

# Package ‘semmcci’

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**Title** Monte Carlo Confidence Intervals in Structural Equation Modeling

**Version** 1.0.2

**Description** Monte Carlo confidence intervals for free and defined parameters in models fitted in the structural equation modeling package 'lavaan' can be generated using the 'semmcci' package. 'semmcci' has two main functions, namely, MC() and MCStd(). The output of 'lavaan' is passed as the first argument to the MC() function to generate Monte Carlo confidence intervals. Monte Carlo confidence intervals for the standardized estimates can also be generated by passing the output of the MC() function to the MCStd() function. Preacher and Selig (2012) <doi:10.1080/19312458.2012.679848>.

**URL** <https://github.com/jeksterslab/semmcci>

**BugReports** <https://github.com/jeksterslab/semmcci/issues>

**License** MIT + file LICENSE

**Encoding** UTF-8

**Roxygen** list(markdown = TRUE)

**Depends** R (>= 3.0.0), stats, lavaan, methods

**Suggests** knitr, rmarkdown, testthat, MASS

**RoxygenNote** 7.2.1

**NeedsCompilation** no

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MC	<i>Monte Carlo Confidence Intervals</i>
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## Description

Calculates Monte Carlo confidence intervals for free and defined parameters

## Usage

```
MC(object, R = 20000L, alpha = c(0.001, 0.01, 0.05))
```

## Arguments

object	object of class lavaan.
R	Positive integer. Number of Monte Carlo replications.
alpha	Numeric vector. Significance level. Default value is alpha = c(0.001, 0.01, 0.05).

## Details

A sampling distribution of parameter estimates is generated from the multivariate normal distribution using the parameter estimates and the sampling variance-covariance matrix. Confidence intervals for free and defined parameters are generated using the simulated sampling distribution. Parameters can be defined using the := operator in the lavaan model syntax.

## Value

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

`R` Number of Monte Carlo replications.

`alpha` Significance level specified.

`lavaan` lavaan object.

`mvn` Method used to generate multivariate normal random variates.

`thetahat` Parameter estimates.

`thetahatstar` Sampling distribution of parameter estimates.

`ci` Confidence intervals.

The list element `ci` is a matrix with the following columns:

`est` Parameter estimates.

`se` Standard errors or the square root of the diagonals of the Monte Carlo sampling distribution of parameter estimates.

R Number of valid Monte Carlo replications.

... Percentiles that correspond to the confidence intervals defined by alpha.

Note that the rows in ci correspond to the model parameters.

### Author(s)

Ivan Jacob Agaloos Pesigan

### Examples

```
library(semmcci)
library(lavaan)

# Generate Data -----
n <- 1000
x <- rnorm(n = n)
m <- 0.50 * x + rnorm(n = n)
y <- 0.25 * x + 0.50 * m + rnorm(n = n)
data <- data.frame(x, m, y)

# Fit Model in lavaan -----
model <- "
  y ~ cp * x + b * m
  m ~ a * x
  ab := a * b
"
fit <- sem(data = data, model = model)

# Monte Carlo -----
MC(
  fit,
  R = 100L, # use a large value e.g., 20000L for actual research
  alpha = c(0.001, 0.01, 0.05)
)
```

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MCStd

*Standardized Monte Carlo Confidence Intervals*

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### Description

Calculates standardized Monte Carlo confidence intervals for free and defined parameters.

### Usage

```
MCStd(object, alpha = c(0.001, 0.01, 0.05))
```

**Arguments**

object	object of class <code>semmcci</code> . Output of the <code>MC()</code> function.
alpha	Numeric vector. Significance level. Default value is <code>alpha = c(0.001, 0.01, 0.05)</code> .

**Details**

The empirical sampling distribution of parameter estimates from the argument object is standardized, that is, each randomly generated vector of parameters is standardized. Defined parameters are computed from the standardized component parameters. Confidence intervals are generated using the standardized empirical sampling distribution.

**Value**

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

`R` Number of Monte Carlo replications.

`alpha` Significance level specified.

`lavaan` lavaan object.

`mvn` Method used to generate multivariate normal random variates.

`thetahat` Parameter estimates.

`thetahatstar` Sampling distribution of parameter estimates.

`ci` Confidence intervals.

`thetahat_std` Standardized parameter estimates.

`thetahatstar_std` Standardized sampling distribution of parameter estimates.

`ci_std` Standardized confidence intervals.

The list element `ci_std` is a matrix with the following columns:

`est` Standardized parameter estimates.

`se` Standard errors or the square root of the diagonals of the standardized Monte Carlo sampling distribution of parameter estimates.

