Package ‘TOSTER’

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Title Two One-Sided Tests (TOST) Equivalence Testing
Description Two one-sided tests (TOST) procedure to test equivalence for t-tests, correlations, differences between proportions, and meta-analyses, including power analysis for t-tests and correlations. Allows you to specify equivalence bounds in raw scale units or in terms of effect sizes. See: Lakens (2017) <doi:10.1177/1948550617697177>.
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Description

TOST One Sample T-Test

Usage

dataTOSTOne(data, vars, mu = 0, low_eqbound = -0.5,
high_eqbound = 0.5, eqbound_type = "d", alpha = 0.05,
desc = FALSE, plots = FALSE, low_eqbound_d = -999999999,
high_eqbound_d = -999999999)

Arguments

data the data as a data frame
vars a vector of strings naming variables of interest in data
mu a number (default: 0) to compare against
low_eqbound a number (default: -0.5) the lower equivalence bounds
high_eqbound a number (default: 0.5) the upper equivalence bounds
eqbound_type 'd' (default) or 'raw'; whether the bounds are specified in Cohen's d or raw units respectively
alpha alpha level (default = 0.05)
desc TRUE or FALSE (default), provide descriptive statistics
plots TRUE or FALSE (default), provide plots
low_eqbound_d deprecated
high_eqbound_d deprecated

Value

A results object containing:
Tables can be converted to data frames with asDF or as.data.frame. For example:
results$tost$asDF
as.data.frame(results$tost)

Examples

library("TOSTER")

dataTOSTOne(data=iris, vars="Sepal.Width", mu=3, low_eqbound=-0.3, high_eqbound=0.3, alpha=0.05, desc=TRUE, plots=TRUE)

TOSTOne(m=3.05733, mu=3, sd=0.4358663, n=150, low_eqbound_d=-0.3, high_eqbound_d=0.3, alpha=0.05)
Value

A results object containing:

- `results$tost` a table
- `results$eqb` a table
- `results$desc` a table
- `results$plots` an array of images

Tables can be converted to data frames with `asDF` or `as.data.frame`. For example:

```r
results$tost$asDF
as.data.frame(results$tost)
```

References


Examples

```r
library("TOSTer")

dataTOSTpaired(data = randu, pairs = list(c(i1="x",i2="y")), low_eqbound_r = -0.3, high_eqbound_r = 0.3, alpha = 0.05, desc = TRUE, plots = TRUE)
```

---

**TOST Correlation**

**Description**

TOST Correlation

**Usage**

```r
dataTOSTr(data, pairs, low_eqbound_r = -0.3, high_eqbound_r = 0.3, alpha = 0.05, desc = FALSE, plots = FALSE)
```

**Arguments**

- `data` the data as a data frame
- `pairs` a list of vectors of strings naming variables to correlate from `data`
- `low_eqbound_r` lower equivalence bounds (e.g., -0.3) expressed in a correlation effect size
- `high_eqbound_r` upper equivalence bounds (e.g., 0.3) expressed in a correlation effect size
TOST Independent Samples T-Test

Description

TOST Independent Samples T-Test

Usage

dataTOSTtwo(data, deps, group, var_equal = FALSE, low_eqbound = -0.5, high_eqbound = 0.5, eqbound_type = "d", alpha = 0.05, desc = FALSE, plots = FALSE, low_eqbound_d = -999999999, high_eqbound_d = -999999999)

Arguments

data the data as a data frame
deps a vector of strings naming dependent variables in data
group a string naming the grouping variable in data; must have two levels
var_equal TRUE or FALSE (default), assume equal variances
low_eqbound a number (default: -0.5) the lower equivalence bounds
high_eqbound a number (default: 0.5) the upper equivalence bounds
eqbound_type 'd' (default) or 'raw'; whether the bounds are specified in Cohen’s d or raw units respectively
alpha alpha level (default = 0.05)
TOST Two Proportions

Description

TOST Two Proportions
powerTOSTone

Usage

datatosttwoprop(data, var, level, group, low_eqbound = -0.1, high_eqbound = 0.1, alpha = 0.05, desc = FALSE, plot = FALSE)

Arguments

data .
var .
level .
group .
low_eqbound a number (default: -0.1) the lower equivalence bounds
high_eqbound a number (default: 0.1) the upper equivalence bounds
alpha alpha level (default = 0.05)
desc TRUE or FALSE (default), provide descriptive statistics
plot TRUE or FALSE (default), provide plot

Value

A results object containing:

- results$tost a table
- results$qeb a table
- results$desc a table
- results$plot an image

Tables can be converted to data frames with asDF or as.data.frame. For example:
results$tost$asDF
as.data.frame(results$tost)

---

powerTOSTone  Power analysis for TOST for one-sample t-test (Cohen’s d).

