Package ‘ratesci’

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Title Confidence Intervals for Comparisons of Binomial or Poisson Rates
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Description Computes confidence intervals for the rate (or risk) difference ("RD") or rate ratio (or relative risk, "RR") for binomial proportions or Poisson rates, or for odds ratio ("OR", binomial only). Also confidence intervals for a single binomial or Poisson rate, and intervals for matched pairs. Includes asymptotic score methods including skewness corrections, which have been developed in Laud (2017, in press) from Miettinen & Nurminen (1985) <doi:10.1002/sim.4780040211> and Gart & Nam (1988) <doi:10.2307/2531848>. Also includes MOVER methods (Method Of Variance Estimates Recovery), derived from the Newcombe method but using equal-tailed Jeffreys intervals, and generalised for incorporating prior information. Also methods for stratified calculations (e.g. meta-analysis), either assuming fixed effects or incorporating stratum heterogeneity.
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ratesci-package

ratesci-package: A package for computing confidence intervals for various comparisons of independent binomial and Poisson rates.

Description

Computes confidence intervals for the rate difference (RD), rate ratio (RR), or odds ratio (OR), for independent binomial or Poisson rates. Includes score-based methods with (or without) skewness correction, developed from the Miettinen-Nurminen and Gart-Nam methods, and the "Method of Variance Estimates Recovery", originating from Newcombe.

ratesci functions

- scoreci: for score-based confidence intervals
- scasci: wrapper function to compute SCAS interval
- tdasci: wrapper function to compute TDAS stratified interval
- moverci: for the MOVER method
- moverbci: wrapper function to compute MOVER-B interval
- jeffreysci: wrapper function to compute Jeffreys interval for a single rate

Author(s)

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References


Jeffreyssci

Jeffreys and other approximate Bayesian confidence intervals for a
single binomial or Poisson rate.

Description
Generalised approximate Bayesian confidence intervals based on a Beta (for binomial rates) or
Gamma (for Poisson rates) conjugate priors. Encompassing the Jeffreys method (with Beta(0.5,
0.5) or Gamma(0.5) respectively), as well as any user-specified prior distribution. Clopper-Pearson
also included by way of a "continuity correction".

Usage

jeffreysci(x, n, ai = 0.5, bi = 0.5, cc = 0, level = 0.95,
distrib = "bin", adj = TRUE, ...)

Arguments

x        Numeric vector of number of events.

n        Numeric vector of sample sizes (for binomial rates) or exposure times (for Pois-

ai, bi   Numbers defining the Beta prior distribution (default ai = bi = 0.5 for Jeffreys

cc       Number or logical specifying (amount of) "continuity correction". cc = 0 (de-

level    Number specifying confidence level (between 0 and 1, default 0.95).

distrib  Character string indicating distribution assumed for the input data: "bin" = bi-

adj      Logical (default TRUE) indicating whether to apply the boundary adjustment

...      Other arguments.

Author(s)

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Examples

#Jeffreys method:
jeffreysci(x = 5, n = 56)

moverbci

Approximate Bayesian ("MOVER-B") confidence intervals for comparisons of independent binomial or Poisson rates.

Description

Wrapper function for the MOVER-B methods. Approximate Bayesian confidence intervals for the rate (or risk) difference ("RD") or ratio ("RR") for independent binomial or Poisson rates, or for odds ratio ("OR", binomial only). (developed from Newcombe, Donner & Zou, Li et al. and Fagerland & Newcombe, and generalised as "MOVER-B" in forthcoming publication) including special case "MOVER-J" using non-informative priors with optional continuity correction. This function is vectorised in x1, x2, n1, and n2.

Usage

moverbci(x1, n1, x2, n2, a1 = 0.5, b1 = 0.5, a2 = 0.5, b2 = 0.5, distrib = "bin", contrast = "RD", level = 0.95, cc = 0, ...)

