# Package ‘presize’

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**Type** Package

**Title** Precision Based Sample Size Calculation

**Version** 0.3.11

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**Description** Bland (2009) <doi:10.1136/bmj.b3985> recommended to base study sizes on the width of the confidence interval rather the power of a statistical test. The goal of 'presize' is to provide functions for such precision based sample size calculations. For a given sample size, the functions will return the precision (width of the confidence interval), and vice versa.

**License** GPL-3

**URL** https://github.com/dcr-unibe-ch/presize, https://dcr-unibe-ch.github.io/presize/

**BugReports** https://github.com/dcr-unibe-ch/presize/issues

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`launch_presize_app` *Presize shiny app*

---

## Description

Besides the programmatic approach to using presize, we also supply a shiny app, enabling point-and-click interaction with the program. The app will open in a new window. Select the appropriate method from the menu on the left and enter the relevant parameters indicated in the panel on the right. The output is then displayed lower down the page.

## Usage

```
launch_presize_app()
```

## Details

The main disadvantage to the app is that it only allows a single scenario at a time.

The app is also available at https://shiny.ctu.unibe.ch/presize/.

## Examples

```
# launch the app
## Not run:
launch_presize_app()

## End(Not run)
```

prec_auc *Sample size or precision for AUC*

## Description

Calculate the sample size from AUC, prevalence and confidence interval width or the expected confidence interval width from AUC, prevalence and sample size, following Hanley and McNeil (1982).

## Usage

```
prec_auc(auc, prev, n = NULL, conf.width = NULL, conf.level = 0.95, ...)
```

## Arguments

| | |
|---|---|
| `auc` | AUC value. |
| `prev` | prevalence. |
| `n` | number of observations. |
| `conf.width` | precision (the full width of the confidence interval). |
| `conf.level` | confidence level. |
| `...` | other arguments to `optimize`. |

## Details

Sample size is derived by optimizing the difference between the difference between the lower and upper limits of the confidence interval and `conf.width`.

## Value

Object of class "presize", a list of arguments (including the computed one) augmented with method and note elements.

## References

Hanley, JA and McNeil, BJ (1982) *The Meaning and Use of the Area under a Receiver Operating Characteristic (ROC) Curve.* Radiology 148, 29-36

## Examples

```
# confidence interval width
N <- 500
prev <- .1
auc <- .65
(prec <- prec_auc(auc, prev, n = N))
cwidth <- prec$conf.width
# sample size
prec_auc(auc, prev, conf.width = cwidth)
```

prec_cor *Sample size or precision for correlation coefficient*

## Description

prec_cor returns the sample size or the precision for the given pearson, spearman, or kendall correlation coefficient.

## Usage

```
prec_cor(
  r,
  n = NULL,
  conf.width = NULL,
  conf.level = 0.95,
  method = c("pearson", "kendall", "spearman"),
  ...
)
```

## Arguments

| | |
|---|---|
| r | desired correlation coefficient. |
| n | sample size. |
| conf.width | precision (the full width of the confidence interval). |
| conf.level | confidence level. |
| method | Exactly one of pearson (*default*), kendall, or spearman. Methods can be abbreviated. |
| ... | other options to uniroot (e.g. tol) |

## Details

Exactly one of the parameters n or conf.width must be passed as NULL, and that parameter is determined from the other.

Sample size or precision is calculated according to formula 2 in Bonett and Wright (2000). The use of pearson is only recommended, if $n \geq 25$. The pearson correlation coefficient assumes bivariate normality. If the assumption of bivariate normality cannot be met, spearman or kendall should be considered.

n is rounded up to the next whole number using ceiling.

uniroot is used to solve n.

## Value

Object of class "presize", a list of arguments (including the computed one) augmented with method and note elements.

## References

Bonett DG, and Wright TA (2000) *Sample size requirements for estimating Pearson, Kendall and Spearman correlations* Psychometrika 65:23-28. doi:10.1007/BF02294183

## Examples

```
# calculate confidence interval width...
# Pearson correlation coefficient
prec_cor(r = 0.5, n = 100)
# Kendall rank correlation coefficient (tau)
prec_cor(r = 0.5, n = 100, method = "kendall")
# Spearman's rank correlation coefficient
prec_cor(r = 0.5, n = 100, method = "spearman")
# calculate N required for a given confidence interval width...
# Pearson correlation coefficient
prec_cor(r = 0.5, conf.width = .15)
# Kendall rank correlation coefficient (tau)
prec_cor(r = 0.5, conf.width = .15, method = "kendall")
# Spearman's rank correlation coefficient
prec_cor(r = 0.5, conf.width = .15, method = "spearman")
```

---

# prec_cronb *Sample size or precision for Cronbach's alpha*

---

## Description

`prec_cronb` returns the sample size or the precision for the given Cronbach's alpha.