Description

Power analysis for TOST for one-sample t-test (Cohen’s d).

Usage

powerTOSTone(alpha, statistical_power, N, low_eqbound_d, high_eqbound_d)
Arguments

alpha | alpha used for the test (e.g., 0.05)
statistical_power | desired power (e.g., 0.8)
N | sample size (e.g., 108)
low_eqbound_d | lower equivalence bounds (e.g., -0.5) expressed in standardized mean difference (Cohen’s d)
high_eqbound_d | upper equivalence bounds (e.g., 0.5) expressed in standardized mean difference (Cohen’s d)

Value

Calculate either achieved power, equivalence bounds, or required N, assuming a true effect size of 0. Returns a string summarizing the power analysis, and a numeric variable for number of observations, equivalence bounds, or power.

References


Examples

```r
## Sample size for alpha = 0.05, 90% power, equivalence bounds of
## Cohen’s d = -0.3 and Cohen’s d = 0.3, and assuming true effect = 0
powerTOST(0.05, 0.9, -0.3, 0.3)

## Power for sample size of 121, alpha = 0.05, equivalence bounds of
## Cohen’s d = -0.3 and Cohen’s d = 0.3, and assuming true effect = 0
powerTOST(0.05, 9, 121, -0.3, 0.3)

## Equivalence bounds for sample size of 121, alpha = 0.05, statistical power of
## 0.9, and assuming true effect = 0
powerTOST(0.05, 9, 121, 0.9)
```

powerTOST.raw | Power analysis for TOST for one-sample t-test (raw scores).

Description

Power analysis for TOST for one-sample t-test (raw scores).

Usage

```r
powerTOST.raw(alpha, statistical_power, N, sd, low_eqbound, high_eqbound)
```
Arguments

- **alpha**: alpha used for the test (e.g., 0.05)
- **statistical_power**: desired power (e.g., 0.8)
- **N**: sample size (e.g., 108)
- **sd**: population standard deviation
- **low_eqbound**: lower equivalence bounds (e.g., -0.5) expressed in raw scores
- **high_eqbound**: upper equivalence bounds (e.g., 0.5) expressed in raw scores

Value

Calculate either achieved power, equivalence bounds, or required N, assuming a true effect size of 0. Returns a string summarizing the power analysis, and a numeric variable for number of observations, equivalence bounds, or power.

References


Examples

```r
## Sample size for alpha = 0.05, 90% power, equivalence bounds of -0.3 and 0.3 in raw units, assuming pooled standard deviation of 1, and assuming true effect = 0
powerTOSTraw(alpha=0.05, statistical_power=0.9, sd = 1, low_eqbound=-0.3, high_eqbound=0.3)

## Power for sample size of 121, alpha = 0.05, equivalence bounds of -0.3 and 0.3 in raw units, assuming pooled standard deviation of 1, and assuming true effect = 0
powerTOSTraw(alpha=0.05, N=121, sd = 1, low_eqbound=-0.3, high_eqbound=0.3)

## Power for sample size of 121, alpha = 0.05, statistical power of 0.9, and assuming true effect = 0
powerTOSTraw(alpha=0.05, N=121, statistical_power=.9, sd=1)
```

Description

Power analysis for TOST for dependent t-test (Cohen’s dz).

Usage

```r
powerTOSTpaired(alpha, statistical_power, N, low_eqbound_dz, high_eqbound_dz)
```
Arguments

- **alpha**: alpha used for the test (e.g., 0.05)
- **statistical_power**: desired power (e.g., 0.8)
- **N**: number of pairs (e.g., 96)
- **low_eqbound_dz**: lower equivalence bounds (e.g., -0.5) expressed in standardized mean difference (Cohen’s dz)
- **high_eqbound_dz**: upper equivalence bounds (e.g., 0.5) expressed in standardized mean difference (Cohen’s dz)

Value

Calculate either achieved power, equivalence bounds, or required N, assuming a true effect size of 0. Returns a string summarizing the power analysis, and a numeric variable for number of observations, equivalence bounds, or power.

