Package 'statpsych'

January 13, 2026

Type Package

Title Statistical Methods for Psychologists

Version 1.9.0

Description Implements confidence interval and sample size methods that
are especially useful in psychological research. The methods can be
applied in 1-group, 2-group, paired-samples, and multiple-group designs
and to a variety of parameters including means, medians, proportions,
slopes, standardized mean differences, standardized linear contrasts
of means, plus several measures of correlation and association.
Confidence interval and sample size functions are given for single
parameters as well as differences, ratios, and linear contrasts of
parameters. The sample size functions can be used to approximate the
sample size needed to estimate a parameter or function of parameters
with desired confidence interval precision or to perform a variety of
hypothesis tests (directional two-sided, equivalence, superiority,
noninferiority) with desired power. For details see: Statistical Methods
for Psychologists, Volumes 1 – 4, <https://dgbonett.sites.ucsc.edu/>.

URL https://github.com/dgbonett/statpsych/,
https://dgbonett.github.io/statpsych/

BugReports https://github.com/dgbonett/statpsych/issues

License GPL-3

Encoding UTF-8

Imports utils, stats, mnonr, Rdpack, mathjaxr

RoxygenNote 7.3.3

RdMacros Rdpack, mathjaxr

Suggests MASS, testthat (>= 3.0.0)

Config/testthat/edition 3

NeedsCompilation no

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Repository CRAN

Date/Publication 2026-01-13 00:50:02 UTC

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adj.se	*Adjusted standard errors for slope coefficients in an exploratory analysis*

Description

Computes adjusted standard errors in a general linear model after one or more predictor variables with nonsignificant slopes have been dropped from the model. The adjusted standard errors are then used to compute adjusted t-values, p-values, and confidence intervals. The mean square error and error degrees of freedom from the full model are used to compute the adjusted standard errors. These adjusted results are less susceptible to the negative effects of an exploratory model selection.

For more details, see Section 2.25 of Bonett (2021, Volume 2)

Usage

```
adj.se(alpha, mse1, mse2, dfe1, se, b)
```

Arguments

alpha	alpha level for 1-alpha confidence
mse1	mean squared error in full model
mse2	mean squared error in selected model
dfe1	error df in full model
se	vector of slope standard errors in selected model
b	vector of estimated slopes in selected model

Value

Returns adjusted standard error, t-statistic, p-value, and confidence interval for each slope coefficient

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
se <- c(1.57, 3.15, 0.982)
b <- c(3.78, 8.21, 2.99)
adj.se(.05, 10.26, 8.37, 114, se, b)

# Should return:
#      Estimate  adj SE        t  df       p         LL         UL
# [1,]     3.78 1.738243 2.174609 114 0.03173 0.3365531  7.223447
# [2,]     8.21 3.487559 2.354082 114 0.02028 1.3011734 15.118827
# [3,]     2.99 1.087233 2.750102 114 0.00693 0.8362007  5.143799
```

---

ci.2x2.mean.bs   *Computes tests and confidence intervals of effects in a 2x2 between-subjects design for means*

Description

Computes confidence intervals and tests for the AB interaction effect, main effect of A, main effect of B, simple main effects of A, and simple main effects of B in a 2x2 between-subjects factorial design with a quantitative response variable. A Satterthwaite adjustment to the degrees of freedom is used and equality of population variances is not assumed.

For more details, see Sections 3.8 and 3.9 of Bonett (2021, Volume 1)

Usage

```
ci.2x2.mean.bs(alpha, y11, y12, y21, y22)
```

Arguments

alpha	alpha level for 1-alpha confidence
y11	vector of scores at level 1 of A and level 1 of B
y12	vector of scores at level 1 of A and level 2 of B
y21	vector of scores at level 2 of A and level 1 of B
y22	vector of scores at level 2 of A and level 2 of B

Value

Returns a 7-row matrix (one row per effect). The columns are:

- Estimate - estimate of effect
- SE - standard error
- t - t test statistic
- df - degrees of freedom
- p - two-sided p-value
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
y11 <- c(14, 15, 11, 7, 16, 12, 15, 16, 10, 9)
y12 <- c(18, 24, 14, 18, 22, 21, 16, 17, 14, 13)
y21 <- c(16, 11, 10, 17, 13, 18, 12, 16, 6, 15)
y22 <- c(18, 17, 11, 9, 9, 13, 18, 15, 14, 11)
ci.2x2.mean.bs(.05, y11, y12, y21, y22)

# Should return:
#           Estimate       SE       t    df       p         LL          UL
# AB:          -5.10 2.224860 -2.2923 35.48 0.02793 -9.6145264 -0.5854736
# A:            1.65 1.112430  1.4832 35.48 0.14684 -0.6072632  3.9072632
# B:           -2.65 1.112430 -2.3822 35.48 0.02270 -4.9072632 -0.3927368
# A at b1:     -0.90 1.545244 -0.5824 17.56 0.56768 -4.1522367  2.3522367
# A at b2:      4.20 1.600694  2.6239 17.94 0.01725  0.8362274  7.5637726
# B at a1:     -5.20 1.536952 -3.3833 17.61 0.00339 -8.4341379 -1.9658621
# B at a2:     -0.10 1.608657 -0.0622 17.92 0.95112 -3.4807927  3.2807927
```

---

ci.2x2.mean.mixed   *Computes tests and confidence intervals of effects in a 2x2 mixed design for means*

Description

Computes confidence intervals and tests for the AB interaction effect, main effect of A, main effect of B, simple main effects of A, and simple main effects of B in a 2x2 mixed factorial design with a quantitative response variable where Factor A is a within-subjects factor and Factor B is a between-subjects factor. A Satterthwaite adjustment to the degrees of freedom is used and equality of population variances is not assumed.

For more details, see Section 4.16 of Bonett (2021, Volume 1)

Usage

```
ci.2x2.mean.mixed(alpha, y11, y12, y21, y22)
```

Arguments

alpha	alpha level for 1-alpha confidence
y11	vector of scores at level 1 of A and level 1 of B (group 1)
y12	vector of scores at level 1 of A and level 2 of B (group 2)
y21	vector of scores at level 2 of A and level 1 of B (group 1)
y22	vector of scores at level 2 of A and level 2 of B (group 2)

Value

Returns a 7-row matrix (one row per effect). The columns are:

- Estimate - estimate of effect
- SE - standard error
- t - t test statistic
- df - degrees of freedom
- p - two-sided p-value
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
y11 <- c(18, 19, 20, 17, 20, 16)
y12 <- c(19, 16, 16, 14, 16, 18)
y21 <- c(19, 18, 19, 20, 17, 16)
y22 <- c(16, 10, 12,  9, 13, 15)
ci.2x2.mean.mixed(.05, y11, y12, y21, y22)

# Should return:
#            Estimate        SE       t   df       p          LL         UL
# AB:      -3.8333333 0.9803627 -3.9101 8.35 0.00412 -6.0778198 -1.588847
# A:        2.0833333 0.4901814  4.2501 8.35 0.00254  0.9610901  3.205577
# B:        3.7500000 1.0226599  3.6669 7.60 0.00693  1.3700362  6.129964
# A at b1:  0.1666667 0.8333333  0.2000 5.00 0.84936 -1.9754849  2.308818
# A at b2:  4.0000000 0.5163978  7.7460 5.00 0.00057  2.6725572  5.327443
# B at a1:  1.8333333 0.9803627  1.8701 9.94 0.09117 -0.3527241  4.019391
# B at a2:  5.6666667 1.2692955  4.4644 7.67 0.00233  2.7173445  8.615989
```

---

ci.2x2.mean.ws	*Computes tests and confidence intervals of effects in a 2x2 within-subjects design for means*

Description

Computes confidence intervals and tests for the AB interaction effect, main effect of A, main effect of B, simple main effects of A, and simple main effects of B in a 2x2 within-subjects factorial design with a quantitative response variable.

For more details, see Section 4.14 of Bonett (2021, Volume 1)

Usage

```
ci.2x2.mean.ws(alpha, y11, y12, y21, y22)
```

Arguments

alpha	alpha level for 1-alpha confidence
y11	vector of scores at level 1 of A and level 1 of B
y12	vector of scores at level 1 of A and level 2 of B
y21	vector of scores at level 2 of A and level 1 of B
y22	vector of scores at level 2 of A and level 2 of B

Value

Returns a 7-row matrix (one row per effect). The columns are:

- Estimate - estimate of effect
- SE - standard error
- t - t test statistic
- df - degrees of freedom
- p - two-sided p-value
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
y11 <- c(1,2,3,4,5,7,7)
y12 <- c(1,0,2,4,3,8,7)
y21 <- c(4,5,6,7,8,9,8)
y22 <- c(5,6,8,7,8,9,9)
ci.2x2.mean.ws(.05, y11, y12, y21, y22)

# Should return:
#              Estimate         SE       t df       p          LL          UL
# AB:         1.28571429 0.5654449  2.2738  6 0.06334 -0.09787945  2.66930802
# A:         -3.21428571 0.4862042 -6.6110  6 0.00058 -4.40398462 -2.02458681
# B:         -0.07142857 0.2296107 -0.3111  6 0.76626 -0.63326579  0.49040865
# A at b1: -2.57142857 0.2973809 -8.6469  6 0.00013 -3.29909331 -1.84376383
# A at b2: -3.85714286 0.7377111 -5.2285  6 0.00196 -5.66225692 -2.05202879
# B at a1:  0.57142857 0.4285714  1.3333  6 0.23081 -0.47724794  1.62010508
# B at a2: -0.71428571 0.2857143 -2.5000  6 0.04653 -1.41340339 -0.01516804
```

---

ci.2x2.median.bs   *Computes tests and confidence intervals of effects in a 2x2 between-subjects design for medians*

Description

Computes distribution-free confidence intervals for the AB interaction effect, main effect of A, main effect of B, simple main effects of A, and simple main effects of B in a 2x2 between-subjects factorial design with a quantitative response variable. The effects are defined in terms of medians rather than means. Tied scores within each group are assumed to be rare.

For more details, see Section 3.21 of Bonett (2021, Volume 1)

Usage

```
ci.2x2.median.bs(alpha, y11, y12, y21, y22)
```

Arguments

alpha	alpha level for 1-alpha confidence
y11	vector of scores at level 1 of A and level 1 of B
y12	vector of scores at level 1 of A and level 2 of B
y21	vector of scores at level 2 of A and level 1 of B
y22	vector of scores at level 2 of A and level 2 of B

Value

Returns a 7-row matrix (one row per effect). The columns are:

- Estimate - estimate of effect
- SE - standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG, Price RM (2002). "Statistical inference for a linear function of medians: Confidence intervals, hypothesis testing, and sample size requirements." *Psychological Methods*, **7**(3), 370–383. ISSN 1939-1463, doi:10.1037/1082989X.7.3.370.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
y11 <- c(19.2, 21.1, 14.4, 13.3, 19.8, 15.9, 18.0, 19.1, 16.2, 14.6)
y12 <- c(21.3, 27.0, 19.1, 21.5, 25.2, 24.1, 19.8, 19.7, 17.5, 16.0)
y21 <- c(16.5, 11.3, 10.3, 17.7, 13.8, 18.2, 12.8, 16.2, 6.1, 15.2)
y22 <- c(18.7, 17.3, 11.4, 12.4, 13.6, 13.8, 18.3, 15.0, 14.4, 11.9)
ci.2x2.median.bs(.05, y11, y12, y21, y22)

# Should return:
#          Estimate       SE        LL         UL
# AB:        -3.850 2.951019 -9.633891  1.9338914
# A:          4.525 1.475510  1.633054  7.4169457
# B:         -1.525 1.475510 -4.416946  1.3669457
# A at b1:    2.600 1.992028 -1.304302  6.5043022
# A at b2:    6.450 2.177232  2.182703 10.7172971
# B at a1:   -3.450 2.045086 -7.458294  0.5582944
# B at a2:    0.400 2.127472 -3.769769  4.5697694
```

---

ci.2x2.median.mixed   *Computes confidence intervals in a 2x2 mixed design for medians*

Description

Computes distribution-free confidence intervals for the AB interaction effect, main effect of A, main effect of B, simple main effects of A, and simple main effects of B in a 2x2 mixed factorial design where Factor A is the within-subjects factor and Factor B is the between subjects factor. Tied scores within each group and within each within-subjects level are assumed to be rare.

Usage

```
ci.2x2.median.mixed(alpha, y11, y12, y21, y22)
```

Arguments

alpha	alpha level for 1-alpha confidence
y11	vector of scores at level 1 of A and level 1 of B (group 1)
y12	vector of scores at level 1 of A and level 2 of B (group 2)
y21	vector of scores at level 2 of A and level 1 of B (group 1)
y22	vector of scores at level 2 of A and level 2 of B (group 2)

Value

Returns a 7-row matrix (one row per effect). The columns are:

- Estimate - estimate of effect
- SE - standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG, Price RM (2020). "Interval estimation for linear functions of medians in within-subjects and mixed designs." *British Journal of Mathematical and Statistical Psychology*, **73**(2), 333–346. ISSN 0007-1102, doi:10.1111/bmsp.12171.

Examples

```
y11 <- c(18.3, 19.5, 20.1, 17.4, 20.5, 16.1)
y12 <- c(19.2, 16.4, 16.5, 14.0, 16.9, 18.3)
y21 <- c(19.1, 18.4, 19.8, 20.0, 17.2, 16.8)
y22 <- c(16.5, 10.2, 12.7,  9.9, 13.5, 15.0)
ci.2x2.median.mixed(.05, y11, y12, y21, y22)

# Should return:
#          Estimate        SE         LL          UL
# AB:        -3.450 1.6317863 -6.6482423 -0.2517577
# A:          1.875 0.8158931  0.2758788  3.4741212
# B:          3.925 1.4262367  1.1296274  6.7203726
# A at b1:    0.150 1.4243192 -2.6416144  2.9416144
# A at b2:    3.600 0.7962670  2.0393454  5.1606546
# B at a1:    2.200 1.5812792 -0.8992503  5.2992503
# B at a2:    5.650 1.7027101  2.3127496  8.9872504
```

`ci.2x2.median.ws`	*Computes confidence intervals of effects in a 2x2 within-subjects design for medians*

Description

Computes distribution-free confidence intervals for the AB interaction effect, main effect of A, main effect of B, simple main effects of A, and simple main effects of B in a 2x2 within-subjects factorial design. The effects are defined in terms of medians rather than means. Tied scores within each level combination are assumed to be rare.

Usage

```
ci.2x2.median.ws(alpha, y11, y12, y21, y22)
```

Arguments

alpha	alpha level for 1-alpha confidence
y11	vector of scores at level 1 of A and level 1 of B
y12	vector of scores at level 1 of A and level 2 of B
y21	vector of scores at level 2 of A and level 1 of B
y22	vector of scores at level 2 of A and level 2 of B

Value

Returns a 7-row matrix (one row per effect). The columns are:

- Estimate - estimate of effect
- SE - standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG, Price RM (2020). "Interval estimation for linear functions of medians in within-subjects and mixed designs." *British Journal of Mathematical and Statistical Psychology*, **73**(2), 333–346. ISSN 0007-1102, doi:10.1111/bmsp.12171.

Examples

```
y11 <- c(222, 402, 333, 301, 284, 182, 281, 230, 290, 182, 133, 278)
y12 <- c(221, 371, 340, 288, 293, 150, 317, 211, 286, 161, 126, 234)
y21 <- c(219, 371, 314, 279, 284, 155, 278, 185, 296, 169, 118, 229)
y22 <- c(170, 332, 280, 273, 272, 160, 260, 204, 252, 153, 137, 223)
ci.2x2.median.ws(.05, y11, y12, y21, y22)
```

```
# Should return:
#           Estimate         SE          LL        UL
# AB:           3.50  21.050122 -37.75748155  44.75748
# A:           24.25   9.603490   5.42750463  43.07250
# B:           17.75   9.101881  -0.08935904  35.58936
# A at b1:     26.00  11.813742   2.84549058  49.15451
# A at b2:     22.50  16.323093  -9.49267494  54.49267
# B at a1:     19.50  15.710347 -11.29171468  50.29171
# B at a2:     16.00  11.850202  -7.22596953  39.22597
```

---

ci.2x2.prop.bs   *Computes tests and confidence intervals of effects in a 2x2 between-subjects design for proportions*

Description

Computes adjusted Wald confidence intervals and tests for the AB interaction effect, main effect of A, main effect of B, simple main effects of A, and simple main effects of B in a 2x2 between-subjects factorial design with a dichotomous response variable. The input vector of frequency counts is f = [f11, f12, f21, f22], and the input vector of sample sizes is n = [n11, n12, n21, n22] where the first subscript represents the levels of Factor A and the second subscript represents the levels of Factor B.

For more details, see Section 2.14 of Bonett (2021, Volume 3)

Usage

```
ci.2x2.prop.bs(alpha, f, n)
```

Arguments

alpha	alpha level for 1-alpha confidence
f	vector of frequency counts of participants who have the attribute
n	vector of sample sizes

Value

Returns a 7-row matrix (one row per effect). The columns are:

- Estimate - adjusted estimate of effect
- SE - standard error
- z - z test statistic
- p - two-sided p-value
- LL - lower limit of the adjusted Wald confidence interval
- UL - upper limit of the adjusted Wald confidence interval

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/.*

Price RM, Bonett DG (2004). "An improved confidence interval for a linear function of binomial proportions." *Computational Statistics & Data Analysis*, **45**(3), 449–456. ISSN 01679473, doi:10.1016/S01679473(03)000070.

Examples

```
f <- c(15, 24, 28, 23)
n <- c(50, 50, 50, 50)
ci.2x2.prop.bs(.05, f, n)

# Should return:
#             Estimate         SE       z        p          LL          UL
# AB:      -0.27450980 0.13692496 -2.0048 0.04498 -0.54287780 -0.00614181
# A:       -0.11764706 0.06846248 -1.7184 0.08572 -0.25183106  0.01653694
# B:       -0.03921569 0.06846248 -0.5728 0.56678 -0.17339968  0.09496831
# A at b1: -0.25000000 0.09402223 -2.6589 0.00784 -0.43428019 -0.06571981
# A at b2:  0.01923077 0.09787658  0.1965 0.84423 -0.17260380  0.21106534
# B at a1: -0.17307692 0.09432431 -1.8349 0.06652 -0.35794917  0.01179533
# B at a2:  0.09615385 0.09758550  0.9853 0.32446 -0.09511021  0.28741790
```

---

ci.2x2.prop.mixed	*Computes tests and confidence intervals of effects in a 2x2 mixed design for proportions*

Description

Computes adjusted Wald confidence intervals and tests for the AB interaction effect, main effect of A, main effect of B, simple main effects of A, and simple main effects of B in a 2x2 mixed factorial design with a dichotomous response variable where Factor A is a within-subjects factor and Factor B is a between-subjects factor. The 4x1 vector of frequency counts for Factor A within each group is f00, f01, f10, f11 where fij is the number of participants with a response of i = 0 or 1 at level 1 of Factor A and a response of j = 0 or 1 at level 2 of Factor A.

For more details, see Section 2.2 of Bonett (2021, Volume 3)

Usage

```
ci.2x2.prop.mixed(alpha, group1, group2)
```

Arguments

alpha	alpha level for 1-alpha confidence
group1	vector of frequency counts from 2x2 contingency table in group 1
group2	vector of frequency counts from 2x2 contingency table in group 2

Value

Returns a 7-row matrix (one row per effect). The columns are:

- Estimate - adjusted estimate of effect
- SE - standard error of estimate
- z - z test statistic
- p - two-sided p-value
- LL - lower limit of the adjusted Wald confidence interval
- UL - upper limit of the adjusted Wald confidence interval

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
group1 <- c(125, 14, 10, 254)
group2 <- c(100, 16, 9, 275)
ci.2x2.prop.mixed (.05, group1, group2)

# Should return:
#              Estimate          SE       z       p           LL           UL
# AB:        0.007555369 0.017716073  0.4265 0.66976 -0.02716750  0.042278234
# A:        -0.013678675 0.008858036 -1.5442 0.12254 -0.03104011  0.003682758
# B:        -0.058393219 0.023032656 -2.5352 0.01124 -0.10353640 -0.013250043
# A at b1: -0.009876543 0.012580603 -0.7851 0.43242 -0.03453407  0.014780985
# A at b2: -0.017412935 0.012896543 -1.3502 0.17695 -0.04268969  0.007863824
# B at a1: -0.054634236 0.032737738 -1.6688 0.09515 -0.11879902  0.009530550
# B at a2: -0.062170628 0.032328556 -1.9231 0.05447 -0.12553343  0.001192177
```

---

ci.2x2.stdmean.bs   *Computes confidence intervals of standardized effects in a 2x2 between-subjects design*

Description

Computes confidence intervals for standardized AB interaction effect, main effect of A, main effect of B, simple main effects of A, and simple main effects of B in a 2x2 between-subjects factorial design with a quantitative response variable. Equality of population variances is not assumed. A square root unweighted average variance standardizer is used, which is the recommended standardizer when both factors are treatment factors.

Usage

```
ci.2x2.stdmean.bs(alpha, y11, y12, y21, y22)
```

Arguments

alpha	alpha level for 1-alpha confidence
y11	vector of scores at level 1 of A and level 1 of B
y12	vector of scores at level 1 of A and level 2 of B
y21	vector of scores at level 2 of A and level 1 of B
y22	vector of scores at level 2 of A and level 2 of B

Value

Returns a 7-row matrix (one row per effect). The columns are:

- Estimate - estimate of standardized effect
- adj Estimate - bias adjusted estimate of standardized effect
- SE - standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG (2008). "Confidence intervals for standardized linear contrasts of means." *Psychological Methods*, **13**(2), 99–109. ISSN 1939-1463, doi:10.1037/1082989X.13.2.99.

Examples

```
y11 <- c(14, 15, 11, 7, 16, 12, 15, 16, 10, 9)
y12 <- c(18, 24, 14, 18, 22, 21, 16, 17, 14, 13)
y21 <- c(16, 11, 10, 17, 13, 18, 12, 16, 6, 15)
y22 <- c(18, 17, 11, 9, 9, 13, 18, 15, 14, 11)
ci.2x2.stdmean.bs(.05, y11, y12, y21, y22)

# Should return:
#           Estimate adj Estimate      SE      LL      UL
# AB:        -1.4498      -1.4194 0.68852 -2.7992 -0.1003
# A:          0.4690       0.4592 0.33795 -0.1933  1.1314
# B:         -0.7533      -0.7375 0.34512 -1.4297 -0.0769
# A at b1:   -0.2558      -0.2505 0.46402 -1.1653  0.6536
# A at b2:    1.1939       1.1689 0.50014  0.2137  2.1742
# B at a1:   -1.4782      -1.4472 0.49284 -2.4441 -0.5122
# B at a2:   -0.0284      -0.0278 0.48204 -0.9732  0.9163
```

---

ci.2x2.stdmean.mixed   *Computes confidence intervals of standardized effects in a 2x2 mixed design*

Description

Computes confidence intervals for the standardized AB interaction effect, main effect of A, main effect of B, simple main effects of A, and simple main effects of B in a 2x2 mixed factorial design where Factor A is a within-subjects factor, and Factor B is a between-subjects factor. Equality of population variances is not assumed. A square root unweighted average variance standardizer is used.

Usage

```
ci.2x2.stdmean.mixed(alpha, y11, y12, y21, y22)
```

Arguments

alpha	alpha level for 1-alpha confidence
y11	vector of scores at level 1 of A and level 1 of B (group 1)
y12	vector of scores at level 1 of A and level 2 of B (group 2)
y21	vector of scores at level 2 of A and level 1 of B (group 1)
y22	vector of scores at level 2 of A and level 2 of B (group 2)

Value

Returns a 7-row matrix (one row per effect). The columns are:

- Estimate - estimated standardized effect
- adj Estimate - bias adjusted standardized effect estimate
- SE - standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG (2008). "Confidence intervals for standardized linear contrasts of means." *Psychological Methods*, **13**(2), 99–109. ISSN 1939-1463, doi:10.1037/1082989X.13.2.99.

Examples

```
y11 <- c(18, 19, 20, 17, 20, 16)
y12 <- c(19, 16, 16, 14, 16, 18)
y21 <- c(19, 18, 19, 20, 17, 16)
y22 <- c(16, 10, 12,  9, 13, 15)
ci.2x2.stdmean.mixed(.05, y11, y12, y21, y22)

# Should return:
#            Estimate adj Estimate      SE      LL      UL
# AB:         -1.9515      -1.8014 0.54074 -3.0114 -0.8917
# A:           1.0606       1.0113 0.27977  0.5123  1.6090
# B:           1.9091       1.7623 0.57589  0.7804  3.0378
# A at b1:     0.0848       0.0759 0.46504 -0.8266  0.9963
# A at b2:     2.0364       1.8214 0.29956  1.4493  2.6235
# B at a1:     0.9333       0.8615 0.50364 -0.0538  1.9205
# B at a2:     2.8849       2.6630 0.74772  1.4194  4.3504
```

---

ci.2x2.stdmean.ws   *Computes confidence intervals of standardized effects in a 2x2 within-subjects design*

Description

Computes confidence intervals for standardized AB interaction effect, main effect of A, main effect of B, simple main effects of A, and simple main effects of B in a 2x2 within-subjects factorial design. Equality of population variances is not assumed. A square root unweighted average variance standardizer is used.

Usage

```
ci.2x2.stdmean.ws(alpha, y11, y12, y21, y22)
```

Arguments

alpha   alpha level for 1-alpha confidence

y11   vector of scores at level 1 of A and level 1 of B

y12   vector of scores at level 1 of A and level 2 of B

y21   vector of scores at level 2 of A and level 1 of B

y22   vector of scores at level 2 of A and level 2 of B

Value

Returns a 7-row matrix (one row per effect). The columns are:

- Estimate - estimated standardized effect
- adj Estimate - bias adjusted standardized effect estimate
- SE - standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG (2008). "Confidence intervals for standardized linear contrasts of means." *Psychological Methods*, **13**(2), 99–109. ISSN 1939-1463, doi:10.1037/1082989X.13.2.99.

Examples

```
y11 <- c(21, 39, 32, 29, 27, 17, 27, 21, 28, 17, 12, 27)
y12 <- c(20, 36, 33, 27, 28, 14, 30, 20, 27, 15, 11, 22)
y21 <- c(21, 36, 30, 27, 28, 15, 27, 18, 29, 16, 11, 22)
y22 <- c(18, 34, 29, 28, 28, 17, 27, 21, 26, 16, 14, 23)
ci.2x2.stdmean.ws(.05, y11, y12, y21, y22)

# Should return:
#           Estimate adj Estimate      SE      LL     UL
# AB:         0.1725       0.1645 0.13655 -0.0951 0.4401
# A:          0.1092       0.1042 0.05753 -0.0035 0.2220
# B:          0.0747       0.0713 0.05921 -0.0413 0.1908
# A at b1:    0.1955       0.1864 0.08461  0.0297 0.3613
# A at b2:    0.0230       0.0219 0.09372 -0.1607 0.2067
# B at a1:    0.1610       0.1535 0.09457 -0.0244 0.3463
# B at a2:   -0.0115      -0.0110 0.08596 -0.1800 0.1570
```

---

ci.agree   *Confidence interval for a G-index of agreement*

Description

Computes an adjusted Wald confidence interval for a G-index of agreement between two polychotomous ratings. This function requires the number of objects that were given the same rating by both raters. The G-index corrects for chance agreement. The G-index is a better measure of agreement than Cohen's kappa, and the confidence interval for the G-index used here has better small-sample properties than the confidence interval for Cohen's kappa.

For more details, see Section 3.5 of Bonett (2021, Volume 3)

Usage

```
ci.agree(alpha, n, f, k)
```

Arguments

alpha	alpha level for 1-alpha confidence
n	sample size
f	number of objects rated in agreement
k	number of rating categories

Value

Returns a 1-row matrix. The columns are:

- Estimate - maximum likelihood estimate of G-index
- SE - standard error
- LL - lower limit of the adjusted Wald confidence interval
- UL - upper limit of the adjusted Wald confidence interval

References

Bonett DG (2022). "Statistical inference for G-indices of agreement." *Journal of Educational and Behavioral Statistics*, **47**(4), 438–458. doi:10.3102/10769986221088561.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
ci.agree(.05, 250, 214, 3)

# Should return:
# Estimate     SE     LL     UL
#    0.784 0.03331 0.7098 0.8414
```

---

ci.agree.3rater	*Computes confidence intervals for a 3-rater design with dichotomous ratings*

Description

Computes adjusted Wald confidence intervals for a G-index of agreement for all pairs of raters in a 3-rater design with a dichotomous rating, and computes adjusted Wald confidence intervals for differences of all pairs of G agreement. An adjusted Wald confidence interval for unanimous G agreement among the three raters is also computed. In the three-rater design, unanimous G agreement is equal to the average of all pairs of G agreement. The G-index corrects for chance agreement.

Usage

```
ci.agree.3rater(alpha, f)
```

Arguments

`alpha`	alpha level for 1-alpha confidence
`f`	vector of frequency counts from 2x2x2 table where f = [f111, f112, f121, f122, f211, f212, f221, f222], first subscript represents the rating of rater 1, second subscript represents the rating of rater 2, and third subscript represents the rating of rater 3

Value

Returns a 7-row matrix. The rows are:

- G(1,2): G-index for raters 1 and 2
- G(1,3): G-index for raters 1 and 3
- G(2,3): G-index for raters 2 and 3
- G(1,2)-G(1,3): difference in G(1,2) and G(1,3)
- G(1,2)-G(2,3): difference in G(1,2) and G(2,3)
- G(2,3)-G(1,3): difference in G(2,3) and G(1,3)
- G(3): G-index of unanimous agreement for all three raters

The columns are:

- Estimate - estimate of G-index (two-rater, difference, or unanimous)
- LL - lower limit of adjusted Wald confidence interval
- UL - upper limit of adjusted Wald confidence interval

References

Bonett DG (2022). "Statistical inference for G-indices of agreement." *Journal of Educational and Behavioral Statistics*, **47**(4), 438–458. doi:10.3102/10769986221088561.

Examples

```
f <- c(100, 6, 4, 40, 20, 1, 9, 120)
ci.agree.3rater(.05, f)

# Should return:
#                Estimate      LL      UL
# G(1,2)           0.5667  0.4660  0.6524
# G(1,3)           0.5000  0.3956  0.5912
# G(2,3)           0.8667  0.7970  0.9135
# G(1,2)-G(1,3)    0.0667  0.0058  0.1266
# G(1,2)-G(2,3)   -0.3000 -0.4068 -0.1892
# G(2,3)-G(1,3)   -0.3667 -0.4622 -0.2663
# G(3)             0.6444  0.5738  0.7069
```

```
ci.agree2                    Confidence interval for G-index difference in a 2-group design
```

Description

Computes adjusted Wald confidence intervals for the G-index of agreement within each group and the difference of G-indices.

For more details, see Section 3.5 of Bonett (2021, Volume 3)

Usage

```
ci.agree2(alpha, n1, f1, n2, f2, k)
```

Arguments

alpha	alpha level for 1-alpha confidence
n1	sample size (objects) in group 1
f1	number of objects rated in agreement in group 1
n2	sample size (objects) in group 2
f2	number of objects rated in agreement in group 2
k	number of rating categories

Value

Returns a 3-row matrix. The rows are:

- Row 1: G-index for group 1
- Row 2: G-index for group 2
- Row 3: G-index difference

The columns are:

- Estimate - maximum likelihood estimate of G-index and difference
- SE - standard error
- LL - lower limit of adjusted Wald confidence interval
- UL - upper limit of adjusted Wald confidence interval

References

Bonett DG (2022). "Statistical inference for G-indices of agreement." *Journal of Educational and Behavioral Statistics*, **47**(4), 438–458. doi:10.3102/10769986221088561.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
ci.agree2(.05, 75, 70, 60, 45, 2)

# Should return:
#          Estimate      SE      LL      UL
# G1         0.8667 0.02880 0.6975 0.9481
# G2         0.5000 0.05590 0.2523 0.6852
# G1 - G2    0.3667 0.06289 0.1117 0.6089
```

---

ci.bayes.cor	*Bayesian credible interval for a Pearson or partial correlation with a skeptical prior*

Description

Computes an approximate Bayesian credible interval for a Pearson or partial correlation with a skeptical prior. The skeptical prior distribution is Normal with a mean of 0 and a small standard deviation. A skeptical prior assumes that the population correlation is within a range of small values (-r to r). If the skeptic is 95% confident that the population correlation is between -r and r, then the prior standard deviation can be set to r/1.96. A correlation that is less than .2 in absolute value is typically considered to be "small", and the prior standard deviation could then be set to .2/1.96. A correlation value that is considered to be small will depend on the application. Set s = 0 for a Pearson correlation.

For more details, see Section 1.33 of Bonett (2021, Volume 2)

Usage

```
ci.bayes.cor(alpha, prior_sd, cor, s, n)
```

Arguments

alpha	alpha level for 1-alpha credibility interval
prior_sd	standard deviation of skeptical prior distribution
cor	estimated Pearson or partial correlation
s	number of control variables
n	sample size

Value

Returns a 1-row matrix. The columns are:

- Posterior mean - posterior mean (Bayesian estimate of correlation)
- LL - lower limit of the credible interval
- UL - upper limit of the credible interval

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
ci.bayes.cor(.05, .1, .536, 0, 50)

# Should return:
# Posterior mean     LL     UL
#         0.1874  0.028 0.3375

ci.bayes.cor(.05, .1, .536, 0, 300)

# Should return:
# Posterior mean     LL     UL
#         0.4195 0.3352 0.4971
```

---

ci.bayes.normal   *Bayesian credible interval for a normal prior distribution*

Description

Computes an approximate Bayesian credible interval for a normal prior distribution. This function can be used with any parameter estimator (e.g., mean, mean difference, linear contrast of means, slope coefficient, standardized mean difference, standardized linear contrast of means, median, median difference, linear contrast of medians, etc.) that has an approximate normal sampling distribution. The mean and standard deviation of the posterior normal distribution are also reported.

For more details, see Section 1.32 of Bonett (2021, Volume 1)

Usage

```
ci.bayes.normal(alpha, prior_mean, prior_sd, est, se)
```

Arguments

alpha	alpha level for 1-alpha credibility interval
prior_mean	mean of prior Normal distribution
prior_sd	standard deviation of prior Normal distribution
est	sample estimate
se	standard error of sample estimate

Value

Returns a 1-row matrix. The columns are:

- Posterior mean - posterior mean of Normal distribution
- Posterior SD - posterior standard deviation of Normal distribution
- LL - lower limit of the credible interval
- UL - upper limit of the credible interval

References

Gelman A, Carlin JB, Stern HS, Rubin DB (2004). *Bayesian Data Analysis*, 2nd edition. Chapman & Hall.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
ci.bayes.normal(.05, 50, 5, 38.3, 2.57)

# Should return:
# Posterior mean Posterior SD      LL      UL
#       40.74511    2.285735 36.26515 45.22506
```

---

ci.bayes.prop   *Bayesian credible interval for a proportion*

Description

Computes a Bayesian credible interval for a population proportion using the mean and standard deviation of a prior Beta distribution along with sample information. The mean and standard deviation of the posterior Beta distribution are also reported. For a noninformative prior, set the prior mean to .5 and the prior standard deviation to 1/sqrt(12) (which corresponds to a Beta(1,1) distribution). The prior variance must be less than m(1 - m) where m is the prior mean.

