

# Package ‘equivUMP’

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**Type** Package

**Title** Uniformly Most Powerful Invariant Tests of Equivalence

**Version** 0.1.1

**Description** Implementation of uniformly most powerful invariant equivalence tests for one- and two-sample problems (paired and unpaired) as described in Wellek (2010, ISBN:978-1-4398-0818-4). Also one-sided alternatives (non-inferiority and non-superiority tests) are supported. Basically a variant of a t-test with (relaxed) null and alternative hypotheses exchanged.

**License** GPL ( $\geq 2$ )

**URL** <https://github.com/thmild/equivUMP>

**BugReports** <https://github.com/thmild/equivUMP/issues>

**Encoding** UTF-8

**LazyData** true

**RoxygenNote** 6.1.1

**NeedsCompilation** no

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**Repository** CRAN

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|            |                                                                               |
|------------|-------------------------------------------------------------------------------|
| equiv.test | <i>Equivalence and non-inferiority tests for one- and two-sample problems</i> |
|------------|-------------------------------------------------------------------------------|

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## Description

Implementation of uniformly most powerful invariant equivalence tests for one- and two-sample problems (paired and unpaired). Also one-sided alternatives (non-inferiority and non-superiority tests) are supported. Basically a variant of a t-test with (relaxed) null and alternative hypotheses exchanged.

## Usage

```
equiv.test(x, ...)

## Default S3 method:
equiv.test(x, y = NULL, alternative = c("two.sided",
    "less", "greater"), eps = 1, mu = 0, paired = FALSE, ...)

## S3 method for class 'formula'
equiv.test(formula, data, subset, na.action, ...)
```

## Arguments

|             |                                                                                                                                                               |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| x           | a (non-empty) numeric vector of data values.                                                                                                                  |
| ...         | further arguments to be passed to or from methods.                                                                                                            |
| y           | an optional (non-empty) numeric vector of data values.                                                                                                        |
| alternative | a character string specifying the alternative hypothesis, must be one of "two.sided" (default), "greater" or "less". You can specify just the initial letter. |
| eps         | a single strictly positive number giving the equivalence limits.                                                                                              |
| mu          | a number indicating the true value of the mean (or difference in means if you are performing a two sample test).                                              |
| paired      | a logical indicating whether you want a paired equivalence test in the two-sample case.                                                                       |
| formula     | a formula of the form lhs ~ rhs where lhs is a numeric variable giving the data values and rhs a factor with two levels giving the corresponding groups.      |
| data        | an optional matrix or data frame containing the variables in the formula formula. By default the variables are taken from environment(formula).               |
| subset      | an optional vector specifying a subset of observations to be used.                                                                                            |
| na.action   | a function which indicates what should happen when the data contain NAs. Defaults to getOption("na.action").                                                  |

## Details

`equiv.test` is modelled after (and borrows code from) R's `t.test()` and is intended to work as similarly as possible.

This functions implements uniformly most powerful invariant equivalence tests for one-sample and (paired or unpaired) two-sample problems. Also supported are one-sided versions (so-called non-inferiority or non-superiority tests).

All tests are on standardized (differences of) means  $\theta$ :

$$\theta = (\mu_x - \mu) / \sigma$$

for the one-sample case,

$$\theta = (\mu_d - \mu) / \sigma_d$$

for the paired two-sample case and

$$\theta = (\mu_x - \mu_y - \mu) / \sigma$$

for the unpaired test, where  $\sigma$  is the standard deviation of  $x$  and  $y$  and  $\sigma_d$  is the standard deviation of the differences.  $\mu$  is a shift parameter that can be used to compare against a known value in the one-sample case.  $\mu$  should usually be zero for two-sample problems.

The null and alternative hypotheses in equivalence tests (`alternative = "two.sided"`) are

$$H_0 : \theta \leq -\epsilon \quad \text{or} \quad \theta \geq \epsilon$$

vs

$$H_1 : -\epsilon < \theta < \epsilon$$

Currently, only symmetric equivalence intervals  $(-\epsilon, \epsilon)$  are supported.

In the non-inferiority-case (`alternative = "greater"`) we test

$$H_0 : \theta \leq -\epsilon$$

vs

$$H_1 : \theta > -\epsilon$$

In the non-superiority-case (`alternative = "less"`) we test

$$H_0 : \theta \geq \epsilon$$

vs

$$H_1 : \theta < \epsilon$$

If `paired` is TRUE then both `x` and `y` must be specified and they must be the same length. Missing values are silently removed (in pairs if `paired` is TRUE).

The formula interface is only applicable for the two-sample tests.

**Value**

A list with class `htest` containing the following components:

|                          |                                                                                                                                                                                                                      |
|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>statistic</code>   | the value of the t-statistic.                                                                                                                                                                                        |
| <code>parameter</code>   | the degrees of freedom for the t-statistic.                                                                                                                                                                          |
| <code>p.value</code>     | the p-value for the test.                                                                                                                                                                                            |
| <code>estimate</code>    | the plug-in estimate of the standardized mean (or mean difference), i.e. the empirical mean (or difference of empirical means) divided by the empirical standard deviation. Note that this estimate is not unbiased. |
| <code>null.value</code>  | non-equivalence limits, i.e. boundaries of null hypothesis                                                                                                                                                           |
| <code>alternative</code> | a character string describing the alternative hypothesis.                                                                                                                                                            |
| <code>method</code>      | a character string indicating what type of equivalence test was performed.                                                                                                                                           |
| <code>data.name</code>   | a character string giving the name(s) of the data.                                                                                                                                                                   |

**Methods (by class)**

- `default`: Default S3 method:
- `formula`: S3 method for class `'formula'`

**References**

Wellek, S. (2010). Testing Statistical Hypotheses of Equivalence and Noninferiority. Second edition. Boca Raton: Chapman & Hall. (especially Chapters 5.3 and 6.1).

**Examples**

```
# compare two feed from chickwts dataset
data("chickwts")
chickwts2 <- chickwts[chickwts$feed %in% c("linseed", "soybean"),]
chickwts2$feed <- droplevels(chickwts2$feed)

# similar but cannot be shown to be equivalent up to 0.5 sigma at 0.05 level^
plot(weight ~ feed, data = chickwts2)
equiv.test(weight ~ feed, data = chickwts2, eps = 0.5)
```

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