

# Package ‘robmed’

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**Version** 0.1.1  
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**Depends** R (>= 3.2.0), ggplot2 (>= 0.9.3)  
**Imports** boot (>= 1.3-1)  
**Description** Perform mediation analysis via a bootstrap test.  
**License** GPL (>= 2)  
**LazyData** yes  
**LazyLoad** yes  
**Author** Andreas Alfons [aut, cre]  
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robmed-package                    *(Robust) Mediation Analysis*

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## Description

Perform mediation analysis via a bootstrap test.

## Details

The DESCRIPTION file:

```
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Title:       (Robust) Mediation Analysis
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Authors@R:  c(person("Andreas", "Alfons", email = "alfons@ese.eur.nl", role = c("aut", "cre")))
Author:     Andreas Alfons [aut, cre]
Maintainer: Andreas Alfons <alfons@ese.eur.nl>
RoxygenNote: 5.0.1
```

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plotMediation	Plot (robust) mediation analysis results
retest	Retest for mediation
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testMediation	(Robust) mediation analysis
weights.covHuber	Robustness weights of Huber M-estimation of

location and scatter

### Author(s)

Andreas Alfons [aut, cre]

Maintainer: Andreas Alfons <alfons@ese.eur.nl>

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coef.testMediation      *Coefficients in (robust) mediation analysis*

---

### Description

Extract coefficients from models computed in (robust) mediation analysis.

### Usage

```
## S3 method for class 'testMediation'
coef(object, parm = NULL, ...)

## S3 method for class 'bootTestMediation'
coef(object, parm = NULL, type = c("boot",
  "data"), ...)

## S3 method for class 'fitMediation'
coef(object, parm = NULL, ...)
```

### Arguments

object	an object inheriting from class " <code>testMediation</code> " containing results from (robust) mediation analysis, or an object inheriting from class " <code>fitMediation</code> " containing a (robust) mediation model fit.
parm	an integer, character or logical vector specifying the coefficients to be extracted, or NULL to extract all coefficients.
type	a character string specifying whether to extract the means of the bootstrap distribution (" <code>boot</code> "; the default), or the coefficient estimates based on the full data set (" <code>data</code> ").
...	additional arguments are currently ignored.

### Value

A numeric vector containing the requested coefficients.

### Author(s)

Andreas Alfons

**See Also**

[testMediation](#), [fitMediation](#), [confint](#)

---

confint.testMediation *Confidence intervals for (robust) mediation analysis*

---

**Description**

Extract or compute confidence intervals for coefficients from (robust) mediation analysis.

**Usage**

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

**Arguments**

object	an object inheriting from class " <a href="#">testMediation</a> " containing results from (robust) mediation analysis, or an object inheriting from class " <a href="#">fitMediation</a> " containing a (robust) mediation model fit.
parm	an integer, character or logical vector specifying the coefficients for which to extract or compute confidence intervals, or NULL to extract or compute confidence intervals for all coefficients.
level	for the "bootTestMediation" method, this is ignored and the confidence level of the bootstrap confidence interval for the indirect effect is used. For the other methods, the confidence level of the confidence intervals to be computed. The default is to compute 95% confidence intervals.
...	additional arguments are currently ignored.

**Value**

A numeric matrix containing the requested confidence intervals.

**Author(s)**

Andreas Alfons

**See Also**

[testMediation](#), [fitMediation](#), [coef](#)

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covControl	<i>Tuning parameters for Huber M-estimation of location and scatter</i>
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**Description**

Obtain a list with tuning parameters for [covHuber](#).

**Usage**

```
covControl(prob = 0.95, maxIterations = 200, tol = 1e-07)
```

**Arguments**

prob	numeric; probability for the quantile of the $\chi^2$ distribution to be used as cutoff point in the Huber weight function (defaults to 0.95).
maxIterations	an integer giving the maximum number of iterations in the iteratively reweighted algorithm.
tol	a small positive numeric value to be used to determine convergence of the iteratively reweighted algorithm.

**Value**

A list with components corresponding to the arguments.

**Author(s)**

Andreas Alfons

**References**

Huber, P.J. (1981) *Robust statistics*. John Wiley & Sons.

**See Also**

[covHuber](#)

covHuber

*Huber M-estimator of location and scatter***Description**

Compute a Huber M-estimator of location and scatter, which is reasonably robust for a small number of variables.