References


Examples

```r
## Sample size for alpha = 0.05, 80% power, equivalence bounds of
## Cohen's dz = -0.3 and Cohen's d = 0.3, and assuming true effect = 0
powerTOSTpaired(alpha=0.05, statistical_power=0.8, low_eqbound_dz=-0.3, high_eqbound_dz=0.3)

## Sample size for alpha = 0.05, N = 96 pairs, equivalence bounds of
## Cohen's dz = -0.3 and Cohen's d = 0.3, and assuming true effect = 0
powerTOSTpaired(alpha=0.05, N=96, low_eqbound_dz=-0.3, high_eqbound_dz=0.3)

## Equivalence bounds for alpha = 0.05, N = 96 pairs, statistical power of
## 0.8, and assuming true effect = 0
powerTOSTpaired(alpha=0.05, N=96, statistical_power=0.8)
```

Description

Power analysis for TOST for dependent t-test (raw scores).

Usage

`powerTOSTpaired.raw(alpha, statistical_power, N, sdif, low_eqbound, high_eqbound)`
**powerTOSTr**

**Arguments**

- **alpha**: alpha used for the test (e.g., 0.05)
- **statistical_power**: desired power (e.g., 0.8)
- **N**: number of pairs (e.g., 96)
- **sdif**: standard deviation of the difference scores
- **low_eqbound**: lower equivalence bounds (e.g., -0.5) expressed in raw mean difference
- **high_eqbound**: upper equivalence bounds (e.g., 0.5) expressed in raw mean difference

**Value**

Calculate either achieved power, equivalence bounds, or required \( N \), assuming a true effect size of 0. Returns a string summarizing the power analysis, and a numeric variable for number of observations, equivalence bounds, or power.

**References**


**Examples**

```r
## Sample size for alpha = 0.05, 80% power, equivalence bounds of -3 and 3 in raw units
## and assuming a standard deviation of the difference scores of 10, and assuming a true effect = 0
powerTOSTpaired.raw(alpha=0.05, statistical_power=0.8, low_eqbound=-3, high_eqbound=3, sdif=10)

## Sample size for alpha = 0.05, N = 96 pairs, equivalence bounds of -3 and 3 in raw units
## and assuming a standard deviation of the difference scores of 10, and assuming a true effect = 0
powerTOSTpaired.raw(alpha=0.05, N=96, low_eqbound=-3, high_eqbound=3, sdif=10)

## Equivalence bounds for alpha = 0.05, N = 96 pairs, statistical power of 0.8
## and assuming a standard deviation of the difference scores of 10, and assuming a true effect = 0
powerTOSTpaired.raw(alpha=0.05, N=96, statistical_power=0.8, sdif=10)
```

---

**powerTOSTTr**  
*Power analysis for TOST for correlations.*

**Description**

Power analysis for TOST for correlations.

**Usage**

```r
powerTOSTTr(alpha, statistical_power, N, low_eqbound_r, high_eqbound_r)
```
Arguments

\[
\begin{align*}
\text{alpha} & \quad \text{alpha used for the test (e.g., 0.05)} \\
\text{statistical\_power} & \quad \text{desired power (e.g., 0.8)} \\
N & \quad \text{number of pairs (e.g., 96)} \\
\text{low\_eqbound\_r} & \quad \text{lower equivalence bounds (e.g., -0.3) expressed in a correlation effect size} \\
\text{high\_eqbound\_r} & \quad \text{upper equivalence bounds (e.g., 0.3) expressed in a correlation effect size}
\end{align*}
\]

Value

Calculate either achieved power, equivalence bounds, or required N, assuming a true effect size of 0. Returns a string summarizing the power analysis, and a numeric variable for number of observations, equivalence bounds, or power.

Examples

```r
## Sample size for alpha = 0.05, 90% power, equivalence bounds of
## r = -0.1 and r = 0.1, assuming true effect = 0
powerTOSTtwo(alpha=0.05, statistical_power=0.9, low_eqbound_r=-0.1, high_eqbound_r=0.1)

## Sample size for alpha = 0.05, N=536, equivalence bounds of
## r = -0.1 and r = 0.1, assuming true effect = 0
powerTOSTtwo(alpha=0.05, n=536, low_eqbound_r=-0.1, high_eqbound_r=0.1)

## Equivalence bounds for alpha = 0.05, N=536, statistical power of
## 0.9, assuming true effect = 0
powerTOSTtwo(alpha=0.05, n=536, statistical_power=0.9)
```

---

powerTOSTtwo  
*Power analysis for TOST for independent t-test (Cohen’s d).*

Description

Power analysis for TOST for independent t-test (Cohen’s d).