`R` Number of valid Monte Carlo replications.

`...` Percentiles that correspond to the confidence intervals defined by `alpha`.

Note that the rows in `ci_std` correspond to the standardized model parameters.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**Examples**

```

library(semmcci)
library(lavaan)

# Generate Data -----
n <- 1000
x <- rnorm(n = n)
m <- 0.50 * x + rnorm(n = n)
y <- 0.25 * x + 0.50 * m + rnorm(n = n)
data <- data.frame(x, m, y)

# Fit Model in lavaan -----
model <- "
  y ~ cp * x + b * m
  m ~ a * x
  ab := a * b
"
fit <- sem(data = data, model = model, fixed.x = FALSE)

# Monte Carlo -----
output <- MC(
  fit,
  R = 100L, # use a large value e.g., 20000L for actual research
  alpha = c(0.001, 0.01, 0.05)
)

# Standardized Monte Carlo -----
MCStd(output)

```

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print.semmcci	<i>Print Method for Object of Class semmcci</i>
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**Description**

Print Method for Object of Class semmcci

**Usage**

```
## S3 method for class 'semmcci'
print(x, digits = 4, ...)
```

**Arguments**

x	an object of class semmcci.
digits	Integer indicating the number of decimal places to display.
...	further arguments.

**Value**

Returns a matrix of estimates, standard errors, number of Monte Carlo replications, and confidence intervals.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**Examples**

```
library(semmcci)
library(lavaan)

# Generate Data -----
n <- 1000
x <- rnorm(n = n)
m <- 0.50 * x + rnorm(n = n)
y <- 0.25 * x + 0.50 * m + rnorm(n = n)
data <- data.frame(x, m, y)

# Fit Model in lavaan -----
model <- "
  y ~ cp * x + b * m
  m ~ a * x
  ab := a * b
"
fit <- sem(data = data, model = model)

# Monte Carlo -----
print(
  MC(
    fit,
    R = 100L, # use a large value e.g., 20000L for actual research
    alpha = c(0.001, 0.01, 0.05)
  )
)
```

---

```
print.semmcci_std      Print Method for Object of Class semmcci_std
```

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**Description**

Print Method for Object of Class semmcci\_std

**Usage**

```
## S3 method for class 'semmcci_std'
print(x, digits = 4, ...)
```

**Arguments**

<code>x</code>	an object of class <code>semmcci_std</code> .
<code>digits</code>	Integer indicating the number of decimal places to display.
<code>...</code>	further arguments.

**Value**

Returns a matrix of estimates, standard errors, number of Monte Carlo replications, and confidence intervals.

**Author(s)**

Ivan Jacob Agaloos Pesigan

**Examples**

```
library(semmcci)
library(lavaan)

# Generate Data -----
n <- 1000
x <- rnorm(n = n)
m <- 0.50 * x + rnorm(n = n)
y <- 0.25 * x + 0.50 * m + rnorm(n = n)
data <- data.frame(x, m, y)

# Fit Model in lavaan -----
model <- "
  y ~ cp * x + b * m
  m ~ a * x
  ab := a * b
"
fit <- sem(data = data, model = model, fixed.x = FALSE)

# Monte Carlo -----
output <- MC(
  fit,
  R = 100L, # use a large value e.g., 20000L for actual research
  alpha = c(0.001, 0.01, 0.05)
)

# Standardized Monte Carlo -----
print(MCStd(output))
```

semccci

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*semccci: Monte Carlo Confidence Intervals in Structural Equation Modeling*


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## Description

Monte Carlo confidence intervals for free and defined parameters in models fitted in the structural equation modeling package *lavaan* can be generated using the *semccci* package. The package has two main functions, namely, `MC()` and `MCStd()`. The output of *lavaan* is passed as the first argument to the `MC()` function to generate Monte Carlo confidence intervals. Monte Carlo confidence intervals for the standardized estimates can also be generated by passing the output of the `MC()` function to the `MCStd()` function.

## Details

In the Monte Carlo method, a sampling distribution of parameter estimates is generated from the multivariate normal distribution using the parameter estimates and the sampling variance-covariance matrix. Confidence intervals for defined parameters are generated by obtaining percentiles corresponding to  $100(1 - \alpha)\%$  from the generated sampling distribution, where  $\alpha$  is the significance level.

## Author(s)

Ivan Jacob Agaloos Pesigan

## References

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- Tofighi, D., & MacKinnon, D. P. (2015). Monte Carlo confidence intervals for complex functions of indirect effects. *Structural Equation Modeling: A Multidisciplinary Journal*, 23(2), 194–205. doi:10.1080/10705511.2015.1057284



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