For more details, see Section 1.18 of Bonett (2021, Volume 3)

Usage

```
ci.bayes.prop(alpha, prior_mean, prior_sd, f, n)
```

Arguments

alpha	alpha level for 1-alpha credibility interval
prior_mean	mean of prior Beta distribution
prior_sd	standard deviation of prior Beta distribution
f	number of participants who have the attribute
n	sample size

Value

Returns a 1-row matrix. The columns are:

- Posterior mean - posterior mean of Beta distribution
- Posterior SD - posterior standard deviation of Beta distribution
- LL - lower limit of the credible interval
- UL - upper limit of the credible interval

References

Gelman A, Carlin JB, Stern HS, Rubin DB (2004). *Bayesian Data Analysis*, 2nd edition. Chapman & Hall.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
ci.bayes.prop(.05, .25, .1, 120, 300)

# Should return:
# Posterior mean Posterior SD         LL         UL
#      0.3916208   0.02742595 0.3387206 0.4458133
```

---

ci.bayes.spcor	*Bayesian credible interval for a semipartial correlation with a skeptical prior*

Description

Computes an approximate Bayesian credible interval for a semipartial correlation with a skeptical prior. The skeptical prior distribution is Normal with a mean of 0 and a small standard deviation. A skeptical prior assumes that the population semipartial correlation is within a range of small values (-r to r). If the skeptic is 95% confident that the population correlation is between -r and r, then the prior standard deviation can be set to r/1.96. A semipartial correlation that is less than .2 in absolute value is typically considered to be "small", and the prior standard deviation could then be set to .2/1.96. A semipartial correlation value that is considered to be small will depend on the application. This function requires the standard error of the estimated semipartial correlation which can be obtained from the ci.spcor function.

For more details, see Section 2.36 of Bonett (2021, Volume 2)

Usage

```
ci.bayes.spcor(alpha, prior_sd, cor, se)
```

Arguments

`alpha`	alpha level for 1-alpha credibility interval
`prior_sd`	standard deviation of skeptical prior distribution
`cor`	estimated semipartial partial correlation
`se`	standard error of estimated semipartial correlation

Value

Returns a 1-row matrix. The columns are:

- Posterior mean - posterior mean (Bayesian estimate of correlation)
- LL - lower limit of the credible interval
- UL - upper limit of the credible interval

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
ci.bayes.spcor(.05, .1, .582, .137)

# Should return:
# Posterior mean     LL     UL
#         0.2273 0.0729 0.371
```

---

ci.biphi   *Confidence interval for a biserial-phi correlation*

Description

Computes a confidence interval for a population biserial-phi correlation using a transformation of a confidence interval for an odds ratio with .5 added to each cell frequency. This measure of association assumes the group variable is naturally dichotomous and the response variable is artificially dichotomous.

For more details, see Section 3.4 of Bonett (2021, Volume 3)

Usage

```
ci.biphi(alpha, f1, f2, n1, n2)
```

Arguments

`alpha`	alpha level for 1-alpha confidence
`f1`	number of participants in group 1 who have the attribute
`f2`	number of participants in group 2 who have the attribute
`n1`	sample size for group 1
`n2`	sample size for group 2

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimate of biserial-phi correlation
- SE - standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Ulrich R, Wirtz M (2004). "On the correlation of a naturally and an artificially dichotomized variable." *British Journal of Mathematical and Statistical Psychology*, **57**(2), 235–251. ISSN 00071102, doi:10.1348/0007110042307203.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
ci.biphi(.05, 34, 22, 50, 50)

# Should return:
# Estimate     SE    LL    UL
#    0.275 0.1075 0.049 0.464
```

---

ci.bscor *Confidence interval for a biserial correlation*

Description

Computes a confidence interval for a population biserial correlation. A biserial correlation can be used when one variable is quantitative and the other variable has been artificially dichotomized to create two groups. The biserial correlation estimates the correlation between the observed quantitative variable and the unobserved quantitative variable that has been measured on a dichotomous scale.

Usage

```
ci.bscor(alpha, m1, m2, sd1, sd2, n1, n2)
```

Arguments

alpha	alpha level for 1-alpha confidence
m1	estimated mean for group 1
m2	estimated mean for group 2
sd1	estimated standard deviation for group 1
sd2	estimated standard deviation for group 2
n1	sample size for group 1
n2	sample size for group 2

Details

This function computes a point-biserial correlation and its standard error as a function of a standardized mean difference with a weighted variance standardizer. Then the point-biserial estimate is transformed into a biserial correlation using the traditional adjustment. The adjustment is also applied to the point-biserial standard error to obtain the standard error for the biserial correlation.

The biserial correlation assumes that the observed quantitative variable and the unobserved quantitative variable have a bivariate normal distribution. Bivariate normality is a crucial assumption underlying the transformation of a point-biserial correlation to a biserial correlation. Bivariate normality also implies equal variances of the observed quantitative variable at each level of the dichotomized variable, and this assumption is made in the computation of the standard error.

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimated biserial correlation
- SE - standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG (2020). "Point-biserial correlation: Interval estimation, hypothesis testing, meta-analysis, and sample size determination." *British Journal of Mathematical and Statistical Psychology*, **73**(S1), 113–144. ISSN 0007-1102, doi:10.1111/bmsp.12189.

Examples

```
ci.bscor(.05, 28.32, 21.48, 3.81, 3.09, 40, 40)

# Should return:
# Estimate     SE      LL      UL
#   0.8856 0.0613  0.7376  0.9844
```

---

ci.cod   *Confidence interval for a coefficient of dispersion*

Description

Computes a confidence interval for a population coefficient of dispersion (COD). The COD is a mean absolute deviation from the median divided by the median. The coefficient of dispersion assumes ratio-scale scores and is a robust alternative to the coefficient of variation (see ci.cv). An approximate standard error is recovered from the confidence interval.

For more details, see Section 1.27 of Bonett (2021, Volume 1)

Usage

```
ci.cod(alpha, y)
```

Arguments

alpha   alpha level for 1-alpha confidence

y   vector of scores

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimated coefficient of dispersion
- SE - recovered standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG, Seier E (2006). "Confidence interval for a coefficient of dispersion in nonnormal distributions." *Biometrical Journal*, **48**(1), 144–148. ISSN 0323-3847, doi:10.1002/bimj.200410148.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
y <- c(30, 20, 15, 10, 10, 60, 20, 25, 20, 30, 10, 5, 50, 40,
       20, 10, 0, 20, 50)
ci.cod(.05, y)

# Should return:
#  Estimate         SE         LL        UL
# 0.5921053 0.1814708 0.3813259 1.092679
```

---

ci.condslope   *Confidence intervals for conditional (simple) slopes in a linear model*

Description

Computes confidence intervals and test statistics for population conditional slopes (simple slopes) in a general linear model that includes a predictor variable (x1), a moderator variable (x2), and a product predictor variable (x1*x2). Conditional slopes are computed at specified low and high values of the moderator variable.

For more details, see Section 2.13 of Bonett (2021, Volume 2)

Usage

```
ci.condslope(alpha, b1, b2, se1, se2, cov, lo, hi, dfe)
```

Arguments

alpha	alpha level for 1-alpha confidence
b1	estimated slope coefficient for predictor variable
b2	estimated slope coefficient for product variable
se1	standard error for predictor coefficient
se2	standard error for product coefficient
cov	estimated covariance between predictor and product coefficients
lo	low value of moderator variable
hi	high value of moderator variable
dfe	error degrees of freedom

Value

Returns a 2-row matrix. The columns are:

- Estimate - estimated conditional slope
- t - t test statistic
- p - two-sided p-value
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
ci.condslope(.05, .132, .154, .031, .021, .015, 5.2, 10.6, 122)

# Should return:
#                   Estimate        SE        t  df            p
# At low moderator    0.9328 0.4109570 2.269824 122 0.024973618
# At high moderator   1.7644 0.6070517 2.906507 122 0.004342076
#                          LL       UL
# At low moderator  0.1192696 1.746330
# At high moderator 0.5626805 2.966119
```

`ci.condslope.log` *Confidence intervals for conditional (simple) slopes in a logistic model*

Description

Computes confidence intervals and test statistics for population conditional slopes (simple slopes) in a logistic model that includes a predictor variable (x1), a moderator variable (x2), and a product predictor variable (x1*x2). Conditional slopes are computed at low and high values of the moderator variable.

For more details, see Section 4.9 of Bonett (2021, Volume 3)

Usage

```
ci.condslope.log(alpha, b1, b2, se1, se2, cov, lo, hi)
```

Arguments

alpha	alpha level for 1-alpha confidence
b1	estimated slope coefficient for predictor variable
b2	estimated slope coefficient for product variable
se1	standard error for predictor coefficient
se2	standard error for product coefficient
cov	estimated covariance between predictor and product coefficients
lo	low value of moderator variable
hi	high value of moderator variable

Value

Returns a 2-row matrix. The columns are:

- Estimate - estimated conditional slope
- exp(Estimate) - estimated exponentiated conditional slope

- z - z test statistic

- p - two-sided p-value

- LL - lower limit of the exponentiated confidence interval

- UL - upper limit of the exponentiated confidence interval

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
ci.condslope.log(.05, .132, .154, .031, .021, .015, 5.2, 10.6)

# Should return:
#                   Estimate exp(Estimate)      z       p
# At low moderator    0.9328      2.541616 2.2698 0.02322
# At high moderator   1.7644      5.838068 2.9065 0.00365
#                          LL        UL
# At low moderator   1.135802  5.687444
# At high moderator  1.776421 19.186357
```

---

ci.cor	*Confidence interval for a Pearson or partial correlation*

Description

Computes a Fisher confidence interval for a population Pearson correlation or partial correlation with s control variables. Set s = 0 for a Pearson correlation. A bias adjustment is used to reduce the bias of the Fisher transformed correlation. This function uses an estimated correlation as input. Use the cor.test function for raw data input.

For more details, see Section 1.14 of Bonett (2021, Volume 2)

Usage

```
ci.cor(alpha, cor, s, n)
```

Arguments

alpha	alpha level for 1-alpha confidence
cor	estimated Pearson or partial correlation
s	number of control variables
n	sample size

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimated correlation (from input)
- SE - standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Snedecor GW, Cochran WG (1989). *Statistical Methods*, 8th edition. ISU University Pres, Ames, Iowa.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
ci.cor(.05, .60, 0, 150)

# Should return:
# Estimate      SE    LL      UL
#      0.6 0.05243 0.485 0.6925

ci.cor(.05, .70, 1, 135)

# Should return:
# Estimate      SE     LL      UL
#      0.7 0.04406 0.6002 0.7763
```

`ci.cor.dep`   *Confidence interval for a difference in dependent Pearson correlations*

Description

Computes a confidence interval for a difference in population Pearson correlations that are estimated from the same sample and have one variable in common. A bias adjustment is used to reduce the bias of each Fisher transformed correlation. An approximate standard error is recovered from the confidence interval.

For more details, see Section 2.17 of Bonett (2021, Volume 2)

Usage

```
ci.cor.dep(alpha, cor1, cor2, cor12, n)
```

Arguments

`alpha`	alpha level for 1-alpha confidence
`cor1`	estimated Pearson correlation between y and x1
`cor2`	estimated Pearson correlation between y and x2
`cor12`	estimated Pearson correlation between x1 and x2
`n`	sample size

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimated correlation difference
- SE - recovered standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Zou GY (2007). "Toward using confidence intervals to compare correlations." *Psychological Methods*, **12**(4), 399–413. ISSN 1939-1463, doi:10.1037/1082989X.12.4.399.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
ci.cor.dep(.05, .396, .179, .088, 166)

# Should return:
# Estimate     SE     LL     UL
#    0.217 0.1027 0.0132 0.4158
```

---

ci.cor2   *Confidence interval for a 2-group Pearson correlation difference*

Description

Computes a confidence interval for a difference in population Pearson correlations in a 2-group design. A bias adjustment is used to reduce the bias of each Fisher transformed correlation.

For more details, see Section 2.17 of Bonett (2021, Volume 2)

Usage

```
ci.cor2(alpha, cor1, cor2, n1, n2)
```

Arguments

`alpha`	alpha level for 1-alpha confidence
`cor1`	estimated Pearson correlation for group 1
`cor2`	estimated Pearson correlation for group 2
`n1`	sample size for group 1
`n2`	sample size for group 2

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimated correlation difference
- SE - standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Zou GY (2007). "Toward using confidence intervals to compare correlations." *Psychological Methods*, **12**(4), 399–413. ISSN 1939-1463, doi:10.1037/1082989X.12.4.399.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
ci.cor2(.05, .64, .31, 200, 200)

# Should return:
# Estimate      SE      LL      UL
#     0.33 0.07692  0.1797  0.4814
```

`ci.cor2.gen`	*Confidence interval for a 2-group correlation difference*

Description

Computes a 100(1 - alpha)% confidence interval for a difference in population correlations in a 2-group design. The correlations can be Pearson, Spearman, partial, semipartial, or point-biserial correlations. The correlations could also be correlations between two latent factors. The function requires a point estimate and a 100(1 - alpha)% confidence interval for each correlation as input. The confidence intervals for each correlation can be obtained using ci.fisher.

For more details, see Section 2.17 of Bonett (2021, Volume 2)

Usage

```
ci.cor2.gen(cor1, ll1, ul1, cor2, ll2, ul2)
```

Arguments

cor1	estimated correlation for group 1
ll1	lower limit for group 1 correlation
ul1	upper limit for group 1 correlation
cor2	estimated correlation for group 2
ll2	lower limit for group 2 correlation
ul2	upper limit for group 2 correlation

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimated correlation difference
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Zou GY (2007). "Toward using confidence intervals to compare correlations." *Psychological Methods*, **12**(4), 399–413. ISSN 1939-1463, doi:10.1037/1082989X.12.4.399.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/.*

Examples

```
ci.cor2.gen(.64, .55, .71, .31, .18, .43)

# Should return:
# Estimate    LL      UL
#     0.33 0.18 0.4776
```

---

ci.cqv   *Confidence interval for a coefficient of quartile variation*

Description

Computes a distribution-free confidence interval for a population coefficient of quartile variation which is defined as (Q3 - Q1)/(Q3 + Q1) where Q1 is the 25th percentile and Q3 is the 75th percentile. The coefficient of quartile variation assumes ratio-scale scores and is a robust alternative to the coefficient of variation (see ci.cv). The 25th and 75th percentiles are computed using the type = 2 method (SAS default).

For more details, see Section 1.27 of Bonett (2021, Volume 1)

Usage

```
ci.cqv(alpha, y)
```

Arguments

alpha	alpha level for 1-alpha confidence
y	vector of scores

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimated coefficient of quartile variation
- SE - standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG (2006). "Confidence interval for a coefficient of quartile variation." *Computational Statistics and Data Analysis*, **50**(11), 2953–2957. doi:10.1016/j.csda.2005.05.007.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
y <- c(30, 20, 15, 10, 10, 60, 20, 25, 20, 30, 10, 5, 50, 40,
       20, 10, 0, 20, 50)
ci.cqv(.05, y)

# Should return:
# Estimate          SE          LL          UL
#      0.5 0.1552485 0.2617885 0.8841821
```

---

ci.cramer	*Confidence interval for Cramer's V*

Description

Computes a confidence interval for a population Cramer's V coefficient of nominal association for an r x s contingency table. The confidence interval is based on a noncentral chi-square distribution, and an approximate standard error is recovered from the confidence interval.

For more details, see Section 3.10 of Bonett (2021, Volume 3)

Usage

```
ci.cramer(alpha, chisqr, r, c, n)
```

Arguments

alpha	alpha value for 1-alpha confidence
chisqr	Pearson chi-square test statistic of independence
r	number of rows in contingency table
c	number of columns in contingency table
n	sample size

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimate of Cramer's V
- SE - recovered standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Smithson M (2003). *Confidence Intervals*. Sage.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
ci.cramer(.05, 19.21, 2, 3, 200)

# Should return:
# Estimate     SE   LL     UL
#     0.31 0.0718 0.16  0.442
```

---

ci.cronbach   *Confidence interval for a Cronbach reliability*

Description

Computes a confidence interval for a population Cronbach reliability. The point estimate of Cronbach reliability assumes essentially tau-equivalent measurements and the confidence interval assumes parallel measurements.

For more details, see Section 4.19 of Bonett (2021, Volume 1)

Usage

```
ci.cronbach(alpha, rel, r, n)
```

Arguments

alpha	alpha level for 1-alpha confidence
rel	estimated Cronbach reliability
r	number of measurements (items, raters, forms)
n	sample size

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimated Cronbach reliability (from input)
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Feldt LS (1965). "The approximate sampling distribution of Kuder-Richardson reliability coefficient twenty." *Psychometrika*, **30**(3), 357–370. ISSN 0033-3123, doi:10.1007/BF02289499.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
ci.cronbach(.05, .85, 7, 89)

# Should return:
# Estimate      SE     LL     UL
#     0.85  0.02457 0.7971 0.8932
```

---

ci.cronbach2	*Confidence interval for a difference in Cronbach reliabilities in a 2-group design*

Description

Computes a confidence interval for a difference in population Cronbach reliability coefficients in a 2-group design. The number of measurements (items, raters, forms) used in each group need not be equal.

For more details, see Section 2.15 of Bonett (2021, Volume 4)

Usage

```
ci.cronbach2(alpha, rel1, rel2, r1, r2, n1, n2)
```

Arguments

alpha	alpha level for 1-alpha confidence
rel1	estimated Cronbach reliability for group 1
rel2	estimated Cronbach reliability for group 2
r1	number of measurements used in group 1
r2	number of measurements used in group 2
n1	sample size for group 1
n2	sample size for group 2

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimated reliability difference

- LL - lower limit of the confidence interval

- UL - upper limit of the confidence interval

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Bonett DG, Wright TA (2015). "Cronbach's alpha reliability: Interval estimation, hypothesis testing, and sample size planning." *Journal of Organizational Behavior*, **36**(1), 3–15. ISSN 08943796, [doi:10.1002/job.1960](doi:10.1002/job.1960).

Examples

```
ci.cronbach2(.05, .88, .76, 8, 8, 200, 250)

# Should return:
# Estimate    LL      UL
#     0.12 0.0697 0.1733
```

---

ci.cv   *Confidence interval for a coefficient of variation*

Description

Computes a confidence interval for a population coefficient of variation (standard deviation divided by mean). This confidence interval is the reciprocal of a confidence interval for a standardized mean (see ci.stdmean). An approximate standard error is recovered from the confidence interval. The coefficient of variation assumes ratio-scale scores.

For more details, see Section 1.27 of Bonett (2021, Volume 1)

Usage

```
ci.cv(alpha, m, sd, n)
```

Arguments

alpha	alpha level for 1-alpha confidence
m	estimated mean
sd	estimated standard deviation
n	sample size

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimated coefficient of variation
- SE - recovered standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
ci.cv(.05, 24.5, 3.65, 40)

# Should return:
#  Estimate         SE        LL        UL
# 0.1489796 0.01817373 0.1214381 0.1926778
```

---

ci.diversity   *Confidence intervals for diversity indices*

Description

Computes estimates, standard errors, and approximate confidence intervals for the Berger-Parker, Simpson, and Shannon diversity indices. For the Shannon index, the value 1/r is added to each frequency count where r is the number of categories. These indices have a range of 0 to 1 where 0 indicates no diversity and 1 indicates maximum diversity.

For more details, see Section 1.13 of Bonett (2021, Volume 3)

Usage

```
ci.diversity(alpha, f)
```

Arguments

alpha   alpha level for 1 - alpha confidence

f   vector of multinomial frequency counts

Value

Returns a 3-row matrix. The columns are:

- Estimate - estimate of diversity index
- SE - standard error of estimate
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
f = c(847, 320, 57, 274, 36)
ci.diversity(.05, f)

# Should return:
#         Estimate      SE     LL     UL
# Berger    0.5598 0.01587 0.5287 0.5909
# Simpson   0.7722 0.01229 0.7481 0.7963
# Shannon   0.7292 0.01224 0.7052 0.7532
```

---

ci.etasqr   *Confidence interval for eta-squared*

Description

Computes a confidence interval for a population eta-squared, partial eta-squared, or generalized eta-squared in a fixed-factor between-subjects design. An approximate bias adjusted estimate is computed, and an approximate standard error is recovered from the confidence interval.

For more details, see Section 3.7 of Bonett (2021, Volume 1)

Usage

```
ci.etasqr(alpha, etasqr, df1, df2)
```

Arguments

alpha	alpha value for 1-alpha confidence
etasqr	estimated eta-squared
df1	degrees of freedom for effect
df2	error degrees of freedom

Value

Returns a 1-row matrix. The columns are:

- Eta-squared - eta-squared (from input)
- adj Eta-squared - bias adjusted eta-squared estimate
- SE - recovered standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
ci.etasqr(.05, .15, 2, 57)

# Should return:
# Eta-squared  adj Eta-squared       SE      LL      UL
#       0.15           0.1202  0.07414  0.0102  0.3008
```

---

ci.fisher   *Fisher confidence interval*

Description

Computes a Fisher confidence interval for any type of correlation (e.g., Pearson, Spearman, Kendall-tau, tetrachoric, phi, partial, semipartial, etc.) or ordinal association such as gamma, Somers' d, or tau-b. The correlation could also be between two latent factors obtained from a SEM analysis (the Fisher CI will be more accurate than the large-sample CI from a SEM analysis). The standard error can be a traditional standard error, a bootstrap standard error, or a robust standard error from a SEM analysis.

Usage

```
ci.fisher(alpha, cor, se)
```

Arguments

alpha	alpha value for 1-alpha confidence
cor	estimated correlation or association coefficient
se	standard error of correlation or association coefficient

Value

Returns a 1-row matrix. The columns are:

- Estimate - correlation (from input)
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

Examples

```
ci.fisher(.05, .692, .049)

# Should return:
# Estimate    LL     UL
#    0.692 0.5833 0.7763
```

---

ci.icc   *Confidence interval for an intraclass reliablity coefficient*

Description

Computes a confidence interval for a population intraclass reliability coefficient using mean squared estimates from a two-way ANOVA. This function will compute point and interval estimates of the ICC(C, 1) and ICC(C, r) reliability coefficients where ICC(C, 1) is the reliability of a single measurements (e.g., a single rater or a single form of a test) and ICC(C, r) is the reliability of a sum or average of r measurements. ICC(C, r) is the same as Cronbach's reliability coefficient. The ci.cronbach function uses a point estimate of Cronbach's reliability as input. The confidence intervals used in this function assume parallel measurements which implies a compound symmetric covariance matrix of the r measurements.

Usage

```
ci.icc(alpha, MSr, MSe, r, n)
```

Arguments

alpha	alpha level for 1-alpha confidence
MSr	mean square for rows
MSe	error mean square
r	number of measurements (items, raters, forms)
n	sample size

Value

Returns a 2-row matrix. The first row results are for ICC(C, 1) and the second row results are for ICC(C, r). The columns are:

- Estimate - estimated reliability
- SE - standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

McGraw KO, Wong SP (1996). "Forming inferences about some intraclass correlation coefficients." *Psychological Methods*, **1**(1), 30–46. doi:10.1037/1082989X.1.1.30.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
ci.icc(.05, 48.2, 11.3, 5, 30)

# Should return:
#            Estimate      SE      LL      UL
# ICC(C, 1)    0.3951 0.09166 0.2311 0.5853
# ICC(C, r)    0.7656 0.07005 0.6005 0.8759
```

---

ci.indirect   *Confidence interval for an indirect effect*

Description

Computes a Monte Carlo confidence interval (500,000 trials) for a population unstandardized or standardized indirect effect in a path model and a Sobel standard error. This function is not recommended for a standardized indirect if the standardized slopes are greater than .4 The Monte Carlo method is general in that the slope estimates and standard errors do not need to be OLS estimates with homoscedastic standard errors. For example, LAD slope estimates and their standard errors, OLS slope estimates and heteroscedastic-consistent standard errors also could be used. In models with no direct effects, distribution-free Theil-Sen slope estimates with recovered standard errors (see ci.theil) also could be used.

For more details, see Section 1.18 of Bonett (2021, Volume 4)

Usage

```
ci.indirect(alpha, b1, b2, se1, se2)
```

Arguments

alpha	alpha level for 1-alpha confidence
b1	slope estimate for first path
b2	slope estimate for second path
se1	standard error for b1
se2	standard error for b2

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimated indirect effect
- SE - standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/.*

Examples

```
ci.indirect (.05, 2.48, 1.92, .586, .379)

# Should return (within sampling error):
# Estimate      SE       LL        UL
#   4.7616 1.625282 2.178812 7.972262
```

---

ci.kappa   *Confidence interval for two kappa reliability coefficients*

Description

Computes confidence intervals for the intraclass kappa coefficient and Cohen's kappa coefficient with two dichotomous ratings. The G-index of agreement (see ci.agree) is arguably a better measure of agreement.

For more details, see Section 3.5 of Bonett (2021, Volume 3)

Usage

```
ci.kappa(alpha, f00, f01, f10, f11)
```

Arguments

alpha	alpha level for 1-alpha confidence
f00	number of objects rated 0 by both Rater 1 and Rater 2
f01	number of objects rated 0 by Rater 1 and 1 by Rater 2
f10	number of objects rated 1 by Rater 1 and 0 by Rater 2
f11	number of objects rated 1 by both Rater 1 and Rater 2

Value

Returns a 2-row matrix. The results in row 1 are for the intraclass kappa. The results in row 2 are for Cohen's kappa. The columns are:

- Estimate - estimate of interrater reliability
- SE - standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Fleiss JL, Paik MC (2003). *Statistical Methods for Rates and Proportions*, 3rd edition. Wiley.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
ci.kappa(.05, 31, 12, 4, 58)

# Should return:
#               Estimate     SE    LL    UL
# IC kappa:        0.674 0.0748 0.527 0.821
# Cohen kappa:     0.676 0.0734 0.532 0.820
```

---

ci.lc.gen.bs	*Confidence interval for a linear contrast of parameters in a between-subjects design*

Description

Computes the estimate, standard error, and approximate confidence interval for a linear contrast of any type of parameter where each parameter value has been estimated from a different sample. The parameter values are assumed to be of the same type and their sampling distributions are assumed to be approximately normal.

Usage

```
ci.lc.gen.bs(alpha, est, se, v)
```

Arguments

alpha	alpha level for 1-alpha confidence
est	vector of parameter estimates
se	vector of standard errors
v	vector of contrast coefficients

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimate of linear contrast
- SE - standard error of linear contrast
- LL - lower limit of confidence interval
- UL - upper limit of confidence interval

Examples

```
est <- c(3.86, 4.57, 2.29, 2.88)
se <- c(0.185, 0.365, 0.275, 0.148)
v <- c(.5, .5, -.5, -.5)
ci.lc.gen.bs(.05, est, se, v)

# Should return:
# Estimate        SE       LL       UL
#     1.63 0.2573806 1.125543 2.134457
```

---

ci.lc.glm	*Confidence interval for a linear contrast of general linear model parameters*

Description

Computes the estimate, standard error, and confidence interval for a linear contrast of parameters in a general linear model using coef(object) and vcov(object) where "object" is a fitted model object from the lm function.

For more details, see Section 2.28 of Bonett (2021, Volume 2)

Usage

```
ci.lc.glm(alpha, n, b, V, q)
```

Arguments

alpha	alpha for 1 - alpha confidence
n	sample size
b	vector of parameter estimates from coef(object)
V	covariance matrix of parameter estimates from vcov(object)
q	vector of contrast coefficients

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimate of linear function
- SE - standard error
- t - t test statistic
- df - degrees of freedom
- p - two-sided p-value
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
y <- c(43, 62, 49, 60, 36, 79, 55, 42, 67, 50)
x1 <- c(3, 6, 4, 6, 2, 7, 4, 2, 7, 5)
x2 <- c(4, 6, 3, 7, 1, 9, 3, 3, 8, 4)
out <- lm(y ~ x1 + x2)
b <- coef(out)
V <- vcov(out)
n <- length(y)
q <- c(0, .5, .5)
b
ci.lc.glm(.05, n, b, V, q)

#  Should return:
# (Intercept)          x1          x2
#   26.891111    3.648889    2.213333
#
# Estimate        SE      t df       p         LL        UL
# 2.931111 0.4462518 6.5683  7 0.00031 1.875893 3.986329
```

---

ci.lc.mean.bs	*Confidence interval for a linear contrast of means in a between-subjects design*

Description

Computes a test statistic and confidence interval for a linear contrast of means in a between-subjects design. This function computes both unequal variance and equal variance confidence intervals and test statistics. A Satterthwaite adjustment to the degrees of freedom is used with the unequal variance method.

For more details, see Section 3.3 of Bonett (2021, Volume 1)

Usage

```
ci.lc.mean.bs(alpha, m, sd, n, v)
```

Arguments

alpha	alpha level for 1-alpha confidence
m	vector of estimated group means
sd	vector of estimated group standard deviations
n	vector of sample sizes
v	vector of between-subjects contrast coefficients

Value

Returns a 2-row matrix. The columns are:

- Estimate - estimated linear contrast
- SE - standard error
- t - t test statistic
- df - degrees of freedom
- p - two-sided p-value
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Snedecor GW, Cochran WG (1989). *Statistical Methods*, 8th edition. ISU University Pres, Ames, Iowa.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/.*

Examples

```
m <- c(24.9, 23.1, 16.4)
sd <- c(5.21, 4.67, 4.98)
n <- c(30, 30, 30)
v <- c(.5, .5, -1)
ci.lc.mean.bs(.05, m, sd, n, v)

# Should return:
#                            Estimate       SE     t    df p       LL       UL
# Equal Variances Assumed:        7.6 1.108703 6.8549 87.00 0 5.396332 9.803668
# Equal Variances Not Assumed:    7.6 1.111135 6.8399 57.59 0 5.375484 9.824516

m <- c(33.5, 37.9, 38.0, 44.1)
sd <- c(3.84, 3.84, 3.65, 4.98)
n <- c(10, 10, 10, 10)
v <- c(.5, .5, -.5, -.5)
ci.lc.mean.bs(.05, m, sd, n, v)

# Should return:
#                            Estimate       SE      t    df       p
# Equal Variances Assumed:       -5.35 1.300136 -4.115 36.00 0.00022
# Equal Variances Not Assumed:   -5.35 1.300136 -4.115 33.52 0.00024
#                                    LL        UL
# Equal Variances Assumed:     -7.986797 -2.713203
# Equal Variances Not Assumed: -7.993583 -2.706417
```

---

ci.lc.mean.scheffe   *Scheffe confidence interval for a linear contrast of means in a between-subjects design*

Description

Computes a Scheffe confidence interval for a linear contrast of population means in a between-subjects design. A Scheffe p-value is computed for the test statistic. The Scheffe method assumes equal population variances. This function is useful in exploratory studies where the linear contrast of means was not planned but was suggested by the pattern of sample means. Use the ci.lc.mean.bs function with a Bonferroni adjusted alpha value to compute simultaneous confidence intervals for two or more planned linear contrasts of means.

Usage

```
ci.lc.mean.scheffe(alpha, m, sd, n, v)
```

Arguments

alpha	alpha level for 1-alpha confidence
m	vector of estimated group means
sd	vector of estimated group standard deviations
n	vector of sample sizes
v	vector of between-subjects contrast coefficients

Value

Returns a 2-row matrix. The columns are:

- Estimate - estimated linear contrast
- SE - standard error
- t - t test statistic
- df - degrees of freedom
- p - two-sided Scheffe p-value
- LL - lower limit of the Scheffe confidence interval
- UL - upper limit of the Scheffe confidence interval

References

Snedecor GW, Cochran WG (1989). *Statistical Methods*, 8th edition. ISU University Pres, Ames, Iowa.

Examples

```
m <- c(33.5, 37.9, 38.0, 44.1)
sd <- c(3.49, 3.84, 3.65, 4.98)
n <- c(10, 10, 10, 10)
v <- c(.5, .5, -.5, -.5)
ci.lc.mean.scheffe(.05, m, sd, n, v)

# Should return:
# Estimate       SE       t       p        LL        UL
#    -5.35 1.275231 -4.1953 0.00228 -9.089451 -1.610549
```

---

ci.lc.median.bs | *Confidence interval for a linear contrast of medians in a between-subjects design*

Description

Computes a distribution-free confidence interval for a linear contrast of medians in a between-subjects design using estimated medians and their standard errors. The sample median and standard error for each group can be computed using the ci.median function.

For more details, see Section 3.21 of Bonett (2021, Volume 1)

Usage

```
ci.lc.median.bs(alpha, m, se, v)
```

Arguments

alpha	alpha level for 1-alpha confidence
m	vector of estimated group medians
se	vector of estimated group standard errors
v	vector of between-subjects contrast coefficients

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimated linear contrast of medians
- SE - standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG, Price RM (2002). "Statistical inference for a linear function of medians: Confidence intervals, hypothesis testing, and sample size requirements." *Psychological Methods*, **7**(3), 370–383. ISSN 1939-1463, doi:10.1037/1082989X.7.3.370.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
m <- c(46.13, 29.19, 30.32, 49.15)
se <- c(6.361, 5.892, 4.887, 6.103)
v <- c(1, -1, -1, 1)
ci.lc.median.bs(.05, m, se, v)

# Should return:
# Estimate      SE       LL       UL
#    35.77 11.67507 12.88727 58.65273
```

---

ci.lc.prop.bs	*Confidence interval for a linear contrast of proportions in a between-subjects design*

Description

Computes an adjusted Wald confidence interval for a linear contrast of population proportions in a between-subjects design.

For more details, see Section 2.8 of Bonett (2021, Volume 3)

Usage

```
ci.lc.prop.bs(alpha, f, n, v)
```

Arguments

alpha	alpha level for 1-alpha confidence
f	vector of frequency counts of participants who have the attribute
n	vector of sample sizes
v	vector of between-subjects contrast coefficients

Value

Returns a 1-row matrix. The columns are:

- Estimate - adjusted estimate of proportion linear contrast
- SE - adjusted standard error

- z - z test statistic

- p - two-sided p-value

- LL - lower limit of the adjusted Wald confidence interval

- UL - upper limit of the adjusted Wald confidence interval

References

Price RM, Bonett DG (2004). "An improved confidence interval for a linear function of binomial proportions." *Computational Statistics & Data Analysis*, **45**(3), 449–456. ISSN 01679473, doi:10.1016/S01679473(03)000070.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
f <- c(26, 24, 38)
n <- c(60, 60, 60)
v1 <- c(-.5, -.5, 1)
ci.lc.prop.bs(.05/2, f, n, v1)

# Should return:
# Estimate        SE      z       p        LL        UL
# 0.2119565 0.07602892 2.7878 0.00531 0.0415451 0.3823679

v2 <- c(1, -1, 0)
ci.lc.prop.bs(.05/2, f, n, v2)

# Should return:
#  Estimate         SE       z       p         LL        UL
# 0.03225806 0.08857951 0.36417 0.71573 -0.1662843 0.2308004
```

---

ci.lc.prop.scheffe	*Scheffe confidence interval for a linear contrast of proportions in a between-subjects design*

Description

Computes an adjusted Wald confidence interval for a linear contrast of population proportions in a between-subjects design using a Scheffe critical value. A Scheffe p-value is computed for the test statistic. This function is useful in exploratory studies where the linear contrast of proportions was not planned but was suggested by the pattern of sample proportions. Use the ci.lc.prop.bs function with a Bonferroni adjusted alpha value to compute simultaneous confidence intervals for two or more planned linear contrasts of proportions.

For more details, see Section 2.9 of Bonett (2021, Volume 3)

Usage

```
ci.lc.prop.scheffe(alpha, f, n, v)
```

Arguments

alpha	alpha level for 1-alpha confidence
f	vector of frequency counts of participants who have the attribute
n	vector of sample sizes
v	vector of between-subjects contrast coefficients

Value

Returns a 1-row matrix. The columns are:

- Estimate - adjusted estimate of proportion linear contrast
- SE - adjusted standard error
- z - z test statistic
- p - two-sided Scheffe p-value
- LL - lower limit of the Scheffe confidence interval
- UL - upper limit of the Scheffe confidence interval

References

Price RM, Bonett DG (2004). "An improved confidence interval for a linear function of binomial proportions." *Computational Statistics & Data Analysis*, **45**(3), 449–456. ISSN 01679473, doi:10.1016/S01679473(03)000070.

