Package ‘metaHelper’

July 28, 2024

Title Transforms Statistical Measures Commonly Used for Meta-Analysis

Version 1.0.0

Description Helps calculate statistical values commonly used in meta-analysis. It provides several methods to compute different forms of standardized mean differences, as well as other values such as standard errors and standard deviations.
The methods used in this package are described in the following references:
Altman D G, Bland J M. (2011) <doi:10.1136/bmj.d2090>
Borenstein, M., Hedges, L.V., Higgins, J.P.T. and Rothstein, H.R. (2009) <doi:10.1002/9780470743386.ch4>
Chinn S. (2000) <doi:10.1002/1097-0258(20001130)19:22%3C3127::aid-sim784%3E3.0.co;2-m>
Cochrane Handbook (2011) <https://handbook-5-1.cochrane.org/front_page.htm>
Cooper, H., Hedges, L. V., & Valentine, J. C. (2009) <https://psycnet.apa.org/record/2009-05060-000>
Cohen, J. (1977) <https://psycnet.apa.org/record/1987-98267-000>
Ellis, P.D. (2009) <https://www.psychometrica.de/effect_size.html>
Goulet-Pelletier, J.-C., & Cousineau, D. (2018) <doi:10.20982/tqmp.14.4.p242>
Hedges, L. V. (1981) <doi:10.2307/1164588>
Hedges L. V., Olkin I. (1985) <doi:10.1016/C2009-0-03396-0>
Murad M H, Wang Z, Zhu Y, Saadi S, Chu H, Lin L et al. (2023) <doi:10.1136/bmj-2022-073141>
Mayer M (2023) <https://search.r-project.org/CRAN/refmans/confintr/html/ci_proportion.html>
Stackoverflow (2014) <https://stats.stackexchange.com/questions/82720/confidence-interval-around-binomial-estimate-of-0-or-1>
Stackoverflow (2018) <https://stats.stackexchange.com/q/338043>.

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Suggests testthat (>= 3.0.0)

Config/testthat/edition 3

Imports magrittr, stats, confintr

URL https://github.com/RobertEmprechtinger/metaHelper

BugReports https://github.com/RobertEmprechtinger/metaHelper/issues

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Contents

`ARD_from_RR` *Absolute Risk Difference*

Description

Calculates the Absolute Risk Difference (ARD) from a Risk Ratio and baseline risk using simulations. The result is ARD as a decimal. The number of replications is fixed at 100,000.

Usage

```
ARD_from_RR(BR, BRLL, BRUL, RR, RRLL, RRUL, seed = 1)
```

Arguments

BR	baseline risk
BRLL	baseline risk lower limit confidence interval
BRUL	baseline risk upper limit confidence interval
RR	risk ratio
RRLL	risk ratio lower limit confidence interval
RRUL	risk ratio upper limit confidence interval
seed	seed that is used for the simulation to ensure reproducibility

Value

Named numeric vector containing median ARD, the lower and upper CI of the ARD.

References

Murad M H, Wang Z, Zhu Y, Saadi S, Chu H, Lin L et al. Methods for deriving risk difference (absolute risk reduction) from a meta-analysis BMJ 2023; 381 :e073141 doi:10.1136/bmj-2022-073141

Examples

```
# Input : Baseline risk and 95% CI (BR BRLL and BRUL), risk ratio and 95% CI (RR, RRLL, RRUL)
BR <- 0.053; BRLL <- 0.039; BRUL <- 0.072
RR <- 0.77; RRLL <- 0.63; RRUL <- 0.94
ARD_from_RR(BR, BRLL, BRUL, RR, RRLL, RRUL)
```

CI_from_proportions *Confidence Interval for Proportions*

Description

Calculates a confidence interval for proportions. For a discussion on the differences between methods to calculate confidence intervals, see the Stack Overflow discussion under References. This method uses the R package "confintr" to calculate the confidence intervals.

Usage

```
CI_from_proportions(events, n, method = "Clopper-Pearson")
```

Arguments

events	number of events
n	sample size
method	the method ("Clopper-Pearson", "Agresti-Coull", "Wilson") that should be used to calculate the confidence intervals.

Value

List of confidence interval of proportions if input length > 1. If input length = 1 Lower CI and Upper CI.