## Usage

```
prec_cronb(k, calpha, n = NULL, conf.level = 0.95, conf.width = NULL)
```

## Arguments

| | |
|---|---|
| `k` | number of measurements/items. |
| `calpha` | desired Cronbach's alpha. |
| `n` | sample size. |
| `conf.level` | confidence level. |
| `conf.width` | precision (the full width of the confidence interval). |

## Details

Exactly one of the parameters `n` or `conf.width` must be passed as NULL, and that parameter is determined from the other.

Sample size or precision is calculated according to the formula & code and provided in Bonett and Wright (2014).

`n` is rounded up to the next whole number using `ceiling`.

### Value

Object of class "presize", a list of arguments (including the computed one) augmented with method and note elements.

### References

Bonett, D. G. and Wright, T. A. (2015) *Cronbach's alpha reliability: Interval estimation, hypothesis testing, and sample size planning* J. Organiz. Behav., 36, pages 3– 15. doi:10.1002/job.1960. # k= number of items

### Examples

```
# calculate confidence interval width...
prec_cronb (k=5,calpha=0.7,n= 349,conf.level= 0.95, conf.width= NULL)
# calculate N required for a given confidence interval width...
prec_cronb (k=5,calpha=0.7,n= NULL,conf.level= 0.95, conf.width= 0.1)
```

---

## prec_icc *Sample size or precision for an intraclass correlation*

---

### Description

`prec_icc` returns the sample size or the precision for the given intraclass correlation.

### Usage

```
prec_icc(rho, k, n = NULL, conf.width = NULL, conf.level = 0.95)
```

### Arguments

| | |
|---|---|
| `rho` | desired intraclass correlation. |
| `k` | number of observations per n (subject). |
| `n` | number of subjects. |
| `conf.width` | precision (the full width of the confidence interval). |
| `conf.level` | confidence level. |

### Details

Exactly one of the parameters `n` or `conf.width` must be passed as NULL, and that parameter is determined from the others.

Sample size or precision is calculated according to formula 3 in Bonett (2002), which is an approximation. Whether ICC is calculated for a one-way or a two-way ANOVA does not matter in the approximation. As suggested by the author, $5 * rho$ is added to n, if $k = 2$ and $rho \geq 7$. This makes the assumption that there is no interaction between rater and subject.

n is rounded up to the next whole number using `ceiling`.

### Value

Object of class "presize", a list of arguments (including the computed one) augmented with method and note elements.

### References

Bonett DG (2002). *Sample size requirements for estimating intraclass correlations with desired precision*. Statistics in Medicine, 21:1331-1335. doi:10.1002/sim.1108

### Examples

```
# Bonett (2002) gives an example using 4 raters, with an ICC of 0.85 and want
# a confidence width of 0.2. Bonett calculated that a sample size of 19.2 was
# required. This can be done via
prec_icc(0.85, 4, conf.width = 0.2)
# note that \code{presamp} rounds up to the nearist integer.

# Bonett then goes on to estimate the width given the sample size, finding a
# value 'close to 0.2':
prec_icc(0.85, 4, 20)
```

---

## prec_kappa *Sample size or precision for Cohen's kappa*

---

### Description

prec_kappa returns the sample size or the precision for the provided Cohen's kappa coefficient.

### Usage

```
prec_kappa(
  kappa,
  n = NULL,
  raters = 2,
  n_category = 2,
  props,
  conf.width = NULL,
  conf.level = 0.95
)
```

### Arguments

| | |
|---|---|
| kappa | expected value of Cohen's kappa. |
| n | sample size. |
| raters | number of raters (maximum of 6). |
| n_category | number of categories of outcomes (maximum of 5). |
| props | expected proportions of each outcome (should have length n_category). |

| | |
|---|---|
| conf.width | precision (the full width of the confidence interval). |
| conf.level | confidence level. |

## Details

This function wraps the FixedN and CI functions in the kappaSize package. The FixedN functions in kappaSize return a one sided confidence interval. The values that are passed to kappaSize ensure that two-sided confidence intervals are returned, although we assume that confidence intervals are symmetrical.