Usage

```
powerTOSTtwo(alpha, statistical_power, N, low_eqbound_d, high_eqbound_d)
```

Arguments

\[
\begin{align*}
\text{alpha} & \quad \text{alpha used for the test (e.g., 0.05)} \\
\text{statistical\_power} & \quad \text{desired power (e.g., 0.8)} \\
N & \quad \text{sample size per group (e.g., 108)}
\end{align*}
\]
low_eqbound_d  lower equivalence bounds (e.g., -0.5) expressed in standardized mean difference (Cohen’s d)

high_eqbound_d  upper equivalence bounds (e.g., 0.5) expressed in standardized mean difference (Cohen’s d)

Value

Calculate either achieved power, equivalence bounds, or required N, assuming a true effect size of 0. Returns a string summarizing the power analysis, and a numeric variable for number of observations, equivalence bounds, or power.

References


Examples

```r
# Sample size for alpha = 0.05, 80% power, equivalence bounds of
# Cohen's d = -0.4 and Cohen's d = 0.4, assuming true effect = 0
powerTOSTtwo(alpha=0.05, statistical_power=0.8, low_eqbound_d=-0.4, high_eqbound_d=0.4)

# Statistical power for alpha = 0.05, N = 108 per group, equivalence bounds of
# Cohen's d = -0.4 and Cohen's d = 0.4, assuming true effect = 0
powerTOSTtwo(alpha=0.05, N=108, low_eqbound_d=-0.4, high_eqbound_d=0.4)

# Equivalence bounds for alpha = 0.05, N = 108 per group, statistical power of
# 0.8, assuming true effect = 0
powerTOSTtwo(alpha=0.05, N=108, statistical_power=0.8)
```

powerTOSTtwo.prop  

Power analysis for TOST for difference between two proportions using Z-test (pooled)

Description

Power analysis for TOST for difference between two proportions using Z-test (pooled)

Usage

```r
powerTOSTtwo.prop(alpha, statistical_power, prop1, prop2, N, 
low_eqbound_prop, high_eqbound_prop)
```
powerTOSTtwo.prop

Arguments

alpha       alpha used for the test (e.g., 0.05)
statistical_power       desired power (e.g., 0.8)
prop1       expected proportion in control condition
prop2       expected proportion in the experimental condition
N       sample size (e.g., 108)
low_eqbound_prop       lower equivalence bounds (e.g., -0.05) expressed in proportion
high_eqbound_prop       upper equivalence bounds (e.g., 0.05) expressed in proportion

Value

Calculate either achieved power, equivalence bounds, or required N, assuming a true effect size of 0. Returns a string summarizing the power analysis, and a numeric variable for number of observations, equivalence bounds, or power.

References


Examples

```r
## Sample size for alpha = 0.05, 90% power, assuming true effect prop1 = prop 2 = 0.5,
## equivalence bounds of 0.4 and 0.6 (so low_eqbound_prop = -0.1 and high_eqbound_prop = 0.1)

powerTOSTtwo.prop(alpha = 0.05, statistical_power = 0.9, prop1 = 0.5, prop2 = 0.5,
                   low_eqbound_prop = -0.1, high_eqbound_prop = 0.1)

## Power for alpha = 0.05, N 542 , assuming true effect prop1 = prop 2 = 0.5,
## equivalence bounds of 0.4 and 0.6 (so low_eqbound_prop = -0.1 and high_eqbound_prop = 0.1)

powerTOSTtwo.prop(alpha = 0.05, N = 542, prop1 = 0.5, prop2 = 0.5,
                   low_eqbound_prop = -0.1, high_eqbound_prop = 0.1)

## Equivalence bounds for alpha = 0.05, N 542 , assuming true effect prop1 = prop 2 = 0.5,
## and 90% power

powerTOSTtwo.prop(alpha=0.05, statistical_power=0.9, N=542, prop1=0.5, prop2=0.5)

#Example 4.2.4 from Chow, Wang, & Shao (2007, p. 93)

powerTOSTtwo.prop(alpha=0.05, statistical_power=0.8, prop1 = 0.75, prop2 = 0.8, 
```
Description

Power analysis for TOST for independent t-test (raw scores).