References

Confintr Function Description Stackoverflow Method Discussion

Examples

```
# CI for 9 events in a sample of 10
CI_from_proportions(9, 10)
```

SDp_from_CIp *Pooled Standard Deviation from Confidence Interval*

Description

Computes the pooled standard deviation (e.g., standard deviation of an intervention effect) from confidence intervals and sample sizes. According to the Cochrane Handbook (see references), this standard deviation is referred to as the "within-group standard deviation." This method is valid only if the confidence interval is symmetrical around the mean and if either the t-distribution or normal distribution (when "t_dist = FALSE") was used to calculate the confidence interval.

Usage

```
SDp_from_CIp(
  CI_low,
  CI_up,
  n1,
  n2,
  sig_level = 0.05,
  two_sided = TRUE,
  t_dist = TRUE
)
```

Arguments

CI_low	lower limit confidence interval
CI_up	upper limit confidence interval
n1	sample size group 1
n2	sample size group 2
sig_level	significance level
two_sided	whether a two sided test for significance was used
t_dist	whether a t distribution has been used to calculate the CI

Value

Pooled standard deviation

References

Cochrane Handbook

See Also

`SD_from_CI()` for single group standard deviation.

Examples

```
#lower CI = 0.5, upper CI = 0.7, N1 = 50, N2 = 70
SDp_from_CIp(0.5, 0.7, 50, 70)
```

SDp_from_SD *Pooled Standard Deviation from Two Standard Deviations*

Description

Calculates the pooled standard deviation.

Usage

```
SDp_from_SD(SD1, SD2, n1 = NA, n2 = NA, method = "hedges")
```

Arguments

SD1	standard deviation of group 1
SD2	standard deviation of group 2
n1	sample size of group 1
n2	sample size of group 2
method	the method ("hedges", "cohen") that should be used to calculate the SD. Method "hedges" requires sample sizes. The "cohen" method uses a simplified method by and does not rely on sample sizes.

Details

The method according to Hedges requires the sample sizes. If only standard deviations are available, the simpler equation provided by Cohen (1988) can be used. If there are more than two groups, `SD_M_n_pooled_from_groups()` should be used. Note: The use of the names "Cohen" and "Hedges" for the methods can be inconsistent in the literature. It is somewhat unusual because Cohen (1977) outlined both estimators for the pooled standard deviation before Hedges (1981) discussed them.

Value

Pooled standard deviation

References

Borenstein, M., Hedges, L.V., Higgins, J.P.T. and Rothstein, H.R. (2009). Converting Among Effect Sizes. In Introduction to Meta-Analysis (eds M. Borenstein, L.V. Hedges, J.P.T. Higgins and H.R. Rothstein). https://doi.org/10.1002/9780470743386.ch7

Cohen, J. (1977). Statistical power analysis for the behavioral sciences (2nd ed.). Hillsdale, NJ, US: Lawrence Erlbaum Associates, Inc.

Ellis, P.D. (2009), "Effect size equations". Link

Hedges, L. V. (1981). Distribution theory for Glass's estimator of effect size and related estimators. Journal of Educational Statistics, 6, 107-128.

Difference between Cohen's d and Hedges' g for effect size metrics. Stackoverflow. Link

See Also

`SD_within_from_SD_r()` for matched groups

Examples

```
# Standard deviation according to Cohen:
SDp_from_SD(2, 3, method = "cohen")

# Standard deviation according to Hedges needs sample sizes:
SDp_from_SD(2, 3, 50, 50)
```

`SDp_from_SEp` *Standard Deviation from the Pooled Standard Error*

Description

IMPORTANT: For a single group, use `SD_from_SE()`! Calculates the standard deviation from the pooled standard error and sample sizes of two groups (e.g., for intervention effects). This method is the reverse of `SEp_from_SDp()`.

Usage

```
SDp_from_SEp(SEp, n1, n2)
```

Arguments

SEp	pooled standard error
n1	sample size group 1
n2	sample size group 2

Value

Pooled standard deviation

References

Cochrane Handbook

See Also

`SD_from_SE()` for a single group. `SEp_from_SDp()` if the standard error should be computed instead.

Examples

```
#pooled standard error, sample size 1 and sample size 2
SE <- 0.12
n1 <- 140
n2 <- 140

SDp_from_SEp(SE, n1, n2)
```

SD_from_CI — *Standard Deviation from Confidence Interval*

Description

Computes the standard deviation from the confidence interval and sample size. This method is valid only for single groups and assumes the confidence interval is symmetrical around the mean. For two groups (e.g., intervention effects), use `SDp_from_CIp()`. For sample sizes smaller than 60, the t-distribution (parameter "t-dist") is typically used to calculate the confidence interval.

