Package ‘orddom’

February 20, 2015

Type Package
Title Ordinal Dominance Statistics
Version 3.1
Date 2013-02-04
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Description Computes ordinal, statistics and effect sizes as an alternative to mean comparison: Cliff's delta or success rate difference (SRD), Vargha and Delaney's A or the Area Under a Receiver Operating Characteristic Curve (AUC), the discrete type of McGraw & Wong’s Common Language Effect Size (CLES) or Grissom & Kim's Probability of Superiority (PS), and the Number needed to treat (NNT) effect size. Moreover, comparisons to Cohen's d are offered based on Huberty & Lowman's Percentage of Group (Non-)Overlap considerations.
Depends psych
License GPL-2
Repository CRAN
Date/Publication 2013-02-07 10:00:29
NeedsCompilation no

R topics documented:

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Description

This package provides ordinal, nonparametric statistics and effect sizes as an alternative to independent or paired group mean comparisons, with special reference to Cliff’s delta statistics (or success rate difference, SRD), but also providing McGraw and Wong’s common language effect size for the discrete case (i.e. Grissom and Kim’s Probability of Superiority), Vargha and Delaney’s A (or the Area Under a Receiver Operating Characteristic Curve AUC), and Cook & Sackett’s number needed to treat (NNT) effect size (cf. Kraemer & Kupfer, 2006). For the nonparametric effect sizes, various bootstrap CI estimates may also be obtained. Nonparametric effect sizes are also expressed as Cohen’s d based on percentages of group non-overlap (cf. Huberty & Lowman, 2000).

Details

Package: anRpackage
Type: Package
Version: 3.1
Date: 2013-02-07
License: GPL-2

Note

Please cite as:


Major changes from orddom version 3.0 to 3.1

• Correction for dmes list names

Major changes from orddom version 2.0 to 3.0

• New function dmes to easily calculate nonparametric effect size measures independently from orddom
• Easier and more reliable input possible (vectors, lists, arrays, data frames) (by means of new function return1colmatrix)
• Individual variable label and test descriptions can now be assigned
• Outputs now also contain Number Needed to Treat (NNT) effect size
• (Para)metric Common Language effect size McGraw & Wong (1992) added
• Metric d CI in orddom now based on Hedges & Olkin (1985)
• Elimination of negative delta-between variance estimates for paired comparisons
• Correction of symmetric CI for independent Cliff’s delta statistics
• New function dmes.boot to calculate bootstrap-based CI for nonparametric effect size measures and Cohen’s d,
• dmes.boot was largely based on R code provided by J. Ruscio and T. Mullen (2011) reused with kind permission
• New function delta_gr now yields a graphical and interpretational output for Cliff’s delta statistic
• New options for one- and two-tailed CI in orddom and orddom_f, resulting in changes of rows 21 and 22 of independent and rows 18 and 19 of paired orddom result matrix
• New Metric_t function (t, p and df can now be calculated and embedded in orddom as standard or Welch approximated)

Major changes from orddom Version 1.5 to 2.0

• orddom now also accepts simple vectors as x or y.
• New orddom_f() function file allows for file output of statistics for multiple sample comparisons (e.g. csv or analyses in MS Excel or Open Office Calc).
• New orddom_p() function file allows for detailed tab-formatted output for single sample comparisons.
• Package dependency on compute.es package was suspended (tes-Function for metric Cohen’s d in orddom).
• New metric_t() function for additional information on metric t-test results.
• The dm() function can now also return difference matrices.
• Improved stability of orddom function as well as minor corrections in orddom output and manuals.

Major changes from orddom Version 1.0 to 1.5

• Calculation of CI and delta z-score-estimates can now be based on Students t-distribution rather than using fixed normal distribution z-scores.
• Symmetric CIs can now be obtained to increase power of the delta statistics in certain cases.
• Formulas used for calculation added in orddom manual.
• Probability of Superiority statistic as well as variance estimates for delta in the independent groups analyses were corrected.

• Minor changes were implemented to allow for calculation of $d = \pm 1$ extreme cases without error abort.

• Output of raw y-dataset in independent group analysis was corrected.

• Dependencies on packages `psych` and `compute.es` declared in DESCRIPTION and NAMES-PACE files.

Author(s)

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References


See Also

`orddom`, `dmes`, `dmes.boot` and `orddom_f`.