Marascuilo LA, McSweeney M (1977). *Nonparametric and Distribution-Free Methods for the Social Sciences*. Brooks/Cole.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
f <- c(26, 24, 38)
n <- c(60, 60, 60)
v <- c(-.5, -.5, 1)
ci.lc.prop.scheffe(.05, f, n, v)

# Should return:
#  Estimate          SE       z       p         LL          UL
# 0.2119565 0.07602892  2.7878 0.02053 0.02585698 0.3980561
```

ci.lc.reg	*Confidence interval for a linear contrast of regression coefficients in multiple group regression model*

Description

Computes a confidence interval and test statistic for a linear contrast of population regression coefficients (e.g., a y-intercept or a slope coefficient) across groups in a multiple group regression model. Equality of error variances across groups is not assumed. A Satterthwaite adjustment to the degrees of freedom is used to improve the accuracy of the confidence interval.

For more details, see Section 2.20 of Bonett (2021, Volume 2)

Usage

```
ci.lc.reg(alpha, est, se, n, s, v)
```

Arguments

alpha	alpha level for 1-alpha confidence
est	vector of parameter estimates
se	vector of standard errors
n	vector of group sample sizes
s	number of predictor variables for each within-group model
v	vector of contrast coefficients

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimated linear contrast
- SE - standard error
- t - t test statistic
- df - degrees of freedom
- p - two-sided p-value
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/.*

Examples

```
est <- c(1.74, 1.83, 0.482)
se <- c(.483, .421, .395)
n <- c(40, 40, 40)
v <- c(.5, .5, -1)
ci.lc.reg(.05, est, se, n, 4, v)

# Should return:
# Estimate        SE      t      df       p        LL        UL
#    1.303 0.5085838 2.5620 78.8197 0.01231 0.2906532 2.315347
```

---

ci.lc.stdmean.bs	*Confidence interval for a standardized linear contrast of means in a between-subjects design*

Description

Computes confidence intervals for a population standardized linear contrast of means in a between-subjects design. The unweighted standardizer is recommended in experimental designs. The weighted standardizer is recommended in nonexperimental designs with simple random sampling. The group 1 standardizer is useful in both experimental and nonexperimental designs. Equality of variances is not assumed.

For more details, see Section 3.4 of Bonett (2021, Volume 1)

Usage

```
ci.lc.stdmean.bs(alpha, m, sd, n, v)
```

Arguments

alpha	alpha level for 1-alpha confidence
m	vector of estimated group means
sd	vector of estimated group standard deviation
n	vector of sample sizes
v	vector of between-subjects contrast coefficients

Value

Returns a 3-row matrix. The columns are:

- Estimate - estimated standardized linear contrast
- adj Estimate - bias adjusted standardized linear contrast estimate
- SE - standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG (2008). "Confidence intervals for standardized linear contrasts of means." *Psychological Methods*, **13**(2), 99–109. ISSN 1939-1463, doi:10.1037/1082989X.13.2.99.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
m <- c(6.94, 7.15, 4.60, 3.68)
sd <- c(2.21, 2.83, 2.29, 1.90)
n <- c(40, 40, 40, 40)
v <- c(.5, .5, -.5, -.5)
ci.lc.stdmean.bs(.05, m, sd, n, v)

# Should return:
#                       Estimate adj Estimate      SE     LL     UL
# Unweighted standardizer:   1.2459      1.2399 0.17621 0.9005 1.5912
# Weighted standardizer:     1.2459      1.2399 0.17313 0.9065 1.5852
# Group 1 standardizer:      1.3145      1.2890 0.22515 0.8732 1.7558
```

---

ci.lc.stdmean.ws	*Confidence interval for a standardized linear contrast of means in a within-subjects design*

Description

Computes confidence intervals for two types of population standardized linear contrast of means (unweighted standardizer and level 1 standardizer) in a within-subjects design. Equality of variances is not assumed, but the correlations among the repeated measures are assumed to be approximately equal.

For more details, see Section 4.7 of Bonett (2021, Volume 1)

Usage

```
ci.lc.stdmean.ws(alpha, m, sd, cor, n, q)
```

Arguments

alpha	alpha level for 1-alpha confidence
m	vector of estimated means for levels of within-subjects factor
sd	vector of estimated standard deviations for levels of within-subjects factor
cor	average estimated correlation of all measurement pairs
n	sample size
q	vector of within-subjects contrast coefficients

Value

Returns a 2-row matrix. The columns are:

- Estimate - estimated standardized linear contrast
- adj Estimate - bias adjusted standardized linear contrast estimate
- SE - standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG (2008). "Confidence intervals for standardized linear contrasts of means." *Psychological Methods*, **13**(2), 99–109. ISSN 1939-1463, doi:10.1037/1082989X.13.2.99.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
m <- c(33.5, 37.9, 38.0, 44.1)
sd <- c(3.84, 3.84, 3.65, 4.98)
q <- c(.5, .5, -.5, -.5)
ci.lc.stdmean.ws(.05, m, sd, .672, 20, q)

# Should return:
#                         Estimate adj Estimate      SE      LL      UL
# Unweighted standardizer:  -1.3013      -1.2666 0.31479 -1.9182 -0.6843
# Level 1 standardizer:     -1.3932      -1.3375 0.36618 -2.1109 -0.6755
```

---

ci.mad   *Confidence interval for a mean absolute deviation*

Description

Computes a confidence interval for a population mean absolute deviation from the median (MAD). The MAD is a robust alternative to the standard deviation.

For more details, see Section 1.26 of Bonett (2021, Volume 1)

Usage

```
ci.mad(alpha, y)
```

Arguments

alpha	alpha level for 1-alpha confidence
y	vector of scores

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimated mean absolute deviation
- SE - standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG, Seier E (2003). "Confidence intervals for mean absolute deviations." *The American Statistician*, **57**(4), 233–236. ISSN 0003-1305, doi:10.1198/0003130032323.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
y <- c(30, 20, 15, 10, 10, 60, 20, 25, 20, 30, 10, 5, 50, 40,
       20, 10, 0, 20, 50)
ci.mad(.05, y)

# Should return:
# Estimate        SE       LL       UL
#     12.5 2.876103 7.962667 19.62282
```

---

ci.mann   *Confidence interval for a Mann-Whitney parameter*

Description

Computes a distribution-free confidence interval for the Mann-Whitney parameter (a "common language effect size"). In a 2-group experiment, this parameter is the proportion of members in the population with scores that would be higher under treatment 1 than treatment 2. In a 2-group nonexperiment where participants are sampled from two subpopulations of sizes N1 and N2, the parameter is the proportion of all N1 x N2 pairs in which a member from subpopulation 1 has a larger score than a member from subpopulation 2.

For more details, see Section 2.12 of Bonett (2021, Volume 1)

Usage

```
ci.mann(alpha, y1, y2)
```

Arguments

alpha	alpha level for 1-alpha confidence
y1	vector of scores for group 1
y2	vector of scores for group 2

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimated proportion
- SE - standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Sen PK (1967). "A note on asymptotically distribution-free confidence bounds for P(X < Y), based on two independent samples." *The Indian Journal of Statistics, Series A*, **29**(1), 95–102.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
y1 <- c(9.4, 10.3, 58.3, 106.0, 31.0, 46.2, 12.0, 19.0, 135.0, 159.0)
y2 <- c(14.6, 5.1, 8.1, 22.7, 6.4, 4.4, 19.0, 3.2)
ci.mann(.05, y1, y2)

# Should return:
# Estimate        SE        LL UL
#  0.86875 0.1222202 0.6292028  1
```

---

ci.mape   *Confidence interval for a mean absolute prediction error*

Description

Computes a confidence interval for a population mean absolute prediction error (MAPE) in a general linear model. The MAPE is a more robust alternative to the residual standard deviation. This function requires a vector of estimated residuals from a general linear model. This confidence interval does not assume zero excess kurtosis but does assume symmetry of the population prediction errors.

For more details, see Section 1.16 of Bonett (2021, Volume 2)

Usage

```
ci.mape(alpha, res, s)
```

Arguments

alpha	alpha level for 1-alpha confidence
res	vector of residuals
s	number of predictor variables in model

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimated mean absolute prediction error
- SE - standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/.*

Examples

```
res <- c(-2.70, -2.69, -1.32, 1.02, 1.23, -1.46, 2.21, -2.10, 2.56,
      -3.02, -1.55, 1.46, 4.02, 2.34)
ci.mape(.05, res, 1)

# Should return:
# Estimate        SE       LL       UL
#   2.3744 0.3314752 1.751678 3.218499
```

---

ci.mean   *Confidence interval for a mean*

Description

Computes a confidence interval for a population mean using the estimated mean, estimated standard deviation, and sample size. Use the t.test function for raw data input.

For more details, see Section 1.7 of Bonett (2021, Volume 1)

Usage

```
ci.mean(alpha, m, sd, n)
```

Arguments

alpha	alpha level for 1-alpha confidence
m	estimated mean
sd	estimated standard deviation
n	sample size

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimated mean
- SE - standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Snedecor GW, Cochran WG (1989). *Statistical Methods*, 8th edition. ISU University Pres, Ames, Iowa.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
ci.mean(.05, 38.3, 8.14, 10)

# Should return:
# Estimate       SE       LL       UL
#     38.3  2.574094 32.47699 44.12301
```

---

ci.mean.fpc   *Confidence interval for a mean with a finite population correction*

Description

Computes a confidence interval for a population mean with a finite population correction (fpc) using the estimated mean, estimated standard deviation, sample size, and population size. This function is useful when the sample size is not a small fraction of the population size.

For more details, see Section 1.33 of Bonett (2021, Volume 1)

Usage

```
ci.mean.fpc(alpha, m, sd, n, N)
```

Arguments

alpha	alpha level for 1-alpha confidence
m	estimated mean
sd	estimated standard deviation
n	sample size
N	population size

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimated mean
- SE - standard error with fpc
- LL - lower limit of the confidence interval with fpc
- UL - upper limit of the confidence interval with fpc

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
ci.mean.fpc(.05, 24.5, 3.65, 40, 300)

# Should return:
# Estimate        SE        LL        UL
#     24.5 0.5381631 23.41146 25.58854
```

---

ci.mean.gen   *Confidence intervals for generalized means*

Description

Computes confidence intervals for three population generalized means (square-root, geometric, and harmonic) using a vector of response scores as input. The square-root mean requires non-negative scores. The geometric and harmonic means require positive scores. The standard errors are recovered from the confidence intervals.

Usage

```
ci.mean.gen(alpha, y)
```

Arguments

alpha   alpha level for 1-alpha confidence
y   vector of scores

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimated mean
- SE - recovered standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

Examples

```
y <- c(32, 47, 28, 15, 20, 41, 87)
ci.mean.gen(.05, y)

# Should return:
#             Estimate      SE      LL      UL
# Square-root 35.79395 8.141122 18.64498 58.48619
# Geometric   33.26410 7.633328 19.47124 56.82741
# Harmonic    29.07073 7.978149 19.35236 58.39602
```

---

ci.mean.ps   *Confidence interval for a paired-samples mean difference*

Description

Computes a confidence interval for a population paired-samples mean difference using the estimated means, estimated standard deviations, estimated correlation, and sample size. Also computes a paired-samples t-test. Use the t.test function for raw data input.

For more details, see Section 4.2 of Bonett (2021, Volume 1)

Usage

```
ci.mean.ps(alpha, m1, m2, sd1, sd2, cor, n)
```

Arguments

alpha	alpha level for 1-alpha confidence
m1	estimated mean for measurement 1
m2	estimated mean for measurement 2
sd1	estimated standard deviation for measurement 1
sd2	estimated standard deviation for measurement 2
cor	estimated correlation between measurements
n	sample size

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimated mean difference
- SE - standard error
- t - t test statistic
- df - degrees of freedom
- p - two-sided p-value
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Snedecor GW, Cochran WG (1989). *Statistical Methods*, 8th edition. ISU University Pres, Ames, Iowa.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
ci.mean.ps(.05, 58.2, 51.4, 7.43, 8.92, .537, 30)

# Should return:
# Estimate       SE     t df      p       LL       UL
#      6.8 1.455922 4.6706 29  6e-05 3.822304 9.777696
```

---

ci.mean2   *Confidence interval for a 2-group mean difference*

Description

Computes equal variance and unequal variance confidence intervals for a population 2-group mean difference using the estimated means, estimated standard deviations, and sample sizes. Also computes equal variance and unequal variance independent-samples t-tests. Use the t.test function for raw data input.

For more details, see Section 2.3 of Bonett (2021, Volume 1)

Usage

```
ci.mean2(alpha, m1, m2, sd1, sd2, n1, n2)
```

Arguments

alpha	alpha level for 1-alpha confidence
m1	estimated mean for group 1
m2	estimated mean for group 2
sd1	estimated standard deviation for group 1
sd2	estimated standard deviation for group 2
n1	sample size for group 1
n2	sample size for group 2

Value

Returns a 2-row matrix. The columns are:

- Estimate - estimated mean difference
- SE - standard error
- t - t test statistic
- df - degrees of freedom
- p - two-sided p-value
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Snedecor GW, Cochran WG (1989). *Statistical Methods*, 8th edition. ISU University Pres, Ames, Iowa.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
ci.mean2(.05, 19.4, 11.3, 2.70, 2.10, 40, 40)
# Should return:
#                          Estimate        SE       t    df p
# Equal Variances Assumed:      8.1 0.5408327 14.9769 78.00 0
# Equal Variances Not Assumed:  8.1 0.5408327 14.9769 73.54 0
#                                LL       UL
# Equal Variances Assumed:    7.023285 9.176715
# Equal Variances Not Assumed: 7.022256 9.177744
```

---

ci.median   *Confidence interval for a median*

Description

Computes a distribution-free confidence interval for a population median. Tied scores are assumed to be rare.

For more details, see Section 1.25 of Bonett (2021, Volume 1)

Usage

```
ci.median(alpha, y)
```

Arguments

alpha	alpha level for 1-alpha confidence
y	vector of scores

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimated median
- SE - standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Snedecor GW, Cochran WG (1989). *Statistical Methods*, 8th edition. ISU University Pres, Ames, Iowa.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
y <- c(25, 29, 35, 36, 36, 40, 41, 43, 44, 54)
ci.median(.05, y)

# Should return:
#  Estimate       SE  LL  UL
#        38 3.261774  29  44
```

---

ci.median.ps *Confidence interval for a paired-samples median difference*

Description

Computes a distribution-free confidence interval for a difference of population medians in a paired-samples design. This function also computes the standard error of each median and the covariance between the two estimated medians. Tied scores within each measurement are assumed to be rare.

For more details, see Section 4.23 of Bonett (2021, Volume 1)

Usage

```
ci.median.ps(alpha, y1, y2)
```

Arguments

alpha	alpha level for 1-alpha confidence
y1	vector of scores for measurement 1
y2	vector of scores for measurement 2 (paired with y1)

Value

Returns a 1-row matrix. The columns are:

- Median1 - estimated median for measurement 1
- Median2 - estimated median for measurement 2
- Median1-Median2 - estimated difference of medians
- SE1 - standard error of median 1
- SE2 - standard error of median 2
- COV - covariance of the two estimated medians
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG, Price RM (2020). "Interval estimation for linear functions of medians in within-subjects and mixed designs." *British Journal of Mathematical and Statistical Psychology*, **73**(2), 333–346. ISSN 0007-1102, doi:10.1111/bmsp.12171.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
y1 <- c(21.1, 4.9, 9.2, 12.4, 35.8, 18.1, 10.7, 22.9, 24.0, 1.2, 6.1, 8.3, 13.1, 16.2)
y2 <- c(67.0, 28.1, 30.9, 28.6, 52.0, 40.8, 25.8, 37.4, 44.9, 10.3, 14.9, 20.2, 28.8, 40.6)
ci.median.ps(.05, y1, y2)

# Should return:
#  Median1 Median2 Median1-Median2       SE        LL        UL
#    12.75   29.85           -17.1 3.704248 -24.36019 -9.839807
#       SE1      SE2     COV
#  3.379695 4.968956 11.1957
```

---

ci.median2   *Confidence interval for a 2-group median difference*

Description

Computes a distribution-free confidence interval for a difference of population medians in a 2-group design. Tied scores within each group are assumed to be rare.

For more details, see Section 2.12 of Bonett (2021, Volume 1)

Usage

```
ci.median2(alpha, y1, y2)
```

Arguments

`alpha`	alpha level for 1-alpha confidence
`y1`	vector of scores for group 1
`y2`	vector of scores for group 2

Value

Returns a 1-row matrix. The columns are:

- Median1 - estimated median for group 1
- Median2 - estimated median for group 2
- Median1-Median2 - estimated difference of medians
- SE - standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG, Price RM (2002). "Statistical inference for a linear function of medians: Confidence intervals, hypothesis testing, and sample size requirements." *Psychological Methods*, **7**(3), 370–383. ISSN 1939-1463, doi:10.1037/1082989X.7.3.370.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
y1 = c(70, 394, 43, 95, 62, 128, 2, 203, 81, 436, 85, 35,
       156, 1, 3, 27, 63, 181, 184, 18)
y2 = c(102, 120, 78, 78, 417, 124, 86, 171, 176, 129, 230,
       194, 100, 157, 306, 411, 164, 103, 193, 312)
ci.median2(.05, y1, y2)

# Should return:
#  Median1 Median2 Median1-Median2      SE        LL        UL
#     75.5   160.5             -85 37.11502 -157.7441 -12.25589
```

`ci.oddsratio`	*Confidence interval for an odds ratio*

Description

Computes a confidence interval for an odds ratio with .5 added to each cell frequency. This function requires the frequency counts from a 2 x 2 contingency table for two dichotomous variables.

For more details, see Section 3.4 of Bonett (2021, Volume 3)

Usage

```
ci.oddsratio(alpha, f00, f01, f10, f11)
```

Arguments

alpha	alpha level for 1-alpha confidence
f00	number of participants with y = 0 and x = 0
f01	number of participants with y = 0 and x = 1
f10	number of participants with y = 1 and x = 0
f11	number of participants with y = 1 and x = 1

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimate of odds ratio
- SE - standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Fleiss JL, Paik MC (2003). *Statistical Methods for Rates and Proportions*, 3rd edition. Wiley.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
ci.oddsratio(.05, 229, 28, 96, 24)

# Should return:
#  Estimate         SE        LL         UL
#  2.044451 0.6154578 1.133267 3.688254
```

---

ci.pairs.mult	*Confidence intervals for pairwise proportion differences of a multinomial variable*

Description

Computes adjusted Wald confidence intervals for pairwise proportion differences of a multinomial variable in a single sample. These adjusted Wald confidence intervals use the same method that is used to compare the two proportions in a paired-samples design.

For more details, see Section 1.12 of Bonett (2021, Volume 3)

Usage

```
ci.pairs.mult(alpha, f)
```

Arguments

alpha	alpha level for 1-alpha confidence
f	vector of multinomial frequency counts

Value

Returns a matrix with the number of rows equal to the number of pairwise comparisons. The columns are:

- Estimate - adjusted estimate of proportion difference

- SE - adjusted standard error

- LL - lower limit of the adjusted Wald confidence interval

- UL - upper limit of the adjusted Wald confidence interval

References

Bonett DG, Price RM (2012). "Adjusted wald confidence interval for a difference of binomial proportions based on paired data." *Journal of Educational and Behavioral Statistics*, **37**(4), 479–488. ISSN 1076-9986, doi:10.3102/1076998611411915.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
f <- c(87, 49, 31, 133)
ci.pairs.mult(.05, f)

# Should return:
#         Estimate         SE          LL          UL
# 1 2  0.12582781 0.03821865  0.050920628  0.20073500
# 1 3  0.18543046 0.03466808  0.117482270  0.25337866
# 1 4 -0.15231788 0.04855183 -0.247477718 -0.05715804
# 2 3  0.05960265 0.02978792  0.001219398  0.11798590
# 2 4 -0.27814570 0.04196760 -0.360400688 -0.19589070
# 3 4 -0.33774834 0.03797851 -0.412184859 -0.26331183
```

---

ci.pairs.prop.bs | *Bonferroni confidence intervals for all pairwise proportion differences in a between-subjects design*

Description

Computes adjusted Wald confidence intervals for all pairwise differences of population proportions in a between-subjects design using a Bonferroni adjusted alpha level.

For more details, see Section 2.7 of Bonett (2021, Volume 3)

Usage

```
ci.pairs.prop.bs(alpha, f, n)
```

Arguments

alpha	alpha level for simultaneous 1-alpha confidence
f	vector of frequency counts of participants who have the attribute
n	vector of sample sizes

Value

Returns a matrix with the number of rows equal to the number of pairwise comparisons. The columns are:

- Estimate - adjusted estimate of proportion difference
- SE - adjusted standard error
- z - z test statistic
- p - two-sided p-value
- LL - lower limit of the adjusted Wald confidence interval
- UL - upper limit of the adjusted Wald confidence interval

References

Agresti A, 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. ISSN 00031305, doi:10.2307/2685779.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
f <- c(111, 161, 132)
n <- c(200, 200, 200)
ci.pairs.prop.bs(.05, f, n)

# Should return:
#       Estimate         SE       z       p          LL          UL
# 1 2  -0.2475248  0.04482323  -5.5222  0.00000  -0.35483065  -0.14021885
# 1 3  -0.1039604  0.04833562  -2.1508  0.03149  -0.21967489   0.01175409
# 2 3   0.1435644  0.04358401   3.2940  0.00099   0.03922511   0.24790360
```

---

ci.pbcor	*Confidence intervals for point-biserial correlations*

Description

Computes confidence intervals for two types of population point-biserial correlations. One type uses a weighted average of the group variances and is appropriate for nonexperimental designs with simple random sampling (but not stratified random sampling). The other type uses an unweighted average of the group variances and is appropriate for experimental designs. Equality of variances is not assumed for either type.

For more details, see Section 1.18 of Bonett (2021, Volume 2)

Usage

```
ci.pbcor(alpha, m1, m2, sd1, sd2, n1, n2)
```

Arguments

alpha	alpha level for 1-alpha confidence
m1	estimated mean for group 1
m2	estimated mean for group 2
sd1	estimated standard deviation for group 1
sd2	estimated standard deviation for group 2
n1	sample size for group 1
n2	sample size for group 2

Value

Returns a 2-row matrix. The columns are:

- Estimate - estimated point-biserial correlation
- SE - standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG (2020). "Point-biserial correlation: Interval estimation, hypothesis testing, meta-analysis, and sample size determination." *British Journal of Mathematical and Statistical Psychology*, **73**(S1), 113–144. ISSN 0007-1102, doi:10.1111/bmsp.12189.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
ci.pbcor(.05, 28.32, 21.48, 3.81, 3.09, 40, 40)

# Should return:
#             Estimate      SE      LL      UL
# Weighted:     0.7066 0.04891 0.5885 0.7854
# Unweighted:   0.7021 0.05019 0.5808 0.7829
```

---

ci.phi	*Confidence interval for a phi correlation*

Description

Computes a Fisher confidence interval for a population phi correlation. This function requires the frequency counts from a 2 x 2 contingency table for two dichotomous variables. This measure of association is usually most appropriate when both dichotomous variables are naturally dichotomous.

For more details, see Section 3.4 of Bonett (2021, Volume 3)

Usage

```
ci.phi(alpha, f00, f01, f10, f11)
```

Arguments

alpha	alpha level for 1-alpha confidence
f00	number of participants with y = 0 and x = 0
f01	number of participants with y = 0 and x = 1
f10	number of participants with y = 1 and x = 0
f11	number of participants with y = 1 and x = 1

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimate of phi correlation
- SE - standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bishop YMM, Fienberg SE, Holland PW (1975). *Discrete Multivariate Analysis*. MIT Press.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
ci.phi(.05, 229, 28, 96, 24)

# Should return:
# Estimate     SE    LL    UL
#    0.123 0.0548 0.015 0.229
```

---

ci.poisson   *Confidence interval for a Poisson rate*

Description

Computes a confidence interval for a population Poisson rate. This function requires the number of occurrences (f) of a specific event that were observed over a specific period of time (t).

Usage

```
ci.poisson(alpha, f, t)
```

Arguments

alpha	alpha value for 1-alpha confidence
f	number of event occurrences
t	time period

Details

The time period (t) does not need to be an integer and can be expressed in any unit of time such as seconds, hours, or months. The occurances are assumed to be independent of one another and the unknown occurance rate is assumed to be constant over time.

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimated Poisson rate
- SE - recovered standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Hahn GJ, Meeker WQ (1991). *Statistical Intervals: A Guide for Practitioners.* Wiley. ISBN 9780470316771, doi:10.1002/9780470316771.

Examples

```
ci.poisson(.05, 23, 5.25)

# Should return:
# Estimate        SE        LL       UL
# 4.380952 0.9684952 2.777148 6.57358
```

---

ci.popsize   *Confidence interval for an unknown population size*

Description

Computes a Wald confidence interval for an unknown population size using mark-recapture sampling. This method assumes independence of the two samples. This function requires the frequency counts from an incomplete 2 x 2 contingency table for the two samples (f11 is the unknown number of people who were not observed in either sample). This method sets the estimated odds ratio (with .5 added to each cell) to 1 and solves for unobserved cell frequency. An approximate standard error is recovered from the confidence interval.

For more details, see Section 3.7 of Bonett (2021, Volume 3)

Usage

```
ci.popsize(alpha, f00, f01, f10)
```

Arguments

alpha	alpha level for 1-alpha confidence
f00	number of people observed in both samples
f01	number of people observed in first sample but not second sample
f10	number of people observed in second sample but not first sample

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimate of the unknown population size
- SE - recovered standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
ci.popsize(.05, 85, 196, 184)

# Should return:
# Estimate    SE  LL    UL
#      889 67.35 777 1041
```

---

ci.prop	*Confidence intervals for a proportion*

Description

Computes adjusted Wald (Agresi-Coull), Wilson, and exact confidence intervals for a population proportion. The Wilson confidence interval uses a continuity correction.

For more details, see Section 1.5 of Bonett (2021, Volume 3)

Usage

```
ci.prop(alpha, f, n)
```

Arguments

alpha	alpha level for 1-alpha confidence
f	number of participants who have the attribute
n	sample size

Value

Returns a 2-row matrix. The columns of row 1 are:

- Estimate - adjusted estimate of proportion
- SE - standard error of adjusted estimate
- LL - lower limit of the adjusted Wald confidence interval
- UL - upper limit of the adjusted Wald confidence interval

The columns of row 2 are:

- Estimate - ML estimate of proportion
- SE - standard error of ML estimate
- LL - lower limit of the Wilson confidence interval

- UL - upper limit of the Wilson confidence interval

The columns of row 3 are:

- Estimate - ML estimate of proportion
- SE - standard error of ML estimate
- LL - lower limit of the exact confidence interval
- UL - upper limit of the exact confidence interval

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Agresti A, Coull BA (1998). "Approximate is better than 'exact' for interval estimation of binomial proportions." *The American Statistician*, **52**(2), 119–126. ISSN 0003-1305, doi:10.1080/00031305.1998.10480550.

Examples

```
ci.prop(.05, 120, 300)

# Should return:
#                 Estimate         SE        LL         UL
# Adjusted Wald  0.4013158 0.02811287 0.3462156 0.4564160
# Wilson with cc 0.4000000 0.02828427 0.3445577 0.4580464
# Exact          0.4000000 0.02828427 0.3441290 0.4578664
```

---

ci.prop.fpc	*Confidence interval for a proportion with a finite population correction*

Description

Computes an adjusted Wald interval for a population proportion with a finite population correction (fpc). This confidence interval is useful when the sample size is not a small fraction of the population size.

For more details, see Section 1.20 of Bonett (2021, Volume 3)

Usage

```
ci.prop.fpc(alpha, f, n, N)
```

Arguments

alpha	alpha level for 1-alpha confidence
f	number of participants who have the attribute
n	sample size
N	population size

Value

Returns a 1-row matrix. The columns are:

- Estimate - adjusted estimate of proportion
- SE - adjusted standard error with fpc
- LL - lower limit of the confidence interval with fpc
- UL - upper limit of the confidence interval with fpc

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/.*

Examples

```
ci.prop.fpc(.05, 61, 75, 415)

# Should return:
#   Estimate        SE        LL        UL
#  0.7974684 0.04097594 0.717157 0.8777797
```

---

ci.prop.inv   *Confidence interval for a proportion using inverse sampling*

Description

Computes an exact confidence interval for a population proportion when inverse sampling has been used. An approximate standard error is recovered from the confidence interval. With inverse sampling, the number of participants who have the attribute (f) is predetermined and sampling continues until f attains its prespecified value. With inverse sampling, the sample size (n) will not be known in advance.

For more details, see Section 1.19 of Bonett (2021, Volume 3)

Usage

```
ci.prop.inv(alpha, f, n)
```

Arguments

alpha	alpha level for 1-alpha confidence
f	number of participants who have the attribute (fixed)
n	sample size (random)

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimate of proportion
- SE - recovered standard error
- LL - lower limit of confidence interval
- UL - upper limit of confidence interval

References

Zou GY (2010). "Confidence interval estimation under inverse sampling." *Computational Statistics & Data Analysis*, **54**(1), 55–64. ISSN 0167-9473, doi:10.1016/j.csda.2005.05.007.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
ci.prop.inv(.05, 10, 87)

# Should return:
# Estimate          SE          LL          UL
# 0.1149425 0.03389574 0.05651668 0.1893855
```

---

ci.prop.ps	*Confidence interval for a paired-samples proportion difference*

Description

Computes an adjusted Wald confidence interval for a difference of population proportions in a paired-samples design. This function requires the frequency counts from a 2 x 2 contingency table for two repeated dichotomous measurements.

For more details, see Section 3.2 of Bonett (2021, Volume 3)

Usage

```
ci.prop.ps(alpha, f00, f01, f10, f11)
```

Arguments

alpha	alpha level for 1-alpha confidence
f00	number of participants with y = 0 and x = 0
f01	number of participants with y = 0 and x = 1
f10	number of participants with y = 1 and x = 0
f11	number of participants with y = 1 and x = 1

Value

Returns a 1-row matrix. The columns are:

- Estimate - adjusted estimate of proportion difference
- SE - adjusted standard error
- LL - lower limit of the adjusted Wald confidence interval
- UL - upper limit of the adjusted Wald confidence interval

References

Bonett DG, Price RM (2012). "Adjusted wald confidence interval for a difference of binomial proportions based on paired data." *Journal of Educational and Behavioral Statistics*, **37**(4), 479–488. ISSN 1076-9986, doi:10.3102/1076998611411915.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
ci.prop.ps(.05, 12, 4, 26, 6)

# Should return:
# Estimate          SE          LL          UL
#     0.44 0.09448809 0.2548067 0.6251933
```

---

ci.prop2   *Confidence interval for a 2-group proportion difference*

Description

Computes an adjusted Wald confidence interval for a population proportion difference in a 2-group design.

For more details, see Section 2.2 of Bonett (2021, Volume 3)

Usage

```
ci.prop2(alpha, f1, f2, n1, n2)
```

Arguments

alpha	alpha level for 1-alpha confidence
f1	number of participants in group 1 who have the attribute
f2	number of participants in group 2 who have the attribute
n1	sample size for group 1
n2	sample size for group 2

Value

Returns a 1-row matrix. The columns are:

- Estimate - adjusted estimate of proportion difference

- SE - adjusted standard error

- LL - lower limit of the adjusted Wald confidence interval

- UL - upper limit of the adjusted Wald confidence interval

References

Agresti A, 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. ISSN 00031305, doi:10.2307/2685779.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
ci.prop2(.05, 57, 15, 100, 100)

# Should return:
#   Estimate         SE        LL        UL
#  0.4117647 0.06083948 0.2925215 0.5310079
```

---

ci.prop2.inv   *Confidence interval for a 2-group proportion difference using inverse sampling*

Description

Computes an approximate confidence interval for a population proportion difference when inverse sampling has been used. An approximate standard error is recovered from the confidence interval. With inverse sampling, the number of participants who have the attribute within group 1 (f1) and group 2 (f2) are predetermined, and sampling continues within each group until f1 and f2 attain their prespecified values. With inverse sampling, the sample sizes (n1 and n2) will not be known in advance.

Usage

```
ci.prop2.inv(alpha, f1, f2, n1, n2)
```

Arguments

`alpha`	alpha level for 1-alpha confidence
`f1`	number of participants in group 1 who have the attribute (fixed)
`f2`	number of participants in group 2 who have the attribute (fixed)
`n1`	sample size for group 1 (random)
`n2`	sample size for group 2 (random)

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimate of proportion difference
- SE - recovered standard error
- LL - lower limit of confidence interval
- UL - upper limit of confidence interval

References

Zou GY (2010). "Confidence interval estimation under inverse sampling." *Computational Statistics & Data Analysis*, **54**(1), 55–64. ISSN 0167-9473, doi:10.1016/j.csda.2005.05.007.

Examples

```
ci.prop2.inv(.05, 10, 10, 48, 213)

# Should return:
# Estimate         SE          LL          UL
#  0.161385 0.05997618 0.05288277 0.2879851
```

---

ci.pv	*Confidence intervals for positive and negative predictive values with retrospective sampling*

Description

Computes adjusted Wald confidence intervals for positive and negative predictive values (PPV and NPV) of a diagnostic test with retrospective sampling where the population prevalence rate is assumed to be known. With retrospective sampling, one random sample is obtained from a subpopulation that is known to have a "positive" outcome, a second random sample is obtained from a subpopulation that is known to have a "negative" outcome, and then the diagnostic test (scored "pass" or "fail") is given in each sample. PPV and NPV can be expressed as a function of proportion ratios and the known population prevalence rate (the population proportion who would "pass"). The confidence intervals for PPV and NPV are based on the Price-Bonett adjusted Wald confidence interval for a proportion ratio.

For more details, see Section 3.6 of Bonett (2021, Volume 3)

Usage

```
ci.pv(alpha, f1, f2, n1, n2, prev)
```

Arguments

alpha	alpha level for 1-alpha confidence
f1	number of participants with a positive outcome who pass the test
f2	number of participants with a negative outcome who fail the test
n1	sample size for the positive outcome group
n2	sample size for the negative outcome group
prev	known population proportion with a positive outcome

Value

Returns a 2-row matrix. The columns are:

- Estimate - adjusted estimate of the predictive value

- LL - lower limit of the adjusted Wald confidence interval

- UL - upper limit of the adjusted Wald confidence interval

References

Price RM, Bonett DG (2008). "Confidence intervals for a ratio of two independent binomial proportions." *Statistics in Medicine*, **27**(26), 5497–5508. ISSN 02776715, doi:10.1002/sim.3376.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
ci.pv(.05, 89, 5, 100, 100, .16)

# Should return:
#        Estimate        LL        UL
# PPV:  0.7640449 0.5838940 0.8819671
# NPV:  0.9779978 0.9623406 0.9872318
```

| ci.random.anova | *Confidence intervals for parameters of one-way random effects ANOVA* |

Description

Computes estimates and confidence intervals for four parameters of the one-way random effects ANOVA: 1) the superpopulation grand mean, 2) the square-root within-group variance component, 3) the square-root between-group variance component, and 4) the omega-squared coefficient. This function assumes equal sample sizes.

For more details, see Section 3.18 of Bonett (2021, Volume 1)

Usage

```
ci.random.anova(alpha, m, sd, n)
```

Arguments

alpha	1 - alpha confidence
m	vector of estimated group means
sd	vector of estimated group standard deviations
n	common sample size in each group

Value

Returns a 4-row matrix. The rows are:

- Grand mean - the mean of the superpopulation of means
- Within SD - the square-root within-group variance component
- Between SD - the square-root between-group variance component
- Omega-squared - the omega-squared coefficient

The columns are:

- Estimate - estimate of parameter
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/.*

Examples

```
m <- c(56.1, 51.2, 60.3, 68.2, 48.9, 70.5)
sd <- c(9.45, 8.79, 9.71, 8.90, 8.31, 9.75)
ci.random.anova(.05, m, sd, 20)

# Should return:
#                 Estimate         LL        UL
# Grand mean      59.200000 49.9363896 68.4636104
# Within SD:       9.166782  8.0509046 10.4373219
# Between SD:      8.585948  8.3239359  8.8562078
# Omega-squared:   0.467317  0.2284142  0.8480383
```

---

ci.ratio.cod2   *Confidence interval for a ratio of dispersion coefficients in a 2-group design*

Description

Computes a confidence interval for a ratio of population dispersion coefficients (mean absolute deviation from median divided by median) in a 2-group design. Ratio-scale scores are assumed.

Usage

```
ci.ratio.cod2(alpha, y1, y2)
```

Arguments

alpha   alpha level for 1-alpha confidence

y1   vector of scores in group 1

y2   vector of scores in group 2

Value

Returns a 1-row matrix. The columns are:

- COD1 - estimated coefficient of dispersion in group 1
- COD2 - estimated coefficient of dispersion in group 2
- COD1/COD2 - estimated ratio of dispersion coefficients
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

Examples

```
y1 <- c(32, 39, 26, 35, 43, 27, 40, 37, 34, 29)
y2 <- c(36, 44, 47, 42, 49, 39, 46, 31, 33, 48)
ci.ratio.cod2(.05, y1, y2)

# Should return:
#      COD1      COD2 COD1/COD2       LL       UL
# 0.1333333 0.1232558  1.081761 0.494964 2.282254
```

---

ci.ratio.cv2   *Confidence interval for a ratio of coefficients of variation in a 2-group design*

Description

Computes a confidence interval for a ratio of population coefficients of variation (CV) in a 2-group design. This confidence interval uses the confidence interval for each CV and then uses the MOVER-DL method (see Newcombe, page 138) to obtain a confidence interval for CV1/CV2. The CV assumes ratio-scale scores.