Usage

```
SD_from_CI(CI_low, CI_up, n, sig_level = 0.05, two_sided = TRUE, t_dist = TRUE)
```

Arguments

`CI_low`	lower limit confidence interval
`CI_up`	upper limit confidence interval
`n`	sample size
`sig_level`	significance level
`two_sided`	whether a two sided test for significance was used
`t_dist`	whether a t-distribution has been used to calculate the CI. See description.

Value

Standard deviation single group

References

Cochrane Handbook

See Also

`SDp_from_CIp()` for two groups (e.g. intervention effects).

Examples

```
# lower CI = -0.5, upper CI = 2, sample size = 100
SD_from_CI(-05, 2, 100)
```

`SD_from_SE` *Standard Deviation from Standard Error (Single Group)*

Description

IMPORTANT: When there are two groups, use the method for calculating the pooled standard error provided by the function `SDp_from_SEp()`! Calculates the standard deviation from the standard error for a single group.

Usage

```
SD_from_SE(SE, n)
```

Arguments

`SE`	standard error
`n`	sample size

Value

Single group standard deviation

References

Cochrane Handbook

See Also

`SDp_from_SEp()` in case of two groups.

Examples

```
# Standard error = 2 and sample size = 100
SE <- 2
n <- 100
SD_from_SE(SE, n)
```

SD_M_n_pooled_from_groups

Combined Standard Deviation for Multiple Groups

Description

Computes the pooled standard deviation for multiple groups.

Usage

```
SD_M_n_pooled_from_groups(M, SD, n)
```

Arguments

M	vector of group means
SD	vector of group SDs
n	vector of group sample sizes

Details

This function also returns the combined mean and the total sample size across all groups. Requires also the mean for all individual groups. If there are only two groups and the mean is not available `SDp_from_SD()` can be used instead.

Value

Within standard deviation

References

Cochrane Handbook

Rücker G, Cates CJ, Schwarzer G. Methods for including information from multi-arm trials in pairwise meta-analysis. Res Synth Methods. 2017 Dec;8(4):392-403. doi: 10.1002/jrsm.1259. Epub 2017 Aug 25. PMID: 28759708.

Examples

```
# Compute the Standard deviation for the following grouped data
M <- c(1, 1.5, 2) # Means
SD <- c(2, 3, 2.5) # SDs
n <- c(72, 80, 55) # sample sizes
SD_M_n_pooled_from_groups(M, SD, n)
```

`SD_within_from_SD_r` *Within-Group Standard Deviation for Matched Groups*

Description

Computes the within-group standard deviation for matched groups. This within-group standard deviation can be used to calculate standardized mean differences for matched groups. This method requires a correlation coefficient r.

Usage

```
SD_within_from_SD_r(SD_diff, r)
```

Arguments

`SD_diff`	standard deviation of the difference
`r`	correlation between pair of observations

Value

Within standard deviation

References

Borenstein, M., Hedges, L.V., Higgins, J.P.T. and Rothstein, H.R. (2009). Effect Sizes Based on Means . In Introduction to Meta-Analysis (eds M. Borenstein, L.V. Hedges, J.P.T. Higgins and H.R. Rothstein). https://doi.org/10.1002/9780470743386.ch4

Examples

```
# SD_diff is the standard deviation of the group difference
SD_diff <- 2
# r is the correlation coefficient between the groups
r <- 0.5
SD_within_from_SD_r(SD_diff, r)
```

`SE.SMD_from_OR.CI` *Standard Error of from Confidence Intervals of Odds Ratio*

Description

Calculates the standard error from an odds ratio confidence interval.

Usage

```
SE.SMD_from_OR.CI(CI_low, CI_up, sig_level = 0.05, two_tailed = TRUE)
```

Arguments

`CI_low`	lower odds ratio confidence interval limit
`CI_up`	upper odds ratio confidence interval limit
`sig_level`	the significance level
`two_tailed`	whether the two-tailed or one-tailed z statistics should be calculated

Details

This method uses multiple steps in the background: 1 Takes odds ratio (OR) limits and transforms them to log(OR) 2 Calculates the standard error for the log(OR) 3 Transforms the log(OR) standard error to standardized mean differences (SMD) standard error by multiplying it with sqrt(3)/pi

Value

Standard Error

References

Chinn S. A simple method for converting an odds ratio to effect size for use in meta-analysis. Stat Med. 2000 Nov 30;19(22):3127-31. doi: 10.1002/1097-0258(20001130)

Examples

```
# lower CI = 0.6, upper CI = 0.9
SE.SMD_from_OR.CI(0.6, 0.9)
```

SE.SMD_from_SMD *Standard Error from Sample Sizes and SMD*

Description

Approximates SMD standard error from sample sizes and SMD.