Examples

```r
## Not run:
# Ordinal comparison and delta statistics for independent groups x and y
# (e.g. x: comparison/control group and y: treatment/experimental group)
orddom(x, y, paired=FALSE)

# Ordinal comparison and delta statistics for paired data
# (e.g. x: Pretest/Baseline and y: Posttest)
orddom(x, y, paired=TRUE)

# Dominance Matrix production
dms(x, y, paired=T)

# Print dominance matrix
orddom_p(x, y, sections="4a")

# Graphic output and interpretational text for Cliff's delta statistics
```
Cohen's d to Cliff's delta

Description
Converts Cohen's d effect size to Cliff's delta as non-overlap between two standard normal distributions.

Usage
cohdd2delta(d)

Arguments
d Cohen's d value

Details
Returns delta (or non-overlap, see Table 2.2.1 in Cohen, 1988, p.22).

Value
\[ \delta(d) = \frac{2 \text{AUC}(\frac{d}{2}) - 1}{\text{AUC}(\frac{d}{2})} \]
where \( \text{AUC}(x) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{x} e^{-t^2/2} \, dt \)

Author(s)
Jens Rogmann
References

See Also
delta2cohd

Examples
```r
## Not run: > cohd2delta(1.1)
[1] 0.589245
> cohd2delta(2.1)
[1] 0.8278607
> cohd2delta(2.2)
[1] 0.8430398
> cohd2delta(4.0)
[1] 0.9767203
## End(Not run)
```

delta2cohd  Cliff’s delta to Cohen’s d

Description
Converts Cliff’s delta estimate to Cohen’s d effect size as non-overlap between two standard normal distributions

Usage
delta2cohd(d)

Arguments
- **d**: Cliff’s delta estimate \( \delta \).

Details
Returns Cohen’s d (or non-overlap, based on U1 in Table 2.2.1, Cohen, 1988, p.22).

Value
\[
d(\delta) = 2z_{\frac{1-p}{2}}, \quad \text{where} \quad z_p \equiv \Phi^{-1}(p) = AUC^{-1}(p)
\]

Author(s)
Jens Rogmann
References


See Also
cohd2delta

Examples

```r
## Not run: > delta2cohd(-.10)
[1] -0.1194342
> delta2cohd(-.86)
[1] -0.7725292
> delta2cohd(.10)
[1] 0.1320236
> delta2cohd(.774)
[1] 1.797902
## End(Not run)
```

delta_gr

Cliff’s delta Graphics and Interpretation

Description

Returns a graphical representation and interpretation of Cliff’s delta

Usage

```r
delta_gr(x,y, ..., dv=2)
```

Arguments

- `x` A 1-column matrix with optional column name containing all \( n_x \) values or scores of group X or 1 (e.g. control or pretest group.).

- `y` A 1-column matrix with optional column name containing all \( n_y \) values of group Y or 2 (e.g. experimental or post-test group). For paired comparisons (e.g. pre-post), \( n_x = n_y \) is required.

- `...` Other arguments to be passed on to the `orddom` function, such as (for example):
  - `paired`: to compare dependent data (e.g. pre-post) set to `paired=TRUE`,
  - `alpha` for the respective significance level to be used, e.g. `alpha=.01` for 1-sided testing and confidence interval (CI) values set to `onetailed=TRUE`,
- **studdist** to obtain CI based on normal distribution $z$ values (instead of Student distribution $t$) set to `studdist=FALSE` for 1 - symmetric to obtain symmetric rather than asymmetric CIs (see `orddom` for details) set to `symmetric=TRUE` .
- **onetailed** for one-sided rather than the default two-tailed testing.
- **x.name** to assign an individual label to group x (i.e. 1st or control or pretest group).
- **y.name** to label the y input matrix or group y (i.e. 2nd or experimental or posttest group).
- **description** This argument allows for assigning a string (as title or description) for the ordinal comparison outputs.

### `dv`
(For paired comparisons ($dv=3$) only.) Determines which ordinal $\delta$ statistics are to be returned. Set to:
- $dv=1$ [within] to return an analysis for the $n_x = n_y$ within-pair changes,
- $dv=2$ [between] to return an analysis for the overall distribution changes, based on all $n^2 - n = n(n-1)$ score comparisons between y and x where $i \neq j$,
- $dv=3$ [combined] to return an analysis for the combined inference $d_w + d_b$. It is advisable to use $dv=3$ in combination with `symmetric=TRUE`.

