

# Package ‘boutliers’

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**Type** Package

**Title** Outlier Detection and Influence Diagnostics for Meta-Analysis

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**Description** Computational tools for outlier detection and influence diagnostics of meta-analysis. Bootstrap distributions of the influence statistics are calculated, and the thresholds to determine outliers are explicitly provided.

**Imports** stats, metafor, MASS

**License** GPL-3

**Encoding** UTF-8

**LazyData** true

**NeedsCompilation** no

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boutliers-package      *The 'boutliers' package.*

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### Description

Computational tools for implementing outlier detection and influence diagnostics for meta-analysis. Bootstrap distributions of the influence statistics are calculated, and the thresholds to determine outliers are provided.

### References

- Hedges, L. V., and Olkins, I. (1985). *Statistical Methods for Meta-Analysis*. New York: Academic Press.
- Noma, H., Goshio, M., Ishii, R., Oba, K., and Furukawa, T. A. (2020). Outlier detection and influence diagnostics in network meta-analysis. *Research Synthesis Methods*. **11**(6): 891-902. [doi:10.1002/jrsm.1455](https://doi.org/10.1002/jrsm.1455)
- Viechtbauer, W., and Cheung, M. W. (2010). Outlier and influence diagnostics for meta-analysis. *Research Synthesis Methods*. **1**(2): 112-125. [doi:10.1002/jrsm.11](https://doi.org/10.1002/jrsm.11)

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finasteride      *A multicenter clinical trial data assessing the treatment effect of finasteride for benign prostatic hyperplasia*

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### Description

- center: Center ID
- n1: Number of observations in finasteride group
- m1: Mean of the change of Boyarsky score from baseline in finasteride group
- s1: SD of the change of Boyarsky score from baseline in finasteride group
- n0: Number of observations in placebo group
- m0: Mean of the change of Boyarsky score from baseline in placebo group
- s0: SD of the change of Boyarsky score from baseline in placebo group

### Usage

```
data(PPI)
```

### Format

A data frame with 29 rows and 7 variables

## References

- Gormley, G. J., Stoner, E., Bruskewitz, R. C., et al. (1992). The effect of finasteride in men with benign prostatic hyperplasia. The Finasteride Study Group. *New England Journal of Medicine*. **327**: 1185-1191. doi:10.1056/nejm199210223271701
- Gould, A. L. (1998). Multi-centre trial analysis revisited. *Statistics in Medicine*. **17**: 1779-1797.

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 LRT

*Likelihood ratio test using a mean-shifted model*


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## Description

Implementing the likelihood ratio tests using the mean-shifted model for the DerSimonian-Laird-type random-effects model. The bootstrap p-values are provided.

## Usage

```
LRT(y, v, B=2000, alpha=0.05)
```

## Arguments

y	A vector of the outcome measure estimates (e.g., MD, SMD, log OR, log RR, RD)
v	A vector of the variance estimate of y
B	The number of bootstrap resampling (default: 2000)
alpha	The significance level (default: 0.05)

## Value

Results of the likelihood ratio tests involving bootstrap p-values. The outputs are ordered by the p-values.

- id: ID of the study.
- LR: The likelihood ratio statistic for based on the mean-shifted model.
- Q: 1-alpha percentile for the bootstrap distribution of the likelihood ratio statistic.
- P: The bootstrap p-value for the likelihood ratio statistic.

## Examples

```
require(metafor)
data(SMT)

edat2 <- escalc(m1i=m1, sd1i=s1, n1i=n1, m2i=m2, sd2i=s2, n2i=n2, measure="MD", data=SMT)

LRT(edat2$yi, edat2$vi, B=10) # This is an example command for illustration. B should be >= 1000.
```

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LRT_FE	<i>Likelihood ratio test using a mean-shifted model by the fixed-effect model</i>
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### Description

Implementing the likelihood ratio tests using the mean-shifted model for the fixed-effect model. The bootstrap p-values are provided.

### Usage

```
LRT_FE(y, v, B=2000, alpha=0.05)
```

### Arguments

y	A vector of the outcome measure estimates (e.g., MD, SMD, log OR, log RR, RD)
v	A vector of the variance estimate of y
B	The number of bootstrap resampling (default: 2000)
alpha	The significance level (default: 0.05)

### Value

Results of the likelihood ratio tests involving bootstrap p-values. The outputs are ordered by the p-values.

- id: ID of the study.
- LR: The likelihood ratio statistic for based on the mean-shifted model.
- Q: 1-alpha percentile for the bootstrap distribution of the likelihood ratio statistic.
- P: The bootstrap p-value for the likelihood ratio statistic.

### Examples

```
require(metafor)
data(SMT)

edat2 <- escalc(m1i=m1, sd1i=s1, n1i=n1, m2i=m2, sd2i=s2, n2i=n2, measure="MD", data=SMT)

LRT_FE(edat2$yi, edat2$vi, B=10)
# This is an example command for illustration. B should be >= 1000.
```

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PPI *Crocker et al. (2018)'s patient and public involvement (PPI) intervention data*

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**Description**

- ID: Study ID
- d1: Number of events in PPI intervention group
- n1: Number of observations in PPI intervention group
- d2: Number of events in non-PPI intervention group
- n2: Number of observations in non-PPI intervention group

**Usage**

`data(PPI)`

**Format**

A data frame with 21 rows and 5 variables

**References**

Crocker, J. C., Ricci-Cabello, I., Parker, A., Hirst, J. A., Chant, A., Petit-Zeman, S., Evans, D., Rees, S. (2018). Impact of patient and public involvement on enrolment and retention in clinical trials: systematic review and meta-analysis. *BMJ*. **363**: k4738. doi:10.1136/bmj.k4738

