Package ‘RMediation’

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Type Package

Title An R Package for Mediation Analysis Confidence Intervals

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Description RMediation package provides functions to compute confidence intervals (CIs) for a well-defined nonlinear function of the model parameters (e.g., product of k coefficients) in single-level and multilevel structural equation models.

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     http://www.public.asu.edu/~davidpm/ripl/Prodclin

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Description

RMediation package provides functions to compute confidence intervals (CIs) for a well-defined nonlinear function of the model parameters (e.g., product of k coefficients) in single-level and multilevel structural equation models.

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medci produces a CI for the product of two normal random variables using three methods: the distribution of the product of coefficients, Monte Carlo, and asymptotic normal theory with the multivariate-delta standard error (Asymptotic-Delta) method. pprodnormal produces percentiles for the distribution of product of two normal random variables. qprodnormal generates quantiles for the distribution of product of two normal random variables. ci produces a CI for a well-defined nonlinear function of the model parameters in single-level and multilevel structural equation models using the Monte Carlo and Asymptotic-Delta method.

Note

The PRODCLIN programs may be downloaded from http://www.public.asu.edu/~davidpm/ripl/Prodclin/. A web application of the RMediation program is available from http://amp.gatech.edu/RMediation.

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References


ci


See Also

qprodnormal pprodnormal medci ci

Examples

```r
medci(mu=x.2,mu.y=.4,se.x=.1,se.y=.05,rho=0,alpha=.05)
pprodnormal(q=.4, mu.x=.5, mu.y=.3, se.x=.03, se.y=.08, rho= 0)
quprodnormal(p=.1, mu.x=.5, mu.y=.3, se.x=.03, se.y=.8, rho=0)
ci(mu=c(0,2,0),Sigma=c(1,2,10), quant=-b1*b2)
ci(mu=c(b1=1,b2=.7,b3=-.6, b4=.45), Sigma=c(.05,0,0,.05,0,0, .03, 0, .03), quant=-b1*b2*b3*b4, type="all", plot=TRUE, plotCI=TRUE)
```

ci

CI for a nonlinear function of coefficients estimates

Description

This function returns a \((1 - \alpha)\%\) confidence interval (CI) for a well-defined nonlinear function of the coefficients in single-level and multilevel structural equation models. The ci function uses the Monte Carlo (type="MC") and the asymptotic normal theory (type="asymp") with the multivariate delta standard error (Asymptotic–Delta) method (Sobel, 1982) to compute a CI. In addition, for each of the methods, when a user specifies plot=TRUE and plotCI=TRUE, a plot of the sampling distribution of the quantity of interest in the quant argument and with an overlaid plot of the CI will be produced. When type="all" and plot=TRUE, two overlaid plots of the sampling distributions corresponding to each method will be produced; when plotCI=TRUE, then the overlaid plots of the CIs for both methods will be displayed as well.

Usage

```r
ci(mu, Sigma, quant, alpha = 0.05, type = "MC", plot = FALSE, plotCI = FALSE, n.mc = 1e+06, ...)
```

Arguments

- **mu**: a vector of means (e.g., coefficient estimates) for the normal random variables. A user can assign a name to each mean value, e.g., `mu=c(b1=1,b2=3)`; otherwise, the coefficient names are assigned automatically as follows: b1, b2, . . . .

- **Sigma**: either a covariance matrix or a vector that stacks all the columns of the lower triangle variance–covariance matrix one underneath the other.

- **quant**: quantity of interest, which is a nonlinear/linear function of the model parameters. Argument `quant` is a formula that must start with the symbol "tilde" (~): e.g., `~b1*b2*b3*b4`. The names of coefficients must conform to the names provided in the argument `mu` or to the default names, i.e., `b1, b2, . . . .`
The confidence interval (CI) is important in statistical analysis for understanding the uncertainty associated with the estimate. It is calculated as follows:

\[
\text{CI} = \text{Estimate} \pm \text{SE} \times \text{Error of Monte Carlo}
\]

where CI stands for confidence interval, Estimate is the point estimate of the quantity of interest, SE is the standard error of the quantity of interest, and Error of Monte Carlo is the error of the Monte Carlo estimate. The default value for the significance level is 0.05.