Arguments

x1, x2 Numeric vectors of numbers of events in group 1 & group 2 respectively.
n1, n2 Numeric vectors of sample sizes (for binomial rates) or exposure times (for Poisson rates) in each group.
a1, b1, a2, b2 Numbers defining the Beta(ai,bi) prior distributions for each group (default ai = bi = 0.5 for Jeffreys uninformative priors). Gamma priors for Poisson rates require only a1, a2.
distrib Character string indicating distribution assumed for the input data: "bin" = binomial (default), "poi" = Poisson.
contrast Character string indicating the contrast required: "RD" (default), "RR", or "OR". "p" gives an interval for the single proportion x1/n1.
level Number specifying confidence level (between 0 and 1, default 0.95).
cc Number or logical specifying (amount of) continuity correction (default 0).
... Additional arguments.
moverci

MOVER confidence intervals for comparisons of independent binomial or Poisson rates.

Description

Confidence intervals applying the MOVER method ("Method of Variance Estimates Recovery", developed from the Newcombe method for binomial RD) across different contrasts (RD, RR, OR) and distributions (binomial, Poisson) using equal-tailed Jeffreys intervals instead of the Wilson score method for the event rates. Also allows more general Beta and Gamma priors for an approximate Bayesian confidence interval incorporating prior beliefs about the group event rates.

Usage

moverci(x1, n1, x2 = NULL, n2 = NULL, a1 = 0.5, b1 = 0.5, a2 = 0.5, b2 = 0.5, cc = 0, level = 0.95, distrib = "bin", contrast = "RD", type = "jeff", adj = FALSE, ...)

Arguments

x1, x2 Numeric vectors of numbers of events in group 1 & group 2 respectively.
n1, n2 Numeric vectors of sample sizes (for binomial rates) or exposure times (for Poisson rates) in each group.
a1, b1, a2, b2 Numbers defining the Beta(ai,bi) prior distributions for each group (default ai = bi = 0.5 for Jeffreys method). Gamma priors for Poisson rates require only a1, a2.
cc Number or logical specifying (amount of) continuity correction (default 0).
level Number specifying confidence level (between 0 and 1, default 0.95).
distrib Character string indicating distribution assumed for the input data: "bin" = binomial (default), "poi" = Poisson.
contrast Character string indicating the contrast required: "RD" (default), "RR", or "OR". "p" gives an interval for the single proportion x1/n1.
type Character string indicating the method used for the intervals for the individual group rates. "jeff" = Jeffreys equal-tailed intervals (default), "exact" = Clopper-Pearson exact intervals (also obtained using type = "jeff" with cc = 0.5), "wilson" = Wilson score intervals (as per Newcombe 1998). NB: "wilson" option is included only for legacy validation against previous published method by Newcombe. It is not recommended, as type="jeff" achieves much better coverage properties.
adj Logical (default FALSE) indicating whether to apply the boundary adjustment for Jeffreys intervals recommended on p108 of Brown et al. (type = "jeff" only: set to FALSE if using informative priors)

... Additional arguments.
**Value**

A matrix containing the confidence interval for the requested contrast

**Author(s)**

Pete Laud, <p.j.laud@sheffield.ac.uk>

**References**


Newcombe RG. Interval estimation for the difference between independent proportions: comparison of eleven methods. Statistics in Medicine 1998;

Donner A, Zou G. Closed-form confidence intervals for functions of the normal mean and standard deviation. Statistical Methods in Medical Research


**Examples**

```
# Binomial RD, MOVER-J method:
moverci(x1 = 5, n1 = 56, x2 = 0, n2 = 29)

# Binomial RD, Newcombe method:
moverci(x1 = 5, n1 = 56, x2 = 0, n2 = 29, type = "wilson")
```

**Description**

Score-based confidence intervals for the rate (or risk) difference ("RD"), rate ratio ("RR") or for odds ratio ("OR"), for paired binomial data. [For paired Poisson rates, use the tdasci function with distrib="poi", with pairs as strata.]. This function applies the stratified TDAS method for RD and RR. For OR, an interval is produced based on transforming a SCAS interval for the single proportion.