## Value

Object of class "presize", a list of arguments (including the computed one) augmented with method and note elements.

## See Also

FixedNBinary, FixedN3Cats, CIBinary, CI3Cats

## Examples

```
# precision based on sample size
#   two categories with proportions of 30 and 70\%, four raters
prec_kappa(kappa = .5, n = 200, raters = 4, n_category = 2, props = c(.3,.7))
# sample size to get a given precision
prec_kappa(kappa = .5, conf.width = .15, raters = 4, n_category = 2,
           props = c(.3,.7))

# as above, but with two scenarios for kappa
prec_kappa(kappa = c(.5, .75), conf.width = .15, raters = 4, n_category = 2,
           props = c(.3,.7))
prec_kappa(kappa = c(.5, .75), conf.width = c(.15, 0.3), raters = 4,
           n_category = 2, props = c(.3,.7))
```

---

prec_lim_agree *Sample size or precision for limit of agreement on Bland-Altman plots*

---

## Description

prec_lim_agree returns the sample size or the precision for the limit of agreement, i.e. the confidence interval around the limit of agreement, expressed in SD-units. It is an approximation based on the Normal distribution, instead of a Student t distribution.

## Usage

```
prec_lim_agree(n = NULL, conf.width = NULL, conf.level = 0.95)
```

### Arguments

| | |
|---|---|
| `n` | sample size. |
| `conf.width` | precision (the full width of the confidence interval). |
| `conf.level` | confidence level. |

### Details

Exactly one of the parameters `n` or `conf.width` must be passed as NULL, and that parameter is determined from the other.

The sample size and precision are calculated according to formulae in Bland & Altman (1986). The CI width is a simple function of the sample size only.

### Value

Object of class "presize", a list of arguments (including the computed one) augmented with method and note elements.

### References

Bland & Altman (1986) *Statistical methods for assessing agreement between two methods of clinical measurement* Lancet i(8476):307-310 doi:10.1016/S01406736(86)908378

### Examples

```
# calculate confidence interval width, given N
prec_lim_agree(200)
# calculate N given, confidence interval width
prec_lim_agree(conf.width = .1)
```

---

## `prec_lr` *Sample size or precision for likelihood ratios*

---

### Description

These functions calculate the precision or sample size for likelihood ratios (LRs). `prec_lr` is a generalized method for that can be used for positive and negative LRs as well as conditional LRs.

`prec_pos_lr` is a wrapper to `prec_lr` to ease calculations for positive likelihood ratios by allowing sensitivity and specificity to be given explicitly.

`prec_neg_lr` is a wrapper to `prec_lr` to ease calculations for negative likelihood ratios by allowing sensitivity and specificity to be given explicitly.

## Usage

```
prec_lr(prev, p1, p2, n = NULL, conf.width = NULL, conf.level = 0.95, ...)

prec_pos_lr(
  prev,
  sens,
  spec,
  n = NULL,
  conf.width = NULL,
  conf.level = 0.95,
  ...
)

prec_neg_lr(
  prev,
  sens,
  spec,
  n = NULL,
  conf.width = NULL,
  conf.level = 0.95,
  ...
)
```

## Arguments

| | |
|---|---|
| `prev` | disease/case prevalence in the study group. |
| `p1` | proportion of positives in group 1 (e.g. sensitivity). |
| `p2` | proportion of positives in group 2 (e.g. 1 - specificity). |
| `n` | total group size. |
| `conf.width` | precision (the full width of the confidence interval). |
| `conf.level` | confidence level (defaults to 0.95). |
| `...` | other arguments to uniroot (e.g. `tol`). |
| `sens` | sensitivity. |
| `spec` | specificity. |

## Details

These functions implement formula 10 from Simel et al 1991. `prec_lr` is a generalized function allowing for many scenarios, while `prec_pos_lr` and `prec_neg_lr` are specific to positive and negative likelihood ratios in the 2*2 setting (e.g. disease status and test positive/negative).

For the positive likelihood ratio (LR+), in a 2x2 style experiment, `p1` should be sensitivity, `p2` should be 1-specificity. Alternatively, use `prec_pos_lr`.

For the negative likelihood ratio (LR-), in a 2x2 style experiment, `p1` should be 1-sensitivity, `p2` should be specificity. Alternatively, use `prec_neg_lr`.