The method used to compute a CI depends on the specified method(s) in the argument type. It can take on the values "mc" (default) for Monte Carlo, "asymp" for Asymptotic-Delta, or "all" that produces CIs using both methods.

When TRUE, plot the approximate sampling distribution of the quantity of interest using the specified method(s) as specified in the argument type. The default value is FALSE. When type is "all", superimposed density plots generated by both methods are displayed.

When TRUE, overlays a CI plot with error bars on the density plot of the sampling distribution of the quantity of interest. When type is "all", the superimposed CI plots generated by both methods are added to the density plot. Note that to obtain a CI plot, one must also specify plot="TRUE". The default value is FALSE.

Monte Carlo sample size. The default sample size is 1e+6.

Additional arguments.

Value

When type is "mc" or "asymp", ci returns a list that contains:

- A vector of lower and upper confidence limits,
- A point estimate of the quantity of interest,
- Standard error of the quantity of interest,
- Error of the Monte Carlo estimate when type is "mc",

When type is "all", ci returns a list of two objects, each of which a list that contains the results produced by each method as described above.

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References


See Also

medci RMediation-package

Examples

```r
ci(mu=c(b1=1,b2=.7,b3=.6, b4 = .45), Sigma=c(.05,0,0,0,.05,0,0,.03,0,.03),
quant=-b1*b2*b3*b4, type="all", plot=TRUE, plotCI=TRUE)
```
Description

Produces confidence intervals for the mediated effect and the product of two normal random variables.

Usage

medci(mu.x, mu.y, se.x, se.y, rho = 0, alpha = 0.05, type = "prodclin",
plot=FALSE, plotCI=FALSE, n.mc = 1e+05, ...)

Arguments

mu.x  mean of x
mu.y  mean of y
se.x  standard error (deviation) of x
se.y  standard error (deviation) of y
rho  correlation between x and y, where -1 < rho < 1. The default value is 0.
alpha  significance level for the confidence interval. The default value is .05.
type  method used to compute confidence interval. It takes on the values "prodclin" (default), "dop", "mc", "asymp" or "all".
plot  when TRUE, plots the distribution of n.mc data points from the distribution of product of two normal random variables using the density estimates provided by the function density. The default value is FALSE.
plotCI  when TRUE, overlays a confidence interval with error bars on the plot for the mediated effect. Note that to obtain the CI plot, one must also specify plot="TRUE". The default value is FALSE.
n.mc  when type="MC", n.mc determines the sample size for the Monte Carlo method. The default sample size is 1E5.
...  additional arguments to be passed on to the function.

Details

This function returns a \((1 - \alpha)\%\) confidence interval for the mediated effect (product of two normal random variables). To obtain a confidence interval using a specific method, the argument type should be specified. The default is type="prodclin", which uses the PRODCLIN program described by MacKinnon et al. (2007). type="dop" uses the code we wrote in R to implement the distribution of product of the coefficients method. Note that both type="prodclin" and type="dop" use the method described by Meeker and Escobar (1994) to evaluate the CDF of the distribution of product. type="MC" uses the Monte Carlo approach to compute the confidence interval (Tofighi & MacKinnon, 2011). type="asymp" produces the asymptotic normal confidence interval. The standard error for the asymptotic normal confidence interval is based on the analytical results by Craig (1936). type="all" prints confidence intervals using all four options.
Percentile for the Distribution of Product of Two Normal Variables

Description

Generates percentiles (100 based quantiles) for the distribution of product of two normal random variables and the mediated effect.

Usage

```r
pprodnormal(q, mu.x, mu.y, se.x=1, se.y=1, rho = 0, lower.tail=TRUE, type="prodclin", n.mc=1e5)
```
Arguments

- **q**: quantile or value of the product
- **mu.x**: mean of \( x \)
- **mu.y**: mean of \( y \)
- **se.x**: standard error (deviation) of \( x \)
- **se.y**: standard error (deviation) of \( y \)
- **rho**: correlation between \( x \) and \( y \), where \(-1 < \rho < 1\). The default value is 0.
- **lower.tail**: logical; if `TRUE` (default), the probability is \( P[X \times Y < q] \); otherwise, \( P[X \times Y > q] \)
- **type**: method used to compute \( P[X \times Y < q] \). It takes on the values "prodclin" (default), "DOP", "MC", or "all".
- **n.mc**: when `type="MC"`, \( n.mc \) determines the sample size for the Monte Carlo method. The default sample size is 1E5.