**Usage**

```
covHuber(x, control = covControl(...), ...)
```

**Arguments**

x	a numeric matrix or data frame.
control	a list of tuning parameters as generated by <code>covControl</code> .
...	additional arguments can be used to specify tuning parameters directly instead of via control.

**Details**

An iterative reweighting algorithm is used to compute the Huber M-estimator. The Huber weight function thereby corresponds to a convex optimization problem, resulting in a unique solution.

**Value**

An object of class "covHuber" with the following components:

center	a numeric vector containing the location vector estimate.
cov	a numeric matrix containing the scatter matrix estimate.
prob	numeric; probability for the quantile of the $\chi^2$ distribution used as cutoff point in the Huber weight function.
weights	a numeric vector containing the relative robustness weights for the observations.
tau	numeric; correction for Fisher consistency under multivariate normal distributions.
converged	a logical indicating whether the iterative reweighting algorithm converged.
iterations	an integer giving the number of iterations required to obtain the solution.

**Author(s)**

Andreas Alfons

**References**

Huber, P.J. (1981) *Robust statistics*. John Wiley & Sons.  
 Zu, J. and Yuan, K.-H. (2010) Local influence and robust procedures for mediation analysis. *Multivariate Behavioral Research*, **45**(1), 1–44.

**See Also**

[covControl](#), [testMediation](#), [fitMediation](#)

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covML

*Maximum likelihood estimator of mean vector and covariance matrix*

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**Description**

Compute the maximum likelihood estimator of the mean vector and the covariance matrix.

**Usage**

```
covML(x, ...)
```

**Arguments**

x	a numeric matrix or data frame.
...	additional arguments are currently ignored.

**Value**

An object of class "covML" with the following components:

center	a numeric vector containing the mean vector estimate.
cov	a numeric matrix containing the covariance matrix estimate.
n	an integer giving the number of observations.

**Author(s)**

Andreas Alfons

**References**

Zu, J. and Yuan, K.-H. (2010) Local influence and robust procedures for mediation analysis. *Multivariate Behavioral Research*, **45**(1), 1–44.

**See Also**

[testMediation](#), [fitMediation](#)

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fitMediation	<i>(Robustly) fit a mediation model</i>
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### Description

(Robustly) estimate the effects in a mediation model.

### Usage

```
fitMediation(x, y, m, covariates = NULL, data, method = c("covariance",
  "regression"), robust = TRUE, control, ...)
```

### Arguments

x	either a numeric vector containing the independent variable, or (if data is supplied) a character string, an integer or a logical vector specifying the corresponding column of data.
y	either a numeric vector containing the dependent variable, or (if data is supplied) a character string, an integer or a logical vector specifying the corresponding column of data.
m	either a numeric vector containing the proposed mediator variable, or (if data is supplied) a character string, an integer or a logical vector specifying the corresponding column of data.
covariates	optional; either a numeric vector or data frame containing additional covariates to be used as control variables, or (if data is supplied) a character, integer or logical vector specifying the corresponding column of data.
data	an optional data.frame.
method	a character string specifying the method of estimation. Possible values are "covariance" (the default) to estimate the effects via the covariance matrix, or "regression" to estimate the effects via regressions. Note that the effects are always estimated via regressions if control variables are specified via covariates.
robust	a logical indicating whether to robustly estimate the effects (defaults to TRUE). This is currently ignored if method is "regression".
control	if robust is TRUE and method is "covariance", a list of tuning parameters for <a href="#">covHuber</a> as generated by <a href="#">covControl</a> .
...	additional arguments can be used to specify tuning parameters directly instead of via control.

### Details

If method is "covariance" and robust is TRUE (the default), the effects are estimated based on a Huber M-estimator of location and scatter.

A much more robust method based on robust regression will be available soon. Currently, least squares regression is always performed if method is "regression".



**Value**

An object inheriting from class "fitMediation" (class "regFitMediation" if method is "regression" or "covFitMediation" if method is "covariance") with the following components:

a	numeric; the point estimate of the effect of the independent variable on the proposed mediator variable.
b	numeric; the point estimate of the direct effect of the proposed mediator variable on the dependent variable.
c	numeric; the point estimate of the direct effect of the independent variable on the dependent variable.
cPrime	numeric; the point estimate of the total effect of the independent variable on the dependent variable.
robust	a logical indicating whether the effects were estimated robustly.
fitMX	an object of class "lm" containing the estimation results from the regression of the proposed mediator variable on the independent variable (only "regFitMediation").
fitYMX	an object of class "lm" containing the estimation results from the regression of the dependent variable on the proposed mediator and independent variables (only "regFitMediation").
fitYX	an object of class "lm" containing the estimation results from the regression of the dependent variable on the independent variable (only "regFitMediation").
cov	an object of class "covHuber" or "covML" containing the covariance matrix estimates (only "covFitMediation").
data	a data frame containing the independent, dependent and proposed mediator variables.