For conditional likelihood ratios with 3x2 tables, such as positive or negative tests against inconclusive ones (yields), `p1` would be the proportion of positive or negative tests in the diseased group and `p2` would be the proportion of positive or negative tests in the non-diseased group.

## Value

Object of class "presize", a list of arguments (including the computed one) augmented with method and note elements.

## Functions

- `prec_pos_lr()`: "Positive likelihood ratio"
- `prec_neg_lr()`: "Negative likelihood ratio"

## References

Simel, DL, Samsa, GP and Matchar, DB (1991) *Likelihood ratios with confidence: Sample size estimation for diagnostic test studies.* J Clin Epidemiol 44(8), 763-770

## Examples

```
# equal numbers of diseased/non-diseased, 80% sens, 73% spec, 74 participants total
prec_lr(.5, .8, .27, 74)

# Simel et al 1991, problem 1 - LR+ CI width from N
# Sensitivity of a new test is at least 80%, specificity is 73% and the LR+
# is 2.96 (= 0.8/(1-0.73)). We have as many diseased as not diseased
# (n1 = n2, n = 2*n1 = 146.8, prevalence = .5)
prec_lr(prev = .5, p1 = .8, p2 = 1-.73, n = 146.8)
prec_pos_lr(prev = .5, sens = .8, spec = .73, n = 146.8)

# problem 1 of Simel et al actually derives n1 rather than the width of the
# confidence interval (ie N from CI width). If we know that the lower limit
# of the CI should be 2.0, the confidence interval width is approximately
# exp(2*(log(2.96) - log(2))) = 2.19 (approximate because the CI Of the LR
# is only symetrical on the log(LR) scale), which we can put in conf.width
prec_lr(prev = .5, p1 = .8, p2 = 1-.73, conf.width = 2.2)
# same, but using the wrapper to specify sens and spec
prec_pos_lr(prev = .5, sens = .8, spec = .73, conf.width = 2.2)

# Simel et al 1991, problem 2 - LR- CI width from N
# p1 = 1 - sens = .1, p2 = spec = .5
# n1 = n2, n = 160, prev = .5
prec_lr(prev = .5, p1 = .1, p2 = .5, n = 160)
# same, but using the wrapper to specify sens and spec
prec_neg_lr(prev = .5, sens = .9, spec = .5, n = 160)
```

prec_mean *Sample size or precision for a mean*

## Description

prec_mean returns the sample size or the precision for the provided mean and standard deviation.

## Usage

```
prec_mean(
  mean,
  sd,
  n = NULL,
  conf.width = NULL,
  conf.level = 0.95,
  ...,
  mu = NULL
)
```

## Arguments

| | |
|---|---|
| mean | mean. |
| sd | standard deviation. |
| n | number of observations. |
| conf.width | precision (the full width of the confidence interval). |
| conf.level | confidence level. |
| ... | other arguments to uniroot (e.g. tol). |
| mu | deprecated argument |

## Details

Exactly one of the parameters n or conf.width must be passed as NULL, and that parameter is determined from the other.

The precision is defined as the full width of the confidence interval. The confidence interval calculated as $t(n-1) * sd/sqrt(n)$, with t(n-1) from the t-distribution with n-1 degrees of freedom.

This function is also suitable for a difference in paired means, as this reduces to a single value per individual - the difference.

uniroot is used to solve n.

## Value

Object of class "presize", a list with mean mean, sd standard deviation, n sample size, conf.width precision (the width of the confidence interval), lwr lower bound of confidence interval, upr upper bound of confidence interval, augmented with method and note elements.

## Examples

```
# mean of 5, SD of 2.5, whats the confidence interval width with 20 participants?
prec_mean(mean = 5, sd = 2.5, n = 20)
# mean of 5, SD of 2.5, how many participants for CI width of 2.34?
prec_mean(mean = 5, sd = 2.5, conf.width = 2.34)  # approximately the inverse of above
```

---

`prec_meandiff` *Sample size or precision for a mean difference*

---

## Description

`prec_meandiff` returns the sample size or the precision for the provided mean difference and standard deviations. For paired differences, use `prec_mean`, as it is equivalent to a simple mean.