Usage

```
SE.SMD_from_SMD(SMD, n1, n2, method = "hedges")
```

Arguments

SMD	standardized mean differences
n1	sample size group 1
n2	sample size group 2
method	transformation method ("hedges", "cohen")

Value

Standard error of SMD (e.g. standard error of intervention effect)

References

Cooper, H., Hedges, L. V., & Valentine, J. C. (Eds.). (2009). Link

Examples

```
# SMD = 0.6, sample size group_1 = 50, sample size group_2 = 75
SE.SMD_from_SMD(0.6, 50, 75)
```

SEp_from_CIp *Standard Error from Confidence Interval for Differences of Means*

Description

Calculates the standard error from the confidence interval limits for differences of means (and can also be used for the confidence intervals of standardized mean differences, SMD). This method is valid only when the confidence interval is symmetrical around the mean and is applicable for t-distributions or normal distributions (as specified by the `t_dist` argument). For sample sizes less than 60, it is generally recommended to use the t-distribution.

Usage

```
SEp_from_CIp(
  CI_low,
  CI_up,
  n1 = NA,
  n2 = NA,
  sig_level = 0.05,
  two_tailed = TRUE,
  t_dist = TRUE
)
```

Arguments

CI_low	lover OR confidence interval limit
CI_up	upper OR confidence interval limit
n1	sample size group 1 (not required if t_dist = FALSE)
n2	sample size group 2 (not required if t_dist = FALSE)
sig_level	the significance level
two_tailed	whether the two-tailed or one-tailed statistics should be calculated
t_dist	whether the t-distribution should be calculated - requires samples sizes

Value

Pooled standard error (e.g. intervention effect)

References

Cochrane Handbook

Examples

```
# lower CI = -1.5, upper CI = 0.5
SEp_from_CIp(-1.5, 0.5)
```

SEp_from_SDp *Standard Error (Pooled)*

Description

IMPORTANT: When there is only one group, the following method has to be used: SE_from_SD() Calculates the pooled standard error for two groups (e.g., intervention effect).

Usage

```
SEp_from_SDp(SDp, n1, n2)
```

Arguments

SDp	pooled standard deviation
n1	sample size group 1
n2	sample size group 2

Value

Pooled standard error for two groups (e.g. standard error of intervention effect)

References

Cochrane Handbook

See Also

`SE_from_SD()` for a single group

Examples

```
# Pooled standard deviation = 2, sample size group a = 50, sample size group b = 75
SEp_from_SDp(2, 50, 75)
```

SEp_from_TE.p — *Standard Error from Treatment Effect and p-Value*

Description

Calculates the pooled standard error using the treatment effect and p-value. To avoid an infinitive return when p-value = 1, the p-value is automatically adjusted to 0.99999

Usage

```
SEp_from_TE.p(TE, p, two_tailed = TRUE)
```

Arguments

TE	reported treatment effect
p	reported p-value
two_tailed	whether one-tailed or two-tailed statistics should be calculated

Value

Pooled standard error (e.g. standard error of intervention effect)

References

Altman D G, Bland J M. How to obtain the confidence interval from a P value BMJ 2011; 343 :d2090 doi:10.1136/bmj.d2090 Cochrane Handbook

Examples

```
# TE = 1.5, p = 0.8
SEp_from_TE.p(1.5, 0.8)
```

`SE_from_SD` *Standard Error for a Single Group*

Description

IMPORTANT: For cases involving two groups (e.g., intervention effects), use `SEp_from_SDp()` instead.#' Calculates the standard error for a single group. This method is only valid for single groups

Usage

```
SE_from_SD(SD, n)
```

Arguments

`SD`	standard deviation
`n`	sample size

Value

Single group standard error

References

Cochrane Handbook

See Also

`SEp_from_SDp()` for two groups

Examples

```
# Standard deviation = 2, group size = 50
SE_from_SD(2, 50)
```

`SMD_from_group` *Standardized Mean Differences from Group Data*

Description

Calculates SMD directly from group data. Method "hedges" needs sample size data and returns Hedges' g. Method "cohen" returns Cohen's d.