**Author(s)**

Andreas Alfons

**References**

Zu, J. and Yuan, K.-H. (2010) Local influence and robust procedures for mediation analysis. *Multivariate Behavioral Research*, **45**(1), 1–44.

**See Also**

[testMediation](#)  
[covHuber](#), [covML](#), [lm](#)

**Examples**

```
# control parameters
n <- 250           # number of observations
a <- b <- c <- 0.2 # true effects
t <- 2            # number of observations to contaminate

# draw clean observations
```

```

set.seed(20160911)
x <- rnorm(n)
m <- a * x + rnorm(n)
y <- b * m + c * x + rnorm(n)

# contaminate the first t observations
m[1:t] <- m[1:t] - 6
y[1:t] <- y[1:t] + 6

# fit mediation model
fitMediation(x, y, m)

```

---

fortify.testMediation *Convert (robust) mediation analysis results into a data frame for plotting*

---

## Description

Supplement the estimated coefficients with other useful information for informative visualization of the (robust) mediation analysis results. It is thereby possible to construct data frames for dot plots of selected coefficients, as well as density plots of the indirect effect.

## Usage

```

## S3 method for class 'bootTestMediation'
fortify(model, data, method = c("dot", "density"),
  parm = c("c", "ab"), ...)

## S3 method for class 'sobelTestMediation'
fortify(model, data, method = c("dot",
  "density"), parm = c("c", "ab"), level = 0.95, ...)

## S3 method for class 'list'
fortify(model, data, ...)

```

## Arguments

model	an object inheriting from class " <code>testMediation</code> " containing results from (robust) mediation analysis.
data	for the " <code>bootTestMediation</code> " method, this is currently ignored. For the " <code>sobelTestMediation</code> " method, this is an optional numeric vector containing the $x$ -values at which to evaluate the assumed normal density from Sobel's test (only used in case of a density plot). The default is to take 100 equally spaced points between the estimated indirect effect $\pm$ three times the standard error according to Sobel's formula.

method	a character string specifying for which plot to construct the data frame. Possible values are "dot" for a dot plot of selected coefficients, or "density" for a density plot of the indirect effect.
parm	a character string specifying the coefficients to be included in a dot plot. The default is to include the direct and the indirect effect.
level	numeric; the confidence level of the confidence intervals from Sobel's test to be included in a dot plot. The default is to include 95% confidence intervals.
...	additional arguments are currently ignored.

**Value**

A data frame containing the necessary data for the selected plot, as well as additional information stored in attributes.

**Author(s)**

Andreas Alfons

**See Also**

[testMediation](#), [plotMediation](#)

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plotMediation	<i>Plot (robust) mediation analysis results</i>
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**Description**

Produce dot plots of selected coefficients from regression models computed in (robust) mediation analysis, or density plots of the indirect effect.

**Usage**

```
plotMediation(object, ...)

## S3 method for class 'bootTestMediation'
plotMediation(object, method = c("dot",
  "density"), parm = c("c", "ab"), ...)

## S3 method for class 'sobelTestMediation'
plotMediation(object, data, method = c("dot",
  "density"), parm = c("c", "ab"), level = 0.95, ...)

## S3 method for class 'list'
plotMediation(object, data, method = c("dot", "density"),
  parm = c("c", "ab"), level = 0.95, ...)

## Default S3 method:
```

```

plotMediation(object, mapping = attr(object, "mapping"),
  facets = attr(object, "facets"), ...)

## S3 method for class 'testMediation'
autoplot(object, ...)

## S3 method for class 'testMediation'
plot(x, ...)