**Usage**

```
pairbinci(x, contrast = "RD", level = 0.95, delta = NULL)
```
Arguments

x A numeric vector object specified as c(a,b,c,d) where: a is the number of pairs with the event (e.g. success) under both conditions (e.g. treated/untreated, or case/control) b is the count of the number with the event on condition 1 only c is the count of the number with the event on condition 2 only d is the number of pairs with no event under both conditions (Note the order of a and d is only important for contrast="RR"). Note for data in columns of success/failure, use the tdasci function instead (not recommended for contrast="OR").

contrast Character string indicating the contrast of interest: "RD" = rate difference (default), "RR" = rate ratio, "OR" = odds ratio.

level Number specifying confidence level (between 0 and 1, default 0.95).

delta Number to be used in a one-sided significance test (e.g. non-inferiority margin). 1-sided p-value will be <0.025 iff 2-sided 95% CI excludes delta. NB: can also be used for a superiority test by setting delta=0.

Author(s)

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References


Examples

#Data example from Agresti-Min 2005
pairbinci(c(53,16,8,9),contrast="RD")
pairbinci(c(53,16,8,9),contrast="RR")
pairbinci(c(53,16,8,9),contrast="OR")

scasci Skewness-corrected asymptotic score ("SCAS") confidence intervals for comparisons of independent binomial or Poisson rates.

Description

Wrapper function for the SCAS method. Score-based confidence intervals for the rate (or risk) difference ("RD") or ratio ("RR") for independent binomial or Poisson rates, or for odds ratio ("OR", binomial only), or the single rate ("p"). (This is the "GNbc" method from Laud & Dane, developed from Gart & Nam, and generalised as "SCAS" in forthcoming publication) including optional continuity correction. This function is vectorised in x1, x2, n1, and n2. Vector inputs may also be combined into a single stratified analysis (e.g. meta-analysis). This method assumes the contrast is constant across strata (fixed effects). For a 'random-effects' method use tdasci (or scoreci with tdas = TRUE).
Usage

```r
casci(x1, n1, x2 = NULL, n2 = NULL, distrib = "bin", contrast = "RD",
level = 0.95, cc = 0, delta = NULL, theta0 = NULL, precis = 6,
plot = FALSE, plotmax = 100, stratified = FALSE, weighting = "IVS",
wt = NULL, ...)
```

Arguments

- **x1**, **x2**: Numeric vectors of numbers of events in group 1 & group 2 respectively.
- **n1**, **n2**: Numeric vectors of sample sizes (for binomial rates) or exposure times (for Poisson rates) in each group.
- **distrib**: Character string indicating distribution assumed for the input data: "bin" = binomial (default), "poi" = Poisson.
- **contrast**: Character string indicating the contrast of interest: "RD" = rate difference (default), "RR" = rate ratio, "OR" = odds ratio, "p" = single proportion.
- **level**: Number specifying confidence level (between 0 and 1, default 0.95).
- **cc**: Number or logical (default FALSE) specifying (amount of) continuity correction.
- **delta**: (deprecated: parameter renamed to theta0)
- **theta0**: Number to be used in a one-sided significance test (e.g. non-inferiority margin). 1-sided p-value will be <0.025 iff 2-sided 95% CI excludes theta0. NB: can also be used for a superiority test by setting theta0 = 0 (RD) or 1 (RR/OR). By default, a two-sided test against theta0 = 0 or 1 is also output: if bcf=F and skew=F this is the same as Pearson's Chi-squared test.
- **precis**: Number (default 6) specifying precision to be used in optimisation subroutine (i.e. number of decimal places).
- **plot**: Logical (default FALSE) indicating whether to output plot of the score function
- **plotmax**: Numeric value indicating maximum value to be displayed on x-axis of plots (useful for ratio contrasts which can be infinite).
- **stratified**: Logical (default FALSE) indicating whether to combine vector inputs into a single stratified analysis.
- **weighting**: String indicating which weighting method to use if stratified = "TRUE": "IVS" = Inverse Variance of Score (default), "MH" = Mantel-Haenszel, "MN" = Miettinen-Nurminen iterative weights.
- **wt**: Numeric vector containing (optional) user-specified weights.
- **...**: Other arguments.
scoreci

Score confidence intervals for comparisons of independent binomial or Poisson rates.