## Usage

```
prec_meandiff(
  delta,
  sd1,
  sd2 = sd1,
  n1 = NULL,
  r = 1,
  conf.width = NULL,
  conf.level = 0.95,
  variance = c("equal", "unequal"),
  ...
)
```

## Arguments

| | |
|---|---|
| `delta` | difference in means between the two groups. |
| `sd1` | standard deviation in group 1. |
| `sd2` | standard deviation in group 2. |
| `n1` | number of patients in group 1. |
| `r` | allocation ratio (relative size of group 2 and group 1 (n2 / n1)). |
| `conf.width` | precision (the full width of the confidence interval). |
| `conf.level` | confidence level. |
| `variance` | `equal` (*default*) or `unequal` variance. |
| `...` | other options to uniroot (e.g. `tol`) |

## Details

Exactly one of the parameters `n` or `conf.width` must be passed as NULL, and that parameter is determined from the other.

### Value

Object of class "presize", a list of arguments (including the computed one) augmented with method and note elements.

### Examples

```
# mean difference of 5, SD of 2.5, CI width with 20 participants assuming equal variances
prec_meandiff(delta = 5, sd1 = 2.5, n1 = 20, var = "equal")
# mean difference of 5, SD of 2.5, number of participants for a CI width of 3,
#  assuming equal variances
prec_meandiff(delta = 5, sd1 = 2.5, conf.width = 3, var = "equal")
```

---

## prec_or — *Sample size or precision for an odds ratio*

---

### Description

`prec_or` returns the sample size or the precision for the provided proportions.

### Usage

```
prec_or(
  p1,
  p2,
  n1 = NULL,
  r = 1,
  conf.width = NULL,
  conf.level = 0.95,
  method = c("gart", "woolf", "indip_smooth"),
  ...
)
```

### Arguments

| | |
|---|---|
| `p1` | risk among exposed. |
| `p2` | risk among unexposed. |
| `n1` | number of patients in exposed group. |
| `r` | allocation ratio (relative size of unexposed and exposed cohort (`n2` / `n1`)). |
| `conf.width` | precision (the full width of the confidence interval). |
| `conf.level` | confidence level. |
| `method` | Exactly one of `indip_smooth` (*default*), `gart`, or `woolf`. Methods can be abbreviated. |
| `...` | other arguments to uniroot (e.g. `tol`). |

## Details

Exactly one of the parameters `n1` or `conf.width` must be passed as NULL, and that parameter is determined from the other.

Woolf (`woolf`), Gart (`gart`), and Independence-smoothed logit (`indip_smooth`) belong to a general family of adjusted confidence intervals, adding 0 (woolf) to each cell, 0.5 (gart) to each cell, or an adjustment for each cell based on observed data (independence-smoothed). In gart and indip_smooth, estimate of the CI is not possible if $p1 = 0$, in which case the OR becomes 0, but the lower level of the CI is > 0. Further, if $p1 = 1$ and $p2 < 1$, or if $p1 > 0$ and $p2 = 0$, the OR becomes $\infty$, but the upper limit of the CI is finite. For the approximate intervals, `gart` and `indip_smooth` are the recommended intervals (Fagerland et al. 2011).

`uniroot` is used to solve n for the woolf, gart, and indip_smooth method.

## Value

Object of class "presize", a list of arguments (including the computed one) augmented with method and note elements.

## References

Fagerland MW, Lydersen S, Laake P (2015). *Recommended confidence intervals for two independent binomial proportions*. Statistical Methods in Medical Research, 24(2):224-254. doi:10.1177/0962280211415469.

## Examples

```
# 10\% events in one group, 15\% in the other, 200 participants total
#  (= 100 in each group), estimate confidence interval width
prec_or(p1 = .1, p2 = .15, n1 = 200/2)
# formula by Gart
prec_or(p1 = .1, p2 = .15, n1 = 200/2, method = "gart")
# formula by Woolf
prec_or(p1 = .1, p2 = .15, n1 = 200/2, method = "woolf")

# 10\% odds in one group, 15\% in the other, desired CI width of 0.1,
#  estimate N
prec_or(p1 = .1, p2 = .15, conf.width = .1)
# formula by Gart
prec_or(p1 = .1, p2 = .15, conf.width = .1, method = "gart")
# formula by Woolf
prec_or(p1 = .1, p2 = .15, conf.width = .1, method = "woolf")
```

---

`prec_prop` *Sample size or precision for a proportion*

---

## Description

`prec_prop` returns the sample size or the precision for the provided proportion.