Usage

```
ci.ratio.cv2(alpha, m1, m2, sd1, sd2, n1, n2)
```

Arguments

alpha	alpha level for 1-alpha confidence
m1	estimated mean for group 1
m2	estimated mean for group 2
sd1	estimated standard deviation for group 1
sd2	estimated standard deviation for group 2
n1	sample size for group 1
n2	sample size for group 2

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimated ratio of coefficients of variation
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Newcombe RG (2013). *Confidence Interval for Proportions and Related Measures of Effect Size*. CRC Press.

Examples

```
ci.ratio.cv2(.05, 34.5, 26.1, 4.15, 2.26, 50, 50)

# Should return:
# Estimate        LL        UL
# 1.389188 1.041478 1.854101
```

---

ci.ratio.mad.ps   *Confidence interval for a paired-samples MAD ratio*

Description

Computes a confidence interval for a ratio of population MADs (mean absolute deviation from median) in a paired-samples design.

For more details, see Section 4.24 of Bonett (2021, Volume 1)

Usage

```
ci.ratio.mad.ps(alpha, y1, y2)
```

Arguments

alpha	alpha level for 1-alpha confidence
y1	vector of measurement 1 scores
y2	vector of measurement 2 scores (paired with y1)

Value

Returns a 1-row matrix. The columns are:

- MAD1 - estimated MAD for measurement 1
- MAD2 - estimated MAD for measurement 2
- MAD1/MAD2 - estimate of MAD ratio
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG, Seier E (2003). "Statistical inference for a ratio of dispersions using paired samples." *Journal of Educational and Behavioral Statistics*, **28**(1), 21–30. ISSN 1076-9986, doi:10.3102/10769986028001021.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
y2 <- c(21, 4, 9, 12, 35, 18, 10, 22, 24, 1, 6, 8, 13, 16, 19)
y1 <- c(67, 28, 30, 28, 52, 40, 25, 37, 44, 10, 14, 20, 28, 40, 51)
ci.ratio.mad.ps(.05, y1, y2)

# Should return:
#     MAD1  MAD2  MAD1/MAD2       LL       UL
# 12.71429   7.5   1.695238 1.109176 2.590961
```

---

ci.ratio.mad2 *Confidence interval for a 2-group ratio of mean absolute deviations*

Description

Computes a confidence interval for a ratio of population MADs (mean absolute deviation from median) in a 2-group design.

For more details, see Section 2.10 of Bonett (2021, Volume 1)

Usage

```
ci.ratio.mad2(alpha, y1, y2)
```

Arguments

alpha	alpha level for 1-alpha confidence
y1	vector of scores for group 1
y2	vector of scores for group 2

Value

Returns a 1-row matrix. The columns are:

- MAD1 - estimated MAD for group 1
- MAD2 - estimated MAD for group 2
- MAD1/MAD2 - estimate of MAD ratio
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG, Seier E (2003). "Confidence intervals for mean absolute deviations." *The American Statistician*, **57**(4), 233–236. ISSN 0003-1305, doi:10.1198/0003130032323.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
y1 <- c(32, 39, 26, 35, 43, 27, 40, 37, 34, 29)
y2 <- c(36, 44, 47, 42, 49, 39, 46, 31, 33, 48)
ci.ratio.mad2(.05, y1, y2)

# Should return:
#     MAD1    MAD2  MAD1/MAD2        LL        UL
# 5.111111 5.888889  0.8679245 0.4520879 1.666253
```

---

ci.ratio.mape2   *Confidence interval for a ratio of mean absolute prediction errors in a 2-group design*

Description

Computes a confidence interval for a ratio of population mean absolute prediction errors from a general linear model in two independent groups. The number of predictor variables can differ across groups and the two models can be non-nested. This function requires a vector of estimated residuals from each group. This function does not assume zero excess kurtosis but does assume symmetry in the population prediction errors for the two models.

Usage

```
ci.ratio.mape2(alpha, res1, res2, s1, s2)
```

Arguments

alpha	alpha level for 1-alpha confidence
res1	vector of residuals from group 1
res2	vector of residuals from group 2
s1	number of predictor variables used in group 1
s2	number of predictor variables used in group 2

Value

Returns a 1-row matrix. The columns are:

- MAPE1 - bias adjusted mean absolute prediction error for group 1

- MAPE2 - bias adjusted mean absolute prediction error for group 2

- MAPE1/MAPE2 - ratio of bias adjusted mean absolute prediction errors

- LL - lower limit of the confidence interval

- UL - upper limit of the confidence interval

Examples

```
res1 <- c(-2.70, -2.69, -1.32, 1.02, 1.23, -1.46, 2.21, -2.10, 2.56, -3.02
        -1.55, 1.46, 4.02, 2.34)
res2 <- c(-0.71, -0.89, 0.72, -0.35, 0.33 -0.92, 2.37, 0.51, 0.68, -0.85,
        -0.15, 0.77, -1.52, 0.89, -0.29, -0.23, -0.94, 0.93, -0.31 -0.04)
ci.ratio.mape2(.05, res1, res2, 1, 1)

# Should return:
#   MAPE1      MAPE2 MAPE1/MAPE2      LL        UL
# 2.58087 0.8327273   3.099298 1.917003 5.010761
```

---

ci.ratio.mean.ps   *Confidence interval for a paired-samples mean ratio*

Description

Compute a confidence interval for a ratio of population means of ratio-scale measurements in a paired-samples design. Equality of variances is not assumed.

For more details, see Section 4.4 of Bonett (2021, Volume 1)

Usage

```
ci.ratio.mean.ps(alpha, y1, y2)
```

Arguments

alpha   alpha level for 1-alpha confidence

y1   vector of measurement 1 scores

y2   vector of measurement 2 scores (paired with y1)

Value

Returns a 1-row matrix. The columns are:

- Mean1 - estimated mean for measurement 1
- Mean2 - estimated mean for measurement 2
- Mean1/Mean2 - estimate of mean ratio
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG, Price RM (2020). "Confidence intervals for ratios of means and medians." *Journal of Educational and Behavioral Statistics*, **45**(6), 750–770. doi:10.3102/1076998620934125.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
y1 = c(76.41, 66.91, 81.06, 74.78, 83.76, 89.31, 78.78, 87.06, 82.61, 76.74, 88.33, 86.18)
y2 = c(59.85, 60.64, 84.86, 68.16, 71.53, 86.18, 67.30, 65.46, 83.50, 66.76, 88.37, 65.02)
ci.ratio.mean.ps(.05, y1, y2)

# Should return:
#    Mean1    Mean2 Mean1/Mean2        LL        UL
# 80.99417 72.3025    1.120213 1.040747 1.205745
```

---

ci.ratio.mean2   *Confidence interval for a 2-group mean ratio*

Description

Computes a confidence interval for a ratio of population means of ratio-scale measurements in a 2-group design. Equality of variances is not assumed.

Usage

```
ci.ratio.mean2(alpha, y1, y2)
```

Arguments

alpha	alpha level for 1-alpha confidence
y1	vector of scores for group 1
y2	vector of scores for group 2

Details

For more details, see Section 2.5 of Bonett (2021, Volume 1)

Value

Returns a 1-row matrix. The columns are:

- Mean1 - estimated mean for group 1
- Mean2 - estimated mean for group 2
- Mean1/Mean2- estimated mean ratio
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG, Price RM (2020). "Confidence intervals for ratios of means and medians." *Journal of Educational and Behavioral Statistics*, **45**(6), 750–770. doi:10.3102/1076998620934125.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
y2 <- c(32, 39, 26, 35, 43, 27, 40, 37, 34, 29, 49, 42, 40)
y1 <- c(36, 44, 47, 42, 49, 39, 46, 31, 33, 48)
ci.ratio.mean2(.05, y1, y2)

# Should return:
#
# Mean1    Mean2 Mean1/Mean2        LL        UL
#  41.5 36.38462    1.140592 0.9897482 1.314425
```

---

ci.ratio.median.ps *Confidence interval for a paired-samples median ratio*

Description

Computes a distribution-free confidence interval for a ratio of population medians in a paired-samples design. Ratio-scale measurements are assumed. Tied scores within each measurement are assumed to be rare.

For more details, see Section 4.23 of Bonett (2021, Volume 1)

Usage

```
ci.ratio.median.ps(alpha, y1, y2)
```

Arguments

`alpha`	alpha level for 1-alpha confidence
`y1`	vector of scores for measurement 1
`y2`	vector of scores for measurement 2 (paired with y1)

Value

Returns a 1-row matrix. The columns are:

- Median1 - estimated median for measurement 1
- Median2 - estimated median for measurement 2
- Median1/Median2 - estimated ratio of medians
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG, Price RM (2020). "Confidence intervals for ratios of means and medians." *Journal of Educational and Behavioral Statistics*, **45**(6), 750–770. doi:10.3102/1076998620934125.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
y1 = c(76.41, 66.91, 81.06, 74.78, 83.76, 89.31, 78.78, 87.06, 82.61, 76.74, 88.33, 86.18)
y2 = c(59.85, 60.64, 84.86, 68.16, 71.53, 86.18, 67.30, 65.46, 83.50, 66.76, 88.37, 65.02)
ci.ratio.median.ps(.05, y1, y2)

# Should return:
# Median1  Median2  Median1/Median2       LL        UL
#  81.835    67.73         1.208253  1.069251  1.365326
```

`ci.ratio.median2`	*Confidence interval for a 2-group median ratio*

Description

Computes a distribution-free confidence interval for a ratio of population medians of ratio-scale measurements in a 2-group design. Tied scores within each group are assumed to be rare.

For more details, see Section 2.12 of Bonett (2021, Volume 1)

Usage

```
ci.ratio.median2(alpha, y1, y2)
```

Arguments

`alpha`	alpha level for 1-alpha confidence
`y1`	vector of scores for group 1
`y2`	vector of scores for group 2

Value

Returns a 1-row matrix. The columns are:

- Median1 - estimated median for group 1
- Median2 - estimated median for group 2
- Median1/Median2 - estimated ratio of medians
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG, Price RM (2020). "Confidence intervals for ratios of means and medians." *Journal of Educational and Behavioral Statistics*, **45**(6), 750–770. doi:10.3102/1076998620934125.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
y2 <- c(32, 39, 26, 35, 43, 27, 40, 37, 34, 29, 49, 42, 40)
y1 <- c(36, 44, 47, 42, 49, 39, 46, 31, 33, 48)
ci.ratio.median2(.05, y1, y2)

# Should return:
# Median1 Median2 Median1/Median2       LL       UL
#      43      37        1.162162 0.927667 1.455933
```

---

ci.ratio.poisson2	*Confidence interval for a ratio of Poisson rates in a 2-group design*

Description

Computes a confidence interval for a ratio of population Poisson rates in a 2-group design. The confidence interval is based on the binomial method with an Agresti-Coull confidence interval. This function requires the number of occurrences of a specific event (f) that were observed over a specific period of time (t) within each group.

Usage

```
ci.ratio.poisson2(alpha, f1, f2, t1, t2)
```

Arguments

`alpha`	alpha value for 1-alpha confidence
`f1`	number of event occurrences for group 1
`f2`	number of event occurrences for group 2
`t1`	time period for group 1
`t2`	time period for group 2

Details

The time periods do not need to be integers and can be expressed in any unit of time such as seconds, hours, or months. The occurances are assumed to be independent of one another and the unknown occurrence rate is assumed to be constant over time within each group condition.

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimated ratio of Poisson rates
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Price RM, Bonett DG (2000). "Estimating the ratio of two Poisson rates." *Computational Statistics & Data Analysis*, **34**(3), 345–356. doi:10.1016/S01679473(99)001000.

Examples

```
ci.ratio.poisson2(.05, 19, 5, 30, 40.5)

# Should return:
# Estimate      LL       UL
#     5.13 1.939576 13.71481
```

`ci.ratio.prop.ps`	*Confidence interval for a paired-samples proportion ratio*

Description

Computes a confidence interval for a ratio of population proportions in a paired-samples design. This function requires the frequency counts from a 2 x 2 contingency table for two repeated dichotomous measurements.

For more details, see Section 3.2 of Bonett (2021, Volume 3)

Usage

```
ci.ratio.prop.ps(alpha, f00, f01, f10, f11)
```

Arguments

alpha	alpha level for 1-alpha confidence
f00	number of participants with y = 0 and x = 0
f01	number of participants with y = 0 and x = 1
f10	number of participants with y = 1 and x = 0
f11	number of participants with y = 1 and x = 1

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimate of proportion ratio
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG, Price RM (2006). "Confidence intervals for a ratio of binomial proportions based on paired data." *Statistics in Medicine*, **25**(17), 3039–3047. ISSN 0277-6715, doi:10.1002/sim.2440.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/.*

Examples

```
ci.ratio.prop.ps(.05, 12, 4, 26, 6)

# Should return:
# Estimate        LL        UL
#      3.2 1.766544 5.796628
```

---

ci.ratio.prop2   *Confidence interval for a 2-group proportion ratio*

Description

Computes an adjusted Wald confidence interval for a population proportion ratio in a 2-group design.

For more details, see Section 2.3 of Bonett (2021, Volume 3)

Usage

```
ci.ratio.prop2(alpha, f1, f2, n1, n2)
```

Arguments

alpha	alpha level for 1-alpha confidence
f1	number of participants in group 1 who have the attribute
f2	number of participants in group 2 who have the attribute
n1	sample size for group 1
n2	sample size for group 2

Value

Returns a 1-row matrix. The columns are:

- Estimate - adjusted estimate of proportion ratio
- LL - lower limit of the adjusted Wald confidence interval
- UL - upper limit of the adjusted Wald confidence interval

References

Price RM, Bonett DG (2008). "Confidence intervals for a ratio of two independent binomial proportions." *Statistics in Medicine*, **27**(26), 5497–5508. ISSN 02776715, doi:10.1002/sim.3376.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
ci.ratio.prop2(.05, 62, 35, 100, 100)

# Should return:
# Estimate       LL       UL
# 1.765957 1.297164 2.404172
```

---

ci.ratio.sd2   *Confidence interval for a 2-group ratio of standard deviations*

Description

Computes a robust confidence interval for a ratio of population standard deviations in a 2-group design. This function is a modification of the confidence interval proposed by Bonett (2006). The original Bonett method used a pooled kurtosis estimate in the standard error that assumed equal variances, which limited the confidence interval's use to tests of equal population variances and equivalence tests. This function uses a pooled kurtosis estimate that does not assume equal variances and provides a useful confidence interval for a ratio of standard deviations under general conditions. This function requires of minimum sample size of four per group but sample sizes of at least 10 per group are recommended.

Usage

```
ci.ratio.sd2(alpha, y1, y2)
```

Arguments

alpha	alpha level for 1-alpha confidence
y1	vector of scores for group 1
y2	vector of scores for group 2

Value

Returns a 1-row matrix. The columns are:

- SD1 - estimated SD for group 1
- SD2 - estimated SD for group 2
- SD1/SD2 - estimate of SD ratio
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG (2006). "Robust confidence interval for a ratio of standard deviations." *Applied Psychological Measurement*, **30**(5), 432–439. ISSN 0146-6216, doi:10.1177/0146621605279551.

Examples

```
y1 <- c(32, 39, 26, 35, 43, 27, 40, 37, 34, 29)
y2 <- c(36, 44, 47, 42, 49, 39, 46, 31, 33, 48)
ci.ratio.sd2(.05, y1, y2)

# Should return:
#      SD1      SD2    SD1/SD2       LL        UL
# 5.711587 6.450667  0.8854257 0.486279 1.728396
```

---

ci.rel2 *Confidence interval for a 2-group reliability difference*

Description

Computes a 100(1 - alpha)% confidence interval for a difference in population reliabilities in a 2-group design. This function can be used with any type of reliability coefficient (e.g., Cronbach alpha, McDonald omega, intraclass reliability). The function requires a point estimate and a 100(1 - alpha)% confidence interval for each reliability as input.

For more details, see Section 2.15 of Bonett (2021, Volume 4)

Usage

```
ci.rel2(rel1, ll1, ul1, rel2, ll2, ul2)
```

Arguments

rel1	estimated reliability for group 1
ll1	lower limit for group 1 reliability
ul1	upper limit for group 1 reliability
rel2	estimated reliability for group 2
ll2	lower limit for group 2 reliability
ul2	upper limit for group 2 reliability

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimated reliability difference
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Bonett DG, Wright TA (2015). "Cronbach's alpha reliability: Interval estimation, hypothesis testing, and sample size planning." *Journal of Organizational Behavior*, **36**(1), 3–15. ISSN 08943796, doi:10.1002/job.1960.

Examples

```
ci.rel2(.4, .35, .47, .2, .1, .32)

# Should return:
# Estimate   LL     UL
#      0.2 0.07 0.3221
```

---

ci.reliability   *Confidence interval for a reliability coefficient*

Description

Computes a confidence interval for a population reliability coefficient such as Cronbach's alpha or McDonald's omega using an estimate of the reliability and its standard error. The standard error can be a robust standard error or bootstrap standard error obtained from an SEM program. Use ci.cronbach for Cronbach's alpha if parallel measurements can be assumed.

For more details, see Section 2.8 of Bonett (2021, Volume 4)

Usage

```
ci.reliability(alpha, rel, se, n)
```

Arguments

alpha	alpha level for 1-alpha confidence
rel	estimated reliability
se	standard error of reliability
n	sample size

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimated reliability (from input)
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
ci.reliability(.05, .88, .0147, 100)

# Should return:
# Estimate    LL      UL
#     0.88  0.849 0.9066
```

---

ci.rsqr   *Confidence interval for squared multiple correlation*

Description

Computes an approximate confidence interval for a population squared multiple correlation in a linear model with random predictor variables. This function uses the scaled central F approximation method. An approximate standard error is recovered from the confidence interval.

For more details, see Section 2.4 of Bonett (2021, Volume 2)

Usage

```
ci.rsqr(alpha, r2, s, n)
```

Arguments

alpha	alpha value for 1-alpha confidence
r2	estimated unadjusted squared multiple correlation
s	number of predictor variables
n	sample size

Value

Returns a 1-row matrix. The columns are:

- R-squared - estimate of unadjusted R-squared (from input)
- adj R-squared - bias adjusted R-squared estimate
- SE - recovered standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Helland IS (1987). "On the interpretation and use of R2 in regression analysis." *Biometrics*, **43**(1), 61–69. doi:10.2307/2531949.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
ci.rsqr(.05, .247, 4, 150)

# Should return:
# R-squared adj R-squared      SE      LL     UL
#     0.247        0.2262 0.06024  0.1152 0.3514
```

---

ci.sd   *Confidence interval for a standard deviation*

Description

Computes the traditional confidence interval for a population standard deviation using a sample
estimate of the standard deviation. The traditional confidence interval assumes normality and is
hypersensitive to minor violations of this assumption. This function should be used only if the data
appear to come from an approximate normal or mildly platykurtic distribution.

Usage

```
ci.sd(alpha, sd, n)
```

Arguments

alpha	alpha value for 1-alpha confidence
sd	estimated standard deviation
n	sample size

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimated standard deviation (from input)

- LL - lower limit of the confidence interval

- UL - upper limit of the confidence interval

Examples

```
ci.sd(.05, 4.65, 50)

# Should return:
# Estimate       LL       UL
#     4.65 3.884303  5.79452
```

`ci.sign`	*Confidence interval for the parameter of the one-sample sign test*

Description

Computes an adjusted Wald interval for the population proportion of quantitative scores that are greater than the null hypothesis value of the population median in a one-sample sign test. This proportion is a measure of effect size that can be reported along with the sign test.

For more details, see Section 1.25 of Bonett (2021, Volume 1)

Usage

```
ci.sign(alpha, y, h)
```

Arguments

alpha	alpha level for 1-alpha confidence
y	vector of y scores
h	null hypothesis value for population median

Value

Returns a 1-row matrix. The columns are:

- Estimate - adjusted estimate of proportion
- SE - adjusted standard error
- LL - lower limit of adjusted Wald confidence interval
- UL - upper limit of adjusted Wald confidence interval

References

Agresti A, Coull BA (1998). "Approximate is better than 'exact' for interval estimation of binomial proportions." *The American Statistician*, **52**(2), 119–126. ISSN 0003-1305, doi:10.1080/00031305.1998.10480550.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/.*

Examples

```
y <- c(30, 20, 15, 10, 10, 60, 20, 25, 20, 30, 10, 5, 50, 40, 20, 10,
       0, 20, 50)
ci.sign(.05, y, 9)

# Should return:
# Estimate         SE         LL         UL
# 0.826087 0.0790342 0.6711828 0.9809911
```

`ci.slope`   *Confidence interval for a slope in a simple linear model*

Description

Computes a confidence interval for a population slope coefficient in a simple linear model using the sample correlation, sample standard deviation of the y scores (response variable), sample standard deviation of the x scores (predictor variable), and sample size as input.

For more details, see Section 1.11 of Bonett (2021, Volume 2)

Usage

```
ci.slope(alpha, cor, sdy, sdx, n)
```

Arguments

alpha	alpha level for 1-alpha confidence
cor	estimated Pearson correlation
sdy	estimated standard deviation of response variable
sdx	estimated standard deviation of predictor variable
n	sample size

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimated slope
- SE - standard error
- t - t test statistic
- df - degrees of freedom
- p - two-sided p-value
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
ci.slope(.05, .362, 25.1, 6.25, 85)

# Should return:
# Estimate        SE      t df        p        LL       UL
#  1.453792 0.4109165 3.5379 83 0.00066 0.6364957 2.271088
```

---

ci.slope.mean.bs   *Confidence interval for the slope of means in a one-factor experimen-*
                          tal design with a quantitative between-subjects factor

---

Description

Computes a test statistic and confidence interval for the slope of means in a one-factor experimental design with a quantitative between-subjects factor. This function computes both the unequal variance and equal variance confidence intervals and test statistics. A Satterthwaite adjustment to the degrees of freedom is used with the unequal variance method.

For more details, see Section 1.11 of Bonett (2021, Volume 2)

Usage

```
ci.slope.mean.bs(alpha, m, sd, n, x)
```

Arguments

alpha	alpha level for 1-alpha confidence
m	vector of sample means
sd	vector of sample standard deviations
n	vector of sample sizes
x	vector of quantiative factor values

Value

Returns a 2-row matrix. The columns are:

- Estimate - estimated slope
- SE - standard error
- t - t test statistic
- df - degrees of freedom
- p - two-sided p-value
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
m <- c(33.5, 37.9, 38.0, 44.1)
sd <- c(3.84, 3.84, 3.65, 4.98)
n <- c(10,10,10,10)
x <- c(5, 10, 20, 30)
ci.slope.mean.bs(.05, m, sd, n, x)

# Should return:
#                             Estimate        SE      t     df
# Equal Variances Assumed:    0.3664407 0.06770529 5.4123 36.00
# Equal Variances Not Assumed: 0.3664407 0.07336289 4.9949 18.66
#                                  p        LL        UL
# Equal Variances Assumed:    4e-06 0.2291280 0.5037534
# Equal Variances Not Assumed: 8e-05 0.2126998 0.5201815
```

---

ci.slope.median.bs   *Confidence interval for the slope of medians in a one-factor experi-*
mental design with a quantitative between-subjects factor

Description

Computes a distribution-free test and confidence interval for the slope of medians in a one-factor
experimental design with a quantitative between-subjects factor using sample group medians and
standard errors as input. The sample median and standard error for each group can be computed
using the ci.median function.

Usage

```
ci.slope.median.bs(alpha, m, se, x)
```

Arguments

alpha	alpha level for 1-alpha confidence
m	vector of sample median
se	vector of standard errors
x	vector of quantitative factor values

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimated slope
- SE - standard error
- z - z test statistic
- p - two-sided p-value
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

Examples

```
m <- c(33.5, 37.9, 38.0, 44.1)
se <- c(0.84, 0.94, 1.65, 2.98)
x <- c(5, 10, 20, 30)
ci.slope.median.bs(.05, m, se, x)

# Should return:
#  Estimate         SE      z      p        LL        UL
#  0.3664407 0.1163593 3.1492 0.00164 0.1383806 0.5945008
```

---

ci.slope.prop.bs	*Confidence interval for a slope of a proportion in a single-factor ex-perimental design with a quantitative between-subjects factor*

Description

Computes a test statistic and an adjusted Wald confidence interval for the population slope of proportions in a one-factor experimental design with a quantitative between-subjects factor.

For more details, see Section 4.4 of Bonett (2021, Volume 3)

Usage

```
ci.slope.prop.bs(alpha, f, n, x)
```

Arguments

alpha	alpha level for 1-alpha confidence
f	vector of frequency counts of participants who have the attribute
n	vector of sample sizes
x	vector of quantitative factor values

Value

Returns a 1-row matrix. The columns are:

- Estimate - adjusted slope estimate
- SE - adjusted standard error
- z - z test statistic
- p - two-sided p-value
- LL - lower limit of the adjusted Wald confidence interval
- UL - upper limit of the adjusted Wald confidence interval

References

Price RM, Bonett DG (2004). "An improved confidence interval for a linear function of binomial proportions." *Computational Statistics & Data Analysis*, **45**(3), 449–456. ISSN 01679473, doi:10.1016/S01679473(03)000070.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
f <- c(11, 15, 20, 27)
n <- c(60, 60, 60, 60)
x <- c(10, 20, 30, 40)
ci.slope.prop.bs(.05, f, n, x)

# Should return:
#   Estimate          SE      z      p         LL         UL
# 0.008688525 0.002566409 3.3855 0.00071 0.003658456 0.01371859
```

---

ci.spcor   *Confidence interval for a semipartial correlation*

Description

Computes a Fisher confidence interval for a population semipartial correlation. This function requires an (unadjusted) estimate of the squared multiple correlation in the full model that contains the predictor variable of interest plus all control variables. This function computes a modified Aloe-Becker confidence interval that uses n - 3 rather than n in the standard error and also uses a Fisher transformation of the semipartial correlation.

For more details, see Section 2.7 of Bonett (2021, Volume 2)

Usage

```
ci.spcor(alpha, cor, r2, n)
```

Arguments

alpha	alpha level for 1-alpha confidence
cor	estimated semipartial correlation
r2	estimated squared multiple correlation in full model
n	sample size

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimated semipartial correlation (from input)
- SE - standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Aloe AM, Becker BJ (2012). "An effect size for regression predictors in meta-analysis." *Journal of Educational and Behavioral Statistics*, **37**(2), 278–297. ISSN 1076-9986, doi:10.3102/1076998610396901.

Examples

```
ci.spcor(.05, -.355, .230, 236)

# Should return:
# Estimate      SE      LL       UL
#   -0.355 0.05426 -0.4565 -0.2444
```

`ci.spear`   *Confidence interval for a Spearman correlation*

Description

Computes a Fisher confidence interval for a population Spearman correlation. Unlike the confidence interval for a Pearson correlation, this function does not assume bivariate normality. Unlike the Pearson correlation which describes a linear bivariate relation, the Spearman correlation describes a monotonic bivariate relation. This function is not appropriate for ordered categorical variables.

For more details, see Section 1.32 of Bonett (2021, Volume 2)

Usage

```
ci.spear(alpha, y, x)
```

Arguments

alpha	alpha level for 1-alpha confidence
y	vector of y scores
x	vector of x scores (paired with y)

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimated Spearman correlation
- SE - standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG, Wright TA (2000). "Sample size requirements for estimating Pearson, Kendall and Spearman correlations." *Psychometrika*, **65**(1), 23–28. ISSN 0033-3123, doi:10.1007/BF02294183.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/.*

Examples

```
y <- c(21, 4, 9, 12, 35, 18, 10, 22, 24, 1, 6, 8, 13, 16, 19)
x <- c(67, 28, 30, 28, 52, 40, 25, 37, 44, 10, 14, 20, 28, 40, 51)
ci.spear(.05, y, x)

# Should return:
# Estimate     SE     LL     UL
#     0.87 0.08241 0.5841 0.9638
```

---

ci.spear2 *Confidence interval for a 2-group Spearman correlation difference*

Description

Computes a confidence interval for a difference of population Spearman correlations in a 2-group design. This function is not appropriate for ordered categorical variables.

Usage

```
ci.spear2(alpha, cor1, cor2, n1, n2)
```

Arguments

alpha	alpha level for 1-alpha confidence
cor1	estimated Spearman correlation for group 1
cor2	estimated Spearman correlation for group 2
n1	sample size for group 1
n2	sample size for group 2

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimated correlation difference
- SE - standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG, Wright TA (2000). "Sample size requirements for estimating Pearson, Kendall and Spearman correlations." *Psychometrika*, **65**(1), 23–28. ISSN 0033-3123, doi:10.1007/BF02294183.

Zou GY (2007). "Toward using confidence intervals to compare correlations." *Psychological Methods*, **12**(4), 399–413. ISSN 1939-1463, doi:10.1037/1082989X.12.4.399.

Examples

```
ci.spear2(.05, .54, .48, 180, 200)

# Should return:
# Estimate      SE      LL      UL
#     0.06 0.08125 -0.1004 0.2185
```

---

ci.stdmean   *Confidence interval for a standardized mean*

Description

Computes a confidence interval for a population standardized mean difference from a hypothesized value. If the hypothesized value is set to 0, the reciprocals of the confidence interval endpoints gives a confidence interval for the coefficient of variation (see ci.cv).

Usage

```
ci.stdmean(alpha, m, sd, n, h)
```

Arguments

alpha	alpha level for 1-alpha confidence
m	estimated mean
sd	estimated standard deviation
n	sample size
h	hypothesized value of mean

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimated standardized mean difference
- adj Estimate - bias adjusted standardized mean difference estimate
- SE - standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG (2008). "Confidence intervals for standardized linear contrasts of means." *Psychological Methods*, **13**(2), 99–109. ISSN 1939-1463, doi:10.1037/1082989X.13.2.99.

Examples

```
ci.stdmean(.05, 24.5, 3.65, 40, 20)

# Should return:
# Estimate adj Estimate      SE     LL     UL
#   1.2329        1.209 0.21244 0.8165 1.6493
```

---

ci.stdmean.ps	*Confidence intervals for a paired-samples standardized mean difference*

Description

Computes confidence intervals for a population standardized mean difference in a paired-samples design. A square root unweighted variance standardizer and single measurement standard deviation standardizers are used. Equality of variances is not assumed.

For more details, see Section 4.3 of Bonett (2021, Volume 1)

Usage

```
ci.stdmean.ps(alpha, m1, m2, sd1, sd2, cor, n)
```

Arguments

alpha	alpha level for 1-alpha confidence
m1	estimated mean for measurement 1
m2	estimated mean for measurement 2
sd1	estimated standard deviation for measurement 1
sd2	estimated standard deviation for measurement 2
cor	estimated correlation between measurements
n	sample size

Value

Returns a 3-row matrix. The columns are:

- Estimate - estimated standardized mean difference
- adj Estimate - bias adjusted standardized mean difference estimate
- SE - standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG (2008). "Confidence intervals for standardized linear contrasts of means." *Psychological Methods*, **13**(2), 99–109. ISSN 1939-1463, doi:10.1037/1082989X.13.2.99.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
ci.stdmean.ps(.05, 602.4, 705.6, 33.17, 51.08, .769, 8)

# Should return:
#                          Estimate adj Estimate      SE      LL      UL
# Unweighted standardizer:   -2.3963      -2.2185 0.65209 -3.6744 -1.1182
# Measurement 1 standardizer: -3.1112     -2.7656 0.91362 -4.9019 -1.3206
# Measurement 2 standardizer: -2.0204     -1.7959 0.59328 -3.1832 -0.8576
```

---

ci.stdmean.strat   *Confidence intervals for a 2-group standardized mean difference with stratified sampling*

Description

Computes confidence intervals for a population standardized mean difference in a 2-group non-experimental design with stratified random sampling (a random sample of a specified size from each subpopulation) using a square root weighted variance standardizer or single group standard deviation standardizer. Equality of variances is not assumed.

Usage

```
ci.stdmean.strat(alpha, m1, m2, sd1, sd2, n1, n2, p1)
```

Arguments

alpha	alpha level for 1-alpha confidence
m1	estimated mean for group 1
m2	estimated mean for group 2
sd1	estimated standard deviation for group 1
sd2	estimated standard deviation for group 2
n1	sample size for group 1
n2	sample size for group 2
p1	proportion of total population in subpopulation 1

Value

Returns a 3-row matrix. The columns are:

- Estimate - estimated standardized mean difference
- adj Estimate - bias adjusted standardized mean difference estimate
- SE - standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG (2020). "Point-biserial correlation: Interval estimation, hypothesis testing, meta-analysis, and sample size determination." *British Journal of Mathematical and Statistical Psychology*, **73**(S1), 113–144. ISSN 0007-1102, doi:10.1111/bmsp.12189.

Examples

```
ci.stdmean.strat(.05, 33.2, 30.8, 10.5, 11.2, 200, 200, .533)

# Should return:
#                      Estimate adj Estimate      SE     LL     UL
# Weighted standardizer:  0.2216       0.2211 0.10052 0.0245 0.4186
# Group 1 standardizer:   0.2286       0.2277 0.10428 0.0242 0.4330
# Group 2 standardizer:   0.2143       0.2277 0.09776 0.0227 0.4059
```

`ci.stdmean2`   *Confidence intervals for a 2-group standardized mean difference*

Description

Computes confidence intervals for a population standardized mean difference. Unweighted, weighted, and single group variance standardizers are used. The square root weighted variance standardizer is recommended in 2-group nonexperimental designs with simple random sampling. The square root unweighted variance standardizer is recommended in 2-group experimental designs. The single group standard deviation standardizer can be used with experimental or nonexperimental designs. Equality of variances is not assumed.

For more details, see Section 2.4 of Bonett (2021, Volume 1)

Usage

```
ci.stdmean2(alpha, m1, m2, sd1, sd2, n1, n2)
```

Arguments

alpha	alpha level for 1-alpha confidence
m1	estimated mean for group 1
m2	estimated mean for group 2
sd1	estimated standard deviation for group 1
sd2	estimated standard deviation for group 2
n1	sample size for group 1
n2	sample size for group 2

Value

Returns a 4-row matrix. The columns are:

- Estimate - estimated standardized mean difference
- adj Estimate - bias adjusted standardized mean difference estimate
- SE - standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG (2008). "Confidence intervals for standardized linear contrasts of means." *Psychological Methods*, **13**(2), 99–109. ISSN 1939-1463, doi:10.1037/1082989X.13.2.99.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
ci.stdmean2(.05, 20.9, 19.1, 3.85, 3.19, 50, 50)

# Should return:
#                          Estimate adj Estimate      SE     LL     UL
# Unweighted standardizer:   0.5091        0.5052 0.20539 0.1066 0.9117
# Weighted standardizer:     0.5091        0.5052 0.20328 0.1107 0.9076
# Group 1 standardizer:      0.4675        0.4603 0.19144 0.0923 0.8427
# Group 2 standardizer:      0.5643        0.5556 0.23105 0.1114 1.0171
```

---

ci.tetra   *Confidence interval for a tetrachoric correlation*

Description

Computes a confidence interval for an approximation to the tetrachoric correlation. This function requires the frequency counts from a 2 x 2 contingency table for two dichotomous variables. This measure of association assumes both of the dichotomous variables are artificially dichotomous. An approximate standard error is recovered from the confidence interval.

For more details, see Section 3.4 of Bonett (2021, Volume 3)

Usage

```
ci.tetra(alpha, f00, f01, f10, f11)
```

Arguments

alpha	alpha level for 1-alpha confidence
f00	number of participants with y = 0 and x = 0
f01	number of participants with y = 0 and x = 1
f10	number of participants with y = 1 and x = 0
f11	number of participants with y = 1 and x = 1

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimate of tetrachoric approximation
- SE - recovered standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Bonett DG, Price RM (2005). "Inferential methods for the tetrachoric correlation coefficient." *Journal of Educational and Behavioral Statistics*, **30**(2), 213–225. ISSN 1076-9986, doi:10.3102/10769986030002213.

Examples

```
ci.tetra(.05, 86, 16, 7, 93)

# Should return:
# Estimate     SE    LL    UL
#    0.938 0.0268 0.868 0.973
```

---

ci.theil   *Theil-Sen estimate and confidence interval for slope*

Description

Computes a Theil-Sen estimate and distribution-free confidence interval for the population slope in a simple linear regression model. An approximate standard error is recovered from the confidence interval.