Details

This function returns the percentile (probability) and the associated error for the distribution of product of mediated effect (two normal random variables). To obtain a percentile using a specific method, the argument `type` should be specified. The default method is `type="prodclin"`, which uses the PRODCLIN program described by MacKinnon et al. (2007). `type="DOP"` uses the code we wrote in R. Note that both `type="prodclin"` and `type="DOP"` use the method described by Meeker and Escobar (1994) to evaluate the CDF of the distribution of product of two normal random variables. `type="MC"` uses the Monte Carlo approach (Tofighi & MacKinnon, 2011). `type="all"` prints percentiles using all three options. For methods `type="prodclin"` and `type="DOP"`, the error is the modulus of absolute error for the numerical integration (for more information see Meeker and Escobar, 1994). For `type="MC"`, the error refers to the Monte Carlo error.

Value

An object of the type `list` that contains the following values:

- **p**: probability (percentile) corresponding to quantile \( q \)
- **error**: estimate of the absolute error

Note

The PRODCLIN programs may be downloaded from [http://www.public.asu.edu/~davidpm/ripl/Prodclin/](http://www.public.asu.edu/~davidpm/ripl/Prodclin/). A web application of the RMediation program is available from [http://amp.gatech.edu/RMediation](http://amp.gatech.edu/RMediation).

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References


See Also

medci qprodnormal RMediation-package

Examples

qprodnormal(q=0, mu.x=.5, mu.y=.3, se.x=1, se.y=1, rho=0, type="all")

qprodnormal

Quantile for the Distribution of Product of Two Normal Variables

Description

Generates quantiles for the distribution of product of two normal random variables

Usage

qprodnormal(p, mu.x, mu.y, se.x, se.y, rho=0, lower.tail=TRUE, type="prodclin", n.mc=1e5)

Arguments

p probability
mu.x mean of x
mu.y mean of y
se.x standard error (deviation) of x
se.y standard error (deviation) of y
rho correlation between x and y, where -1 < rho < 1. The default value is 0.
lower.tail logical; if TRUE (default), the probability is \( P[X \times Y < q] \); otherwise, \( P[X \times Y > q] \)
type method used to compute \( P[X \times Y < q] \). It takes on the values "prodclin" (default), "DOP", "MC", or "all".
n.mc when type="MC", n.mc determines the sample size of Monte Carlo method. The default sample size is 1E5.
Details

This function returns a quantile and the associated error (accuracy) corresponding the requested percentile (probability) \( p \) of the distribution of product of mediated effect (product of two normal random variables). To obtain a quantile using a specific method, the argument type should be specified. The default method is \texttt{type="prodclin"}, which uses the PRODCLIN program described by MacKinnon et al. (2007). \texttt{type="dop"} uses the code we wrote in R. Note that both \texttt{type="prodclin"} and \texttt{type="dop"} use the method described by Meeker and Escobar (1994) to evaluate the CDF of the distribution of product of two normal variables. \texttt{type="mc"} uses the Monte Carlo approach (Tofighi & MacKinnon, 2011). \texttt{type="all"} prints quantiles using all three options. For methods \texttt{type="prodclin"} and \texttt{type="dop"}, the error is the modulus of absolute error for the numerical integration (for more information see Meeker and Escobar, 1994). For \texttt{type="mc"}, the error refers to the Monte Carlo error.

Value

An object of the type \texttt{list} that contains the following values:

- \texttt{q} quantile corresponding to probability \( p \)
- \texttt{error} estimate of the absolute error

Note

The PRODCLIN programs may be downloaded from \url{http://www.public.asu.edu/~davidpm/ripl/Prodclin/}. A web application of the RMediation program is available from \url{http://amp.gatech.edu/RMediation}.

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References


See Also

\texttt{medci pprodnormal RMediation-package}
Examples

```r
qprodnormal(p=.1, mu.x=.5, mu.y=.3, se.x=1, se.y=1, rho=0, lower.tail = TRUE, type="all")
qprodnormal(p=.1, mu.x=.5, mu.y=.3, se.x=1, se.y=1, rho=0, lower.tail = FALSE, type="all")
```
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