## Usage

```
prec_prop(
  p,
  n = NULL,
  conf.width = NULL,
  conf.level = 0.95,
  method = c("wilson", "agresti-coull", "exact", "wald"),
  ...
)
```

## Arguments

| | |
|---|---|
| p | proportion. |
| n | number of observations. |
| conf.width | precision (the full width of the confidence interval). |
| conf.level | confidence level. |
| method | The method to use to calculate precision. Exactly one method may be provided. Methods can be abbreviated. |
| ... | other arguments to uniroot (e.g. tol). |

## Details

Exactly one of the parameters n or conf.width must be passed as NULL, and that parameter is determined from the other.

The wilson, agresti-coull, exact, and wald method are implemented. The wilson method is suggested for small n (< 40), and the agresti-coull method is suggested for larger n (see reference). The wald method is not suggested, but provided due to its widely distributed use.

uniroot is used to solve n for the agresti-coull, wilson, and exact methods. Agresti-coull can be abbreviated by ac.

## Value

Object of class "presize", a list of arguments (including the computed one) augmented with method and note elements. In the wilson and agresti-coull formula, the p from which the confidence interval is calculated is adjusted by a term (i.e. $p + term \pm ci$). This adjusted p is returned in padj.

## References

Brown LD, Cai TT, DasGupta A (2001) *Interval Estimation for a Binomial Proportion*, Statistical Science, 16:2, 101-117, doi:10.1214/ss/1009213286

## See Also

binom.test, binom.confint in package **binom**, and binconf in package **Hmisc**

## Examples

```
# CI width for 15\% with 50 participants
prec_prop(0.15, n = 50)
# number of participants for 15\% with a CI width of 0.2
prec_prop(0.15, conf.width = 0.2)
# confidence interval width for a range of scenarios between 10 and 90\% with
#  100 participants via the wilson method
prec_prop(p = 1:9 / 10, n = 100, method = "wilson")
# number of participants for a range of scenarios between 10 and 90\% with
#  a CI of 0.192 via the wilson method
prec_prop(p = 1:9 / 10, conf.width = .192, method = "wilson")
```

---

`prec_rate` *Sample size or precision for a rate*

---

## Description

`prec_rate` returns the sample size or the precision for the provided rate.

## Usage

```
prec_rate(
  r,
  x = NULL,
  conf.width = NULL,
  conf.level = 0.95,
  method = c("score", "vs", "exact", "wald"),
  ...
)
```

## Arguments

| | |
|---|---|
| `r` | rate or rate ratio. |
| `x` | number of events. |
| `conf.width` | precision (the full width of the confidence interval). Should not exceed 5 times `r`. |
| `conf.level` | confidence level. |
| `method` | The method to use to calculate precision. Exactly one method may be provided. Methods can be abbreviated. |
| `...` | other arguments to uniroot (e.g. `tol`). |

## Details

Exactly one of the parameters `r` or `conf.width` must be passed as NULL, and that parameter is determined from the other.

The `score`, variance stabilizing (`vs`), `exact`, and `wald` method are implemented to calculate the rate and the precision. For few events `x` (<5), the exact method is recommended.

If more than one method is specified or the method is miss-specified, the 'score' method will be used.

`uniroot` is used to solve n for the score and exact method.

## Value

Object of class "presize", a list of arguments (including the computed one) augmented with method and note elements.

## References

Barker, L. (2002) *A Comparison of Nine Confidence Intervals for a Poisson Parameter When the Expected Number of Events is* $\leq$ *5*, The American Statistician, 56:2, 85-89, doi:10.1198/000313002317572736

## See Also

`poisson.test`

## Examples

```
# confidence interval width for a rate of 2.5 events per unit and 20 events,
#  using the score method
prec_rate(2.5, x = 20, met = "score")
# number of events to yield a CI width of 2.243 for a rate of 2.5 events per
#  unit and 20 events, using the score method
prec_rate(2.5, conf.width = 2.243, met = "score")
# confidence interval width for a rate of 2.5 events per unit and 20 events,
#  using the exact method
prec_rate(2.5, x = 20, met = "exact")
# vs and wald have the same conf.width, but different lwr and upr
prec_rate(2.5, x = 20, met = "vs")
prec_rate(2.5, x = 20, met = "wald")
```

---

`prec_rateratio` *Sample size or precision for a rate ratio*

---

## Description

`prec_rateratio` returns the sample size or the precision for the provided proportions.