For more details, see Section 1.32 of Bonett (2021, Volume 2)

Usage

```
ci.theil(alpha, y, x)
```

Arguments

alpha	alpha level for 1-alpha confidence
y	vector of response variable scores
x	vector of predictor variable scores (paired with y)

Value

Returns a 1-row matrix. The columns are:

- Estimate - Theil-Sen estimate of population slope
- SE - recovered standard error
- LL - lower limit of confidence interval
- UL - upper limit of confidence interval

References

Hollander M, Wolf DA (1999). *Nonparametric Statistical Methods*. Wiley.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
y <- c(21, 4, 9, 12, 35, 18, 10, 22, 24, 1, 6, 8, 13, 16, 19)
x <- c(67, 28, 30, 28, 52, 40, 25, 37, 44, 10, 14, 20, 28, 40, 51)
ci.theil(.05, y, x)

# Should return:
# Estimate        SE        LL    UL
#      0.5 0.1085927 0.3243243 0.75
```

---

ci.tukey	*Tukey-Kramer confidence intervals for all pairwise mean differences in a between-subjects design*

Description

Computes heteroscedastic Tukey-Kramer (also known as Games-Howell) confidence intervals for all pairwise comparisons of population means using estimated means, estimated standard deviations, and samples sizes as input. A Satterthwaite adjustment to the degrees of freedom is used to improve the accuracy of the confidence intervals.

For more details, see Section 3.1 of Bonett (2021, Volume 1)

Usage

```
ci.tukey(alpha, m, sd, n)
```

Arguments

alpha	alpha level for simultaneous 1-alpha confidence
m	vector of estimated group means
sd	vector of estimated group standard deviations
n	vector of sample sizes

Value

Returns a matrix with the number of rows equal to the number of pairwise comparisons. The columns are:

- Estimate - estimated mean difference
- SE - standard error

- t - t test statistic

- df - degrees of freedom

- p - two-sided Tukey p-value

- LL - lower limit of the confidence interval

- UL - upper limit of the confidence interval

References

Games PA, Howell JF (1976). "Pairwise multiple comparison procedures with unequal N's and/or variances: A Monte Carlo study." *Journal of Educational Statistics*, **1**(2), 113. ISSN 03629791, doi:10.2307/1164979.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
m <- c(12.86, 17.57, 26.29, 30.21)
sd <- c(13.185, 12.995, 14.773, 15.145)
n <- c(20, 20, 20, 20)
ci.tukey(.05, m, sd, n)

# Should return:
#     Estimate       SE       t    df       p        LL          UL
# 1 2    -4.71 4.139530 -1.1378 37.99 0.66881 -15.83085   6.4108517
# 1 3   -13.43 4.427673 -3.0332 37.52 0.02177 -25.33172  -1.5282764
# 1 4   -17.35 4.490074 -3.8641 37.29 0.00233 -29.42281  -5.2771918
# 2 3    -8.72 4.399497 -1.9820 37.39 0.21291 -20.54783   3.1078269
# 2 4   -12.64 4.462292 -2.8326 37.14 0.03572 -24.64034  -0.6396589
# 3 4    -3.92 4.730817 -0.8286 37.98 0.84055 -16.62958   8.7895768
```

---

ci.var.upper   *Upper confidence limit of a variance*

Description

Computes an upper confidence limit for a population variance using an estimated variance from a sample of size n in a prior study. The upper limit can be used as a variance planning value in sample size functions for desired power that require a planning value of the population variance.

For more details, see Section 1.31 of Bonett (2021, Volume 1)

Usage

```
ci.var.upper(alpha, var, n)
```

Arguments

alpha	alpha value for 1-alpha confidence (one-sided)
var	estimated variance
n	sample size

Value

Returns an upper limit (UL) variance planning value

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/.*

Examples

```
ci.var.upper(.10, 1.45, 100)

# Should return:
#       UL
# 1.762447
```

---

ci.yule	*Confidence intervals for generalized Yule coefficients*

Description

Computes confidence intervals for four generalized Yule measures of association (Yule Q, Yule Y, Digby H, and Bonett-Price Y*) using a transformation of a confidence interval for an odds ratio with .5 added to each cell frequency. This function requires the frequency counts from a 2 x 2 contingency table for two dichotomous variables. Digby H is sometimes used as a crude approximation to the tetrachoric correlation. Yule Y is equal to the phi coefficient only when all marginal frequencies are equal. Bonett-Price Y* is a better approximation to the phi coefficient when the marginal frequencies are not equal.

For more details, see Section 3.4 of Bonett (2021, Volume 3)

Usage

```
ci.yule(alpha, f00, f01, f10, f11)
```

Arguments

alpha	alpha level for 1-alpha confidence
f00	number of participants with $y = 0$ and $x = 0$
f01	number of participants with $y = 0$ and $x = 1$
f10	number of participants with $y = 1$ and $x = 0$
f11	number of participants with $y = 1$ and $x = 1$

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimate of generalized Yule coefficient
- SE - standard error
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*. Bonett DG, Price RM (2007). "Statistical inference for generalized Yule coefficients in 2x2 contingency tables." *Sociological Methods & Research*, **35**(3), 429–446. ISSN 0049-1241, doi:10.1177/0049124106292358.

Examples

```
ci.yule(.05, 229, 28, 96, 24)

# Should return:
#    Estimate     SE    LL    UL
# Q:    0.343 0.1328 0.062 0.573
# Y:    0.177 0.0729 0.031 0.315
# H:    0.262 0.1051 0.047 0.454
# Y*:   0.131 0.0546 0.023 0.236
```

---

etasqr.adj   *Bias adjustment for an eta-squared estimate*

Description

Computes an approximate bias adjustment for eta-squared. This adjustment can be applied to eta-squared, partial-eta squared, and generalized eta-squared estimates.

For more details, see Section 3.7 of Bonett (2021, Volume 1)

Usage

```
etasqr.adj(etasqr, dfeffect, dferror)
```

Arguments

etasqr	unadjusted eta-square estimate
dfeffect	degrees of freedom for the effect
dferror	error degrees of freedom

Value

Returns a bias adjusted eta-squared estimate

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
etasqr.adj(.315, 2, 42)

# Should return:
# adj Eta-squared
#         0.2824
```

---

etasqr.gen.2way   *Generalized eta-squared estimates in a two-factor design*

Description

Computes generalized eta-square estimates in a two-factor design where one or both factors are classification factors. If both factors are treatment factors, then partial eta-square estimates are typically recommended. The eta-squared estimates from this function can be used in the etasqr.adj function to obtain bias adjusted estimates.

For more details, see Section 3.12 of Bonett (2021, Volume 1)

Usage

```
etasqr.gen.2way(SSa, SSb, SSab, SSe)
```

Arguments

SSa	sum of squares for factor A
SSb	sum of squares for factor B
SSab	sum of squares for A x B interaction
SSe	error (within) sum of squares

Value

Returns a 3-row matrix. The columns are:

- A - estimate of eta-squared for factor A
- B - estimate of eta-squared for factor B
- AB - estimate of eta-squared for A x B interaction

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
etasqr.gen.2way(12.3, 15.6, 5.2, 7.9)

# Should return:
#                                          A          B         AB
# A treatment, B classification:    0.300000 0.5435540 0.1811847
# A classification, B treatment:    0.484252 0.3804878 0.2047244
# A classification, B classification: 0.300000 0.3804878 0.1268293
```

---

expon.slope   *Confidence interval for an exponentiated slope*

Description

Computes confidence intervals for exp(B) - 1 (as a percent) and exp(B) where B is a population slope coefficient in a binary logit, ordinal logit, or log-Poisson model. This function is useful with software that does not have an option to compute exp(B) and exp(B) - 1.

For more details, see Section 4.1 of Bonett (2021, Volume 3)

Usage

```
expon.slope(alpha, b, se)
```

Arguments

alpha	alpha level for 1-alpha confidence
b	estimated slope coefficient
se	slope standard error

Value

Returns a 2-row matrix. The first row gives the results for exp(B), and the the second row gives the results for exp(B) - 1 (as a percent). The columns are:

- Estimate - estimate of exp(B) or exp(B) - 1
- LL - lower limit of the confidence interval
- UL - upper limit of the confidence interval

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
expon.slope(.05, .502, .0396)

# Should return:
#                  Estimate       LL       UL
# exp(B)           1.652022  1.528651  1.78535
# 100[exp(B) - 1]% 65.202201 52.865066 78.53502
```

---

fitindices   *SEM fit indices*

Description

Computes the normed fit index (NFI), adjusted normed fit index (adj NFI), comparative fit index (CFI), Tucker-Lewis fit index (TLI), and root mean square error of approximation index (RMSEA). Of the first four indices, the adj NFI index is recommended because it has smaller sampling variability than CFI and TLI and less negative bias than NFI.

For more details, see Section 2.14 of Bonett (2021, Volume 4)

Usage

```
fitindices(chi1, df1, chi2, df2, n)
```

Arguments

chi1	chi-square test statistic for full model
df1	degrees of freedom for full model
chi2	chi-square test statistic for reduced model
df2	degrees of freedom for reduced model
n	sample size

Value

Returns NFI, adj NFI, CFI, TLI, and RMSEA

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
fitindices(14.21, 10, 258.43, 20, 300)

# Should return:
#    NFI   adj NFI   CFI    TLI  RMSEA
#  0.945    0.9837  0.98 0.9647 0.0375
```

---

iqv   *Indices of qualitative variation*

Description

Computes the Shannon, Berger, and Simpson indices of qualitative variation. Will be replaced soon with ci.diversity.

Usage

```
iqv(f)
```

Arguments

f   vector of multinomial frequency counts

Value

Returns estimates of the Shannon, Berger, and Simpson indices

Examples

```
f <- c(10, 46, 15, 3)
iqv(f)

# Should return:
#   Simpson    Berger    Shannon
# 0.7367908 0.5045045        0.7
```

pi.cor	*Prediction limits for a sample correlation in a future study*

Description

Computes approximate one-sided or two-sided prediction limits for the estimated Pearson correlation in a future study with a planned sample size of n. The prediction interval uses a correlation estimate from a prior study that had a sample size of n0.

Several confidence interval sample size functions in this package require a planning value of the expected sample value of a Pearson correlation in the planned study. A one-sided lower correlation prediction limit is useful as a correlation planning value for a conservatively large sample size required to obtain a confidence interval with desired width. This strategy for specifying a correlation planning value is useful in applications where the population correlation in the prior study is assumed to be very similar to the population correlation in the planned study.

For more details, see Section 1.26 of Bonett (2021, Volume 2)

Usage

```
pi.cor(alpha, cor, n0, n, type)
```

Arguments

alpha	alpha value for 1-alpha confidence
cor	estimated Pearson correlation from prior study
n0	sample size used to estimate the correlation in prior study
n	planned sample size of future study
type	• set to 1 for two-sided prediction interval
	• set to 2 for one-sided upper prediction limit
	• set to 3 for one-sided lower prediction limit

Value

Returns one-sided or two-sided prediction limit(s) of an estimated Pearson correlation in a future study

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
pi.cor(.1, .761, 50, 100, 1)

# Should return:
#      LL      UL
#  0.6034 0.8573
```

```
pi.cor(.1, .761, 50, 100, 3)

# Should return:
#       LL
#   0.6429
```

---

pi.cronbach   *Prediction limits for sample value of Cronbach reliability in a future study*

Description

Computes approximate one-sided or two-sided prediction limits for the estimated Cronbach reliability in a future study with a planned sample size of n. The prediction interval uses a Cronbach reliability estimate from a prior study.

The size.ci.cronbach and size.ci.cronbach2 functions require a planning value of the expected sample value of Cronbach's reliability in the planned study. A one-sided lower prediction limit for the sample value of Cronbach's reliability in the planned study can be used in the size.ci.cronbach and size.ci.cronbach2 functions to obtain conservatively large sample size requirements. This strategy for specifying a reliability planning value is useful in applications where the population Cronbach reliability in the prior study is assumed to be very similar to the population Cronbach reliability in the planned study.

Usage

```
pi.cronbach(alpha, rel, r, n0, n, type)
```

Arguments

alpha	alpha value for 1-alpha confidence
rel	estimated Cronbach reliability from prior study
r	number of measurements (e.g., items, raters, etc.)
n0	sample size used to estimate reliability in prior study
n	planned sample size of future study
type	• set to 1 for two-sided prediction interval
	• set to 2 for one-sided upper prediction limit
	• set to 3 for one-sided lower prediction limit

Value

Returns one-sided or two-sided prediction limit(s) of an estimated Cronbach reliability in a future study

Examples

```
pi.cronbach(.1, .852, 5, 100, 150, 1)

# Should return:
#       LL     UL
#   0.7944 0.8956

pi.cronbach(.1, .852, 5, 100, 150, 3)

# Should return:
#       LL
#   0.8092
```

---

pi.prop   *Prediction interval for a sample proportion in a future study*

Description

Computes an approximate one-sided or two-sided prediction interval for the estimated proportion in a future study with a planned sample size of n. The prediction interval uses a proportion estimate from a prior study that had a sample size of n0.

Several confidence interval sample size functions in this package require a planning value of the expected sample value of a proportion in the planned study. A one-sided proportion prediction limit is useful as a proportion planning value for a conservatively large sample size required to obtain a confidence interval with desired width. This strategy for specifying a proportion planning value is useful in applications where the population proportion in the prior study is assumed to be very similar to the population proportion in the planned study.

For sample size planning, use an upper prediction limit if the population proportion is assumed to be less than .5; and if the upper prediction limit is greater than .5, set the proportion planning value to .5. Use a lower prediction limit if the population proportion is asumed to be greater than .5; and if the lower prediction limit is less than .5, set the proportion planning value to .5.

For more details, see Section 1.16 of Bonett (2021, Volume 3)

Usage

```
pi.prop(alpha, prop, n0, n, type)
```

Arguments

alpha	alpha value for 1-alpha confidence
prop	estimated proportion from prior study
n0	sample size used to estimate proportion in prior study
n	planned sample size of future study
type	• set to 1 for two-sided prediction interval

- set to 2 for one-sided upper prediction limit
- set to 3 for one-sided lower prediction limit

Value

Returns one-sided or two-sided prediction limit(s) for an estimated proportion in a future study

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
pi.prop(.1, .225, 80, 120, 1)

# Should return:
#        LL       UL
#  0.1390955 0.337095
```

---

pi.score   *Prediction interval for one score*

Description

Computes a prediction interval for the response variable score of one randomly selected member from the study population.

For more details, see Section 1.9 of Bonett (2021, Volume 1)

Usage

```
pi.score(alpha, m, sd, n)
```

Arguments

alpha	alpha level for 1-alpha confidence
m	estimated mean
sd	estimated standard deviation
n	sample size

Value

Returns a 1-row matrix. The columns are:

- Predicted - predicted score
- df - degrees of freedom
- LL - lower limit of the prediction interval
- UL - upper limit of the prediction interval

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/.*

Examples

```
pi.score(.05, 24.5, 3.65, 40)

# Should return:
# Predicted  df       LL       UL
#     24.5   39 17.02546 31.97454
```

---

pi.score.ps	*Prediction interval for difference of scores in a 2-level within-subjects experiment*

Description

For a 2-level within-subjects experiment, this function computes a prediction interval for how the response variable score for one randomly selected person from the study population would differ under the two treatment conditions.

For more details, see Section 4.5 of Bonett (2021, Volume 1)

Usage

```
pi.score.ps(alpha, m1, m2, sd1, sd2, cor, n)
```

Arguments

alpha	alpha level for 1-alpha confidence
m1	estimated mean for measurement 1
m2	estimated mean for measurement 2
sd1	estimated standard deviation for measurement 1
sd2	estimated standard deviation for measurement 2
cor	estimated correlation of paired scores
n	sample size

Value

Returns a 1-row matrix. The columns are:

- Predicted - predicted difference in scores
- df - degrees of freedom
- LL - lower limit of the prediction interval
- UL - upper limit of the prediction interval

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/.*

Examples

```
pi.score.ps(.05, 265.1, 208.6, 23.51, 19.94, .814, 30)

# Should return:
# Predicted df       LL       UL
#      56.5 29 28.05936 84.94064
```

---

pi.score2   *Prediction interval for a difference of scores in a 2-group experiment*

Description

For a 2-group experimental design, this function computes a prediction interval for how the response variable score for one randomly selected person from the study population would differ under the two treatment conditions. Both equal variance and unequal variance prediction intervals are computed.

For more details, see Section 2.6 of Bonett (2021, Volume 1)

Usage

```
pi.score2(alpha, m1, m2, sd1, sd2, n1, n2)
```

Arguments

alpha	alpha level for 1-alpha confidence
m1	estamated mean for group 1
m2	estimated mean for group 1
sd1	estimated standard deviation for group 1
sd2	estimated standard deviation for group 2
n1	sample size for group 1
n2	sample size for group 2

Value

Returns a 2-row matrix. The columns are:

- Predicted - predicted difference in scores
- df - degrees of freedom
- LL - lower limit of the prediction interval
- UL - upper limit of the prediction interval

References

Hahn GJ (1977). "A prediction interval on the difference between two future sample means and its application to a claim of product superiority." *Technometrics*, **19**(2), 131–134. ISSN 0040-1706, doi:10.1080/00401706.1977.10489520.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/.*

Examples

```
pi.score2(.05, 19.4, 11.3, 2.70, 2.10, 40, 40)

# Should return:
#                          Predicted   df       LL       UL
# Equal Variances Assumed:        8.1 78.00 1.205659 14.99434
# Equal Variances Not Assumed:    8.1 73.54 1.199073 15.00093
```

---

pi.var	*Prediction limits for a sample variance in a future study*

Description

Computes a two-sided or one-sided prediction limit for the estimated variance in a future study for a planned sample size of n. The prediction limit uses a variance estimate from a prior study of size n0.

Several confidence interval sample size functions in this package require a planning value of the expected sample variance in the planned study. A one-sided upper variance prediction limit is useful as a variance planning value for a conservatively large sample size required to obtain a confidence interval with desired width. This strategy for specifying a variance planning value is useful in applications where the population variance in the prior study is assumed to be very similar to the population variance in the planned study.

For more details, see Section 1.31 of Bonett (2021, Volume 1)

Usage

```
pi.var(alpha, var, n0, n, type)
```

Arguments

alpha	alpha value for upper 1-alpha confidence
var	estimated variance from prior study
n0	sample size used to estimate the variance
n	planned sample size of future study
type	• set to 1 for two-sided prediction interval
	• set to 2 for one-sided upper prediction limit
	• set to 3 for one-sided lower prediction limit

Value

Returns two-sided or one-sided prediction limit(s) of an estimate variance in a future study

References

Hahn GJ (1972). "Simultaneous prediction intervals to contain the standard deviations or ranges of future samples from a normal population." *Journal of the American Statistical Association*, **67**(340), 938–942. doi:10.1080/01621459.1972.10481322.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
pi.var(.05, 15, 40, 100, 2)

# Should return:
#      UL
# 23.9724
```

---

power.cor   *Approximates the power of a correlation test for a planned sample size*

Description

Computes the approximate power of a test for a population Pearson or partial correlation test for a planned sample size. Set s = 0 for a Pearson correlation.

Usage

```
power.cor(alpha, n, cor, h, s)
```

Arguments

alpha	alpha level for hypothesis test
n	planned sample size
cor	planning value of correlation
h	null hypothesis value of correlation
s	number of control variables

Value

Returns the approximate power of the test

Examples

```
power.cor(.05, 80, .3, 0, 0)

# Should return:
#     Power
# 0.7751947
```

---

power.cor2	*Approximates the power of a test for equal correlations in a 2-group design for planned sample sizes*

Description

Computes the approximate power of a test for equal population Pearson or partial correlations in a 2-group design for planned sample sizes. Set s = 0 for Pearson correlations.

Usage

```
power.cor2(alpha, n1, n2, cor1, cor2, s)
```

Arguments

alpha	alpha level for hypothesis test
n1	planned sample size for group 1
n2	planned sample size for group 2
cor1	correlation planning value for group 1
cor2	correlation planning value for group 2
s	number of control variables

Value

Returns the approximate power of the test

Examples

```
power.cor2(.05, 200, 200, .4, .2, 0)

# Should return:
#     Power
# 0.5919682
```

---

power.lc.mean.bs	*Approximates the power of a test for a linear contrast of means for planned sample sizes in a between-subjects design*

Description

Computes the approximate power of a test for a linear contrast of population means for planned sample sizes in a between-subject design. The groups can be the factor levels of a single factor design or the combinations of factors in a factorial design. For a conservatively low power approximation, set the variance planning values to the largest values within their plausible ranges, and set the effect size to a minimally interesting value. The within-group variances can be unequal across groups and a Satterthwaite degree of freedom adjustment is used to improve the accuracy of the power approximation.

Usage

```
power.lc.mean.bs(alpha, n, var, es, v)
```

Arguments

alpha	alpha level for hypothesis test
n	vector of planned sample sizes
var	vector of within-group variance planning values
es	planning value of linear contrast of means
v	vector of contrast coefficients

Value

Returns the approximate power of the test

Examples

```
n <- c(20, 20, 20, 20)
var <- c(70, 70, 80, 80)
v <- c(.5, .5, -.5, -.5)
power.lc.mean.bs(.05, n, var, 5, v)

# Should return:
#     Power
# 0.7221171
```

power.mean   *Approximates the power of a one-sample t-test for a planned sample*
                              size

Description

Computes the approximate power of a one-sample t-test for a planned sample size. For a conservatively low power approximation, set the variance planning value to the largest value within its plausible range, and set the effect size to a minimally interesting value.

Usage

```
power.mean(alpha, n, var, es)
```

Arguments

alpha   alpha level for hypothesis test

n   planned sample size

var   planning value of response variable variance

es   planning value of mean minus null hypothesis value

Value

Returns the approximate power of the test

Examples

```
power.mean(.05, 15, 80.5, 7)

# Should return:
#     Power
# 0.8021669
```

power.mean.ps   *Approximates the power of a paired-samples t-test for a planned sam-*
                              ple size

Description

Computes the approximate power of a paired-samples t-test for a planned sample size. For a conservatively low power approximation, set the variance planning values to the largest values within their plausible ranges, set the correlation planning value to the smallest value within its plausible range, and set the effect size to a minimally interesting value. The variances of the two measurements can be unequal.

Usage

```
power.mean.ps(alpha, n, var1, var2, es, cor)
```

Arguments

alpha	alpha level for hypothesis test
n	planned sample size
var1	planning value of measurement 1 variance
var2	planning value of measurement 2 variance
es	planning value of mean difference
cor	planning value of correlation between measurements

Value

Returns the approximate power of the test

Examples

```
power.mean.ps(.05, 20, 10.0, 12.0, 2, .7)

# Should return:
#     Power
# 0.9074354
```

---

power.mean2	*Approximates the power of a two-sample t-test for planned sample sizes*

Description

Computes the approximate power of a two-sample t-test for planned sample sizes. For a conservatively low power approximation, set the variance planning values to the largest values within their plausible ranges, and set the effect size to a minimally interesting value. The within-group variances can be unequal across groups and a Satterthwaite degree of freedom adjustment is used to improve the accuracy of the power approximation.

Usage

```
power.mean2(alpha, n1, n2, var1, var2, es)
```

Arguments

`alpha`	alpha level for hypothesis test
`n1`	planned sample size for group 1
`n2`	planned sample size for group 2
`var1`	planning value of within-group variance for group 1
`var2`	planning value of within-group variance for group 2
`es`	planning value of mean difference

Value

Returns the approximate power of the test

Examples

```
power.mean2(.05, 25, 25, 5.0, 6.0, 2)

# Should return:
#     Power
# 0.8398417
```

`power.prop`	*Approximates the power of a 1-group proportion test for a planned sample size*

Description

Computes the approximate power of a one-sample proportion test for a planned sample size. Set the proportion planning value to .5 for a conservatively low power estimate. The value of the effect size need not be based on the proportion planning value.

Usage

```
power.prop(alpha, n, p, es)
```

Arguments

`alpha`	alpha level for hypothesis test
`n`	planned sample size
`p`	planning value of proportion
`es`	planning value of proportion minus null hypothesis value

Value

Returns the approximate power of the test

Examples

```
power.prop(.05, 40, .5, .2)

# Should return:
#      Power
# 0.7156044
```

---

power.prop.ps   *Approximates the power of a paired-samples test of equal proportions*
                                 for a planned sample size

Description

Computes the approximate power of a test for equal population proportions in a paired-samples
design (the McNemar test). This function requires planning values for both proportions and a phi
coefficient that describes the correlation between the two dichotomous measurements. The propor-
tion planning values can set to .5 for a conservatively low power estimate. The planning value for
the proportion difference (effect size) could be set to the difference of the two proportion planning
values or it could be set to a minimally interesting effect size. Set the phi correlation planning value
to the smallest value within a plausible range for a conservatively low power estimate.

Usage

```
power.prop.ps(alpha, n, p1, p2, phi, es)
```

Arguments

alpha	alpha level for hypothesis test
n	planned sample size
p1	planning value of proportion for measurement 1
p2	planning value of proportion for measurement 2
phi	planning value of phi correlation
es	planning value of proportion difference

Value

Returns the approximate power of the test

Examples

```
power.prop.ps(.05, 45, .5, .5, .4, .2)

# Should return:
#    Power
# 0.6877704
```

---

power.prop2   *Approximates the power of a 2-group proportion test for planned sam-*
                                ple sizes

Description

Computes the approximate power for a test of equal population proportions in a 2-group design for the planned sample sizes. This function requires planning values for both proportions. Set the proportion planning values to .5 for a conservatively low power estimate. The planning value for the proportion difference could be set to the difference of the two proportion planning values or it could be set to a minimally interesting effect size.

Usage

```
power.prop2(alpha, n1, n2, p1, p2, es)
```

Arguments

alpha	alpha level for hypothesis test
n1	planned sample size for group 1
n2	planned sample size for group 2
p1	planning value of proportion for group 1
p2	planning value of proportion for group 2
es	planning value of proportion difference

Value

Returns the approximate power of the test

Examples

```
power.prop2(.05, 60, 40, .5, .5, .2)

# Should return:
#    Power
# 0.4998959
```

---

random.sample   *Generate a random sample*

Description

Generates a random sample of participant IDs without replacement.

Usage

```
random.sample(popsize, samsize)
```

Arguments

popsize   study population size

samsize   sample size

Value

Returns a vector of randomly generated participant IDs

Examples

```
random.sample(3000, 25)

# Should return random numbers such as:
# [1]    37    94  134  186  212  408  485  697  722  781  998 1055
# [13] 1182 1224 1273 1335 1452 1552 1783 1817 2149 2188 2437 2850 2936
```

---

random.y   *Generate random sample of scores*

Description

Generates a random sample of scores from a normal distribution with a specified population mean and standard deviation. This function is useful for generating hypothetical data for classroom demonstrations.

Usage

```
random.y(n, m, sd, min, max, dec)
```

Arguments

n	sample size
m	population mean of scores
sd	population standard deviation of scores
min	minimum allowable value
max	maximum allowable value
dec	number of decimal points

Value

Returns a vector of randomly generated scores.

Examples

```
random.y(10, 3.6, 2.8, 1, 7, 0)

# Should return random numbers such as:
# [1] 2 7 7 1 6 3 1 3 2 1
```

---

random.yx   *Generates random bivariate scores*

Description

Generates a random sample of y scores and x scores from a bivariate normal distributions with specified population means, standard deviations, and correlation. This function is useful for generating hypothetical data for classroom demonstrations.

Usage

```
random.yx(n, my, mx, sdy, sdx, cor, dec)
```

Arguments

n	sample size
my	population mean of y scores
mx	population mean of x scores
sdy	population standard deviation of y scores
sdx	population standard deviation of x scores
cor	population correlation between x and y
dec	number of decimal points

Value

Returns n pairs of y and x scores

Examples

```
random.yx(10, 50, 20, 4, 2, .5, 1)

# Should return:
#       y    x
#  1  50.3 21.6
#  2  52.0 21.6
#  3  53.0 22.7
#  4  46.9 21.3
#  5  56.3 23.8
#  6  50.4 20.3
#  7  44.6 19.9
#  8  49.9 18.3
#  9  49.4 18.5
# 10  42.3 20.2
```

---

randomize   *Randomize a sample into groups*

Description

Randomly assigns a sample of participants into k groups.

Usage

```
randomize(n)
```

Arguments

n   k x 1 vector of sample sizes

Value

Returns a vector of randomly generated group assignments

Examples

```
n <- c(10, 10, 5)
randomize(n)

# Should return random numbers such as:
# [1] 2 3 2 1 1 2 3 3 2 1 2 1 3 1 1 2 3 1 1 2 2 1 1 2 2
```

Description

Computes the hit rate, false alarm rate, d-prime, threshold, and bias for one participant (observer) in a Yes/No signal detection study. An equal-variance Gaussian model is assumed. The parameter estimates are computed after adding .5 to the number of "Yes" responses in each condition (the signal and noise conditions) and adding 1 to the number of signal trials and to the number of noise trails. In memory recognition studies, the observer is first presented with set of words or images to study, and is later presented with another set of words or images where some items are from the first list (old items) and some items are new items.

For more details, see Section 3.8 of Bonett (2021, Volume 3)

Usage

```
signal(f1, f2, n1, n2)
```

Arguments

f1	number of "Yes" responses in the stimulus (old item) trials
f2	number of "Yes" responses in the noise (new item) trials
n1	number of stimulus (or old item) trials
n2	number of noise (or new item) trials

Value

Returns a 1-row matrix. The columns are:

- HR - estimate of hit rate
- FAR - estimate of false alarm rate
- d-prime - estimate of d-prime
- Threshold - estimate of threshold (criterion)
- Bias - estimate of threshold minus d-prime/2

References

Wickens TD (2002). *Elementary Signal Detection Theory*. Oxford.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
signal(82, 46, 100, 100)

# Should return:
#        HR      FAR  d-prime  Threshold       Bias
#  0.8168317 0.460396 1.002793 0.09943603 -0.4019603
```

---

sim.ci.cor	*Simulates confidence interval coverage probability for a Pearson cor-relation*

Description

Performs a computer simulation of confidence interval performance for a Pearson correlation. A bias adjustment is used to reduce the bias of the Fisher transformed Pearson correlation. Sample data can be generated from bivariate population distributions with five different marginal distributions. All distributions are scaled to have standard deviations of 1.0. Bivariate random data with specified marginal skewness and kurtosis are generated using the unonr function in the mnonr package.

Usage

```
sim.ci.cor(alpha, n, cor, dist1, dist2, rep)
```

Arguments

alpha	alpha level for 1-alpha confidence
n	sample size
cor	population Pearson correlation
dist1	type of distribution for variable 1 (1, 2, 3, 4, or 5)
dist2	type of distribution for variable 2 (1, 2, 3, 4, or 5)

- 1 = Gaussian (skewness = 0 and excess kurtosis = 0)
- 2 = platykurtic (skewness = 0 and excess kurtosis = -1.2)
- 3 = leptokurtic (skewness = 0 and excess kurtosis = 6)
- 4 = moderate skew (skewness = 1 and excess kurtosis = 1.5)
- 5 = large skew (skewness = 2 and excess kurtosis = 6)

rep	number of Monte Carlo samples

Value

Returns a 1-row matrix. The columns are:

- Coverage - probability of confidence interval including population correlation
- Lower Error - probability of lower limit greater than population correlation
- Upper Error - probability of upper limit less than population correlation
- Ave CI Width - average confidence interval width

Examples

```
sim.ci.cor(.05, 30, .7, 4, 5, 1000)

# Should return (within sampling error):
#      Coverage Lower Error Upper Error Ave CI Width
# [1,]  0.93815     0.05125      0.0106    0.7778518
```

---

sim.ci.mean   *Simulates confidence interval coverage probability for a mean*

Description

Performs a computer simulation of the confidence interval performance for a population mean. Sample data can be generated from five different population distributions. All distributions are scaled to have a standard deviation of 1.0.

Usage

```
sim.ci.mean(alpha, n, dist, rep)
```

Arguments

alpha	alpha level for 1-alpha confidence
n	sample size
dist	type of distribution (1, 2, 3, 4,or 5)

- 1 = Gaussian (skewness = 0 and excess kurtosis = 0)
- 2 = platykurtic (skewness = 0 and excess kurtosis = -1.2)
- 3 = leptokurtic (skewness = 0 and excess kurtosis = 6)
- 4 = moderate skew (skewness = 1 and excess kurtosis = 1.5)
- 5 = large skew (skewness = 2 and excess kurtosis = 6)

rep	number of Monte Carlo samples

Value

Returns a 1-row matrix. The columns are:

- Coverage - probability of confidence interval including population mean
- Lower Error - probability of lower limit greater than population mean
- Upper Error - probability of upper limit less than population mean
- Ave CI Width - average confidence interval width

Examples

```
sim.ci.mean(.05, 10, 1, 5000)

# Should return (within sampling error):
# Coverage Lower Error Upper Error Ave CI Width
#   0.9484      0.0264      0.0252     1.392041

sim.ci.mean(.05, 40, 4, 1000)

# Should return (within sampling error):
# Coverage Lower Error Upper Error Ave CI Width
#  0.94722     0.01738      0.0354    0.6333067
```

---

sim.ci.mean.ps	*Simulates confidence interval coverage probability for a paired-samples mean difference*

Description

Performs a computer simulation of confidence interval performance for a population mean difference in a paired-samples design. Sample data for the two levels of the within-subjects factor can be generated from bivariate population distributions with five different marginal distributions. All distributions are scaled to have a standard deviation of 1.0 at level 1. Bivariate random data with specified marginal skewness and kurtosis are generated using the unonr function in the mnonr package.

Usage

```
sim.ci.mean.ps(alpha, n, sd2, cor, dist1, dist2, rep)
```

Arguments

alpha	alpha level for 1-alpha confidence
n	sample size
sd2	population standard deviation at level 2
cor	population correlation of paired observations
dist1	type of distribution at level 1 (1, 2, 3, 4, or 5)
dist2	type of distribution at level 2 (1, 2, 3, 4, or 5)

- 1 = Gaussian (skewness = 0 and excess kurtosis = 0)
- 2 = platykurtic (skewness = 0 and excess kurtosis = -1.2)
- 3 = leptokurtic (skewness = 0 and excess kurtosis = 6)
- 4 = moderate skew (skewness = 1 and excess kurtosis = 1.5)
- 5 = large skew (skewness = 2 and excess kurtosis = 6)

rep	number of Monte Carlo samples

Value

Returns a 1-row matrix. The columns are:

- Coverage - probability of confidence interval including population mean difference
- Lower Error - probability of lower limit greater than population mean difference
- Upper Error - probability of upper limit less than population mean difference
- Ave CI Width - average confidence interval width

Examples

```
sim.ci.mean.ps(.05, 30, 1.5, .7, 4, 5, 1000)

# Should return (within sampling error):
# Coverage Lower Error Upper Error Ave CI Width
#  0.94415    0.04525      0.0106    0.7818518
```

---

sim.ci.mean2   *Simulates confidence interval coverage probability for a 2-group mean difference*

Description

Performs a computer simulation of separate variance and pooled variance confidence interval performance for a population mean difference in a 2-group design. Sample data within each group can be generated from five different population distributions. All distributions are scaled to have a standard deviation of 1.0 for group 1.

Usage

```
sim.ci.mean2(alpha, n1, n2, sd2, dist1, dist2, rep)
```

Arguments

alpha	alpha level for 1-alpha confidence
n1	sample size in group 1
n2	sample size in group 2
sd2	population standard deviation for group 2
dist1	type of distribution for group 1 (1, 2, 3, 4, or 5)
dist2	type of distribution for group 2 (1, 2, 3, 4, or 5)

- 1 = Gaussian (skewness = 0 and excess kurtosis = 0)
- 2 = platykurtic (skewness = 0 and excess kurtosis = -1.2)
- 3 = leptokurtic (skewness = 0 and excess kurtosis = 6)
- 4 = moderate skew (skewness = 1 and excess kurtosis = 1.5)
- 5 = large skew (skewness = 2 and excess kurtosis = 6)

rep	number of Monte Carlo samples

Value

Returns a 1-row matrix. The columns are:

- Coverage - probability of confidence interval including population mean difference
- Lower Error - probability of lower limit greater than population mean difference
- Upper Error - probability of upper limit less than population mean difference
- Ave CI Width - average confidence interval width

Examples

```
sim.ci.mean2(.05, 30, 25, 1.5, 1, 1, 1000)

# Should return (within sampling error):
#                            Coverage Lower Error Upper Error Ave CI Width
# Equal Variances Assumed:     0.93988      0.0322     0.02792     1.354437
# Equal Variances Not Assumed: 0.94904      0.0262     0.02476     1.411305

sim.ci.mean2(.05, 30, 25, 1.5, 4, 5, 1000)

# Should return (within sampling error):
#                            Coverage Lower Error Upper Error Ave CI Width
# Equal Variances Assumed:     0.93986     0.04022     0.01992     1.344437
# Equal Variances Not Assumed: 0.94762     0.03862     0.01376     1.401305
```

---

sim.ci.median   *Simulates confidence interval coverage probability for a median*

Description

Performs a computer simulation of the confidence interval performance for a population median. Sample data can be generated from five different population distributions. All distributions are scaled to have a standard deviation of 1.0.