Description

Score-based confidence intervals for the rate (or risk) difference ("RD") or ratio ("RR") for independent binomial or Poisson rates, or for odds ratio ("OR", binomial only). Including options for bias correction (from Miettinen & Nurminen), skewness correction ("GNbc" method from Laud & Dane, developed from Gart & Nam, and generalised as "SCAS" in Laud 2017 [in press]) and continuity correction. Also includes intervals for a single proportion, i.e. Wilson score method, with skewness correction, which has slightly better coverage properties than the Jeffreys method. This function is vectorised in x1, x2, n1, and n2. Vector inputs may also be combined into a single stratified analysis (e.g. meta-analysis), either using fixed effects, or the more general "TDAS" method, which incorporates stratum variability using a t-distribution score (inspired by to Hartung-Knapp-Sidik-Jonkman).

Usage

scoreci(x1, n1, x2 = NULL, n2 = NULL, distrib = "bin", contrast = "RD", level = 0.95, skew = TRUE, bcf = TRUE, cc = 0, delta = NULL, theta0 = NULL, precis = 6, plot = FALSE, plotmax = 100, stratified = FALSE, weighting = "IVS", wt = NULL, tdas = FALSE, warn = TRUE, ...)

Arguments

x1, x2 Numeric vectors of numbers of events in group 1 & group 2 respectively.
n1, n2 Numeric vectors of sample sizes (for binomial rates) or exposure times (for Poisson rates) in each group.
distrib Character string indicating distribution assumed for the input data: "bin" = binomial (default), "poi" = Poisson.
contrast Character string indicating the contrast of interest: "RD" = rate difference (default), "RR" = rate ratio, "OR" = odds ratio, "p" = single proportion.
level Number specifying confidence level (between 0 and 1, default 0.95).
skew Logical (default TRUE) indicating whether to apply skewness correction (Laud 2016).
bcf Logical (default TRUE) indicating whether to apply bias correction in the score denominator. Applicable to distrib = "bin" only. (NB: bcf = FALSE option is really only included for legacy validation against previous published methods (i.e. Gart & Nam, Mee).
cc Number or logical (default FALSE) specifying (amount of) continuity correction.
delta (deprecated: parameter renamed to theta0)
theta0: Number to be used in a one-sided significance test (e.g. non-inferiority margin). 1-sided p-value will be <0.025 iff 2-sided 95% CI excludes theta0. NB: can also be used for a superiority test by setting theta0 = 0 (RD) or 1 (RR/OR). By default, a two-sided test against theta0 = 0 or 1 is also output: if bcf=F and skew=F this is the same as Pearson’s Chi-squared test.

precis: Number (default 6) specifying precision to be used in optimisation subroutine (i.e. number of decimal places).

plot: Logical (default FALSE) indicating whether to output plot of the score function

plotmax: Numeric value indicating maximum value to be displayed on x-axis of plots (useful for ratio contrasts which can be infinite).

stratified: Logical (default FALSE) indicating whether to combine vector inputs into a single stratified analysis.

weighting: String indicating which weighting method to use if stratified = "TRUE": "IVS" = Inverse Variance of Score (default), "MH" = Mantel-Haenszel, "MN" = Miettinen-Nurminen iterative weights.

wt: Numeric vector containing (optional) user-specified weights.

tdas: Logical (default FALSE) indicating whether to use t-distribution method for stratified data (defined in Laud 2016).

warn: Logical (default TRUE) giving the option to suppress warnings.

Value

A list containing the following components:

- estimates: a matrix containing estimates of the rates in each group and of the requested contrast, with its confidence interval
- pval: a matrix containing details of the corresponding 2-sided significance test against the null hypothesis that p_1 = p_2, and one-sided significance tests against the null hypothesis that theta >= or <= theta0
- call: details of the function call

If stratified = TRUE, the following outputs are added:

- Qtest: a vector of values describing and testing heterogeneity
- weighting: a string indicating the selected weighting method
- stratdata: a matrix containing stratum estimates and weights

Author(s)