### Usage

```
prec_rateratio(
  n1 = NULL,
  rate1 = NULL,
  rate2 = 2 * rate1,
  prec.level = NULL,
  r = 1,
  conf.level = 0.95
)
```

### Arguments

| | |
|---|---|
| `n1` | number of patients in exposed group. |
| `rate1` | event rate in the exposed group. |
| `rate2` | event rate in the unexposed group. |
| `prec.level` | ratio of the upper limit over the lower limit of the rate ratio confidence interval. |
| `r` | allocation ratio (relative size of unexposed and exposed cohort (`n2` / `n1`)). |
| `conf.level` | confidence level. |

### Details

Exactly one of the parameters `n1` or `conf.width` must be passed as NULL, and that parameter is determined from the other. Event rates in the two groups should also be provided (`rate1`, `rate2`). If only `rate1` is provided, `rate2` is assumed to be 2 times `rate1`.

### References

Rothman KJ, Greenland S (2018). *Planning Study Size Based on Precision Rather Than Power*. Epidemiology, 29:599-603. doi:10.1097/EDE.0000000000000876.

### Examples

```
# 20 participants, a rate of 50%  against a rate of 300\%
prec_rateratio(20, .5, 3)
# sample size required to attain a CI whose upper limit is not more than 3.81 larger
#  than the lower limit
prec_rateratio(rate1 = .5, rate2 = 3, prec.level = 3.81)
```

---

## `prec_riskdiff` *Sample size or precision for risk difference*

---

### Description

`prec_riskdiff` returns the risk difference and the sample size or the precision for the provided proportions.

## Usage

```
prec_riskdiff(
  p1,
  p2,
  n1 = NULL,
  conf.width = NULL,
  r = 1,
  conf.level = 0.95,
  method = c("newcombe", "mn", "ac", "wald"),
  ...
)
```

## Arguments

| | |
|---|---|
| p1 | risk among exposed. |
| p2 | risk among unexposed. |
| n1 | number of patients in exposed group. |
| conf.width | precision (the full width of the confidence interval). |
| r | allocation ratio (relative size of exposed and unexposed cohort (n1 / n2)). |
| conf.level | confidence level. |
| method | Exactly one of newcombe (*default*), mn (Miettinen-Nurminen), ac (Agresti-Caffo), wald. Methods can be abbreviated. |
| ... | other options to uniroot (e.g. tol) |

## Details

Exactly one of the parameters n1 or conf.width must be passed as NULL, and that parameter is determined from the other.

Newcombe (newcombe) proposed a confidence interval based on the wilson score method for the single proportion (see prec_prop). The confidence interval without continuity correction is implemented from equation 10 in Newcombe (1998).

Miettinen-Nurminen (mn) provide a closed from equation for the restricted maximum likelihood estimate . The implementation is based on code provided by Yongyi Min on https://users.stat.ufl.edu/~aa/cda/R/two-sample/R2/index.html.

Agresti-Caffo (ac) confidence interval is based on the Wald confidence interval, adding 1 success to each cell of the 2 x 2 table (see Agresti and Caffo 2000).

uniroot is used to solve n for the newcombe, ac, and mn method.

## References

Agresti A (2003) *Categorical Data Analysis*, Second Edition, Wiley Series in Probability and Statistics, doi:10.1002/0471249688.

Agresti A and Caffo B (2000) *Simple and Effective Confidence Intervals for Proportions and Differences of Proportions Result from Adding Two Successes and Two Failures*, The American Statistician, 54(4):280-288.

Miettinen O and Nurminen M (1985) *Comparative analysis of two rates*, Statistics in Medicine, 4:213-226.

Newcombe RG (1998) *Interval estimation for the difference between independent proportions: comparison of eleven methods*, Statistics in Medicine, 17:873-890.

Fagerland MW, Lydersen S, and Laake P (2015). *Recommended confidence intervals for two independent binomial proportions*, Statistical methods in medical research 24(2):224-254.

## Examples

```
# proportions of 40 and 30\%, 50 participants, how wide is the CI?
prec_riskdiff(p1 = .4, p2 = .3, n1 = 50)
# proportions of 40 and 30\%, 50 participants, how many participants for a CI 0.2 wide?
prec_riskdiff(p1 = .4, p2 = .3, conf.width = .2)

# Validate Newcombe (1998)
prec_riskdiff(p1 = 56/70, p2 = 48/80, n1 = 70, r = 70/80, met = "newcombe")  # Table IIa
prec_riskdiff(p1 = 10/10, p2 = 0/10, n1 = 10, met = "newcombe")  # Table IIh

# multiple scenarios
prec_riskdiff(p1 = c(56/70, 9/10, 6/7, 5/56),
              p2 = c(48/80, 3/10, 2/7, 0/29),
              n1 = c(70, 10, 7, 56),
              r = c(70/80, 1, 1, 56/29),
              method = "wald")
```

---

`prec_riskratio` *Sample size or precision for risk ratio*

---

## Description

`prec_riskratio` returns the risk ratio and the sample size or the precision for the provided proportions.