Usage

```
sim.ci.median(alpha, n, dist, rep)
```

Arguments

alpha   alpha level for 1-alpha confidence

n   sample size

dist   type of distribution (1, 2, 3, 4, or 5)

- 1 = Gaussian (skewness = 0 and excess kurtosis = 0)
- 2 = platykurtic (skewness = 0 and excess kurtosis = -1.2)

- 3 = leptokurtic (skewness = 0 and excess kurtosis = 6)

- 4 = moderate skew (skewness = 1 and excess kurtosis = 1.5)

- 5 = large skew (skewness = 2 and excess kurtosis = 6)

rep   number of Monte Carlo samples

Value

Returns a 1-row matrix. The columns are:

- Coverage - probability of confidence interval including population median

- Lower Error - probability of lower limit greater than population median

- Upper Error - probability of upper limit less than population median

- Ave CI Width - average confidence interval width

Examples

```
sim.ci.median(.05, 20, 5, 1000)

# Should return (within sampling error):
# Coverage Lower Error Upper Error Ave CI Width
#   0.9589      0.0216       0.0195    0.9735528
```

---

sim.ci.median.ps   *Simulates confidence interval coverage probability for a median difference in a paired-samples design*

Description

Performs a computer simulation of confidence interval performance for a population median difference in a paired-samples design. Sample data for the two levels of the within-subjects factor can be generated from bivariate population distributions with five different marginal distributions. All distributions are scaled to have a standard deviation of 1.0 at level 1. Bivariate random data with specified marginal skewness and kurtosis are generated using the unonr function in the mnonr package.

Usage

```
sim.ci.median.ps(alpha, n, sd2, cor, dist1, dist2, rep)
```

Arguments

`alpha`	alpha level for 1-alpha confidence
`n`	sample size
`sd2`	population standard deviation at level 2
`cor`	population correlation of paired observations
`dist1`	type of distribution at level 1 (1, 2, 3, 4, or 5)
`dist2`	type of distribution at level 2 (1, 2, 3, 4, or 5)

- 1 = Gaussian (skewness = 0 and excess kurtosis = 0)
- 2 = platykurtic (skewness = 0 and excess kurtosis = -1.2)
- 3 = leptokurtic (skewness = 0 and excess kurtosis = 6)
- 4 = moderate skew (skewness = 1 and excess kurtosis = 1.5)
- 5 = large skew (skewness = 2 and excess kurtosis = 6)

`rep`	number of Monte Carlo samples

Value

Returns a 1-row matrix. The columns are:

- Coverage - probability of confidence interval including population median difference
- Lower Error - probability of lower limit greater than population median difference
- Upper Error - probability of upper limit less than population median difference
- Ave CI Width - average confidence interval width

Examples

```
sim.ci.median.ps(.05, 30, 1.5, .7, 4, 3, 1000)

# Should return (within sampling error):
# Coverage Lower Error Upper Error Ave CI Width
#   0.961      0.026       0.013      0.9435462
```

---

sim.ci.median2	*Simulates confidence interval coverage probability for a median difference in a 2-group design*

Description

Performs a computer simulation of the confidence interval performance for a difference of population medians in a 2-group design. Sample data for each group can be generated from five different population distributions. All distributions are scaled to have a standard deviation of 1.0 for group 1.

Usage

```
sim.ci.median2(alpha, n1, n2, sd2, dist1, dist2, rep)
```

Arguments

alpha   alpha level for 1-alpha confidence

n1   sample size for group 1

n2   sample size for group 2

sd2   population standard deviation for group 2

dist1   type of distribution for group 1 (1, 2, 3, 4, or 5)

dist2   type of distribution for group 2 (1, 2, 3, 4, or 5)

- 1 = Gaussian (skewness = 0 and excess kurtosis = 0)
- 2 = platykurtic (skewness = 0 and excess kurtosis = -1.2)
- 3 = leptokurtic (skewness = 0 and excess kurtosis = 6)
- 4 = moderate skew (skewness = 1 and excess kurtosis = 1.5)
- 5 = large skew (skewness = 2 and excess kurtosis = 6)

rep   number of Monte Carlo samples

Value

Returns a 1-row matrix. The columns are:

- Coverage - Probability of confidence interval including population median difference
- Lower Error - Probability of lower limit greater than population median difference
- Upper Error - Probability of upper limit less than population median difference
- Ave CI Width - Average confidence interval width

Examples

```
sim.ci.median2(.05, 20, 20, 2, 5, 4, 5000)

# Should return (within sampling error):
# Coverage Lower Error Upper Error Ave CI Width
#    0.952       0.027       0.021     2.368914
```

| sim.ci.spear | *Simulates confidence interval coverage probability for a Spearman correlation* |

Description

Performs a computer simulation of confidence interval performance for a Spearman correlation. Sample data can be generated from bivariate population distributions with five different marginal distributions. All distributions are scaled to have standard deviations of 1.0. Bivariate random data with specified marginal skewness and kurtosis are generated using the unonr function in the mnonr package.

Usage

```
sim.ci.spear(alpha, n, cor, dist1, dist2, rep)
```

Arguments

alpha	alpha level for 1-alpha confidence
n	sample size
cor	population Spearman correlation
dist1	type of distribution for variable 1 (1, 2, 3, 4, or 5)
dist2	type of distribution for variable 2 (1, 2, 3, 4, or 5)

- 1 = Gaussian (skewness = 0 and excess kurtosis = 0)
- 2 = platykurtic (skewness = 0 and excess kurtosis = -1.2)
- 3 = leptokurtic (skewness = 0 and excess kurtosis = 6)
- 4 = moderate skew (skewness = 1 and excess kurtosis = 1.5)
- 5 = large skew (skewness = 2 and excess kurtosis = 6)

rep	number of Monte Carlo samples

Value

Returns a 1-row matrix. The columns are:

- Coverage - probability of confidence interval including population correlation
- Lower Error - probability of lower limit greater than population correlation
- Upper Error - probability of upper limit less than population correlation
- Ave CI Width - average confidence interval width

Examples

```
sim.ci.spear(.05, 30, .7, 4, 5, 1000)

# Should return (within sampling error):
#      Coverage Lower Error Upper Error Ave CI Width
# [1,]  0.96235     0.01255      0.0251    0.4257299
```

---

sim.ci.stdmean.ps	*Simulates confidence interval coverage probability for a standardized mean difference in a paired-samples design*

Description

Performs a computer simulation of confidence interval performance for two types of standardized mean differences in a paired-samples design (see ci.stdmean.ps). Sample data for the two levels of the within-subjects factor can be generated from five different population distributions. All distributions are scaled to have a standard deviation of 1.0 at level 1. Bivariate random data with specified marginal skewness and kurtosis are generated using the unonr function in the mnonr package.

Usage

```
sim.ci.stdmean.ps(alpha, n, sd2, cor, dist1, dist2, d, rep)
```

Arguments

alpha	alpha level for 1-alpha confidence
n	sample size
sd2	population standard deviation at level 2
cor	correlation between paired measurements
dist1	type of distribution at level 1 (1, 2, 3, 4, or 5)
dist2	type of distribution at level 2 (1, 2, 3, 4, or 5)

- 1 = Gaussian (skewness = 0 and excess kurtosis = 0)
- 2 = platykurtic (skewness = 0 and excess kurtosis = -1.2)
- 3 = leptokurtic (skewness = 0 and excess kurtosis = 6)
- 4 = moderate skew (skewness = 1 and excess kurtosis = 1.5)
- 5 = large skew (skewness = 2 and excess kurtosis = 6)

d	population standardized mean difference
rep	number of Monte Carlo samples

Value

Returns a 1-row matrix. The columns are:

- Coverage - Probability of confidence interval including population std mean difference
- Lower Error - Probability of lower limit greater than population std mean difference
- Upper Error - Probability of upper limit less than population std mean difference
- Ave CI Width - Average confidence interval width

Examples

```
sim.ci.stdmean.ps(.05, 20, 1.5, .8, 4, 4, .5, 2000)

# Should return (within sampling error):
#                        Coverage Lower Error Upper Error Ave CI Width   Ave Est
# Unweighted Standardizer   0.9095      0.0555       0.035    0.7354865 0.5186796
# Level 1 Standardizer      0.9525      0.0255       0.022    0.9330036 0.5058198
```

---

sim.ci.stdmean2   *Simulates confidence interval coverage probability for a standardized mean difference in a 2-group design*

Description

Performs a computer simulation of confidence interval performance for two types of standardized mean differences in a 2-group design (see ci.stdmean2). Sample data for each group can be generated from five different population distributions. All distributions are scaled to have a standard deviation of 1.0 for group 1.

Usage

```
sim.ci.stdmean2(alpha, n1, n2, sd2, dist1, dist2, d, rep)
```

Arguments

alpha	alpha level for 1-alpha confidence
n1	sample size for group 1
n2	sample size for group 2
sd2	population standard deviation for group 2
dist1	type of distribution for group 1 (1, 2, 3, 4, or 5)
dist2	type of distribution for group 2 (1, 2, 3, 4, or 5)

- 1 = Gaussian (skewness = 0 and excess kurtosis = 0)
- 2 = platykurtic (skewness = 0 and excess kurtosis = -1.2)
- 3 = leptokurtic (skewness = 0 and excess kurtosis = 6)

- 4 = moderate skew (skewness = 1 and excess kurtosis = 1.5)
- 5 = large skew (skewness = 2 and excess kurtosis = 6)

| d | population standardized mean difference |
| rep | number of Monte Carlo samples |

Value

Returns a 1-row matrix. The columns are:

- Coverage - Probability of confidence interval including population std mean difference
- Lower Error - Probability of lower limit greater than population std mean difference
- Upper Error - Probability of upper limit less than population std mean difference
- Ave CI Width - Average confidence interval width

Examples

```
sim.ci.stdmean2(.05, 20, 20, 1.5, 3, 4, .75, 5000)

# Should return (within sampling error):
#                        Coverage Lower Error Upper Error Ave CI Width   Ave Est
# Unweighted Standardizer   0.9058      0.0610      0.0332     1.342560 0.7838679
# Group 1 Standardizer      0.9450      0.0322      0.0228     1.827583 0.7862640
```

| size.ci.agree | *Sample size for a G-index confidence interval* |

Description

Computes the sample size required to estimate a population G-index of agreement for two dichotomous ratings with desired confidence interval precision. Set the G-index planning value to the smallest value within a plausible range for a conservatively large sample size.

For more details, see Section 3.12 of Bonett (2021, Volume 3)

Usage

```
size.ci.agree(alpha, G, w)
```

Arguments

alpha	alpha level for 1-alpha confidence
G	planning value of G-index
w	desired confidence interval width

Value

Returns the required sample size

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/.*

Examples

```
size.ci.agree(.05, .8, .2)

# Should return:
# Sample size
#       139
```

---

size.ci.ancova2   *Sample size for a 2-group ANCOVA confidence interval*

Description

Computes the sample size for each group required to estimate a mean difference in a 2-group AN-COVA model with desired confidence interval precision. In a nonexperimental design, the sample size is affected by the magnitude of covariate mean differences across groups. The covariate mean differences can be approximated by specifying the largest standardized covariate mean difference of all covariates. In an experiment, this standardized mean difference should be set to 0. Set the error variance planning value to the largest value within a plausible range for a conservatively large sample size.

For more details, see Section 2.28 of Bonett (2021, Volume 2)

Usage

```
size.ci.ancova2(alpha, evar, s, d, w, R)
```

Arguments

alpha	alpha level for 1-alpha confidence
evar	planning value of within group (error) variance
s	number of covariates
d	largest standardized mean difference of all covariates
w	desired confidence interval width
R	ratio of n2/n1

Value

Returns the required sample size for each group

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.ci.ancova2(.05, 1.37, 1, 0, 1.5, 1)

# Should return:
#  n1 n2
#  21 21

size.ci.ancova2(.05, 1.37, 1, 0, 1.5, 2)

# Should return:
#  n1 n2
#  16 32

size.ci.ancova2(.05, 1.37, 1, .75, 1.5, 1)

# Should return:
#  n1 n2
#  24 24
```

---

size.ci.biphi *Sample size for biserial-phi correlation confidence interval*

Description

Computes the sample size required to estimate a biserial-phi correlation with desired confidence interval precision. Set the biserial-phi planning value to the smallest absolute value within a plausible range for a conservatively large sample size. The column variable is assumed to be naturally dichotomous and the row variable is assumed to be artificially dichotomous.

Usage

```
size.ci.biphi(alpha, p1, p2, cor, w)
```

Arguments

alpha	alpha level for 1 - alpha confidence
p1	planning value for row 1 marginal proportion
p2	planning value for column 1 marginal proportion
cor	planning value for biserial-phi correlation
w	desired confidence interval width

Value

Returns the required sample size

Examples

```
size.ci.biphi(.05, .2, .5, .3, .4)

# Should return:
#  Sample size
#          195
```

---

size.ci.condmean   *Sample size for a conditional mean confidence interval*

Description

Computes the total sample size required to estimate a population conditional mean of y at x = x*
in a fixed-x linear regression model with desired confidence interval precision. The total sample
size would be allocated to the levels of the quantitative factor, and it might be necessary to increase
the total sample size to give the desired sample size at each level of the fixed factor. Set the error
variance planning value to the largest value within a plausible range for a conservatively large
sample size.

For more details, see Section 1.24 of Bonett (2021, Volume 2)

Usage

```
size.ci.condmean(alpha, evar, xvar, diff, w)
```

Arguments

alpha	alpha level for 1-alpha confidence
evar	planning value of within group (error) variance
xvar	variance of fixed predictor variable
diff	difference between x* and mean of x
w	desired confidence interval width

Value

Returns the required total sample size

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.ci.condmean(.05, 120, 125, 15, 5)

# Should return:
# Total sample size
#              210
```

---

size.ci.cor   *Sample size for a Pearson or partial correlation confidence interval*

Description

Computes the sample size required to estimate a population Pearson or partial correlation with desired confidence interval precision. Set s = 0 for a Pearson correlation. Set the correlation planning value to the smallest absolute value within a plausible range for a conservatively large sample size.

For more details, see Section 1.24 of Bonett (2021, Volume 2)

Usage

```
size.ci.cor(alpha, cor, s, w)
```

Arguments

alpha	alpha level for 1-alpha confidence
cor	planning value of correlation
s	number of control variables
w	desired confidence interval width

Value

Returns the required sample size

References

Bonett DG, Wright TA (2000). "Sample size requirements for estimating Pearson, Kendall and Spearman correlations." *Psychometrika*, **65**(1), 23–28. ISSN 0033-3123, doi:10.1007/BF02294183.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.ci.cor(.05, .3, 0, .2)

# Should return:
# Sample size
#       320
```

size.ci.cor.prior	*Sample size for a Pearson correlation confidence interval using an estimated correlation from a prior study*

Description

Computes the sample size required to estimate a Pearson correlation with desired confidence interval precision in applications where an estimated Pearson correlation from a prior study is available. The actual confidence interval width in the planned study will depend on the value of the estimated correlation in the planned study. An estimated correlation from a prior study can be used to compute a prediction interval for the value of the estimated correlation in the planned study, which is then used as a planning value in the sample size analysis. If the prediction interval includes 0, then the correlation planning value is set to 0; otherwise, the correlation planning value is set to the lower prediction limit (if the prior correlation is positive) or the upper prediction limit (if the prior correlation is negative). The probability that the prediction interval will have a width that is less than the desired width in the planned study is approximately 1 - alpha2.

This sample size approach assumes that the population Pearson correlation that was estimated in the prior study is very similar to the population Pearson correlation that will be estimated in the planned study. If an estimated Pearson correlation from a prior study is not available the researcher must use expert opinion to guess the value of the Pearson correlation that will be observed in the planned study. The size.ci.cor function uses a correlation planning value that is based on expert opinion regarding the likely value of the correlation estimate that will be observed in the planned study.

For more details, see Section 1.26 of Bonett (2021, Volume 2)

Usage

```
size.ci.cor.prior(alpha1, alpha2, cor0, n0, w)
```

Arguments

alpha1	alpha level for 1-alpha1 confidence in the planned study
alpha2	alpha level for the 1-alpha2 prediction interval
cor0	estimated correlation in prior study
n0	sample size in prior study
w	desired confidence interval width

Value

Returns the required sample size

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.ci.cor.prior(.05, .10, -.56, 120, .2)

# Should return:
# Sample size
#        246
```

---

size.ci.cor2	*Sample size for a 2-group Pearson correlation difference confidence interval*

Description

Computes the sample size required to estimate a difference in population Pearson or partial correlations with desired confidence interval precision in a 2-group design. Set the correlation planning values to the smallest absolute values within their plausible ranges for a conservatively large sample size.

Usage

```
size.ci.cor2(alpha, cor1, cor2, w)
```

Arguments

alpha	alpha level for 1-alpha confidence
cor1	correlation planning value for group 1
cor2	correlation planning value for group 2
w	desired confidence interval width

Value

Returns the required sample size

References

Bonett DG, Wright TA (2000). "Sample size requirements for estimating Pearson, Kendall and Spearman correlations." *Psychometrika*, **65**(1), 23–28. ISSN 0033-3123, doi:10.1007/BF02294183.

Examples

```
size.ci.cor2(.05, .8, .5, .2)

# Should return:
# Sample size per group
#                  271
```

size.ci.cronbach   *Sample size for a Cronbach reliability confidence interval*

Description

Computes the sample size required to estimate a Cronbach reliability with desired confidence interval precision. Set the reliability planning value to the smallest value within a plausible range for a conservatively large sample size.

Usage

```
size.ci.cronbach(alpha, rel, r, w)
```

Arguments

alpha	alpha value for 1-alpha confidence
rel	reliability planning value
r	number of measurements (items, raters, forms)
w	desired confidence interval width

Details

For more details, see Section 4.26 of Bonett (2021, Volume 1)

Value

Returns the required sample size

References

Bonett DG, Wright TA (2015). "Cronbach's alpha reliability: Interval estimation, hypothesis testing, and sample size planning." *Journal of Organizational Behavior*, **36**(1), 3–15. ISSN 08943796, doi:10.1002/job.1960.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.ci.cronbach(.05, .75, 5, .15)

# Should return:
# Sample size
#        109
```

size.ci.cronbach.prior

Sample size for a Cronbach reliability confidence interval using an reliability estimate from a prior study

Description

Computes the sample size required to estimate a Cronbach reliability with desired confidence interval precision in applications where an estimated Cronbach reliability from a prior study is available. The actual confidence interval width in the planned study will depend on the value of the estimated reliability in the planned study. An estimated Cronbach reliability from a prior study can be used to compute a lower prediction limit for the estimated reliability in the planned study, which is then used as a planning value in the sample size analysis. The probability that the prediction interval will have a width that is less than the desired width in the planned study is approximately 1 - alpha2.

This sample size approach assumes that the population Cronbach reliability that was estimated in the prior study is very similar to the population Cronbach reliability that will be estimated in the planned study. If an estimated Cronbach reliability from a prior study is not available, the researcher must use expert opinion to guess the value of the Cronbach reliability that will be observed in the planned study. The size.ci.cronbach function uses a reliability planning value that is based on expert opinion regarding the likely value of the reliability estimate that will be observed in the planned study.

Usage

```
size.ci.cronbach.prior(alpha1, alpha2, rel0, n0, r, w)
```

Arguments

alpha1	alpha level for 1-alpha1 confidence in the planned study
alpha2	alpha level for the 1-alpha2 prediction interval
rel0	estimated reliability in prior study
n0	sample size in prior study
r	number of measurements (items, raters, forms)
w	desired confidence interval width

Value

Returns the required sample size

Examples

```
size.ci.cronbach.prior(.05, .10, .86, 50, 5, .15)

# Should return:
# Sample size
#           71
```

---

size.ci.cronbach2   *Sample size for a 2-group Cronbach reliability difference confidence interval*

Description

Computes the sample size per group (assuming equal sample sizes) required to estimate a difference in population Cronbach reliability coefficients with desired precision in a 2-group design.

Usage

```
size.ci.cronbach2(alpha, rel1, rel2, r, w)
```

Arguments

alpha	alpha level for hypothesis test
rel1	reliability planning value for group 1
rel2	reliability planning value for group 2
r	number of measurements (items, raters, forms)
w	desired confidence interval width

Details

For more details, see Section 2.19 of Bonett (2021, Volume 4)

Value

Returns the required sample size for each group

References

Bonett DG, Wright TA (2015). "Cronbach's alpha reliability: Interval estimation, hypothesis testing, and sample size planning." *Journal of Organizational Behavior*, **36**(1), 3–15. ISSN 08943796, doi:10.1002/job.1960.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.ci.cronbach2(.05, .85, .70, 8, .15)

# Should return:
# Sample size per group
#                   180
```

---

size.ci.cv   *Sample size for a coefficient of variation*

Description

Computes an approximate sample size required to estimate a population coefficient of variation (CV) with desired confidence interval precision. Set the CV planning value to the largest value within a plausible range for a conservatively large sample size.

Usage

```
size.ci.cv(alpha, CV, w)
```

Arguments

alpha	alpha level for 1-alpha confidence
CV	planning value of coefficient of variation
w	desired confidence interval width

Value

Returns the required sample size

Examples

```
size.ci.cv(.05, .25, .10)

# Should return:
# Sample size
#         60
```

---

size.ci.etasqr   *Sample size for an eta-squared confidence interval*

Description

Computes the sample size required to estimate an eta-squared coefficient in a one-way ANOVA with desired confidence interval precision. Set the planning value of eta-squared to about 1/3 for a conservatively large sample size.

For more details, see Section 3.24 of Bonett (2021, Volume 1)

Usage

```
size.ci.etasqr(alpha, etasqr, groups, w)
```

Arguments

alpha	alpha level for 1-alpha confidence
etasqr	planning value of eta-squared
groups	number of groups
w	desired confidence interval width

Value

Returns the required sample size for each group

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.ci.etasqr(.05, .2, 3, .15)

# Should return:
# Sample size per group
#                    103
```

---

size.ci.gen   *Sample size for a confidence interval for any type of parameter*

Description

Computes the sample size required to estimate a single population parameter with desired precision using a standard error for the parameter estimate from a prior or pilot study. This function can be used with any type of parameter where the standard error of the parameter estimate is a function of the square root of the sample size (most parameter estimates have this property). This function also assumes that the sampling distribution of the parameter estimate is approximately normal in large samples.

Usage

```
size.ci.gen(alpha, se, n0, w)
```

Arguments

alpha	alpha level for hypothesis test
se	standard error of parameter estimate from prior/pilot study
n0	sample size of prior/pilot study
w	desired confidence interval width

Value

Returns the required sample size

Examples

```
size.ci.gen(.05, 2.89, 30, 8)

# Should return:
# Sample size
#          61
```

---

size.ci.gen2	*Sample size for a confidence interval for the difference of any type of parameter*

Description

Computes the sample size required to estimate a difference in population parameters with desired precision in a 2-group design using a standard error for a parameter estimate from a prior or pilot study. This function can be used with any type of parameter where the standard error of the parameter estimate is a function of the square root of the sample size (most parameter estimates have this property). This function also assumes that the sampling distribution of the parameter estimate is approximately normal in large samples. Set R = 1 for equal sample sizes.

Usage

```
size.ci.gen2(alpha, se, n0, w, R)
```

Arguments

alpha	alpha level for hypothesis test
se	standard error of parameter estimate from prior/pilot study
n0	sample size of prior/pilot study
w	desired confidence interval width
R	n2/n1 ratio

Value

Returns the required sample size for each group

Examples

```
size.ci.gen2(.05, .175, 30, .8, 1)

# Should return:
# n1  n2
# 45  45
```

---

size.ci.icc   *Sample size for a intraclass correlation confidence interval*

Description

Computes the sample size required to estimate an intraclass correlation with desired confidence interval precision. This type of intraclass correlation can be used to describe the reliability of a single measurement (e.g., a single rater or a single form of a test). This intraclass correlation assumes a two-factor (subject x measurement) model. Use the size.ci.cronbach function to determine the sample size required to estimate the reliability of a sum or average of r measurements (e.g., items) with desired confidence interval precision.

Usage

```
size.ci.icc(alpha, icc, r, w)
```

Arguments

alpha	alpha value for 1-alpha confidence
icc	intraclass correlation planning value
r	number of measurements (raters, forms, occasions)
w	desired confidence interval width

Details

Specifying an intraclass correlation planning value for a conservatively large sample size requirement is not straightforward with an intraclass correlation. For r = 2, the sample size requirement is largest for an intraclass correlation of zero. But for r = 3, 4, 5, 10, 20, and 40 an intraclass correlation planning value of about .26, .33, .38, .43, .44, and .45, respectively, maximizes the sample size requirement.

Value

Returns the required sample size

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

```
size.ci.icc(.05, .70, 3, .2)

# Should return:
# Sample size
#         68
```

---

size.ci.icc.prior	*Sample size for an intraclass correlation confidence interval using a planning value from a prior study*

Description

Computes the sample size required to estimate an intraclass correlation with desired confidence interval precision in applications where an estimated intraclass correlation from a prior study is available. The actual confidence interval width in the planned study will depend on the value of the estimated intraclas correlation in the planned study. An estimated intraclass correlation from a prior study can be used to compute a lower prediction limit for the estimated intraclass correlation in the planned study, which is then used as a planning value in the sample size analysis. The probability that the prediction interval will have a width that is less than the desired width in the planned study is approximately 1 - alpha2.

This sample size approach assumes that the population intraclass correlation that was estimated in the prior study is very similar to the population intraclass correlation that will be estimated in the planned study. If an estimated intraclas correlation from a prior study is not available, the researcher must use expert opinion to guess the value of the intraclass correlation that will be observed in the planned study. The size.ci.icc function uses an intraclass correlation planning value that is based on expert opinion regarding the likely value of the intraclass correlation estimate that will be observed in the planned study.

Usage

```
size.ci.icc.prior(alpha1, alpha2, cor0, n0, r, w)
```

Arguments

alpha1	alpha level for 1-alpha1 confidence in the planned study
alpha2	alpha level for the 1-alpha2 prediction interval
cor0	estimated correlation in prior study
n0	sample size in prior study
r	number of measurements (raters, forms)
w	desired confidence interval width

Value

Returns the required sample size

Examples

```
size.ci.icc.prior(.05, .10, .674, 50, 3, .2)

# Should return:
# Sample size
#         114
```

---

size.ci.indirect   *Sample size for an indirect effect confidence interval*

Description

Computes the approximate sample size required to estimate a population standardized indirect effect in a simple mediation model. The direct effect of the independent (exogenous) variable on the response variable, controlling for the mediator variable, is assumed to be negligible.

For more details, see Section 1.19 of Bonett (2021, Volume 4)

Usage

```
size.ci.indirect(alpha, cor1, cor2, w)
```

Arguments

alpha	alpha level for 1-alpha confidence
cor1	planning value of correlation between the independent and mediator variables
cor2	planning value of correlation between the mediator and response variables
w	desired confidence interval width

Value

Returns the required sample size

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/.*

Examples

```
size.ci.indirect(.05, .4, .5, .2)

# Should return:
# Sample size
#        106
```

---

size.ci.lc.ancova   *Sample size for a linear contrast confidence interval in an ANCOVA*

Description

Computes the sample size for each group (assuming equal sample sizes) required to estimate a population linear contrast of means in an ANCOVA model with desired confidence interval precision. In a nonexperimental design, the sample size is affected by the magnitude of covariate mean differences across groups. The covariate mean differences can be approximated by specifying the largest standardized covariate mean difference across all pairwise group differences and for all covariates. In an experiment, this standardized mean difference should be set to 0. Set the error variance planning value to the largest value within a plausible range for a conservatively large sample size.

For more details, see Section 2.28 of Bonett (2021, Volume 2)

Usage

```
size.ci.lc.ancova(alpha, evar, s, d, w, v)
```

Arguments

alpha	alpha level for 1-alpha confidence
evar	planning value of within group (error) variance
s	number of covariates
d	largest standardized mean difference for all covariates
w	desired confidence interval width
v	vector of between-subjects contrast coefficients

Value

Returns the required sample size for each group

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
v <- c(.5, .5, -.5, -.5)
size.ci.lc.ancova(.05, 6.4, 1, 0, 3.0, v)

# Should return:
# Sample size per group
#                      13
```

---

size.ci.lc.mean.bs	*Sample size for a between-subjects mean linear contrast confidence interval*

Description

Computes the sample size in each group (assuming equal sample sizes) required to estimate a linear contrast of population means with desired confidence interval precision in a between-subjects design. Set the variance planning value to the largest value within a plausible range for a conservatively large sample size.

For more details, see Section 3.24 of Bonett (2021, Volume 1)

Usage

```
size.ci.lc.mean.bs(alpha, var, w, v)
```

Arguments

alpha	alpha level for 1-alpha confidence
var	planning value of average within-group variance
w	desired confidence interval width
v	vector of between-subjects contrast coefficients

Value

Returns the required sample size for each group

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
v <- c(.5, .5, -.5, -.5)
size.ci.lc.mean.bs(.05, 8.0, 3.0, v)

# Should return:
# Sample size per group
#                    15
```

---

size.ci.lc.mean.ws	*Sample size for a within-subjects mean linear contrast confidence interval*

Description

Computes the sample size required to estimate a linear contrast of population means with desired confidence interval precision in a within-subjects design. Set the variance planning value to the largest value within a plausible range for a conservatively large sample size. Set the Pearson correlation planning value to the smallest value within a plausible range for a conservatively large sample size.

For more details, see Section 4.26 of Bonett (2021, Volume 1)

Usage

```
size.ci.lc.mean.ws(alpha, var, cor, w, q)
```

Arguments

alpha	alpha level for 1-alpha confidence
var	planning value of average variance of the measurements
cor	planning value of average correlation between measurements
w	desired confidence interval width
q	vector of within-subjects contrast coefficients

Value

Returns the required sample size

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/.*

Examples

```
q <- c(.5, .5, -.5, -.5)
size.ci.lc.mean.ws(.05, 161.9, .77, 4, q)

# Should return:
# Sample size
#         38
```

---

size.ci.lc.median.bs   *Sample size for a between-subjects median linear contrast confidence interval*

Description

Computes the sample size in each group (assuming equal sample sizes) required to estimate a linear contrast of population medians with desired confidence interval precision in a between-subjects design. Set the variance planning value to the largest value within a plausible range for a conservatively large sample size. The sample size requirement depends on the shape of the distribution. Select one of the four distribution options (Normal, Logistic, Laplace, Exponential) that approximates the most likely distribution shape in the planned study. Select the Normal distribution for a conservatively large sample size requirement.

For more details, see Sections 1.28 and 3.24 of Bonett (2021, Volume 1)

Usage

```
size.ci.lc.median.bs(alpha, var, w, v, dist)
```

Arguments

alpha	alpha level for 1-alpha confidence
var	planning value of average within-group variance
w	desired confidence interval width
v	vector of between-subjects contrast coefficients
dist	• set to 1 for Normal distribution (skew = 0, kurtosis = 3)
	• set to 2 for Logistic distribution (skew = 0, kurtosis = 4.2)
	• set to 3 for Laplace distribution (skew = 0, kurtosis = 6)
	• set to 4 for Gamma(5) (skew = .89, kurtosis = 4.2)
	• set to 5 for Exponential distribution (skew = 2, kurtosis = 9)

Value

Returns the required sample size for each group

References

Bonett DG, Price RM (2002). "Statistical inference for a linear function of medians: Confidence intervals, hypothesis testing, and sample size requirements." *Psychological Methods*, **7**(3), 370–383. ISSN 1939-1463, doi:10.1037/1082989X.7.3.370.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
v <- c(.5, .5, -1)
size.ci.lc.median.bs(.05, 5.62, 2.0, v, 1)

# Should return:
# Sample size per group
#                  51

size.ci.lc.median.bs(.05, 5.62, 2.0, v, 4)

# Should return:
# Sample size per group
#                  33
```

---

size.ci.lc.prop.bs	*Sample size for a between-subjects proportion linear contrast confidence interval*

Description

Computes the sample size in each group (assuming equal sample sizes) required to estimate a linear contrast of population proportions with desired confidence interval precision in a between-subjects design. Set the proportion planning values to .5 for a conservatively large sample size.

For more details, see Section 2.22 of Bonett (2021, Volume 3)

Usage

```
size.ci.lc.prop.bs(alpha, p, w, v)
```

Arguments

alpha	alpha level for 1-alpha confidence
p	vector of proportion planning values
w	desired confidence interval width
v	vector of between-subjects contrast coefficients

Value

Returns the required sample size for each group

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
p <- c(.1, .2, .2, .3)
v <- c(.5, -.5, .5, -.5)
size.ci.lc.prop.bs(.05, p, .2, v)

# Should return:
# Sample size per group
#                   60
```

---

size.ci.lc.stdmean.bs   *Sample size for a between-subjects standardized linear contrast of means confidence interval*

Description

Computes the sample size per group (assuming equal sample sizes) required to estimate two types of standardized linear contrasts of population means (unweighted average standardizer and single group standardizer) with desired confidence interval precision in a between-subjects design. Set the standardized linear contrast of means to the largest value within a plausible range for a conservatively large sample size.

For more details, see Section 3.24 of Bonett (2021, Volume 1)

Usage

```
size.ci.lc.stdmean.bs(alpha, d, w, v)
```

Arguments

alpha	alpha level for 1-alpha confidence
d	planning value of standardized linear contrast of means
w	desired confidence interval width
v	vector of between-subjects contrast coefficients

Value

Returns the required sample size per group for each standardizer

References

Bonett DG (2009). "Estimating standardized linear contrasts of means with desired precision." *Psychological Methods*, **14**(1), 1–5. ISSN 1939-1463, doi:10.1037/a0014270.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
v <- c(.5, .5, -1)
size.ci.lc.stdmean.bs(.05, .8, .6, v)

# Should return:
#                              Sample size per group
# Unweighted standardizer:                        69
# Single group standardizer:                      78
```

---

size.ci.lc.stdmean.ws   *Sample size for a within-subjects standardized linear contrast of means confidence interval*

Description

Computes the sample size required to estimate two types of standardized linear contrasts of population means (unweighted standardizer and single level standardizer) with desired confidence interval precision in a within-subjects design. For a conservatively large sample size, set the standardized linear contrast of means planning value to the largest value within a plausible range, and set the Pearson correlation planning value to the smallest value within a plausible range.

For more details, see Section 4.26 of Bonett (2021, Volume 1)

Usage

```
size.ci.lc.stdmean.ws(alpha, d, cor, w, q)
```

Arguments

alpha	alpha level for 1-alpha confidence
d	planning value of standardized linear contrast
cor	planning value of average correlation between measurements
w	desired confidence interval width
q	vector of within-subjects contrast coefficients

Value

Returns the required sample size for each standardizer

References

Bonett DG (2009). "Estimating standardized linear contrasts of means with desired precision." *Psychological Methods*, **14**(1), 1–5. ISSN 1939-1463, doi:10.1037/a0014270.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
q <- c(1/3, 1/3, 1/3, -1)
size.ci.lc.stdmean.ws(.05, .5, .7, .4, q)

# Should return:
#                                 Sample size
# Unweighted standardizer:            46
# Single level standardizer:          51
```

---

size.ci.mape	*Sample size for a mean absolute prediction error confidence interval*

Description

Computes the sample size required to estimate a population mean absolute prediction error for a general linear model with desired confidence interval precision. Setting s = 0 gives the sample size requirement for a mean absolute deviation in a one-group design. This function assumes that the prediction errors have an approximate normal distribution.

Usage

```
size.ci.mape(alpha, mape, s, w)
```

Arguments

alpha	alpha value for 1-alpha confidence
mape	mean absolute prediction error planning value
s	number of predictor variables
w	desired confidence interval width

Value

Returns the required sample size

Examples

```
size.ci.mape(.05, 4.5, 5, 2)

# Should return:
# Sample size
#           57
```

---

size.ci.mean   *Sample size for a mean confidence interval*

Description

Computes the sample size required to estimate a population mean with desired confidence interval precision. Set the variance planning value to the largest value within a plausible range for a conservatively large sample size.

For more details, see Section 1.28 of Bonett (2021, Volume 1)

Usage

```
size.ci.mean(alpha, var, w)
```

Arguments

alpha   alpha level for 1-alpha confidence

var   planning value of response variable variance

w   desired confidence interval width

Value

Returns the required sample size

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.ci.mean(.05, 6.0, 1.5)

# Should return:
# Sample size
#          43
```

---

size.ci.mean.prior   *Sample size for a mean confidence interval using an estimated vari-ance from a prior study*

Description

Computes the sample size required to estimate a population mean with desired confidence interval precision in applications where an estimated variance from a prior study is available. The actual confidence interval width in the planned study will depend on the value of the estimated variance in the planned study. An estimated variance from a prior study can be used to compute an upper prediction limit for the estimated variance in the planned study. The upper prediction limit is then used as the variance planning value. The probability that the prediction interval in the planned study will have a width that is less than the desired width is approximately 1 - alpha2.