### Value
Returns a graphical representation and text interpretation of Cliff’s delta.

### Author(s)
Jens Rogmann

### See Also
`orddom`

### Examples
```r
# Not run:
# Paired comparison combined inference (Data taken from Long et al. (2003), Table 4)
x2<-t(matrix(c(2,6,6,7,7,8,9,9,9,10,10,10,11,11,12,13,14,15,16),1))
colnames(x2)<-c("Incidental")
y2<-t(matrix(c(4,11,8,9,10,11,11,5,14,12,13,10,14,16,14,13,15,15,16,10),1))
colnames(y2)<-c("Intentional")
delta_gr(x2,y2,paired=TRUE,studdist=FALSE,dv=3)
```

---

`delta_gr` is a function that calculates Cliff's delta, a measure of effect size for ordinal data. It takes several arguments:

- **delta_gr**
- **dv** (For paired comparisons ($dv=3$) only.) Determines which ordinal $\delta$ statistics are to be returned.
- **studdist** to obtain CI based on normal distribution $z$ values (instead of Student distribution $t$) set to `studdist=FALSE` for 1 - symmetric to obtain symmetric rather than asymmetric CIs (see `orddom` for details) set to `symmetric=TRUE`.
- **onetailed** for one-sided rather than the default two-tailed testing.
- **x.name** to assign an individual label to group x (i.e. 1st or control or pretest group).
- **y.name** to label the y input matrix or group y (i.e. 2nd or experimental or posttest group).
- **description** This argument allows for assigning a string (as title or description) for the ordinal comparison outputs.

### Value
Returns a graphical representation and text interpretation of Cliff’s delta.

### Author(s)
Jens Rogmann

### See Also
`orddom`

### Examples
```r
# Not run:
# Paired comparison combined inference (Data taken from Long et al. (2003), Table 4)
x2<-t(matrix(c(2,6,6,7,7,8,9,9,9,10,10,10,11,11,12,13,14,15,16),1))
colnames(x2)<-c("Incidental")
y2<-t(matrix(c(4,11,8,9,10,11,11,5,14,12,13,10,14,16,14,13,15,15,16,10),1))
colnames(y2)<-c("Intentional")
delta_gr(x2,y2,paired=TRUE,studdist=FALSE,dv=3)
```

---

This function is useful for comparing ordinal data across two groups. It takes into account the direction of change and provides a CI based on normal distribution $z$ values. The `symmetric` and `onetailed` arguments allow for obtaining symmetric rather than asymmetric CIs and testing for one-sided rather than two-tailed testing, respectively. The `x.name` and `y.name` arguments are used to label the groups, and `description` allows for a title or description to be added to the output. The `dv` argument is used to specify the type of analysis: within-pair changes, overall changes, or combined inference.
colnames(x)<-"Placebo Phase"
y<-subset(data, data$Treatment==1)[6] #Treatment EECmax
colnames(y)<-"Treatment Phase"
delta_gr(x,y,paired=TRUE, onetailed=TRUE, dv=2)
#
#checks treatment groups delta equivalence in placebo phase
#returns delta and YU
plac<-subset(data, data$Treatment==0)
x<-subset(plac, plac$Period==1)[6] #control (placebo before drug)
colnames(x)<-"Control (before Drug)"
y<-subset(plac, plac$Period==2)[6] #experimental (placebo after drug)
colnames(y)<-"Exp (Placebo after Drug)"
delta_gr(x, y)
#
## End(Not run)

---

**dm**  
*Dominance or Difference Matrix Creation*

**Description**

Returns a dominance or difference matrix based on the comparison of all values of two 1-column matrices x and y

**Usage**

dm(x, y, diff=FALSE)

**Arguments**

- **x**  
  1 column matrix with $n_1$ values (e.g. from group X)

- **y**  
  1 column matrix with $n_2$ values (e.g. from group Y)

- **diff**  
  If argument is set to true, the function will return a difference matrix. Otherwise, a dominance matrix is produced.

**Details**

Each difference matrix cell value $d_{ij}$ is calculated as $y_j - x_i$ across all $i = 1, 2, 3, ..., n_1$ values (=rows) of x and $j = 1, 2, 3, ..., n_2$ values (=rows) of y. Dominance matrix cell values are calculated as $\text{sign}(y_j - x_i)$.

