

coef.rsqbetamc, [6](#)

confint.betamc, [6](#)

confint.diffbetamc, [7](#)

confint.rsqbetamc, [8](#)

dif, [9](#)

DiffBetaMC, [4](#), [9](#), [14](#)

nas1982, [10](#)

print.betamc, [11](#)

print.diffbetamc, [12](#)

print.rsqbetamc, [12](#)

rsq, [13](#)

RSqBetaMC, [4](#), [10](#), [14](#)

summary.betamc, [15](#)

summary.diffbetamc, [15](#)

summary.rsqbetamc, [16](#)

vcov.betamc, [17](#)

vcov.diffbetamc, [18](#)

vcov.rsqbetamc, [18](#)