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SMT *Rubinstein et al. (2019)'s chronic low back pain data*

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**Description**

- ID: Study ID
- Souce: First author name and year of publication
- m1: Estimated mean in experimental group
- s1: Standard deviation in experimental group
- n1: Number of observations in experimental group
- m2: Estimated mean in control group
- s2: Standard deviation in control group
- n2: Number of observations in control group

**Usage**

`data(SMT)`

**Format**

A data frame with 23 rows and 8 variables

**References**

Rubinstein, S. M., de Zoete, A., van Middelkoop, M., Assendelft, W. J. J., de Boer, M. R., van Tulder, M. W. (2019). Benefits and harms of spinal manipulative therapy for the treatment of chronic low back pain: systematic review and meta-analysis of randomised controlled trials. *BMJ*. **364**: l689. doi:10.1136/bmj.l689

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 STR

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*Studentized residuals by leave-one-out analysis*


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**Description**

Calculating the studentized residuals by leave-one-out analysis (studentized deleted residuals) and the percentiles of their bootstrap distributions.

**Usage**

```
STR(y, v, B=2000, alpha=0.95)
```

**Arguments**

y	A vector of the outcome measure estimates (e.g., MD, SMD, log OR, log RR, RD)
v	A vector of the variance estimate of y
B	The number of bootstrap resampling (default: 2000)
alpha	The bootstrap percentiles to be outputted; 0.5(1-alpha)th and (1-0.5(1-alpha))th percentiles. Default is 0.95; 2.5th and 97.5th percentiles are calculated.

**Value**

The studentized residuals by leave-one-out analysis. The outputs are ordered by the sizes of the studentized residuals.

- id: ID of the study.
- psi: The studentized residuals by leave-one-out analysis (studentized deleted residuals).
- Q1: 0.5(1-alpha)th percentile for the bootstrap distribution of the studentized residual (default: 2.5th percentile).
- Q2: 1-0.5(1-alpha)th percentile for the bootstrap distribution of the studentized residual (default: 97.5th percentile).

**Examples**

```
require(metafor)
data(PPI)

edat1 <- escalc(ai=d1,n1i=n1,ci=d2,n2i=n2,measure="OR",data=PPI)

STR(edat1$yi,edat1$vi,B=10) # This is an example command for illustration. B should be >= 1000.
```

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STR_FE	<i>Studentized residuals by leave-one-out analysis for the fixed-effect model</i>
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**Description**

Calculating the studentized residuals by leave-one-out analysis (studentized deleted residuals) for the fixed-effect model and the percentiles of their bootstrap distributions.

**Usage**

```
STR_FE(y, v, B=2000, alpha=0.95)
```

**Arguments**

y	A vector of the outcome measure estimates (e.g., MD, SMD, log OR, log RR, RD)
v	A vector of the variance estimate of y
B	The number of bootstrap resampling (default: 2000)
alpha	The bootstrap percentiles to be outputted; 0.5(1-alpha)th and (1-0.5(1-alpha))th percentiles. Default is 0.95; 2.5th and 97.5th percentiles are calculated.

**Value**

The studentized residuals by leave-one-out analysis. The outputs are ordered by the sizes of the studentized residuals.

- id: ID of the study.
- psi: The studentized residuals by leave-one-out analysis (studentized deleted residuals).
- Q1: 0.5(1-alpha)th percentile for the bootstrap distribution of the studentized residual (default: 2.5th percentile).
- Q2: 1-0.5(1-alpha)th percentile for the bootstrap distribution of the studentized residual (default: 97.5th percentile).

**Examples**

```
require(metafor)
data(PPI)

edat1 <- escalc(ai=d1,n1i=n1,ci=d2,n2i=n2,measure="OR",data=PPI)

STR_FE(edat1$yi,edat1$vi)
```

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 VRATIO

*Variance ratio influential statistics*


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**Description**

Calculating the variance ratio influential statistics by leave-one-out analysis and the percentiles of their bootstrap distributions.

**Usage**

```
VRATIO(y, v, B=2000, alpha=0.05)
```

**Arguments**

<code>y</code>	A vector of the outcome measure estimates (e.g., MD, SMD, log OR, log RR, RD)
<code>v</code>	A vector of the variance estimate of <code>y</code>
<code>B</code>	The number of bootstrap resampling (default: 2000)
<code>alpha</code>	The bootstrap percentile to be outputted (default: 0.05)

**Value**

The variance ratio influential statistics by leave-one-out analysis and their bootstrap percentiles. The outputs are ordered by the sizes of the variance ratio statistics.

- `id`: ID of the study.
- `VR`: The VRATIO statistic (relative change of the variance of the overall estimator) by leave-one-out analysis.
- `Q1`: `alpha`th percentile for the bootstrap distribution of the VRATIO statistic.
- `TR`: The TAU2RATIO statistic (relative change of the heterogeneity variance) by leave-one-out analysis.
- `Q2`: `alpha`th percentile for the bootstrap distribution of the TAU2RATIO statistic.

**Examples**

```
require(metafor)
data(finasteride)

edat3 <- escalc(m1i=m1,sd1i=s1,n1i=n1,m2i=m0,sd2i=s0,n2i=n0,measure="MD",data=finasteride)

VRATIO(edat3$yi, edat3$vi, B=10)
# This is an example command for illustration. B should be >= 1000.
```

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