```

### Arguments

object, x	an object inheriting from class " <a href="#">testMediation</a> " containing results from (robust) mediation analysis. For <code>plotMediation</code> , a list of such objects may be supplied as well.
method	a character string specifying which plot to produce. Possible values are "dot" for a dot plot of selected coefficients, or "density" for a density plot of the indirect effect.
parm	a character string specifying the coefficients to be included in a dot plot. The default is to include the direct and the indirect effect.
data	an optional numeric vector containing the $x$ -values at which to evaluate the assumed normal density from Sobel's test (only used in case of a density plot). The default is to take 100 equally spaced points between the estimated indirect effect $\pm$ three times the standard error according to Sobel's formula.
level	numeric; the confidence level of the confidence intervals from Sobel's test to be included in a dot plot. The default is to include 95% confidence intervals.
mapping	an aesthetic mapping to override the default behavior (see <a href="#">aes</a> or <a href="#">aes_string</a> ).
facets	a faceting formula to override the default behavior (only used in case of a dot plot). If supplied, <a href="#">facet_wrap</a> or <a href="#">facet_grid</a> is called depending on whether the formula is one-sided or two-sided.
...	additional arguments to be passed to and from methods.

### Value

An object of class "ggplot" (see [ggplot](#)).

### Author(s)

Andreas Alfons

### See Also

[testMediation](#), [fortify](#)

retest

*Retest for mediation***Description**

Reperform a (fast and robust) bootstrap test or Sobel's test for the indirect effect based on results from (robust) mediation analysis.

**Usage**

```
retest(object, ...)

## S3 method for class 'bootTestMediation'
retest(object, alternative = c("twosided", "less",
  "greater"), level = 0.95, type = c("bca", "perc"), ...)

## S3 method for class 'sobelTestMediation'
retest(object, alternative = c("twosided",
  "less", "greater"), ...)
```

**Arguments**

object	an object inheriting from class " <a href="#">testMediation</a> " containing results from (robust) mediation analysis.
alternative	a character string specifying the alternative hypothesis in the test for the indirect effect. Possible values are "twosided" (the default), "less" or "greater".
level	numeric; the confidence level of the confidence interval in the bootstrap test. The default is to compute a 95% confidence interval.
type	a character string specifying the type of confidence interval to be computed in the bootstrap test. Possible values are "bca" (the default) for the bias-corrected and accelerated bootstrap, or "perc" for the percentile bootstrap.
...	additional arguments to be passed down to methods.

**Value**

An object of the same class as `object` with updated test results (see [testMediation](#)).

**Author(s)**

Andreas Alfons

**See Also**

[testMediation](#)

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testMediation	<i>(Robust) mediation analysis</i>
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### Description

Perform (robust) mediation analysis via a bootstrap test or Sobel's test.

### Usage

```
testMediation(x, ...)

## Default S3 method:
testMediation(x, y, m, covariates = NULL, data,
  test = c("boot", "sobel"), alternative = c("twosided", "less", "greater"),
  R = 5000, level = 0.95, type = c("bca", "perc"),
  method = c("covariance", "regression"), robust = TRUE, control, ...)

## S3 method for class 'fitMediation'
testMediation(x, test = c("boot", "sobel"),
  alternative = c("twosided", "less", "greater"), R = 5000, level = 0.95,
  type = c("bca", "perc"), ...)

indirect(..., test = c("boot", "sobel"), method = "regression",
  robust = FALSE)
```

### Arguments

x	either a numeric vector containing the independent variable, or (if data is supplied) a character string, an integer or a logical vector specifying the corresponding column of data.
y	either a numeric vector containing the dependent variable, or (if data is supplied) a character string, an integer or a logical vector specifying the corresponding column of data.
m	either a numeric vector containing the proposed mediator variable, or (if data is supplied) a character string, an integer or a logical vector specifying the corresponding column of data.
covariates	optional; either a numeric vector or data frame containing additional covariates to be used as control variables, or (if data is supplied) a character, integer or logical vector specifying the corresponding column of data.
data	an optional data.frame.
test	a character string specifying the test to be performed for the indirect effect. Possible values are "boot" (the default) for the bootstrap, or "sobel" for Sobel's test.
alternative	a character string specifying the alternative hypothesis in the test for the indirect effect. Possible values are "twosided" (the default), "less" or "greater".

R	an integer giving the number of bootstrap replicates. The default is to use 5000 bootstrap replicates.
level	numeric; the confidence level of the confidence interval in the bootstrap test. The default is to compute a 95% confidence interval.
type	a character string specifying the type of confidence interval to be computed in the bootstrap test. Possible values are "bca" (the default) for the bias-corrected and accelerated bootstrap, or "perc" for the percentile bootstrap.
method	a character string specifying the method of estimation for the mediation model. Possible values are "covariance" (the default) to estimate the effects via the covariance matrix, or "regression" to estimate the effects via regressions. Note that the effects are always estimated via regressions if control variables are specified via covariates.
robust	a logical indicating whether to perform a robust test (defaults to TRUE). This is currently ignored if method is "regression".
control	if robust is TRUE and method is "covariance", a list of tuning parameters for <a href="#">covHuber</a> as generated by <a href="#">covControl</a> .
...	additional arguments to be passed to <a href="#">boot</a> in case of a bootstrap test.

