Package ‘RMediation’

February 19, 2015

**Type** Package

**Title** An R Package for Mediation Analysis Confidence Intervals

**Version** 1.1.3

**Date** 2010-11-21

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**Depends** R (>= 2.11.0), base, MASS, lavaan, e1071

**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.

**License** GPL-2

**URL** http://amp.gatech.edu/RMediation

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

**NeedsCompilation** yes

**Repository** CRAN

**Date/Publication** 2014-03-07 18:33:35

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**RMediation-package**

**RMediation: An R Package for Mediation Analysis Confidence Intervals**

**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.

**Details**

```
Package: RMediation
Type: Package
Version: 1.1.3
Date: 2014-3-6
License: GPL-2
LazyLoad: yes
```


**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**


ci


See Also
qprodnormal pprodnormal medci ci

Examples

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(b1=0,b2=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

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, ...
alpha  significance level for the CI. The default value is .05.

type  method used to compute a CI. It takes on the values "MC" (default) for Monte Carlo, "asymp" for Asymptotic-Delta, or "all" that produces CIs using both methods.

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

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

n.mc  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:

(1 – α)% CI  a vector of lower and upper confidence limits,
Estimate  a point estimate of the quantity of interest,
SE  standard error of the quantity of interest,
MC Error  When type="MC", error of the Monte Carlo estimate.

When type="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

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)
medci

Confidence Interval for the Mediated Effect

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.
pprodnormal

Value

A vector of lower confidence limit and upper confidence limit.

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


See Also

qprodnormal pprodnormal RMediation-package

Examples

```r
# produces CI using PRODCLIN and density plot of distribution of xy
medci(mu.x=2, mu.y=.4, se.x=1, se.y=1, rho=0, alpha=.05,
      type="prodclin", plot=TRUE, plotCI=TRUE)
```

pprodnormal

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

```r
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

```r
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 * Y < q]`; otherwise, `P[X * Y > q]`
- `type`: method used to compute `P[X * 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 nor-
mal random variables). To obtain a quantile 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 variables. type="MC" uses the Monte
Carlo approach (Tofighi & MacKinnon, 2011). type="all" prints quantiles 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:

- **q**: quantile corresponding to probability \( p \)
- **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

MacKinnon, D. P., Fritz, M. S., Williams, J., and Lockwood, C. M. (2007). Distribution of the
product confidence limits for the indirect effect: Program PRODCLIN. *Behavior Research Methods*,


See Also

medci ppordnormal RMediation-package
Examples

---

#/lower tail
qprodnorm(p=.1, mu.x=.5, mu.y=.3, se.x=1, se.y=1, rho=0, lower.tail = TRUE, type="all")

#/upper tail
qprodnorm(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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