## Usage

```
prec_riskratio(
  p1,
  p2,
  n1 = NULL,
  r = 1,
  conf.width = NULL,
  conf.level = 0.95,
  method = c("koopman", "katz"),
  ...
)
```

### Arguments

| | |
|---|---|
| `p1` | risk among exposed. |
| `p2` | risk among unexposed. |
| `n1` | number of patients in exposed group. |
| `r` | allocation ratio (relative size of unexposed and exposed cohort (`n2` / `n1`)). |
| `conf.width` | precision (the full width of the confidence interval). |
| `conf.level` | confidence level. |
| `method` | Exactly one of `koopman` (*default*), `katz`. Methods can be abbreviated. |
| `...` | other arguments to uniroot (e.g. `tol`). |

### Details

Exactly one of the parameters `n1` or `conf.width` must be passed as NULL, and that parameter is determined from the other.

Koopman (`koopman`) provides an asymptotic score confidence interval that is always consistent with Pearsons chi-squared test. It is the recommended interval (Fagerland et al.).

Katz (`katz`) use a logarithmic transformation to calculate the confidence interval. The CI cannot be computed if one of the proportions is zero. If both proportions are 1, the estimate of the standard error becomes zero, resulting in a CI of [1, 1].

`uniroot` is used to solve n for the katz, and koopman method.

### References

Fagerland MW, Lydersen S, and Laake P (2015). *Recommended confidence intervals for two independent binomial proportions*, Statistical methods in medical research 24(2):224-254.

Katz D, Baptista J, Azen SP, and Pike MC (1978) *Obtaining Confidence Intervals for the Risk Ratio in Cohort Studies*, Biometrics 34:469-474.

Koopman PAR (1984) *Confidence Intervals for the Ratio of Two Binomial Proportions*, Biometrics 40:513-517.

### Examples

```
# Validate function with example in Fagerland et al. (2015), Table 5.
prec_riskratio(p1 = 7/34, p2 = 1/34, n1 = 34, r = 1, met = "katz")
# 7 (0.91 to 54)
prec_riskratio(p1 = 7/34, p2 = 1/34, n1 = 34, r = 1, met = "koopman")
# 7 (1.21 to 43)

# Validate the Koopman method with example in Koopman (1984)
prec_riskratio(p1 = 36/40, p2 = 16/80, n1 = 40, r = 2, met = "koopman")
# 4.5 (2.94 to 7.15)
```

prec_sens *Sample size and precision of sensitivity and specificity*

## Description

Because sensitivity (true positives/total number of positives) and specificity (true negatives/total number of negatives) are simple proportions, these functions act as wrappers for `prec_prop`.

## Usage

```
prec_sens(
  sens,
  n = NULL,
  ntot = NULL,
  prev = NULL,
  conf.width = NULL,
  round = "ceiling",
  ...
)

prec_spec(
  spec,
  n = NULL,
  ntot = NULL,
  prev = NULL,
  conf.width = NULL,
  round = "ceiling",
  ...
)
```

## Arguments

| | |
|---|---|
| `sens`, `spec` | proportions. |
| `n` | number of observations. |
| `ntot` | total sample size. |
| `prev` | prevalence of cases/disease (i.e. proportion of `ntot` with the disease). |
| `conf.width` | precision (the full width of the confidence interval). |
| `round` | string, round calculated `n` up (`ceiling`) or down (`floor`). |
| `...` | options passed to prec_prop (e.g. method, conf.width, conf.level). |

## Details

If `ntot` and `prev` are given, they are used to calculate `n`.

## Value

Object of class "presize", a list of arguments (including the computed one) augmented with method and note elements.

## Note

Calculated `n` can take on non-integer numbers, but `prec_prop` requires integers, so the calculated `n` is rounded according to the approach indicated in `round`.

## See Also

`prec_prop`

## Examples

```
# confidence interval width with n
prec_sens(.6, 50)
# confidence interval width with ntot and prevalence (assuming 50% prev)
prec_sens(.6, ntot = 100, prev = .5)
# sample size with confidence interval width
prec_sens(.6, conf.width = 0.262)
```

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