Usage

```r
powerTOSTtwo.raw(alpha, statistical_power, N, sdpoooled, low_eqbound, high_eqbound)
```

Arguments

- `alpha`: alpha used for the test (e.g., 0.05)
- `statistical_power`: desired power (e.g., 0.8)
- `N`: sample size per group (e.g., 108)
- `sdpoooled`: specify the pooled standard deviation
- `low_eqbound`: lower equivalence bounds (e.g., -0.5) expressed in raw scale units (e.g., scale-points)
- `high_eqbound`: upper equivalence bounds (e.g., 0.5) expressed in raw scale units (e.g., scale-points)

Value

Calculate either achieved power, equivalence bounds, or required N, assuming a true effect size of 0. Returns a string summarizing the power analysis, and a numeric variable for number of observations, equivalence bounds, or power.

References

TOSTmeta

Examples

```r
## Sample size for alpha = 0.05, 80% power, equivalence bounds of -200 and 200 in raw
## units, assuming pooled standard deviation of 350, and assuming true effect = 0
powerTOSTtwo.raw(alpha=0.05, statistical_power=0.8, low_eqbound=-200, high_eqbound=200, sdpooled=350)

## Power for alpha = 0.05, N = 53 per group, equivalence bounds of
## -200 and 200 in raw units, assuming sdpooled = 350 and true effect = 0
powerTOSTtwo.raw(alpha=0.05, N=53, low_eqbound=-200, high_eqbound=200, sdpooled=350)

## Equivalence bounds for alpha = 0.05, N = 108 per group, statistical power of
## 0.8, assuming true effect = 0
powerTOSTtwo.raw(alpha=0.05, N=53, statistical_power=0.8, sdpooled=350)
```

TOSTmeta

TOST function for meta-analysis

Usage

TOSTmeta(ES, var, se, low_eqbound_d, high_eqbound_d, alpha, plot = TRUE,
verbose = TRUE)

Arguments

- **ES**: meta-analytic effect size
- **var**: meta-analytic variance
- **se**: standard error
- **low_eqbound_d**: lower equivalence bounds (e.g., -0.5) expressed in standardized mean difference (Cohen's d)
- **high_eqbound_d**: upper equivalence bounds (e.g., 0.5) expressed in standardized mean difference (Cohen's d)
- **alpha**: alpha level (default = 0.05)
- **plot**: set whether results should be plotted (plot = TRUE) or not (plot = FALSE) - defaults to TRUE
- **verbose**: logical variable indicating whether text output should be generated (verbose = TRUE) or not (verbose = FALSE) - default to TRUE

Value

Returns TOST Z-value 1, TOST p-value 1, TOST Z-value 2, TOST p-value 2, alpha, low equivalence bound d, high equivalence bound d, Lower limit confidence interval TOST, Upper limit confidence interval TOST
References


Examples

## Run TOSTmeta by specifying the standard error
TOSTmeta(ES=0.12, se=0.09, low_eqbound_d=-0.2, high_eqbound_d=0.2, alpha=0.05)

## Run TOSTmeta by specifying the variance
TOSTmeta(ES=0.12, var=0.0081, low_eqbound_d=-0.2, high_eqbound_d=0.2, alpha=0.05)

## If both variance and se are specified, TOSTmeta will use standard error and ignore variance
TOSTmeta(ES=0.12, var=9999, se = 0.09, low_eqbound_d=-0.2, high_eqbound_d=0.2, alpha=0.05)

TOSTone

TOST function for a one-sample t-test (Cohen’s d)

Description

TOST function for a one-sample t-test (Cohen’s d)

Usage

TOSTone(m, mu, sd, n, low_eqbound_d, high_eqbound_d, alpha, plot = TRUE, verbose = TRUE)

Arguments

- m: mean
- mu: value to compare against
- sd: standard deviation
- n: sample size
- low_eqbound_d: lower equivalence bounds (e.g., -0.5) expressed in standardized mean difference (Cohen’s d)
- high_eqbound_d: upper equivalence bounds (e.g., 0.5) expressed in standardized mean difference (Cohen’s d)
- alpha: alpha level (default = 0.05)
- plot: set whether results should be plotted (plot = TRUE) or not (plot = FALSE) - defaults to TRUE
- verbose: logical variable indicating whether text output should be generated (verbose = TRUE) or not (verbose = FALSE) - default to TRUE