This sample size approach assumes that the population variance in the prior study is very similar to the population variance in the planned study. If an estimated variance from a prior study is not available, the researcher must use expert opinion to guess the value of the variance that will be observed in the planned study. The size.ci.mean function uses a variance planning value that is based on expert opinion regarding the likely value of the variance estimate that will be observed in the planned study.

For more details, see Section 1.31 of Bonett (2021, Volume 1)

Usage

```
size.ci.mean.prior(alpha1, alpha2, var0, n0, w)
```

Arguments

alpha1	alpha level for 1-alpha1 confidence in the planned study
alpha2	alpha level for the 1-alpha2 prediction interval
var0	estimated variance in prior study
n0	sample size in prior study
w	desired confidence interval width

Value

Returns the required sample size

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/.*

Examples

```
size.ci.mean.prior(.05, .10, 0.71, 204, .4)

# Should return:
# Sample size
#          88
```

---

size.ci.mean.ps	*Sample size for a paired-samples mean difference confidence interval*

Description

Computes the sample size required to estimate a difference in population means with desired confidence interval precision in a paired-samples design. Set the Pearson correlation planning value to the smallest value within a plausible range for a conservatively large sample size. Set the variance planning value to the largest value within a plausible range for a conservatively large sample size.

For more details, see Section 4.26 of Bonett (2021, Volume 1)

Usage

```
size.ci.mean.ps(alpha, var, cor, w)
```

Arguments

alpha	alpha level for 1-alpha confidence
var	planning value of average variance of the two measurements
cor	planning value of correlation between measurements
w	desired confidence interval width

Value

Returns the required sample size

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.ci.mean.ps(.05, 5.0, .5, 2.0)

# Should return:
# Sample size
#          22
```

---

size.ci.mean2   *Sample size for a 2-group mean difference confidence interval*

Description

Computes the sample size for each group required to estimate a population mean difference with desired confidence interval precision in a 2-group design. Set the variance planning value to the largest value within a plausible range for a conservatively large sample size. Set R = 1 for equal sample sizes. For unequal sample sizes, this function assumes approximately equal population variances.

For more details, see Section 2.13 of Bonett (2021, Volume 1)

Usage

```
size.ci.mean2(alpha, var, w, R)
```

Arguments

alpha	alpha level for 1-alpha confidence
var	planning value of average within-group variance
w	desired confidence interval width
R	n2/n1 ratio

Value

Returns the required sample size for each group

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/.*

Examples

```
size.ci.mean2(.01, 81, 12, 1)

# Should return:
# n1  n2
# 32  32

size.ci.mean2(.05, 4.0, 2.5, 2)

# Should return:
# n1  n2
# 16  32
```

---

size.ci.median *Sample size for a median confidence interval*

Description

Computes the sample size required to estimate a population median with desired confidence interval precision. Set the variance planning value to the largest value within a plausible range for a conservatively large sample size. The sample size requirement depends on the shape of the distribution. Select one of the four distribution options (Normal, Logistic, Laplace, Exponential) that approximates the most likely distribution shape in the planned study. Select the Normal distribution for a conservatively large sample size requirement.

For more details, see Section 1.28 of Bonett (2021, Volume 1)

Usage

```
size.ci.median(alpha, var, w, dist)
```

Arguments

alpha	alpha level for 1-alpha confidence
var	planning value of response variable variance
w	desired confidence interval width
dist	• set to 1 for Normal distribution (skew = 0, kurtosis = 3)
	• set to 2 for Logistic distribution (skew = 0, kurtosis = 4.2)
	• set to 3 for Laplace distribution (skew = 0, kurtosis = 6)
	• set to 4 for Gamma(5) (skew = .89, kurtosis = 4.2)
	• set to 5 for Exponential distribution (skew = 2, kurtosis = 9)

Value

Returns the required sample size

References

Bonett DG, Price RM (2002). "Statistical inference for a linear function of medians: Confidence intervals, hypothesis testing, and sample size requirements." *Psychological Methods*, **7**(3), 370–383. ISSN 1939-1463, doi:10.1037/1082989X.7.3.370.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.ci.median(.05, 264.4, 10, 1)

# Should return:
# Sample size
#          64
```

```
size.ci.median(.05, 264.4, 10, 3)

# Should return:
# Sample size
#          21
```

---

size.ci.median2   *Sample size for a 2-group median difference confidence interval*

Description

Computes the sample size for each group required to estimate a population median difference with desired confidence interval precision in a 2-group design. Set the variance planning value to the largest value within a plausible range for a conservatively large sample size. The sample size requirement depends on the shape of the distribution. Select one of the four distribution options (Normal, Logistic, Laplace, Exponential) that approximates the most likely distribution shape in the planned study. Select the Normal distribution for a conservatively large sample size requirement. Set R = 1 for equal sample sizes.

For more details, see Sections 1.28 and 2.13 of Bonett (2021, Volume 1)

Usage

```
size.ci.median2(alpha, var, w, R, dist)
```

Arguments

alpha   alpha level for 1-alpha confidence

var   planning value of average within-group variance

w   desired confidence interval width

R   n2/n1 ratio

dist
- set to 1 for Normal distribution (skew = 0, kurtosis = 3)
- set to 2 for Logistic distribution (skew = 0, kurtosis = 4.2)
- set to 3 for Laplace distribution (skew = 0, kurtosis = 6)
- set to 4 for Gamma(5) (skew = .89, kurtosis = 4.2)
- set to 5 for Exponential distribution (skew = 2, kurtosis = 9)

Value

Returns the required sample size for each group

References

Bonett DG, Price RM (2002). "Statistical inference for a linear function of medians: Confidence intervals, hypothesis testing, and sample size requirements." *Psychological Methods*, **7**(3), 370–383. ISSN 1939-1463, doi:10.1037/1082989X.7.3.370.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.ci.median2(.05, 37.1, 5, 1, 1)

# Should return:
# n1  n2
# 72  72

size.ci.median2(.05, 37.1, 5, 2, 4)

# Should return:
# n1  n2
# 51 102
```

---

size.ci.oddsratio   *Sample size for an odds ratio confidence interval*

Description

Computes the sample size required to estimate an odds ratio with desired confidence interval precision.

Usage

```
size.ci.oddsratio(alpha, p1, p2, or, r)
```

Arguments

alpha	alpha level for 1 - alpha confidence
p1	planning value for row 1 marginal proportion
p2	planning value for column 1 marginal proportion
or	planning value of odds ratio
r	desired upper to lower confidence interval endpoint ratio

Value

Returns the required sample size

Examples

```
size.ci.oddsratio(.05, .3, .2, 5.5, 3.0)

# Should return:
#  Sample size
#       356
```

---

size.ci.pbcor   *Sample size for a point-biserial correlation confidence interval*

Description

Computes the sample size required to estimate a population point-biserial correlation with desired confidence interval precision in a two-group nonexperimental design with simple random sampling. A two-group nonexperimental design implies two subpopulations (e.g., all boys and all girls in a school district). This function requires a planning value for the proportion of population members who belong to one of the two subpopulations. Set the correlation planning value to the smallest absolute value within a plausible range for a conservatively large sample size.

For more details, see Section 1.24 of Bonett (2021, Volume 2)

Usage

```
size.ci.pbcor(alpha, cor, w, p)
```

Arguments

alpha	alpha level for 1-alpha confidence
cor	planning value of point-biserial correlation
w	desired confidence interval width
p	proportion of members in one of the two subpopulations

Value

Returns the required sample size

References

Bonett DG (2020). "Point-biserial correlation: Interval estimation, hypothesis testing, meta-analysis, and sample size determination." *British Journal of Mathematical and Statistical Psychology*, **73**(S1), 113–144. ISSN 0007-1102, doi:10.1111/bmsp.12189.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/.*

Examples

```
size.ci.pbcor(.05, .40, .25, .73)

# Should return:
# Sample size
#        168
```

---

size.ci.phi   *Sample size for phi correlation confidence interval*

Description

Computes the sample size required to estimate a phi correlation with desired confidence interval precision. Set the phi correlation planning value to the smallest absolute value within a plausible range for a conservatively large sample size.

Usage

```
size.ci.phi(alpha, p1, p2, phi, w)
```

Arguments

alpha	alpha level for 1 - alpha confidence
p1	planning value for row 1 marginal proportion
p2	planning value for column 1 marginal proportion
phi	planning value for phi correlation
w	desired confidence interval width

Value

Returns the required sample size

Examples

```
size.ci.phi(.05, .7, .8, .35, .2)

# Should return:
#  Sample size
#        416
```

---

size.ci.prop   *Sample size for a proportion confidence interval*

Description

Computes the sample size required to estimate a population proportion with desired confidence interval precision. Set the proportion planning value to .5 for a conservatively large sample size.

For more details, see Section 1.14 of Bonett (2021, Volume 3)

Usage

```
size.ci.prop(alpha, p, w)
```

Arguments

alpha	alpha level for 1-alpha confidence
p	planning value of proportion
w	desired confidence interval width

Value

Returns the required sample size

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.ci.prop(.05, .5, .1)

# Should return:
# Sample size
#         385
```

size.ci.prop.prior	*Sample size for a proportion confidence interval using an estimated proportion from a prior study*

Description

Computes the sample size required to estimate a population proportion with desired confidence interval precision in applications where an estimated proportion from a prior study is available. The actual confidence interval width in the planned study will depend on the value of the estimated proportion in the planned study. An estimated proportion from a prior study is used to predict the value of the estimated proportion in the planned study, and the predicted proportion estimate is then used as a planning value in the sample size computation. The probability that the prediction interval in the planned study will have a width that is less than the desired width is approximately 1 - alpha2.

This sample size approach assumes that the population proportion in the prior study is very similar to the population proportion in the planned study. If an estimated proportion from a prior study is not available the researcher must use expert opinion to guess the value of the proportion that will be observed in the planned study. The size.ci.prop function uses a proportion planning value that is based on expert opinion regarding the likely value of the proportion estimate that will be observed in the planned study.

For more details, see Section 1.16 of Bonett (2021, Volume 3)

Usage

```
size.ci.prop.prior(alpha1, alpha2, p0, n0, w)
```

Arguments

alpha1	alpha level for 1-alpha1 confidence in the planned study
alpha2	alpha level for the 1-alpha2 prediction interval
p0	estimated proportion in prior study
n0	sample size in prior study
w	desired confidence interval width

Value

Returns the required sample size

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.ci.prop.prior(.05, .10, .78, 50, .1)

# Should return:
# Sample size
#        384
```

---

size.ci.prop.ps	*Sample size for a paired-sample proportion difference confidence interval*

Description

Computes the sample size required to estimate a population proportion difference with desired confidence interval precision in a paired-samples design. Set the proportion planning values to .5 for a conservatively large sample size. Set the phi correlation planning value to the smallest value within a plausible range for a conservatively large sample size.

For more details, see Section 3.12 of Bonett (2021, Volume 3)

Usage

```
size.ci.prop.ps(alpha, p1, p2, phi, w)
```

Arguments

alpha	alpha level for 1-alpha confidence
p1	planning value of proportion for measurement 1
p2	planning value of proportion for measurement 2
phi	planning value of phi correlation
w	desired confidence interval width

Value

Returns the required sample size

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.ci.prop.ps(.05, .25, .35, .6, .1)

# Should return:
# Sample size
#         257
```

---

size.ci.prop2   *Sample size for a 2-group proportion difference confidence interval*

Description

Computes the sample size in each group required to estimate a difference of proportions with desired confidence interval precision in a 2-group design. Set the proportion planning values to .5 for a conservatively large sample size. Set R = 1 for equal sample sizes.

For more details, see Section 2.22 of Bonett (2021, Volume 3)

Usage

```
size.ci.prop2(alpha, p1, p2, w, R)
```

Arguments

alpha	alpha level for 1-alpha confidence
p1	planning value of proportion for group 1
p2	planning value of proportion for group 2
w	desired confidence interval width
R	n2/n1 ratio

Value

Returns the required sample size for each group

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.ci.prop2(.05, .05, .15, .1, 1)

# Should return:
#   n1  n2
#  269 269

size.ci.prop2(.05, .4, .2, .15, .5)

# Should return:
#   n1  n2
#  383 192
```

---

size.ci.ratio.mean.ps   *Sample size for a paired-samples mean ratio confidence interval*

Description

Computes the sample size required to estimate a ratio of population means with desired confidence interval precision in a paired-samples design. Set the correlation planning value to the smallest value within a plausible range for a conservatively large sample size. This function requires planning values for each mean and the sample size requirement is very sensitive to these planning values. Set the variance planning value to the largest value within a plausible range for a conservatively large sample size.

For more details, see Section 4.26 of Bonett (2021, Volume 1)

Usage

```
size.ci.ratio.mean.ps(alpha, var, m1, m2, cor, r)
```

Arguments

alpha	alpha level for 1-alpha confidence
var	planning value of average variance of the two measurements
m1	planning value of mean for measurement 1
m2	planning value of mean for measurement 2
cor	planning value for correlation between measurements
r	desired upper to lower confidence interval endpoint ratio

Value

Returns the required sample size

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.ci.ratio.mean.ps(.05, 400, 150, 100, .7, 1.2)

# Should return:
# Sample size
#          21
```

---

size.ci.ratio.mean2   *Sample size for a 2-group mean ratio confidence interval*

Description

Computes the sample size in each group required to estimate a ratio of population means with desired confidence interval precision in a 2-group design. This function requires planning values for each mean and the sample size requirement is very sensitive to these planning values. Set the variance planning value to the largest value within a plausible range for a conservatively large sample size. Set R = 1 for equal sample sizes. For unequal sample sizes, this function assumes approximately equal population variances.

For more details, see Section 2.13 of Bonett (2021, Volume 1)

Usage

```
size.ci.ratio.mean2(alpha, var, m1, m2, r, R)
```

Arguments

alpha	alpha level for 1-alpha confidence
var	planning value of average within-group variance
m1	planning value of mean for group 1
m2	planning value of mean for group 2
r	desired upper to lower confidence interval endpoint ratio
R	n2/n1 ratio

Value

Returns the required sample size for each group

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.ci.ratio.mean2(.05, .4, 3.5, 3.1, 1.2, 1)

# Should return:
# n1   n2
# 70   70

size.ci.ratio.mean2(.05, .4, 3.5, 3.1, 1.2, 2)

# Should return:
# n1   n2
# 53   106
```

---

size.ci.ratio.prop.ps   *Sample size for a paired-samples proportion ratio confidence interval*

Description

Computes the sample size required to estimate a ratio of population proportions with desired confidence interval precision in a paired-samples design. Set the phi correlation planning value to the smallest value within a plausible range for a conservatively large sample size.

For more details, see Section 3.12 of Bonett (2021, Volume 3)

Usage

```
size.ci.ratio.prop.ps(alpha, p1, p2, phi, r)
```

Arguments

alpha	alpha level for 1-alpha confidence
p1	planning value of proportion for measurement 1
p2	planning value of proportion for measurement 2
phi	planning value of phi correlation
r	desired upper to lower confidence interval endpoint ratio

Value

Returns the required sample size

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.ci.ratio.prop.ps(.05, .4, .2, .7, 2)

# Should return:
# Sample size
#          67
```

---

size.ci.ratio.prop2   *Sample size for a 2-group proportion ratio confidence interval*

Description

Computes the sample size in each group required to estimate a ratio of proportions with desired confidence interval precision in a 2-group design. Set R = 1 for equal sample sizes.

For more details, see Section 2.22 of Bonett (2021, Volume 3)

Usage

```
size.ci.ratio.prop2(alpha, p1, p2, r, R)
```

Arguments

alpha	alpha level for 1-alpha confidence
p1	planning value of proportion for group 1
p2	planning value of proportion for group 2
r	desired upper to lower confidence interval endpoint ratio
R	n2/n1 ratio

Value

Returns the required sample size for each group

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.ci.ratio.prop2(.05, .9, .7, 1.5, 1)

# Should return:
#   n1  n2
#   51  51

size.ci.ratio.prop2(.05, .9, .7, 1.5, .5)
```

```
# Should return:
#  n1  n2
#  91  46
```

---

size.ci.rsqr   *Sample size for a squared multiple correlation confidence interval*

Description

Computes the sample size required to estimate a population squared multiple correlation in a random-x regression model with desired confidence interval precision. Set the planning value of the squared multiple correlation to 1/3 for a conservatively large sample size.

For more details, see Section 2.28 of Bonett (2021, Volume 2)

Usage

```
size.ci.rsqr(alpha, r2, s, w)
```

Arguments

alpha	alpha level for 1-alpha confidence
r2	planning value of squared multiple correlation
s	number of predictor variables in model
w	desired confidence interval width

Value

Returns the required sample size

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.ci.rsqr(.05, .3, 5, .2)

# Should return:
# Sample size
#        227
```

---

size.ci.sd   *Sample size for a standard deviation confidence interval*

Description

Computes the sample size required to estimate a population standard deviation with desired confidence interval precision. This function assumes that the traditional confidence interval for a population standard deviation will be used. The traditional confidence interval assumes that the response variable has an approximate normal distribution and can be highly innacurate when this assumption is not satisfied.

Usage

```
size.ci.sd(alpha, r)
```

Arguments

alpha   alpha level for 1-alpha confidence
r   desired upper to lower confidence interval endpoint ratio

Value

Returns the required sample size

Examples

```
size.ci.sd(.05, 1.5)

# Should return:
# Sample size
#         49
```

---

size.ci.second   *Sample size for a second-stage confidence interval*

Description

Computes the second-stage sample size required to obtain desired confidence interval precision. This function can use either the total sample size for all groups in the first stage sample or a single group sample size in the first stage sample. If the total first-stage sample size is given, then the function computes the total sample size required in the second-stage sample. If a single group first-stage sample size is given, then the function computes the single-group sample size required in the second-stage sample. The second-stage sample is combined with the first-stage sample to obtain the desired confidence interval width.

For more details, see Section 1.30 of Bonett (2021, Volume 1)

Usage

```
size.ci.second(n0, w0, w)
```

Arguments

n0	first-stage sample size
w0	confidence interval width in first-stage sample
w	desired confidence interval width

Value

Returns the required sample size for the second-stage sample

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/.*

Examples

```
size.ci.second(25, 4.38, 2.0)

# Should return:
# Second-stage sample size
#                         95
```

---

size.ci.slope   *Sample size for a slope confidence interval*

Description

Computes the total sample size required to estimate a population slope with desired confidence interval precision in a between-subjects design with a quantitative factor. In an experimental design, the total sample size would be allocated to the levels of the quantitative factor and it might be necessary to increase the total sample size to achieve equal sample sizes. Set the error variance planning value to the largest value within a plausible range for a conservatively large sample size.

For more details, see Section 1.24 of Bonett (2021, Volume 2)

Usage

```
size.ci.slope(alpha, evar, x, w)
```

Arguments

alpha	alpha level for 1-alpha confidence
evar	planning value of within-group (error) variance
x	vector of x values of the quantitative factor
w	desired confidence interval width

Value

Returns the required total sample size

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/.*

Examples

```
x <- c(5, 7, 9)
size.ci.slope(.05, 300, x, 5)

# Should return:
# Total sample size
#                73
```

---

size.ci.slope.gen	*Sample size for a slope confidence interval in a general statistical model*

Description

Computes the sample size required to estimate a slope coefficient with desired confidence interval precision in any type of statistical model. This function requires a standard error estimate for the slope of interest from a prior or pilot study and the sample size that was used in the prior or pilot study. This function can be used for both unstandardized and standardized slopes. This function also can be used for both unstandardized and standardized factor loadings in a confirmatory factor analysis model. This function will soon be replaced with size.ci.gen.

For more details, see Section 2.28 of Bonett (2021, Volume 2)

Usage

```
size.ci.slope.gen(alpha, se, n0, w)
```

Arguments

alpha	alpha level for 1-alpha confidence
se	standard error of slope from prior/pilot study
n0	sample size used in prior/pilot study
w	desired confidence interval width

Value

Returns the required sample size

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.ci.slope.gen(.05, 3.15, 50, 5)

# Should return:
#  Sample size
#         305
```

---

size.ci.spear	*Sample size for a Spearman correlation confidence interval*

Description

Computes the sample size required to estimate a population Spearman correlation with desired confidence interval precision. Set the correlation planning value to the smallest absolute value within a plausible range for a conservatively large sample size.

Usage

```
size.ci.spear(alpha, cor, w)
```

Arguments

alpha	alpha level for 1-alpha confidence
cor	planning value of Spearman correlation
w	desired confidence interval width

Value

Returns the required sample size

References

Bonett DG, Wright TA (2000). "Sample size requirements for estimating Pearson, Kendall and Spearman correlations." *Psychometrika*, **65**(1), 23–28. ISSN 0033-3123, doi:10.1007/BF02294183.

Examples

```
size.ci.spear(.05, .362, .25)

# Should return:
# Sample size
#        200
```

---

size.ci.spear2	*Sample size for a 2-group Spearman correlation difference confidence interval*

Description

Computes the sample size required to estimate a difference in population Spearman correlations with desired confidence interval precision in a 2-group design. Set the correlation planning values to the smallest absolute values within their plausible ranges for a conservatively large sample size.

Usage

```
size.ci.spear2(alpha, cor1, cor2, w)
```

Arguments

alpha	alpha level for 1-alpha confidence
cor1	Spearman correlation planning value for group 1
cor2	Spearman correlation planning value for group 2
w	desired confidence interval width

Value

Returns the required sample size

References

Bonett DG, Wright TA (2000). "Sample size requirements for estimating Pearson, Kendall and Spearman correlations." *Psychometrika*, **65**(1), 23–28. ISSN 0033-3123, doi:10.1007/BF02294183.

Examples

```
size.ci.spear2(.05, .8, .5, .2)

# Should return:
# Sample size per group
#                       314
```

---

size.ci.stdmean.ps   *Sample size for a paired-samples standardized mean difference confidence interval*

Description

Computes the sample size required to estimate two types of population standardized mean differences (unweighted standardizer and single group standardizer) with desired confidence interval precision in a paired-samples design. Set the standardized mean difference planning value to the largest value within a plausible range, and set the Pearson correlation planning value to the smallest value within a plausible range for a conservatively large sample size.

For more details, see Section 4.26 of Bonett (2021, Volume 1)

Usage

```
size.ci.stdmean.ps(alpha, d, cor, w)
```

Arguments

alpha	alpha level for 1-alpha confidence
d	planning value of standardized mean difference
cor	planning value of correlation between measurements
w	desired confidence interval width

Value

Returns the required sample size for each standardizer

References

Bonett DG (2009). "Estimating standardized linear contrasts of means with desired precision." *Psychological Methods*, **14**(1), 1–5. ISSN 1939-1463, doi:10.1037/a0014270.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.ci.stdmean.ps(.05, 1, .65, .6)

# Should return:
#                            Sample Size
# Unweighted standardizer:        46
# Single group standardizer:      52
```

---

size.ci.stdmean2	*Sample size for a 2-group standardized mean difference confidence interval*

Description

Computes the sample size per group required to estimate two types of population standardized mean differences (unweighted standardizer and single group standardizer) with desired confidence interval precision in a 2-group design. Set the standardized mean difference planning value to the largest value within a plausible range for a conservatively large sample size. Set R = 1 for equal sample sizes. For unequal sample sizes, this function assumes approximately equal population variances.

For more details, see Section 2.13 of Bonett (2021, Volume 1)

Usage

```
size.ci.stdmean2(alpha, d, w, R)
```

Arguments

alpha	alpha level for 1-alpha confidence
d	planning value of standardized mean difference
w	desired confidence interval width
R	n2/n1 ratio

Value

Returns the required sample size per group for each standardizer

References

Bonett DG (2009). "Estimating standardized linear contrasts of means with desired precision." *Psychological Methods*, **14**(1), 1–5. ISSN 1939-1463, doi:10.1037/a0014270.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.ci.stdmean2(.05, 1.0, .5, 1)

# Should return:
#                             n1  n2
# Unweighted standardizer:    139 139
# Single group standardizer:  154 154

size.ci.stdmean2(.05, 1.0, .5, 2)

# Should return:
#                             n1  n2
# Unweighted standardizer:    104 208
# Single group standardizer:  116 232
```

---

size.ci.tetra   *Sample size for a tetrachoric correlation confidence interval*

Description

Computes the sample size required to estimate a tetrachoric correlation with desired confidence interval precision. Set the tetrachoric planning value to the smallest absolute value within a plausible range for a conservatively large sample size.

Usage

```
size.ci.tetra(alpha, p1, p2, cor, w)
```

Arguments

alpha	alpha level for 1 - alpha confidence
p1	planning value for row 1 marginal proportion
p2	planning value for column 1 marginal proportion
cor	tetrachoric planning value
w	desired confidence interval width

Value

Returns the required sample size

References

Bonett DG, Price RM (2005). "Inferential methods for the tetrachoric correlation coefficient." *Journal of Educational and Behavioral Statistics*, **30**(2), 213–225. ISSN 1076-9986, doi:10.3102/10769986030002213.

Examples

```
size.ci.tetra(.05, .5, .3, .7, .25)

# Should return:
#  Sample size
#          304
```

---

size.ci.yule   *Sample size for a Yule's Q confidence interval*

Description

Computes the sample size required to estimate Yule's Q with desired confidence interval precision. Set the Yule's Q planning value to the smallest absolute value within a plausible range for a conservatively large sample size.

Usage

```
size.ci.yule(alpha, p1, p2, Q, w)
```

Arguments

alpha	alpha level for 1 - alpha confidence
p1	planning value for row 1 marginal proportion
p2	planning value for column 1 marginal proportion
Q	planning value of Yule's Q
w	desired confidence interval width

Value

Returns the required sample size

Examples

```
size.ci.yule(.05, .3, .2, .5, .4)

# Should return:
#  Sample size
#          354
```

---

size.equiv.mean.ps   *Sample size for a paired-samples mean equivalence test*

Description

Computes the sample size required to perform an equivalence test for the difference in population means with desired power in a paired-samples design. The value of h specifies a range of practical equivalence, -h to h, for the difference in population means. The planning value for the absolute mean difference must be less than h. Equivalence tests often require a very large sample size. Equivalence tests usually use 2 x alpha rather than alpha (e.g., use alpha = .10 rather alpha = .05). Set the Pearson correlation value to the smallest value within a plausible range, and set the variance planning value to the largest value within a plausible range for a conservatively large sample size.

For more details, see Section 4.27 of Bonett (2021, Volume 1)

Usage

```
size.equiv.mean.ps(alpha, pow, var, es, cor, h)
```

Arguments

alpha	alpha level for hypothesis test
pow	desired power
var	planning value of average variance of the two measurements
es	planning value of mean difference
cor	planning value of the correlation between measurements
h	upper limit for range of practical equivalence

Value

Returns the required sample size

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.equiv.mean.ps(.10, .90, 25, .5, .75, 2)

# Should return:
# Sample size
#          49
```

`size.equiv.mean2` *Sample size for a 2-group mean equivalence test*

Description

Computes the sample size in each group (assuming equal sample sizes) required to perform an equivalence test for the difference in population means with desired power in a 2-group design. The value of h specifies a range of practical equivalence, -h to h, for the difference in population means. The planning value for the absolute mean difference must be less than h. Equivalence tests often require a very large sample size. Equivalence tests usually use 2 x alpha rather than alpha (e.g., use alpha = .10 rather alpha = .05). Set the variance planning value to the largest value within a plausible range for a conservatively large sample size.

For more details, see Section 2.14 of Bonett (2021, Volume 1)

Usage

```
size.equiv.mean2(alpha, pow, var, es, h)
```

Arguments

alpha	alpha level for hypothesis test
pow	desired power
var	planning value of average within-group variance
es	planning value of mean difference
h	upper limit for range of practical equivalence

Value

Returns the required sample size for each group

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.equiv.mean2(.10, .80, 15, 2, 4)

# Should return:
# Sample size per group
#                   50
```

size.equiv.prop.ps   *Sample size for a paired-samples proportion equivalence test*

Description

Computes the sample size required to perform an equivalence test for the difference in population proportions with desired power in a paired-samples design. The value of h specifies a range of practical equivalence, -h to h, for the difference in population proportions. The absolute difference in the proportion planning values must be less than h. Equivalence tests often require a very large sample size. Equivalence tests usually use 2 x alpha rather than alpha (e.g., use alpha = .10 rather alpha = .05). This function sets the effect size equal to the difference in proportion planning values. Set the phi correlation planning value to the smallest absolute value within a plausible range for a conservatively large sample size.

For more details, see Section 3.13 of Bonett (2021, Volume 3)

Usage

```
size.equiv.prop.ps(alpha, pow, p1, p2, phi, h)
```

Arguments

alpha	alpha level for hypothesis test
pow	desired power
p1	planning value of proportion for measurement 1
p2	planning value of proportion for measurement 2
phi	planning value of phi correlation
h	upper limit for range of practical equivalence

Value

Returns the required sample size

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.equiv.prop.ps(.1, .8, .30, .35, .40, .15)

# Should return:
# Sample size
#        173
```

Description

Computes the sample size in each group (assuming equal sample sizes) required to perform an equivalence test for the difference in population proportions with desired power in a 2-group design. The value of h specifies a range of practical equivalence, -h to h, for the difference in population proportions. The absolute difference in the proportion planning values must be less than h. Equivalence tests often require a very large sample size. Equivalence tests usually use 2 x alpha rather than alpha (e.g., use alpha = .10 rather than alpha = .05). This function sets the effect size equal to the difference in proportion planning values.

For more details, see Section 2.23 of Bonett (2021, Volume 3)

Usage

```
size.equiv.prop2(alpha, pow, p1, p2, h)
```

Arguments

alpha	alpha level for hypothesis test
pow	desired power
p1	planning value of proportion for group 1
p2	planning value of proportion for group 2
h	upper limit for range of practical equivalence

Value

Returns the required sample size for each group

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.equiv.prop2(.1, .9, .8, .8, .075)

# Should return:
# Sample size per group
#                     488
```

size.equiv.prop2

size.interval.cor   *Sample size for an interval test of a Pearson or partial correlation*

Description

Computes the sample size required to perform an interval test for a population Pearson or a partial correlation with desired power where the interval midpoint is equal to zero. This function can be used to plan a study where the goal is to show that the population correlation is small. Set s = 0 for a Pearson correlation. The correlation planning value must be a value within the hypothesized interval.

For more details, see Section 1.25 of Bonett (2021, Volume 2)

Usage

```
size.interval.cor(alpha, pow, cor, s, h)
```

Arguments

alpha	alpha level for hypothesis test
pow	desired power
cor	planning value of correlation
s	number of control variables
h	upper limit of hypothesized interval

Value

Returns the required sample size

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/.*

Examples

```
size.interval.cor(.05, .9, .1, 0, .3)

# Should return:
# Sample size
#        251
```

---

size.supinf.mean.ps	*Sample size for a paired-samples mean superiority or noninferiority test*

Description

Computes the sample size required to perform a superiority or noninferiority test for the difference in population means with desired power in a paired-samples design. For a superiority test, specify the upper limit (h) for the range of practical equivalence and specify an effect size (es) such that es > h. For a noninferiority test, specify the lower limit (-h) for the range of practical equivalence and specify an effect size such that es > -h. Set the Pearson correlation planning value to the smallest value within a plausible range, and set the variance planning value to the largest value within a plausible range for a conservatively large sample size.

For more details, see Section 4.27 of Bonett (2021, Volume 1)

Usage

```
size.supinf.mean.ps(alpha, pow, var, es, cor, h)
```

Arguments

alpha	alpha level for hypothesis test
pow	desired power
var	planning value of average variance of the two measurements
es	planning value of mean difference
cor	planning value of the correlation between measurements
h	upper or lower limit for range of practical equivalence

Value

Returns the required sample size

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.supinf.mean.ps(.05, .80, 225, 9, .75, 4)

# Should return:
# Sample size
#          38
```

---

size.supinf.mean2   *Sample size for a 2-group mean superiority or noninferiority test*

Description

Computes the sample size in each group (assuming equal sample sizes) required to perform a superiority or noninferiority test for the difference in population means with desired power in a 2-group design. For a superiority test, specify the upper limit (h) for the range of practical equivalence and specify an effect size (es) such that es > h. For a noninferiority test, specify the lower limit (-h) for the range of practical equivalence and specify an effect size such that es > -h. Set the variance planning value to the largest value within a plausible range for a conservatively large sample size.

For more details, see Section 2.14 of Bonett (2021, Volume 1)

Usage

```
size.supinf.mean2(alpha, pow, var, es, h)
```

Arguments

alpha	alpha level for hypothesis test
pow	desired power
var	planning value of average within-group variance
es	planning value of mean difference
h	upper or lower limit for range of practical equivalence

Value

Returns the required sample size for each group

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/.*

Examples

```
size.supinf.mean2(.05, .80, 225, 9, 4)

# Should return:
# Sample size per group
#                    143
```

size.supinf.prop.ps   *Sample size for a paired-samples superiority or inferiority test of proportions*

Description

Computes the sample size required to perform a superiority or inferiority test for the difference in population proportions with desired power in a paired-samples design. For a superiority test, specify the upper limit (h) for the range of practical equivalence and specify values of p1 and p2 such that p1 - p2 > h. For an inferiority test, specify the lower limit (-h) for the range of practical equivalence and specify values of p1 and p2 such that p1 - p2 > -h. This function sets the effect size equal to p1 - p2. Set the phi correlation planning value to the smallest absolute value within a plausible range for a conservatively large sample size.

For more details, see Section 3.13 of Bonett (2021, Volume 3)

Usage

```
size.supinf.prop.ps(alpha, pow, p1, p2, phi, h)
```

Arguments

alpha	alpha level for hypothesis test
pow	desired power
p1	planning value of proportion for measurement 1
p2	planning value of proportion for measurement 2
phi	planning value of phi correlation
h	lower or upper limit for range of practical equivalence

Value

Returns the required sample size

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.supinf.prop.ps(.05, .9, .35, .20, .45, .05)

# Should return:
# Sample size
#         227
```

size.supinf.prop2   *Sample size for a 2-group superiority or inferiority test of proportions*

Description

Computes the sample size in each group (assuming equal sample sizes) required to perform a superiority or inferiority test for the difference in population proportions with desired power in a 2-group design. For a superiority test, specify the upper limit (h) for the range of practical equivalence and specify values of p1 and p2 such that p1 - p2 > h. For an inferiority test, specify the lower limit (-h) for the range of practical equivalence and specify values of p1 and p2 such that p1 - p2 > -h. This function sets the effect size equal to p1 - p2.

For more details, see Section 2.23 of Bonett (2021, Volume 3)

Usage

```
size.supinf.prop2(alpha, pow, p1, p2, h)
```

Arguments

alpha	alpha level for hypothesis test
pow	desired power
p1	planning value of proportion for group 1
p2	planning value of proportion for group 2
h	lower or upper limit for range of practical equivalence

Value

Returns the required sample size for each group

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.supinf.prop2(.05, .9, .35, .20, .05)

# Should return:
# Sample size per group
#                   408
```

size.test.ancova2   *Sample size for a 2-group ANCOVA hypothesis test*

Description

Computes the sample size for each group required to test a mean difference in an ANCOVA model with desired power in a 2-group design. In a nonexperimental design, the sample size is affected by the magnitude of covariate mean differences across groups. The covariate mean differences can be approximated by specifying the largest standardized covariate mean difference across of all covariates. In an experiment, this standardized mean difference is set to 0. Set the error variance planning value to the largest value within a plausible range for a conservatively large sample size.