**Value**

Returns difference or dominance matrix with X values as rownames and with Y values as column-names.
Author(s)

Jens Rogmann

References


See Also
dms

Examples

```r
## Not run:
> x <- t(matrix(c(1,1,2,2,2,3,3,4,5,1)),2)
> y <- t(matrix(c(1,2,3,4,4,5),2))
> dm(x,y,diff=TRUE)
     1 2 3 4 5
1 1 -1 -2 -3 -4
1 1 -1 -2 -3 -4
2 1 0 -1 -2 -3
2 1 0 -1 -2 -3
3 1 1 0 -1 -2
3 1 1 0 -1 -2
4 1 2 1 0 0 -1
5 4 3 2 1 1 0

> dm(x,y)
     1 2 3 4 5
1 1 -1 -1 -1 -1
1 1 -1 -1 -1 -1
2 1 0 -1 -1 -1
2 1 0 -1 -1 -1
2 1 0 -1 -1 -1
3 1 1 0 -1 -1 -1
3 1 1 0 -1 -1 -1
3 1 1 0 -1 -1 -1
4 1 1 0 0 0 -1
5 1 1 1 1 1 0

## End(Not run)
```

---

dmes  Dominance Matrix Effect Sizes

---

Description
Generates simple list of nonparametric ordinal effect size measures such as
-the Probability of Superiority (or discrete case Common Language) effect size,
-the Vargha and Delaney’s A (or area under the receiver operating characteristic curve, AUC)
-Cliff’s delta (or success rate difference, SRD), and 
-the number needed to treat (NNT) effect size (based on Cliff’s delta value).

Usage
\texttt{dmes(x,y)}

Arguments
\begin{itemize}
\item \texttt{x} A vector or 1 column matrix with \( n_x \) values from (control or pre-test or comparison) group X
\item \texttt{y} A vector or 1 column matrix with \( n_y \) values from (treatment or post-test) group Y
\end{itemize}

Details
Based on the dominance matrix created by direct ordinal comparison of values of Y with values of X, an associative list is returned.

Value
\begin{itemize}
\item \$nx\ Vector or sample size of \( x, n_x \).
\item \$ny\ Vector or sample size of \( y, n_y \).
\item \$PSc\ Discrete case Common Language CL effect size or Probability of Superiority (PS) of all values of Y over all values of X:
\[
PS_c(Y > X) = \frac{#(y_i > x_j)}{n_y n_x}
\]
where \( i = \{1, 2, \ldots, n_y\} \) and \( j = \{1, 2, \ldots, n_x\} \). See orddom \texttt{PS Y>X} for details.
\item \$Ac\ Vargha & Delaney’s A or Area under the receiver operating characteristics curve (AUC) for all possible comparisons:
\[
A(Y > X) = \frac{#(y_i > x_j) + .5(#(y_i = x_j))}{n_y n_x}^{-1}
\]
where \( i = \{1, 2, \ldots, n_y\} \) and \( j = \{1, 2, \ldots, n_x\} \). See orddom \texttt{A Y>X} for details.
\item \$dc\ Success rate difference when comparing all values of Y with all values of X:
\[
dc(Y > X) = \frac{#(y_i > x_j) - #(y_i < x_j)}{n_y n_x}
\]
where \( i = \{1, 2, \ldots, n_y\} \) and \( j = \{1, 2, \ldots, n_x\} \). See orddom Cliff’s delta for
independent groups for details.

Note that in the paired samples case with \( n_y = n_x \), \( dc \) does not return the combined estimate, i.e. \( dc \neq dw + db! \)

$\text{NNT}_c$ Number needed to treat, based on the success rate difference or \( dc^{-1} \). See orddom "NNT" for details.

$\text{PS}_w$ When sample sizes are equal, this value returns the Probability of Superiority (PS) for within-changes, i.e. all paired values: \( PS_w(Y > X) = \frac{\#(y_i > x_i)}{n_y n_x} \), limited to the \( n_x = n_y \) paired cases where \( i = 1, 2, ..., n_x = n_y \). (For unequal sample sizes, this equals $\text{PSc}$.)

$\text{A}_w$ When sample sizes are equal, this value returns A for the paired subsample values, i.e. limited to the \( n_x = n_y \) paired cases where \( i = j = 1, 2, ..., n_x = n_y \). (For unequal sample sizes, this equals $\text{Ac}$.)

$\text{d}_w$ When \( n_x = n_y \), this value returns Cliff's delta-within, i.e. paired comparisons limited to the diagonal of the dominance matrix or those cases where \( i = j \). (For unequal sample sizes, this equals $\text{dc}$.)