Value

Returns TOST t-value 1, TOST p-value 1, TOST t-value 2, TOST p-value 2, degrees of freedom, low equivalence bound, high equivalence bound, Lower limit confidence interval TOST, Upper limit confidence interval TOST
Examples

```R
## Test observed mean of 0.54 and standard deviation of 1.2 in sample of 100 participants
## against 0.5 given equivalence bounds of Cohen's d = -0.3 and 0.3, with an alpha = 0.05.
TOSTone(m=0.54, mu=0.5, sd=1.2, n=100, low_eqbound_d=-0.3, high_eqbound_d=0.3, alpha=0.05)
```

Description

TOST function for a one-sample t-test (raw scores)

Usage

```R
TOSTone.raw(m, mu, sd, n, low_eqbound, high_eqbound, alpha, plot = TRUE, verbose = TRUE)
```

Arguments

- `m`: mean
- `mu`: value to compare against
- `sd`: standard deviation
- `n`: sample size
- `low_eqbound`: lower equivalence bounds (e.g., -0.5) expressed in raw units
- `high_eqbound`: upper equivalence bounds (e.g., 0.5) expressed in raw units
- `alpha`: alpha level (default = 0.05)
- `plot`: set whether results should be plotted (plot = TRUE) or not (plot = FALSE) - defaults to TRUE
- `verbose`: logical variable indicating whether text output should be generated (verbose = TRUE) or not (verbose = FALSE) - default to TRUE

Value

Returns TOST t-value 1, TOST p-value 1, TOST t-value 2, TOST p-value 2, degrees of freedom, low equivalence bound, high equivalence bound, Lower limit confidence interval TOST, Upper limit confidence interval TOST

Examples

```R
## Test observed mean of 0.52 and standard deviation of 0.52 in sample of 300 participants
## against 0.5 given equivalence bounds in raw units of -0.1 and 0.1, with an alpha = 0.05.
TOSTone.raw(m=0.52, mu=0.5, sd=0.5, n=300, low_eqbound=-0.1, high_eqbound=0.1, alpha=0.05)
```
TOSTpaired

TOST function for a dependent t-test (Cohen’s dz)

Description

TOST function for a dependent t-test (Cohen’s dz)

Usage

TOSTpaired(n, m1, m2, sd1, sd2, r12, low_eqbound_dz, high_eqbound_dz, alpha, plot = TRUE, verbose = TRUE)

Arguments

- n: sample size (pairs)
- m1: mean of group 1
- m2: mean of group 2
- sd1: standard deviation of group 1
- sd2: standard deviation of group 2
- r12: correlation of dependent variable between group 1 and group 2
- low_eqbound_dz: lower equivalence bounds (e.g., -0.5) expressed in standardized mean difference (Cohen’s dz)
- high_eqbound_dz: upper equivalence bounds (e.g., 0.5) expressed in standardized mean difference (Cohen’s dz)
- alpha: alpha level (default = 0.05)
- plot: set whether results should be plotted (plot = TRUE) or not (plot = FALSE) - defaults to TRUE
- verbose: logical variable indicating whether text output should be generated (verbose = TRUE) or not (verbose = FALSE) - default to TRUE

Value

Returns TOST t-value 1, TOST p-value 1, TOST t-value 2, TOST p-value 2, degrees of freedom, low equivalence bound, high equivalence bound, low equivalence bound in dz, high equivalence bound in dz, Lower limit confidence interval TOST, Upper limit confidence interval TOST

References

Examples

```R
# Test means of 5.83 and 5.75, standard deviations of 1.17 and 1.29 in sample of 65 pairs
# with correlation between observations of 0.75 using equivalence bounds in Cohen's dz of
# -0.4 and 0.4 (with default alpha setting of = 0.05).
TOSTpaired(n=65, m1=5.83, m2=5.75, sd1=1.17, sd2=1.29, r12=0.75, low_eqbound_dz=-0.4, high_eqbound_dz=0.4)
```

TOSTpaired.raw  TOST function for a dependent t-test (raw scores)

Description

TOST function for a dependent t-test (raw scores)

Usage

```R
TOSTpaired.raw(n, m1, m2, sd1, sd2, r12, low_eqbound, high_eqbound, alpha,
    plot = TRUE, verbose = TRUE)
```