For more details, see Section 2.29 of Bonett (2021, Volume 2)

Usage

```
size.test.ancova2(alpha, pow, evar, es, s, d, R)
```

Arguments

alpha	alpha level for hypothesis test
pow	desired power
evar	planning value of within-group (error) variance
es	planning value of mean difference
s	number of covariates
d	largest standardized mean difference of all covariates
R	n2/n1 ratio

Value

Returns the required sample size for each group

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.test.ancova2(.05, .9, 1.37, .7, 1, 0, 1)

# Should return:
#  n1 n2
#  61 61

size.test.ancova2(.05, .9, 1.37, .7, 1, 0, 2)

# Should return:
```

```
#  n1 n2
#  47 94

size.test.ancova2(.05, .9, 1.37, .7, 1, .5, 1)

# Should return:
#  n1 n2
#  65 65
```

---

size.test.cor   *Sample size for a test of a Pearson or partial correlation*

Description

Computes the sample size required to test a population Pearson or a partial correlation with desired power. Set s = 0 for a Pearson correlation.

For more details, see Section 1.25 of Bonett (2021, Volume 2)

Usage

```
size.test.cor(alpha, pow, cor, s, h)
```

Arguments

alpha	alpha level for hypothesis test
pow	desired power
cor	planning value of correlation
s	number of control variables
h	null hypothesis value of correlation

Value

Returns the required sample size

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.test.cor(.05, .95, -.50, 0, 0)

# Should return:
# Sample size
#          47

size.test.cor(.05, .90, .4, 2, 0)

# Should return:
# Sample size
#          64
```

---

size.test.cor2	*Sample size for a test of equal Pearson or partial correlation in a 2-group design*

Description

Computes the sample size required to test equality of two Pearson or partial correlation with desired power in a 2-group design. Set s = 0 for a Pearson correlation. Set R = 1 for equal sample sizes.

Usage

```
size.test.cor2(alpha, pow, cor1, cor2, s, R)
```

Arguments

alpha	alpha level for hypothesis test
pow	desired power
cor1	correlation planning value for group 1
cor2	correlation planning value for group 2
s	number of control variables
R	n2/n1 ratio

Value

Returns the required sample size for each group

Examples

```
size.test.cor2(.05, .8, .4, .2, 0, 1)

# Should return:
#  n1  n2
# 325 325

size.test.cor2(.05, .8, .4, .2, 0, 2)

# Should return:
#  n1  n2
# 245 490
```

---

size.test.cronbach   *Sample size to test a Cronbach reliability*

Description

Computes the sample size required to test a Cronbach reliability with desired power.

Usage

```
size.test.cronbach(alpha, pow, rel, r, h)
```

Arguments

alpha	alpha level for hypothesis test
pow	desired power
rel	reliability planning value
r	number of measurements (items, raters, forms)
h	null hypothesis value of reliability

Value

Returns the required sample size

References

Bonett DG, Wright TA (2015). "Cronbach's alpha reliability: Interval estimation, hypothesis testing, and sample size planning." *Journal of Organizational Behavior*, **36**(1), 3–15. ISSN 08943796, doi:10.1002/job.1960.

Examples

```
size.test.cronbach(.05, .85, .80, 5, .7)

# Should return:
# Sample size
#          139
```

---

size.test.cronbach2   *Sample size to test equality of Cronbach reliability coefficients in a 2-group design*

Description

Computes the sample size required to test a difference in population Cronbach reliability coefficients with desired power in a 2-group design.

Usage

```
size.test.cronbach2(alpha, pow, rel1, rel2, r)
```

Arguments

alpha	alpha level for hypothesis test
pow	desired power
rel1	reliability planning value for group 1
rel2	reliability planning value for group 2
r	number of measurements (items, raters, forms)

Value

Returns the required sample size for each group

References

Bonett DG, Wright TA (2015). "Cronbach's alpha reliability: Interval estimation, hypothesis testing, and sample size planning." *Journal of Organizational Behavior*, **36**(1), 3–15. ISSN 08943796, doi:10.1002/job.1960.

Examples

```
size.test.cronbach2(.05, .80, .85, .70, 8)

# Should return:
# Sample size per group
#                     77
```

---

size.test.gen   *Sample size for a test of any type of parameter*

Description

Computes the sample size required to test a single population parameter with desired power using a standard error for the parameter estimate from a prior or pilot study. This function can be used with any type of parameter where the standard error of the parameter estimate is a function of the square root of the sample size (most parameter estimates have this property). This function also assumes that the sampling distribution of the parameter estimate is approximately normal in large samples.

For more details, see Section 2.29 of Bonett (2021, Volume 2)

Usage

```
size.test.gen(alpha, pow, se, n0, es)
```

Arguments

alpha	alpha level for hypothesis test
pow	desired power
se	standard error of parameter estimate from prior/pilot study
n0	sample size of prior/pilot study
es	planning value of parameter minus null hypothesis value

Value

Returns the required sample size

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.test.gen(.05, .8, 2.89, 30, 5)

# Should return:
# Sample size
#          79
```

| size.test.gen2 | *Sample size for a test of 2-group difference for any type of parameter* |

Description

Computes the sample size per group required to test a difference in two population parameters with desired power using a standard error for a single parameter estimate from a prior or pilot study. This function can be used with any type of parameter where the standard error of the parameter estimate is a function of the square root of the sample size (most parameter estimates have this property). This function also assumes that the sampling distribution of the parameter estimate is approximately normal in large samples. Set R = 1 for equal sample sizes.

Usage

```
size.test.gen2(alpha, pow, se, n0, es, R)
```

Arguments

alpha	alpha level for hypothesis test
pow	desired power
se	standard error of parameter estimate from prior/pilot study
n0	sample size of prior/pilot study
es	planning value of parameter difference
R	n2/n1 ratio

Value

Returns the required sample size for each group

Examples

```
size.test.gen2(.05, .85, .175, 30, .5, 1)

# Should return:
# n1  n2
# 66  66
```

---

size.test.lc.ancova   *Sample size for a mean linear contrast test in an ANCOVA*

Description

Computes the sample size for each group (assuming equal sample sizes) required to test a linear contrast of population means in an ANCOVA model with desired power. In a nonexperimental design, the sample size is affected by the magnitude of covariate mean differences across groups. The covariate mean differences can be approximated by specifying the largest standardized covariate mean difference across all pairwise comparisons and for all covariates. In an experiment, this standardized mean difference is set to 0. Set the error variance planning value to the largest value within a plausible range for a conservatively large sample size.

For more details, see Section 2.29 of Bonett (2021, Volume 2)

Usage

```
size.test.lc.ancova(alpha, pow, evar, es, s, d, v)
```

Arguments

alpha	alpha level for hypothesis test
pow	desired power
evar	planning value of within-group (error) variance
es	planning value of linear contrast
s	number of covariates
d	largest standardized mean difference for all covariates
v	vector of between-subjects contrast coefficients

Value

Returns the required sample size for each group

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
v <- c(.25, .25, .25, .25, -1)
size.test.lc.ancova(.05, .9, 17.5, 4.0, 2, 0, v)

# Should return:
# Sample size per group
#                   17
```

---

size.test.lc.mean.bs   *Sample size for a test of a between-subjects mean linear contrast*

Description

Computes the sample size in each group (assuming equal sample sizes) required to test a linear contrast of population means with desired power in a between-subjects design. Set the variance planning value to the largest value within a plausible range for a conservatively large sample size.

For more details, see Section 3.25 of Bonett (2021, Volume 1)

Usage

```
size.test.lc.mean.bs(alpha, pow, var, es, v)
```

Arguments

alpha	alpha level for hypothesis test
pow	desired power
var	planning value of average within-group variance
es	planning value of linear contrast of means
v	vector of between-subjects contrast coefficients

Value

Returns the required sample size for each group

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/.*

Examples

```
v <- c(1/4, 1/4, 1/4, 1/4, -1)
size.test.lc.mean.bs(.05, .90, 1, .5, v)

# Should return:
# Sample size per group
#                     53

v <- c(1, -1, -1, 1)
size.test.lc.mean.bs(.05, .90, 27.5, 5, v)

# Should return:
# Sample size per group
#                     47
```

---

size.test.lc.mean.ws   *Sample size for a test of a within-subjects mean linear contrast*

Description

Computes the sample size required to test a linear contrast of population means with desired power in a within-subjects design. Set the average variance planning value to the largest value within a plausible range for a conservatively large sample size. Set the average correlation planning value to the smallest value within a plausible range for a conservatively large sample size.

For more details, see Section 4.27 of Bonett (2021, Volume 1)

Usage

```
size.test.lc.mean.ws(alpha, pow, var, es, cor, q)
```

Arguments

alpha	alpha level for hypothesis test
pow	desired power
var	planning value of average variance of measurements
es	planning value of linear contrast of means
cor	planning value of average correlation between measurements
q	vector of with-subjects contrast coefficients

Value

Returns the required sample size

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
q <- c(1, -1, -1, 1)
size.test.lc.mean.ws(.05, .95, 15.0, 3, .8, q)

# Should return:
# Sample size
#          20
```

---

size.test.lc.prop.bs   *Sample size for a test of between-subjects proportion linear contrast*

Description

Computes the sample size in each group (assuming equal sample sizes) required to test a linear contrast of population proportions with desired power in a between-subjects design. The planning value for the effect size (linear contrast of proportions) could be set equal to the linear contrast of proportion planning values or it could be set equal to a minimally interesting effect size. For a conservatively large sample size, set the proportion planning values to .5 and set the effect size to a minimally interesting value.

For more details, see Section 2.23 of Bonett (2021, Volume 3)

Usage

```
size.test.lc.prop.bs(alpha, pow, p, es, v)
```

Arguments

alpha	alpha level for hypothesis test
pow	desired power
p	vector of proportion planning values
es	planning value of proportion linear contrast
v	vector of between-subjects contrast coefficients

Value

Returns the required sample size for each group

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
p <- c(.35, .35, .20)
v <- c(.5, .5, -1)
size.test.lc.prop.bs(.05, .9, p, .15, v)

# Should return:
# Sample size per group
#                 128
```

---

size.test.mann   *Sample size for a Mann-Whitney test*

Description

Computes the sample size in each group (assuming equal sample sizes) required for the Mann-Whitney test with desired power. A planning value of the Mann-Whitney parameter is required. In a 2-group experiment, this parameter is the proportion of members in the population with scores that would be larger under treatment 1 than treatment 2. In a 2-group nonexperiment where participants are sampled from two subpopulations of sizes N1 and N2, the parameter is the proportion of all N1 x N2 pairs in which a member from subpopulation 1 has a larger score than a member from subpopulation 2.

For more details, see Section 2.14 of Bonett (2021, Volume 1)

Usage

```
size.test.mann(alpha, pow, p)
```

Arguments

alpha	alpha level for hypothesis test
pow	desired power
p	planning value of Mann-Whitney parameter

Value

Returns the required sample size for each group

References

Noether GE (1987). "Sample size determination for some common nonparametric tests." *Journal of the American Statistical Association*, **82**(398), 645–647. ISSN 0162-1459, doi:10.1080/01621459.1987.10478478.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.test.mann(.05, .90, .3)

# Should return:
# Sample size per group
#                      44
```

---

size.test.mean   *Sample size for a test of a mean*

Description

Computes the sample size required to test a single population mean with desired power in a 1-group design. Set the variance planning value to the largest value within a plausible range for a conservatively large sample size.

For more details, see Section 1.29 of Bonett (2021, Volume 1)

Usage

```
size.test.mean(alpha, pow, var, es)
```

Arguments

alpha	alpha level for hypothesis test
pow	desired power
var	planning value of response variable variance
es	planning value of mean minus null hypothesis value

Value

Returns the required sample size

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.test.mean(.05, .9, 8.2, 1.5)

# Should return:
# Sample size
#          41
```

---

size.test.mean.ps   *Sample size for a test of a paired-samples mean difference*

Description

Computes the sample size required to test a difference in population means with desired power in a paired-samples design. Set the Pearson correlation planning value to the smallest value within a plausible range, and set the variance planning value to the largest value within a plausible range for a conservatively large sample size.

For more details, see Section 4.27 of Bonett (2021, Volume 1)

Usage

```
size.test.mean.ps(alpha, pow, var, es, cor)
```

Arguments

alpha	alpha level for hypothesis test
pow	desired power
var	planning value of average variance of the two measurements
es	planning value of mean difference
cor	planning value of correlation

Value

Returns the required sample size

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.test.mean.ps(.05, .80, 1.25, .5, .75)

# Should return:
# Sample size
#         22
```

size.test.mean2	*Sample size for a test of a 2-group mean difference*

Description

Computes the sample size in each group required to test a difference in population means with desired power in a 2-group design. Set the variance planning value to the largest value within a plausible range for a conservatively large sample size. Set R = 1 for equal sample sizes. For unequal sample sizes, this function assumes approximately equal population variances.

For more details, see Section 2.14 of Bonett (2021, Volume 1)

Usage

```
size.test.mean2(alpha, pow, var, es, R)
```

Arguments

alpha	alpha level for hypothesis test
pow	desired power
var	planning value of average within-group variance
es	planning value of mean difference
R	n2/n1 ratio

Value

Returns the required sample size for each group

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.test.mean2(.05, .95, 100, 10, 1)

# Should return:
# n1  n2
# 27  27

size.test.mean2(.05, .95, 100, 10, 3)

# Should return:
# n1  n2
# 19  57

size.test.mean2(.05, .95, 100, 10, .5)
```

```
# Should return:
# n1  n2
# 40  20
```

---

size.test.prop   *Sample size for a test of a single proportion*

Description

Computes the sample size required to test a population proportion with desired power (using a correction for continuity) in a 1-group design.

For more details, see Section 1.15 of Bonett (2021, Volume 3)

Usage

```
size.test.prop(alpha, pow, p, h)
```

Arguments

alpha	alpha level for hypothesis test
pow	desired power
p	planning value of proportion
h	null hypothesis value of proportion

Value

Returns the required sample size

References

Fleiss JL, Paik MC (2003). *Statistical Methods for Rates and Proportions*, 3rd edition. Wiley.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.test.prop(.05, .9, .5, .3)

# Should return:
# Sample size
#          65
```

---

size.test.prop.ps	*Sample size for a test of a paired-samples proportion difference*

Description

Computes the sample size required to test a difference in population proportions with desired power in a paired-samples design. This function requires planning values for both proportions and a phi coefficient that describes the correlation between the two dichotomous measurements. The proportion planning values can be set to .5 for a conservatively large sample size. The planning value for the effect size (proportion difference) could be set equal to the difference of the two proportion planning values or it could be set equal to a minimally interesting effect size. Set the phi correlation planning value to the smallest absolute value within a plausible range for a conservatively large sample size.

For more details, see Section 3.13 of Bonett (2021, Volume 3)

Usage

```
size.test.prop.ps(alpha, pow, p1, p2, phi, es)
```

Arguments

alpha	alpha level for hypothesis test
pow	desired power
p1	planning value of proportion for measurement 1
p2	planning value of proportion for measurement 2
phi	planning value of phi correlation
es	planning value of proportion difference

Value

Returns the required sample size

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.test.prop.ps(.05, .90, .6, .7, .5, .1)

# Should return:
# Sample size
#        237
```

---

size.test.prop2   *Sample size for a test of a 2-group proportion difference*

Description

Computes the sample size in each group required to test a difference in population proportions
with desired power (using a continuity correction) in a 2-group design. This function requires
planning values for both proportions. Set each proportion planning value to .5 for a conservatively
large sample size requirement. This function does not require the planning value for the proportion
difference (effect size) to equal the difference of the two proportion planning values; for example,
the planning value of the proportion difference could be set equal to a minimally interesting effect
size.

For more details, see Section 2.23 of Bonett (2021, Volume 3)

Usage

```
size.test.prop2(alpha, pow, p1, p2, es)
```

Arguments

alpha	alpha level for hypothesis test
pow	desired power
p1	planning value of proportion for group 1
p2	planning value of proportion for group 2
es	planning value of proportion difference (effect size)

Value

Returns the required sample size for each group

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/.*

Examples

```
size.test.prop2(.05, .8, .6, .4, .2)
# Should return:
# Sample size per group
#                   106

size.test.prop2(.05, .8, .5, .5, .2)
# Should return:
# Sample size per group
#                   109
```

---

size.test.sign   *Sample size for a 1-group sign test*

Description

Computes the sample size required for a 1-group sign test with desired power (see size.test.sign.ps for a paired-samples sign test). The Sign test is a test of the null hypothesis that the population median is equal to some specified value. This null hypothesis can also be expressed in terms of the proportion of scores in the population that are greater than the hypothesized population median value. Under the null hypothesis, the population proportion is equal to .5. This function requires a planning value of the population proportion.

For more details, see Section 1.29 of Bonett (2021, Volume 1)

Usage

```
size.test.sign(alpha, pow, p)
```

Arguments

alpha	alpha level for hypothesis test
pow	desired power
p	planning value of proportion

Value

Returns the required sample size

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
size.test.sign(.05, .90, .3)

# Should return:
# Sample size
#          67
```

---

size.test.sign.ps   *Sample size for a paired-samples sign test*

Description

Computes sample size required for a paired-samples sign test with desired power. The null hypothesis can be expressed in terms of a population proportion. In a paired-samples experiment, the proportion is defined as the proportion of members in the population with scores that would be larger under treatment 1 than treatment 2. In a paired-samples nonexperiment, the proportion is the proportion of members in the population with measurement 1 scores that are larger than their measurement 2 scores. Under the null hypothesis, the population proportion is equal to to .5. This function requires a planning value of the population proportion.

Usage

```
size.test.sign.ps(alpha, pow, p)
```

Arguments

alpha   alpha level for hypothesis test
pow   desired power
p   planning value of proportion

Value

Returns the required sample size

Examples

```
size.test.sign.ps(.05, .90, .75)

# Should return:
# Sample size
#          42
```

---

size.test.slope   *Sample size for a test of a slope*

Description

Computes the total sample size required to test a population slope with desired power in a between-subjects design with a quantitative factor. In an experimental design, the total sample size would be allocated to the levels of the quantitative factor and it might be necessary to use a larger total sample size to achieve equal sample sizes. Set the error variance planning value to the largest value within a plausible range for a conservatively large sample size.

For more details, see Section 1.25 of Bonett (2021, Volume 2)

Usage

```
size.test.slope(alpha, pow, evar, x, slope, h)
```

Arguments

alpha	alpha level for hypothesis test
pow	desired power
evar	planning value of within-group (error) variance
x	vector of x values of the quantitative factor
slope	planning value of slope
h	null hypothesis value of slope

Value

Returns the required total sample size

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/.*

Examples

```
x <- c(2, 5, 8)
size.test.slope(.05, .9, 31.1, x, .75, 0)

# Should return:
# Total sample size
#               100
```

---

slope.contrast   *Contrast coefficients for the slope of a quantitative factor*

Description

Computes the contrast coefficients that are needed to estimate the slope of a line in a one-factor design with a quantitative factor.

For more details, see Section 1.11 of Bonett (2021, Volume 2)

Usage

```
slope.contrast(x)
```

Arguments

x	vector of numeric factor levels

Value

Returns the vector of contrast coefficients

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/.*

Examples

```
x <- c(25, 50, 75, 100)
slope.contrast(x)

# Should return:
#      Coefficient
# [1,]     -0.012
# [2,]     -0.004
# [3,]      0.004
# [4,]      0.012
```

---

spearmanbrown   *Computes the reliability of a scale with r2 measurements given the reliability of a scale with r1 measurements*

Description

Computes the reliability of a scale that is the sum or average of r2 parallel measurements given the reliability of a scale that is the sum or average of r1 parallel measurements. The "measurements" can be items, forms, raters, or occasions.

For more details, see Section 4.19 of Bonett (2021, Volume 1)

Usage

```
spearmanbrown(rel, r1, r2)
```

Arguments

rel	reliability of the sum or average of r1 measurements
r1	number of measurements in the original scale
r2	number of measurements in the new scale

Value

Returns the reliability of the sum or average of r2 measurements

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/.*

Examples

```
spearmanbrown(.6, 10, 20)

# Should return:
# Reliability of r2 measurements
#                              .75
```

---

test.anova.bs	*Between-subjects F statistic and eta-squared from summary informa-tion*

Description

Computes the F statistic, p-value, eta-squared, and adjusted eta-squared for the main effect in a one-way between-subjects ANOVA using the estimated group means, estimated group standard deviations, and group sample sizes.

For more details, see Section 3.7 of Bonett (2021, Volume 1)

Usage

```
test.anova.bs(m, sd, n)
```

Arguments

m	vector of estimated group means
sd	vector of estimated group standard deviations
n	vector of group sample sizes

Value

Returns a 1-row matrix. The columns are:

- F - F statistic for test of null hypothesis
- dfA - degrees of freedom for between-subjects factor
- dfE - error degrees of freedom
- p - p-value
- Eta-squared - estimate of eta-squared
- adj Eta-squared - a bias adjusted estimate of eta-squared

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
m <- c(12.4, 8.6, 10.5)
sd <- c(3.84, 3.12, 3.48)
n <- c(20, 20, 20)
test.anova.bs(m, sd, n)

#  Should return:
#     F dfA  dfE      p Eta-squared  adj Eta-squared
# 5.9196   2   57 0.00461       0.172           0.1429
```

---

test.cor   *Hypothesis test for a Pearson or partial correlation*

Description

Computes a t test for a test of the null hypothesis that a population Pearson or partial correlations is equal to 0, or a z test using a Fisher transformation for a test of the null hypothesis that a Pearson or partial correlation is equal to some specified nonzero value. Set s = 0 for a Pearson correlation. The hypothesis testing results should be accompanied with a confidence interval for the population Pearson or partial correlation value (see ci.cor).

For more details, see Section 1.19 of Bonett (2021, Volume 2)

Usage

```
test.cor(cor, n, s, h)
```

Arguments

cor	estimated correlation
n	sample size
s	number of control variables
h	null hypothesis value of correlation

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimate of correlation
- t or z - t test statistic (for h = 0) or z test statistic (for nonzero h)
- p - two-sided p-value

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
test.cor(.484, 100, 0, .2)

# Should return:
# Estimate     z        p
#    0.484 3.2054 0.00135


test.cor(.372, 100, 0, 0)

# Should return:
# Estimate     t df       p
#    0.372 3.9673 98 0.00014
```

---

test.cor2   *Hypothesis test for a 2-group Pearson or partial correlation difference*

Description

Computes a z test for a difference of population Pearson or partial correlations in a 2-group design. Set s = 0 for a Pearson correlation. The hypothesis testing results should be accompanied with a confidence interval for the difference in population correlation values (see ci.cor2).

Usage

```
test.cor2(cor1, cor2, n1, n2, s)
```

Arguments

cor1	estimated correlation for group 1
cor2	estimated correlation for group 2
n1	sample size for group 1
n2	sample size for group 2
s	number of control variables

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimate of correlation difference
- z - z test statistic
- p - two-sided p-value

Examples

```
test.cor2(.684, .437, 100, 125, 0)

# Should return:
# Estimate     z       p
#    0.247 2.7057 0.00682
```

***

test.kurtosis   *Computes p-value for test of excess kurtosis*

***

Description

Computes a Monte Carlo p-value (250,000 replications) for the null hypothesis that the sample data come from a normal distribution. If the p-value is small (e.g., less than .05) and excess kurtosis is positive, then the normality assumption can be rejected due to leptokurtosis. If the p-value is small (e.g., less than .05) and excess kurtosis is negative, then the normality assumption can be rejected due to platykurtosis.

For more details, see Section 1.23 of Bonett (2021, Volume 1)

Usage

```
test.kurtosis(y)
```

Arguments

y   vector of quantitative scores

Value

Returns a 1-row matrix. The columns are:

- Kurtosis - estimate of kurtosis coefficient

- Excess - estimate of excess kurtosis (kurtosis - 3)

- p - Monte Carlo two-sided p-value

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/.*

Examples

```
y <- c(30, 20, 15, 10, 10, 60, 20, 25, 20, 30, 10, 5, 50, 40, 95)
test.kurtosis(y)

# Should return:
# Kurtosis  Excess     p
#   4.8149  1.8149 0.038
```

test.mean	*Hypothesis test for a mean*

Description

Computes a one-sample t-test for a population mean using the estimated mean, estimated standard deviation, sample size, and null hypothesis value. Use the t.test function for raw data input. A confidence interval for a population mean is a recommended supplement to the t-test (see ci.mean).

For more details, see Section 1.11 of Bonett (2021, Volume 1)

Usage

```
test.mean(m, sd, n, h)
```

Arguments

m	estimated mean
sd	estimated standard deviation
n	sample size
h	null hypothesis value of mean

Value

Returns a 1-row matrix. The columns are:

- t - t test statistic
- df - degrees of freedom
- p - two-sided p-value

References

Snedecor GW, Cochran WG (1989). *Statistical Methods*, 8th edition. ISU University Pres, Ames, Iowa.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
test.mean(7.9, 3.05, 100, 7)

# Should return:
#       t df       p
#  2.9508 99 0.00396
```

---

test.mono.mean.bs   *Test of a monotonic trend in means for an ordered between-subjects*
                           factor

Description

Computes simultaneous confidence intervals for all adjacent pairwise comparisons of population means using estimated group means, estimated group standard deviations, and samples sizes as input. Equal variances are not assumed. A Satterthwaite adjustment to the degrees of freedom is used to improve the accuracy of the confidence intervals. If one or more lower limits are greater than 0 and no upper limit is less than 0, then conclude that the population means are monotonic decreasing. If one or more upper limits are less than 0 and no lower limits are greater than 0, then conclude that the population means are monotonic increasing. Reject the hypothesis of a monotonic trend if any lower limit is greater than 0 and any upper limit is less than 0.

For more details, see Section 1.21 of Bonett (2021, Volume 2)

Usage

```
test.mono.mean.bs(alpha, m, sd, n)
```

Arguments

alpha	alpha level for simultaneous 1-alpha confidence
m	vector of estimated group means
sd	vector of estimated group standard deviations
n	vector of sample sizes

Value

Returns a matrix with the number of rows equal to the number of adjacent pairwise comparisons. The columns are:

- Estimate - estimated mean difference
- SE - standard error
- LL - one-sided lower limit of the confidence interval
- UL - one-sided upper limit of the confidence interval

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
m <- c(12.86, 24.57, 36.29, 53.21)
sd <- c(13.185, 12.995, 14.773, 15.145)
n <- c(20, 20, 20, 20)
test.mono.mean.bs(.05, m, sd, n)

# Should return:
#     Estimate       SE        LL          UL
# 1 2    -11.71 4.139530 -22.07803 -1.3419744
# 2 3    -11.72 4.399497 -22.74731 -0.6926939
# 3 4    -16.92 4.730817 -28.76921 -5.0707936
```

---

test.mono.median.bs	*Test of a monotonic trend in medians for an ordered between-subjects factor*

Description

Computes simultaneous confidence intervals for all adjacent pairwise comparisons of population medians using sample group medians and standard errors as input. If one or more lower limits are greater than 0 and no upper limit is less than 0, then conclude that the population medians are monotonic decreasing. If one or more upper limits are less than 0 and no lower limits are greater than 0, then conclude that the population medians are monotonic increasing. Reject the hypothesis of a monotonic trend if any lower limit is greater than 0 and any upper limit is less than 0. The sample median and standard error for each group can be computed using the ci.median function.

For more details, see Section 1.21 of Bonett (2021, Volume 2)

Usage

```
test.mono.median.bs(alpha, m, se)
```

Arguments

alpha	alpha level for simultaneous 1-alpha confidence
m	vector of estimated group medians
se	vector of estimated group standard errors

Value

Returns a matrix with the number of rows equal to the number of adjacent pairwise comparisons. The columns are:

- Estimate - estimated median difference

- SE - standard error

- LL - one-sided lower limit of the confidence interval

- UL - one-sided upper limit of the confidence interval

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/.*

Examples

```
m <- c(12.86, 24.57, 36.29, 53.21)
se <- c(2.85, 2.99, 3.73, 3.88)
test.mono.median.bs(.05, m, se)

# Should return:
#      Estimate       SE        LL        UL
# 1 2    -11.71 4.130690 -21.59879 -1.8212115
# 2 3    -11.72 4.780481 -23.16438 -0.2756247
# 3 4    -16.92 5.382128 -29.80471 -4.0352947
```

---

test.mono.prop.bs   *Test of monotonic trend in proportions for an ordered between-subjects factor*

Description

Computes simultaneous confidence intervals for all adjacent pairwise comparisons of population proportions using group frequency counts and samples sizes as input. If one or more lower limits are greater than 0 and no upper limit is less than 0, then conclude that the population proportions are monotonic decreasing. If one or more upper limits are less than 0 and no lower limits are greater than 0, then conclude that the population proportions are monotonic increasing. Reject the hypothesis of a monotonic trend if any lower limit is greater than 0 and any upper limit is less than 0.

For more details, see Section 2.12 of Bonett (2021, Volume 3)

Usage

```
test.mono.prop.bs(alpha, f, n)
```

Arguments

alpha	alpha level for simultaneous 1-alpha confidence
f	vector of frequency counts of participants who have the attribute
n	vector of sample sizes

Value

Returns a matrix with the number of rows equal to the number of adjacent pairwise comparisons. The columns are:

- Estimate - estimated proportion difference
- SE - standard error
- LL - one-sided lower limit of the confidence interval
- UL - one-sided upper limit of the confidence interval

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/.*

Examples

```
f <- c(67, 49, 30, 10)
n <- c(100, 100, 100, 100)
test.mono.prop.bs(.05, f, n)

# Should return:
#      Estimate         SE         LL         UL
# 1 2 0.1764706 0.06803446 0.01359747 0.3393437
# 2 3 0.1862745 0.06726135 0.02525219 0.3472968
# 3 4 0.1960784 0.05493010 0.06457688 0.3275800
```

---

test.prop	*Hypothesis test for a proportion*

Description

Computes a continuity-corrected z-test for a population proportion in a 1-group design. A confidence interval for a population proportion is a recommended supplement to the z-test (see ci.prop).

For more details, see Section 1.7 of Bonett (2021, Volume 3)

Usage

```
test.prop(f, n, h)
```

Arguments

f	number of participants who have the attribute
n	sample size
h	null hypothesis value of proportion

Value

Returns a 1-row matrix. The columns are:

- Estimate - ML estimate of proportion
- z - z test statistic
- p - two-sided p-value

References

Snedecor GW, Cochran WG (1989). *Statistical Methods*, 8th edition. ISU University Pres, Ames, Iowa.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
test.prop(76, 100, .6)

# Should return:
# Estimate     z      p
#     0.76 3.1639 0.00156
```

---

test.prop.bs   *Hypothesis test of equal proportions in a between-subjects design*

Description

Computes a Pearson chi-square test for equal population proportions for a dichotomous response variable in a one-factor between-subjects design.

For more details, see Section 2.13 of Bonett (2021, Volume 3)

Usage

```
test.prop.bs(f, n)
```

Arguments

f	vector of frequency counts of participants who have the attribute
n	vector of sample sizes

Value

Returns a 1-row matrix. The columns are:

- Chi-square - chi-square test statistic
- df - degrees of freedom
- p - p-value

References

Fleiss JL, Paik MC (2003). *Statistical Methods for Rates and Proportions*, 3rd edition. Wiley.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
f <- c(111, 118, 132)
n <- c(200, 200, 200)
test.prop.bs (f, n)

# Should return:
# Chi-square df       p
#     4.7706  2 0.09206
```

---

test.prop.ps	*Hypothesis test for a paired-samples proportion difference*

Description

Computes a continuity-corrected McNemar test for equality of population proportions in a paired-samples design. This function requires the frequency counts from a 2 x 2 contingency table for two paired dichotomous measurements. A confidence interval for a difference in population proportions (see ci.prop.ps) is a recommended supplement to the McNemar test.

For more details, see Section 3.2 of Bonett (2021, Volume 3)

Usage

```
test.prop.ps(f00, f01, f10, f11)
```

Arguments

f00	number participants with y = 0 and x = 0
f01	number participants with y = 0 and x = 1
f10	number participants with y = 1 and x = 0
f11	number participants with y = 1 and x = 1

Value

Returns a 1-row matrix. The columns are:

- Estimate - ML estimate of proportion difference

- z - z test statistic

- p - two-sided p-value

References

Snedecor GW, Cochran WG (1989). *Statistical Methods*, 8th edition. ISU University Pres, Ames, Iowa.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/*.

Examples

```
test.prop.ps(12, 4, 26, 6)

# Should return:
#   Estimate      z        p
# -0.4583333 3.8341 0.00013
```

---

    test.prop2   *Hypothesis test for a 2-group proportion difference*

Description

Computes a continuity-corrected z-test for a difference of population proportions in a 2-group design. A confidence interval for a difference in population proportions is a recommended supplement to the z-test (see ci.prop2).

For more details, see Section 2.4 of Bonett (2021, Volume 3)

Usage

```
test.prop2(f1, f2, n1, n2)
```

Arguments

f1	number of group 1 participants who have the attribute
f2	number of group 2 participants who have the attribute
n1	sample size for group 1
n2	sample size for group 2

Value

Returns a 1-row matrix. The columns are:

- Estimate - ML estimate of proportion difference
- z - z test statistic
- p - two-sided p-value

References

Snedecor GW, Cochran WG (1989). *Statistical Methods*, 8th edition. ISU University Pres, Ames, Iowa.

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/.*

Examples

```
test.prop2(39, 24, 50, 50)

# Should return:
# Estimate     z       p
#      0.3 2.8997 0.00373
```

---

test.skew   *Computes p-value for test of skewness*

Description

Computes a Monte Carlo p-value (250,000 replications) for the null hypothesis that the sample data come from a normal distribution. If the p-value is small (e.g., less than .05) and the skewness estimate is positive, then the normality assumption can be rejected due to positive skewness. If the p-value is small (e.g., less than .05) and the skewness estimate is negative, then the normality assumption can be rejected due to negative skewness.

For more details, see Section 1.23 of Bonett (2021, Volume 1)

Usage

```
test.skew(y)
```

Arguments

y   vector of quantitative scores

Value

Returns a 1-row matrix. The columns are:

- Skewness - estimate of skewness coefficient
- p - Monte Carlo two-sided p-value

References

Bonett DG (2021). *Statistical Methods for Psychologists https://dgbonett.sites.ucsc.edu/.*

Examples

```
y <- c(30, 20, 15, 10, 10, 60, 20, 25, 20, 30, 10, 5, 50, 40, 95)
test.skew(y)

# Should return:
# Skewness     p
#   1.5201 0.007
```

---

test.spear   *Hypothesis test for a Spearman correlation*

Description

Computes a t test for a test of the null hypothesis that a population Spearman correlation is equal to 0, or a z test using a Fisher transformation for a test of the null hypothesis that a Spearman correlation is equal to some specified nonzero value. The hypothesis testing results should be accompanied with a confidence interval for the population Spearman correlation value (see ci.spear).

Usage

```
test.spear(cor, h, n)
```

Arguments

cor	estimated correlation
h	null hypothesis value of correlation
n	sample size

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimate of correlation
- t or z - t test statistic (for h = 0) or z test statistic (for nonzero h)
- p - two-sided p-value

Examples

```
test.spear(.471, .2, 100)

# Should return:
# Estimate      z       p
#    0.471 3.0096 0.00262


test.spear(.341, 0, 100)

# Should return:
# Estimate     t df       p
#    0.341 3.591 98 0.00052
```

---

test.spear2   *Hypothesis test for a 2-group Spearman correlation difference*

Description

Computes a z test for a difference of population Spearman correlations in a 2-group design. The test statistic uses a Bonett-Wright standard error for each Spearman correlation. The hypothesis testing results should be accompanied with a confidence interval for a difference in population Spearman correlation values (see ci.spear2).

Usage

```
test.spear2(cor1, cor2, n1, n2)
```

Arguments

cor1	estimated Spearman correlation for group 1
cor2	estimated Spearman correlation for group 2
n1	sample size for group 1
n2	sample size for group 2

Value

Returns a 1-row matrix. The columns are:

- Estimate - estimate of correlation difference
- z - z test statistic
- p - two-sided p-value

References

Bonett DG, Wright TA (2000). "Sample size requirements for estimating Pearson, Kendall and Spearman correlations." *Psychometrika*, **65**(1), 23–28. ISSN 0033-3123, doi:10.1007/BF02294183.

Examples

```
test.spear2(.684, .437, 100, 125)

# Should return:
# Estimate      z       p
#    0.247 2.4986 0.01247
```

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