$\text{NNT}_w$ Number needed to treat, based on the within-case-success rate difference or \( dw^{-1} \). See orddom NNT within for dependent groups for details.

$\text{PS}_b$ When sample sizes are equal, this gives the Probability of Superiority (PS) for all cases but within-pair changes, i.e.:

\[
PS_b(Y > X) = \frac{\#(y_i > x_j)}{n_y n_x},
\]

limited to those cases where \( i \neq j \). (For unequal sample sizes, this equals $\text{PSc}$ and $\text{PSw}$.)

$\text{A}_b$ When sample sizes are equal, this value returns A for all cases where \( i \neq j \). (For unequal sample sizes, this equals $\text{Ac}$.)

$\text{d}_b$ When \( n_x = n_y \), this value returns Cliff’s delta-between, i.e. all but the paired comparisons or excepting the diagonal of the dominance matrix. The parameter is calculated by taking only those ordinal comparisons into account where \( i \neq j \). (For unequal sample sizes, this equals $\text{dc}$.)

$\text{NNT}_b$ Number needed to treat, based on Cliff’s delta-between or $\text{db}^{-1}$. See orddom NNT between for dependent groups for details.

Author(s)

Jens J. Rogmann

References


**See Also**

*dm, orddom*

**Examples**

```r
## Not run:
> #Example from Efron & Tibshirani (1993, Table 2.1, p. 11)
> y<-c(94,197,16,38,99,141,23) # Treatment Group
> x<-c(52,104,146,10,50,31,40,27,46) # Control Group
> dmes(x,y)

$nx
[1] 9

$ny
[1] 7

$SPSc
[1] 0.5714286

$SAC
[1] 0.5714286

$dc
[1] 0.1428571

$NNNTc
[1] 7

$SPSw
[1] 0.5714286

$Aw
[1] 0.5714286

$dw
[1] 0.1428571

$NNNTw
Example from Ruscio & Mullen (2012, p. 202)


```r
dx <- c(6, 7, 8, 7, 9, 6, 5, 4, 7, 8, 7, 6, 9, 5, 4) # Treatment Group
y <- c(4, 3, 5, 3, 6, 2, 2, 1, 6, 7, 4, 3, 2, 4, 3) # Control Group
dmes(y, x)