Arguments

- `n`: sample size (pairs)
- `m1`: mean of group 1
- `m2`: mean of group 2
- `sd1`: standard deviation of group 1
- `sd2`: standard deviation of group 2
- `r12`: correlation of dependent variable between group 1 and group 2
- `low_eqbound`: lower equivalence bounds (e.g., -0.5) expressed in raw scores
- `high_eqbound`: upper equivalence bounds (e.g., 0.5) expressed in raw scores
- `alpha`: alpha level (default = 0.05)
- `plot`: set whether results should be plotted (plot = TRUE) or not (plot = FALSE) - defaults to TRUE
- `verbose`: logical variable indicating whether text output should be generated (verbose = TRUE) or not (verbose = FALSE) - default to TRUE

Value

Returns TOST t-value 1, TOST p-value 1, TOST t-value 2, TOST p-value 2, degrees of freedom, low equivalence bound, high equivalence bound, Lower limit confidence interval TOST, Upper limit confidence interval TOST

References

Examples
## Test means of 5.83 and 5.75, standard deviations of 1.17 and 1.30 in sample of 65 pairs
## with correlation between observations of 0.745 using equivalence bounds in raw units of
## -0.34 and 0.34, (with default alpha setting of = 0.05).
TOSTpaired.raw(n=65,m1=5.83,m2=5.75,sd1=1.17,sc2=1.30,r12=0.745,low_eqbound=-0.34,high_eqbound=0.34)

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TOSTr

| TOST function for correlations |

Description
TOST function for a correlations

Usage
TOSTr(n, r, low_eqbound_r, high_eqbound_r, alpha, plot = TRUE, verbose = TRUE)

Arguments
- n: number of pairs of observations
- r: observed correlation
- low_eqbound_r: lower equivalence bounds (e.g., -0.3) expressed in a correlation effect size
- high_eqbound_r: upper equivalence bounds (e.g., 0.3) expressed in a correlation effect size
- alpha: alpha level (default = 0.05)
- plot: set whether results should be plotted (plot = TRUE) or not (plot = FALSE) - defaults to TRUE
- verbose: logical variable indicating whether text output should be generated (verbose = TRUE) or not (verbose = FALSE) - default to TRUE

Value
Returns TOST p-value 1, TOST p-value 2, alpha, low equivalence bound r, high equivalence bound r, Lower limit confidence interval TOST, Upper limit confidence interval TOST

References

Examples
TOSTr(n=100, r = 0.02, low_eqbound_r=-0.3, high_eqbound_r=0.3, alpha=0.05)
Description

TOST function for an independent t-test (Cohen’s d)

Usage

TOSTtwo(m1, m2, sd1, sd2, n1, n2, low_eqbound_d, high_eqbound_d, alpha, var.equal, plot = TRUE, verbose = TRUE)

Arguments

m1  mean of group 1
m2  mean of group 2
sd1 standard deviation of group 1
sd2 standard deviation of group 2
n1  sample size in group 1
n2  sample size in group 2
low_eqbound_d lower equivalence bounds (e.g., -0.5) expressed in standardized mean difference (Cohen’s d)
high_eqbound_d upper equivalence bounds (e.g., 0.5) expressed in standardized mean difference (Cohen’s d)
alpha alpha level (default = 0.05)
var.equal logical variable indicating whether equal variances assumption is assumed to be TRUE or FALSE. Defaults to FALSE.
plot set whether results should be plotted (plot = TRUE) or not (plot = FALSE) - defaults to TRUE
verbose logical variable indicating whether text output should be generated (verbose = TRUE) or not (verbose = FALSE) - default to TRUE

Value

Returns TOST t-value 1, TOST p-value 1, TOST t-value 2, TOST p-value 2, degrees of freedom, low equivalence bound, high equivalence bound, low equivalence bound in Cohen’s d, high equivalence bound in Cohen’s d, Lower limit confidence interval TOST, Upper limit confidence interval TOST

References

Examples

## Eskine (2013) showed that participants who had been exposed to organic food were substantially harsher in their moral judgments relative to those exposed to control (d = 0.81, 95% CI: [0.19, 1.45]). A replication by Moery & Calin-Jageman (2016, Study 2) did not observe a significant effect (Control: n = 95, M = 5.25, SD = 0.95, Organic Food: n = 89, M = 5.22, SD = 0.83). Following Simonsohn's (2015) recommendation the equivalence bound was set to the effect size the original study had 33% power to detect (with n = 21 in each condition, this means the equivalence bound is d = 0.48, which equals a difference of 0.384 on a 7-point scale given the sample sizes and a pooled standard deviation of 0.894). Using a TOST equivalence test with default alpha = 0.05, not assuming equal variances, and equivalence bounds of d = -0.43 and d = 0.43 is significant, t(182) = -2.69, p = 0.004. We can reject effects larger than d = 0.43.

```
TOSTtwo(m1=5.25,m2=5.22,sd1=0.95,sd2=0.83,n1=95,n2=89,low_eqbound_d=-0.43,high_eqbound_d=0.43)
```