### Details

If method is "covariance" and robust is TRUE, the tests are based on a Huber M-estimator of location and scatter. For the bootstrap test, the M-estimates are used to first clean the data via a transformation. Then the standard bootstrap is performed with the cleaned data. Note that this does not account for the variability from cleaning the data.

A much more robust method based on robust regression will be available soon. Currently, least squares regression is always performed if method is "regression".

indirect is a wrapper function for performing non-robust mediation analysis via regressions (inspired by Preacher & Hayes' SPSS macro INDIRECT).

### Value

An object inheriting from class "testMediation" (class "bootTestMediation" if test is "boot" or "sobelTestMediation" if test is "sobel") with the following components:

ab	numeric; the point estimate of the indirect effect.
ci	a numeric vector of length two containing the bootstrap confidence interval for the indirect effect (only "bootTestMediation").
reps	an object of class " <a href="#">boot</a> " containing the bootstrap replicates of the indirect effect (only "bootTestMediation").
se	numeric; the standard error of the indirect effect according to Sobel's formula (only "sobelTestMediation").
statistic	numeric; the test statistic for Sobel's test (only "sobelTestMediation").
pvalue	numeric; the p-Value from Sobel's test (only "sobelTestMediation").
alternative	a character string specifying the alternative hypothesis in the test for the indirect effect.

R	an integer giving the number of bootstrap replicates (only "bootTestMediation").
level	numeric; the confidence level of the bootstrap confidence interval (only "bootTestMediation").
type	a character string specifying the type of bootstrap confidence interval (only "bootTestMediation").
fit	an object inheriting from class " <a href="#">fitMediation</a> " containing the estimation results for the direct effect and the total effect in the mediation model.

**Author(s)**

Andreas Alfons

**References**

- Preacher, K.J. and Hayes, A.F. (2004) SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behavior Research Methods, Instruments, & Computers*, **36**(4), 717–731.
- Sobel, M.E. (1982) Asymptotic confidence intervals for indirect effects in structural equation models. *Sociological Methodology*, **13**, 290–312.
- Zu, J. and Yuan, K.-H. (2010) Local influence and robust procedures for mediation analysis. *Multivariate Behavioral Research*, **45**(1), 1–44.

**See Also**

[fitMediation](#)  
[coef](#), [confint](#), [fortify](#) and [plot](#) methods  
[boot](#), [covHuber](#), [covML](#), [lm](#)

**Examples**

```
# control parameters
n <- 250          # number of observations
a <- b <- c <- 0.2 # true effects
t <- 2           # number of observations to contaminate

# draw clean observations
set.seed(20160911)
x <- rnorm(n)
m <- a * x + rnorm(n)
y <- b * m + c * x + rnorm(n)

# contaminate the first t observations
m[1:t] <- m[1:t] - 6
y[1:t] <- y[1:t] + 6

# perform mediation analysis
test <- testMediation(x, y, m)
summary(test)
```



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weights.covHuber	<i>Robustness weights of Huber M-estimation of location and scatter</i>
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**Description**

Extract (relative) robustness weights of a Huber M-estimate of location and scatter.

**Usage**

```
## S3 method for class 'covHuber'  
weights(object, type = c("consistent", "relative"), ...)
```

**Arguments**

object	an object inheriting from class " <a href="#">covHuber</a> " containing Huber M-estimates of location and scatter.
type	a character string specifying the type of robustness weights to be extracted. Possible values are "consistent" and "relative". The former can be used for a robust transformation of the data such that the covariance matrix of the transformed data is Fisher consistent. Observations that are not downweighted in general receive a weight larger than 1. The latter are useful for interpretation, as observations that are not downweighted receive a relative weight of 1.
...	additional arguments are currently ignored.

**Value**

A numeric vector containing the requested robustness weights.

**Author(s)**

Andreas Alfons

**References**

Zu, J. and Yuan, K.-H. (2010) Local influence and robust procedures for mediation analysis. *Multivariate Behavioral Research*, **45**(1), 1–44.

**See Also**

[covHuber](#)

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