Usage

```
SMD_from_group(M1, M2, SD1, SD2, n1 = NA, n2 = NA, method = "hedges")
```

Arguments

`M1`	treatment effect size group 1
`M2`	treatment effect size group 2
`SD1`	standard deviation group 1
`SD2`	standard deviation group 2
`n1`	sample size group 1
`n2`	sample size group 2
`method`	calculation method ("hedges", "cohen")

Value

Standardized Mean Differences

References

Borenstein, M., Hedges, L.V., Higgins, J.P.T. and Rothstein, H.R. (2009). Converting Among Effect Sizes. In Introduction to Meta-Analysis (eds M. Borenstein, L.V. Hedges, J.P.T. Higgins and H.R. Rothstein). https://doi.org/10.1002/9780470743386.ch7

Hedges L. V., Olkin I. (1985). Statistical methods for meta-analysis. San Diego, CA: Academic Press

Goulet-Pelletier, J.-C., & Cousineau, D. (2018). A review of effect sizes and their confidence intervals, Part 1: The Cohen's d family. The Quantitative Methods for Psychology, 14(4), 242–265. https://doi.org/10.20982/tqmp.14.4.p242

Examples

```
# Mean control = 23, Mean intervention = 56, SD control = 30,
#    SD intervention = 35, sample size control = 45, sample size intervention = 60
SMD_from_group(23, 56, 30, 35, 45, 60)
```

`SMD_from_mean` *Standardized Mean Difference (SMD) from Means and Pooled Standard Deviation*

Description

Calculates the SMD. It needs to be provided with the pooled standard deviation. If the pooled standard deviation is not available `SMD_from_group()` provides a direct method to calculate the SMD and also offers different forms like Hedges' g or Cohen's d.

Usage

```
SMD_from_mean(M1, M2, SD_pooled)
```

Arguments

`M1`	treatment effect size group 1
`M2`	treatment effect size group 2
`SD_pooled`	the pooled standard deviation or the standard deviation of the control group in case Glass's delta should be calculated

Details

CAVE: If you want to get Hedges' g it is insufficient to simply pool the standard deviation with `SDp_from_SD()`. The resulting SMD needs to be further multiplied with the hedges factor. This is done automatically when you use `SMD_from_group()`.

Value

Standardized Mean Differences

References

https://handbook-5-1.cochrane.org/chapter_9/9_2_3_2_the_standardized_mean_difference.htm

Examples

```
# Mean control = 153, Mean intervention = 136, pooled SD = 25
SMD_from_mean(153, 136, 25)
```

SMD_from_mean_matched *Calculates SMD from Matched Groups*

Description

Calculates the standardized mean differences for matched groups. Needs either the mean of the groups or the difference between groups. SD_within is usually not reported but can be calculated by the use of SD_within_from_SD_r().

Usage

```
SMD_from_mean_matched(M_diff = NA, M1 = NA, M2 = NA, SD_within)
```

Arguments

M_diff	mean difference between groups
M1	mean group 1 (in case M_diff not provided)
M2	mean group 2 (in case M_diff not provided)
SD_within	within standard deviation. CAVE this is usually not reported but needs to be computed from the difference standard deviation. This can be done with SD_within_from_SD_r().

Value

Standardized Mean Differences

References

M., Hedges, L.V., Higgins, J.P.T. and Rothstein, H.R. (2009). Converting Among Effect Sizes. In Introduction to Meta-Analysis (eds M. Borenstein, L.V. Hedges, J.P.T. Higgins and H.R. Rothstein). https://doi.org/10.1002/9780470743386.ch7

Examples

```
# Calcuation with group means
SMD_from_mean_matched(M1 = 103, M2 = 100, SD_within = 7.1005)

# Calculation with group difference
SMD_from_mean_matched(M_diff = 3, SD_within = 7.1005)

# Calculation with standard deviation between
# Correlation Coefficient between groups
r <- 0.7

# SD between groups
SD_between <- 5.5

SMD_from_mean_matched(M_diff = 3,
    SD_within = SD_within_from_SD_r(SD_between, r))
```

SMD_from_OR *Standardized Mean Difference from Odds Ratio*

Description

Approximates SMD from OR.

Usage

```
SMD_from_OR(OR)
```

Arguments

OR	odds ratio

Value

Standardized Mean Difference

References

Borenstein, M., Hedges, L.V., Higgins, J.P.T. and Rothstein, H.R. (2009). Converting Among Effect Sizes. In Introduction to Meta-Analysis (eds M. Borenstein, L.V. Hedges, J.P.T. Higgins and H.R. Rothstein). https://doi.org/10.1002/9780470743386.ch7

Examples

```
# Transform an OR of 0.3 to SMD
SMD_from_OR(0.3)
```

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