> dmes


## Confidence Intervals for the Probability of Superiority Effect Size Measure and the Area Under a Receiver Operating Characteristic Curve

```
dmes.boot

Dominance Matrix Effect Sizes

Description

Bootstrap-based calculation of standard error and CI constructs for Cohen’s d and the statistics used in the Dominance Matrix Effect Size (dmes) function

Usage

dmes.boot(x,y,theta.es="dc",ci.meth="BCA",B=1999, alpha=.05, seed=1)

Arguments

x A vector or 1 column matrix with \( n_x \) values from (control or pre-test or comparison) group X

y A vector or 1 column matrix with \( n_y \) values from (treatment or post-test) group Y

theta.es Specification of the nonparametric effect size for which the SE and CI is to be constructed. All output values of the dmes function can be used, e.g. "PSc", "Ac", "dc", "NNTc", "PSw", "Aw", "dw", "NNTw", "Psb", "Ab", "db" or "NNTb".

ci.meth Specify type of method used for bootstrap confidence interval construction: "BSE", "BP" or "BCA".

"BSE" uses the bootstrap standard error estimate of the respective nonparametric effect size to construct a confidence interval with \( \hat{\theta} \pm z_{\alpha/2} \cdot \hat{S}E_{\theta} \), where \( \hat{\theta} \) ist the observed effect size, \( z_{\alpha/2} \) the z value of the standard normal table at the given (two-tailed) significance level (e.g. \( z=1.96 \) when alpha=5). "BP" calculates confidence intervals based on bootstrap percentiles. B bootstrap sample estimates of the respective nonparametric effect size \( \theta \) are generated and ordered, and the \( (B \cdot 100 \cdot \alpha) \)th as well as the \( (B \cdot 100 \cdot (1 - \alpha)) \)th of these ordered estimates are used to determine the confidence intervals. For example, if \( B=2000 \) bootstrap samples are calculated and \( \alpha = .05 \), then the 100th and 1900th of the ordered values are selected as lower and upper CI limits.

"BCA" calculates bias-corrected and accelerated confidence intervals (also based
on bootstrap percentiles). Here, however, the \( \alpha \) levels (or percentiles) are corrected depending on the bias and the rate of change of the standard error with formulas suggested by Efron & Tibshirani (1993, Chapter 14).

\[ B \]
Number of bootstrap samples to be used for the estimates.

\[ \alpha \]
Significance level.

\[ \text{seed} \]
Integer argument to set random number generation seeds, see Random.

**Details**

Returns an associative list with the following values:

**Value**

\[ \theta \]
Type and observed value of the respective nonparametric effect size estimate for samples Y and X.

\[ \theta.\text{SE} \]
The bootstrap-based estimated standard error of the respective nonparametric effect size estimate.

\[ \text{bci.meth} \]
String indicating which type of bootstrap (BSE, BP or BCA) was used to construct the confidence interval for the respective nonparametric effect size estimate and Cohen's d.

\[ \theta.\text{bci.lo} \]
Lower end of the confidence interval for the respective nonparametric effect size estimate as determined by type of bootstrap used (BSE, BP or BCA).

\[ \theta.\text{bci.up} \]
Upper end of the confidence interval for the respective nonparametric effect size estimate as determined by type of bootstrap used (BSE, BP or BCA).

\[ \text{Coh.d} \]
Effect size estimate of Cohen's d based on student's t and assuming pooled variance. For details, see metric_t.

\[ \text{Coh.d.bSE} \]
The bootstrap-based estimated standard error of Cohen's d.

\[ \text{Coh.d.bci.lo} \]
Lower end of the confidence interval for the Cohen's d estimated through bootstrapping (type BSE, BP or BCA).

\[ \text{Coh.d.bci.up} \]
Upper end of the confidence interval for the Cohen's d estimated through bootstrapping (type BSE, BP or BCA).

**Note**

*dmes.boot* was largely based on R code provided by John Ruscio and Tara Mullen (2011) which was reused with kind permission from the authors.

**Author(s)**

Jens J. Rogmann
References


See Also
dmes

Examples

```r
## Not run:
> # cf. Efron & Tibshirani (1993, Ch. 14)
> # Spatial Test Data (Table 14.1, p.180)
> A<-c(48,36,20,29,42,20,22,41,45,14,6,0,33,28,34,4,32,24,47,41,24,26,30,41)
> B<-c(42,33,16,39,38,36,15,33,20,43,34,22,7,15,34,29,41,13,38,25,27,41,28,14,28,40)
> dmes.boot(A,B)
$theta
  d
-0.08136095

$theta.SE
[1] 0.1656658

$bci.meth
[1] "BCA"

$theta.bci.lo
[1] -0.4008876

$theta.bci.up
[1] 0.2440828

$Coh.d
[1] -0.06364221

$Coh.d.bSE
[1] 0.2895718

$Coh.d.bci.lo
[1] -0.6106167

$Coh.d.bci.up
[1] 0.5031792
```
Dominance Matrix in Symbols

Description

Returns a character-based dominance matrix based on the signs of all cell values of a given matrix.

Usage

dms(dom, paired = FALSE)
Arguments

- **dom**
  - Input matrix, typically raw difference or dominance matrix

- **paired**
  - Should only be set to TRUE if the number of rows equal the number of columns and if the difference data in the matrix diagonal are to be given different symbols.

Details

According to the sign of each input matrix’ cell value ($\text{sign}(d_{ij})$), a respective symbol is written to the output matrix ("-" for -1, "O" for 0" and "+" for 1).

If paired==TRUE, the diagonal vector of the output matrix receives different symbols (i.e. "<" for -1, "=" for 0, "<" for 1).

Author(s)

Jens Rogmann

References


See Also

dm

Examples

```r
## Not run: > x<-t(matrix(c(1,1,2,2,2,3,3,3,4,5),1))
> y<-t(matrix(c(1,2,3,4,4,5),1))
> write.table(dms(dm(x,y)),quote=FALSE,row.names=FALSE,col.names=FALSE,sep="")
  0-----
  0-----
 +0-----
 +0-----
 +0-----
 +0-----
 +0-----
 +0-----
 +0-----
 +0-----
 +0-----
 +0-----
 +0-----
 +0-----
 +0-----
 # End(Not run)
```
**Description**

Returns a matrix of independent or paired t-test data for comparison to ordinal alternatives.

**Usage**