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References


Examples

```r
# Binomial RD, SCAS method:
scoreci(x1 = c(12,19,5), n1 = c(16,29,56), x2 = c(1,22,0), n2 = c(16,30,29))

# Binomial RD, MN method:
scoreci(x1 = c(12,19,5), n1 = c(16,29,56), x2 = c(1,22,0), n2 = c(16,30,29), skew = FALSE)

# Poisson RR, SCAS method:
scoreci(x1 = 5, n1 = 56, x2 = 0, n2 = 29, distrib = "poi", contrast = "RR")

# Poisson RR, MN method:
scoreci(x1 = 5, n1 = 56, x2 = 0, n2 = 29, distrib = "poi", contrast = "RR", skew = FALSE)

# Binomial rate, SCAS method:
scoreci(x1 = c(5,0), n1 = c(56,29), contrast = "p")

# Binomial rate, Wilson score method:
scoreci(x1 = c(5,0), n1 = c(56,29), contrast = "p", skew = FALSE)

# Poisson rate, SCAS method:
scoreci(x1 = c(5,0), n1 = c(56,29), distrib = "poi", contrast = "p")

# Stratified example, using data from Hartung & Knapp:
scoreci(x1 = c(15,12,29,42,14,44,14,29,10,17,38,19,21),
  x2 = c(9,1,18,31,6,17,7,23,3,6,12,22,19),
  n1 = c(16,16,34,56,22,54,17,58,14,26,44,29,38),
  n2 = c(16,16,34,56,22,55,15,58,15,27,45,30,38),
  stratified = TRUE)

# TDAS example, using data from Hartung & Knapp:
scoreci(x1 = c(15,12,29,42,14,44,14,29,10,17,38,19,21),
```
tdasci

$t$-distribution asymptotic score ("TDAS") confidence intervals for comparisons of independent binomial or Poisson rates.

Description

Wrapper function for the TDAS method. Score-based stratified confidence intervals for the rate (or risk) difference ("RD") or ratio ("RR") for independent binomial or Poisson rates, or for odds ratio ("OR", binomial only), or the single rate ("p"). This function combines vector inputs into a single stratified analysis (e.g. meta-analysis). The TDAS method incorporates any stratum variability into the confidence interval.

Usage

```r
tdasci(x1, n1, x2 = NULL, n2 = NULL, distrib = "bin", contrast = "RD", level = 0.95, cc = 0, delta = NULL, theta0 = NULL, precis = 6, plot = FALSE, plotmax = 100, weighting = "IVS", wt = NULL, ...)
```

Arguments

- `x1, x2`: Numeric vectors of numbers of events in group 1 & group 2 respectively.
- `n1, n2`: Numeric vectors of sample sizes (for binomial rates) or exposure times (for Poisson rates) in each group.
- `distrib`: Character string indicating distribution assumed for the input data: "bin" = binomial (default), "poi" = Poisson.
- `contrast`: Character string indicating the contrast of interest: "RD" = rate difference (default), "RR" = rate ratio, "OR" = odds ratio, "p" = single proportion.
- `level`: Number specifying confidence level (between 0 and 1, default 0.95).
- `cc`: Number or logical (default FALSE) specifying (amount of) continuity correction.
- `delta`: (deprecated: parameter renamed to theta0)
- `theta0`: Number to be used in a one-sided significance test (e.g. non-inferiority margin). 1-sided p-value will be <0.025 iff 2-sided 95% CI excludes theta0. NB: can also be used for a superiority test by setting theta0 = 0 (RD) or 1 (RR/OR). By default, a two-sided test against theta0 = 0 or 1 is also output: if bcf=F and skew=F this is the same as Pearson’s Chi-squared test.
- `precis`: Number (default 6) specifying precision to be used in optimisation subroutine (i.e. number of decimal places).
- `plot`: Logical (default FALSE) indicating whether to output plot of the score function.
plotmax Numeric value indicating maximum value to be displayed on x-axis of plots (useful for ratio contrasts which can be infinite).

weighting String indicating which weighting method to use if stratified = "TRUE": "IVS" = Inverse Variance of Score (default), "MH" = Mantel-Haenszel, "MN" = Miettinen-Nurminen iterative weights.

wt Numeric vector containing (optional) user-specified weights.

... Other arguments.
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