TOSTtwo.prop

### Description

TOST function for two proportions (raw scores)

### Usage

```
TOSTtwo.prop(prop1, prop2, n1, n2, low_eqbound, high_eqbound, alpha,
plot = TRUE, verbose = TRUE)
```

### Arguments

- `prop1`: proportion of group 1
- `prop2`: proportion of group 2
- `n1`: sample size in group 1
- `n2`: sample size in group 2
- `low_eqbound`: lower equivalence bounds (e.g., -0.1) expressed in proportions
- `high_eqbound`: upper equivalence bounds (e.g., 0.1) expressed in proportions
- `alpha`: alpha level (default = 0.05)
- `plot`: set whether results should be plotted (plot = TRUE) or not (plot = FALSE) - defaults to TRUE
- `verbose`: logical variable indicating whether text output should be generated (verbose = TRUE) or not (verbose = FALSE) - default to TRUE
Value

Returns TOST z-value 1, TOST p-value 1, TOST z-value 2, TOST p-value 2, low equivalence bound, high equivalence bound, Lower limit confidence interval TOST, Upper limit confidence interval TOST

References


Examples

```r
## Equivalence test for two independent proportions equal to .65 and .70, with 100 samples
## per group, lower equivalence bound of -0.1, higher equivalence bound of 0.1, and alpha of 0.05.

tosttwo.prop(prop1 = .65, prop2 = .70, n1 = 100, n2 = 100,
             low_eqbound = -0.1, high_eqbound = 0.1, alpha = 0.05)
```

Description

TOST function for an independent t-test (raw scores)

Usage

```r
TOSTtwo.raw(m1, m2, sd1, sd2, n1, n2, low_eqbound, high_eqbound, alpha,
             var.equal, plot = TRUE, verbose = TRUE)
```

Arguments

- `m1`: mean of group 1
- `m2`: mean of group 2
- `sd1`: standard deviation of group 1
- `sd2`: standard deviation of group 2
- `n1`: sample size in group 1
- `n2`: sample size in group 2
- `low_eqbound`: lower equivalence bounds (e.g., -0.5) expressed in raw scale units (e.g., scale-points)
- `high_eqbound`: upper equivalence bounds (e.g., 0.5) expressed in raw scale units (e.g., scale-points)
alpha level (default = 0.05)

var.equal logical variable indicating whether equal variances assumption is assumed to be TRUE or FALSE. Defaults to FALSE.

plot set whether results should be plotted (plot = TRUE) or not (plot = FALSE) - defaults to TRUE

verbose logical variable indicating whether text output should be generated (verbose = TRUE) or not (verbose = FALSE) - default to TRUE

Value

Returns TOST t-value 1, TOST p-value 1, TOST t-value 2, TOST p-value 2, degrees of freedom, low equivalence bound, high equivalence bound, Lower limit confidence interval TOST, Upper limit confidence interval TOST

References


Examples

```r
## Eskine (2013) showed that participants who had been exposed to organic
## food were substantially harsher in their moral judgments relative to
## those exposed to control (d = 0.81, 95% CI: [0.19, 1.45]). A
## replication by Moery & Calin-Jageman (2016, Study 2) did not observe
## a significant effect (Control: n = 95, M = 5.25, SD = 0.95, Organic
## Food: n = 89, M = 5.22, SD = 0.83). Following Simonsohn’s (2015)
## recommendation the equivalence bound was set to the effect size the
## original study had 33% power to detect (with n = 21 in each condition,
## this means the equivalence bound is d = 0.48, which equals a
## difference of 0.384 on a 7-point scale given the sample sizes and a
## pooled standard deviation of 0.894). Using a TOST equivalence test
## with alpha = 0.05, assuming equal variances, and equivalence
## bounds of d = -0.43 and d = 0.43 is significant, t(182) = -2.69,
## p = 0.004. We can reject effects larger than d = 0.43.

TOSTtwo.raw(m1=5.25,m2=5.22,sd1=0.95,sd2=0.83,n1=95,n2=89,low_eqbound=-0.384,high_eqbound=0.384)
```
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