```r
metric_t(a, b, alpha=0.05, paired=FALSE, t.welch=TRUE)
```

**Arguments**

- `a`: First dataset (vector or matrix).
- `b`: Second dataset (vector or matrix).
- `alpha`: Significance or α-level used for the calculation of the confidence intervals. Default value is α = .05 or 5 Percent.
- `paired`: By default, independence of the two groups or data sets is assumed. If the number of cases in x and y are equal and paired (e.g. pre-post) comparisons, this should be set to TRUE.
- `t.welch`: By default, the variances of the two datasets are not assumed equal. If the pooled variance is needed for t, p, and df this should be set to FALSE. This setting has no effect on the calculation of Cohens’d.

**Value**

- `[1,1]` or `"Diff M", 1`
  - Mean Difference $\bar{y} - \bar{x}$ or estimate (in the paired case) See `t.test` for details.
- `[2,1]` or `"t value", 1` or `"t(dep.)", 1`
  - Value of the t-statistic for the independent or the paired case. See `t.test` for details.
- `[3,1]` or `"df", 1` or `"df", 1`
  - Degrees of freedom for the t-statistic. For independent samples, the Welch approximation of degrees of freedom is returned unless t.welch is set to FALSE. See `t.test` for details.
- `[4,1]` or `"p value", 1`
  - The p-value of the test. See `t.test` for details. For independent samples, the Welch approximation of degrees of freedom is returned unless t.welch is set to FALSE.
- `[5,1]` or `"Cohen’s d", 1`
  - Cohen’s d effect size for both the independent and the paired case calculated using student’s t (i.e. assuming pooled variance) as
    
    $d_{Cohen} = \frac{t_{(pooledvar)}}{\sqrt{\frac{n_y + n_x}{n_y n_x}}}$
following the advice of Dunlap, Cortina, Vaslow and Burke (1996) who suggested using the independent group t-value and the original standard deviations also for the paired case to avoid overestimation of the effect size.

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References

See Also
t.test

Examples

```r
## Not run:
> # Example from Dunlap et al. (1996), Table 1
> y <- c(27, 25, 30, 29, 30, 33, 31, 35)
> x <- c(21, 25, 23, 26, 26, 29, 31)
> metric_t(x, y)
[,1]
   Diff M 4.000000000
   t value 2.52982213
   df Welch 14.00000000
   p value 0.02403926
   Cohen's d 1.26491106
> metric_t(x, y, paired=TRUE)
[,1]
   Diff M 4.000000000
   t(dep.) 4.512608599
   df 7.000000000
   p value 0.002756406
   Cohen's d 1.264911064

## End(Not run)
```

 oder dom

Ordinal Dominance Statistics

Description

Returns an array of ordinal dominance statistics based on the input of two 1-column matrices as an alternative to independent or paired group mean comparisons (especially for Cliff’s delta statistics).
orddom

Usage

orddom(x,y,alpha=.05,paired=FALSE,outputfile="",studdist=TRUE,
        symmetric=FALSE,onetailed=FALSE,t.welch=TRUE,
        x.name="",y.name="",description="")

Arguments

x A 1-column matrix with optional column name containing all \( n_x \) values or
scores of group X or 1 (e.g. control or pretest group.), e.g. declared in R as
\[
x<-t(matrix(c(x_1,x_2,x_3,x_4,\ldots,x_{n_x}),1))
\]
\( colnames(x)<-c("[label of group X]") \).
If x is a vector, a default column name is assigned.

y A 1-column matrix with optional column name containing all \( n_y \) values of group
Y or 2 (e.g. experimental or post-test group). For paired comparisons (e.g. pre-
post), \( n_x = n_y \) is required. If y is a vector, a default column name is assigned.

alpha Significance or \( \alpha \)-level used for the calculation of the confidence intervals. De-
fault value is \( \alpha = .05 \) or 5 Percent, giving a 95 Percent CI. For multiple
dominance comparisons, a Bonferroni procedure may be implemented: Cliff
(1996, p.150) suggested dividing \( \alpha \) by the number of possible comparisons, i.e.
\[
\alpha \left( \frac{1}{2} k( k - 1) \right)^{-1}
\]
for comparisons between \( k \) data sets.

paired By default, independence of the two groups or data sets is assumed. If the
number of cases in x and y are equal and paired (e.g. pre-post) comparis-
s, this should be set to TRUE to return the full array of within, between, combined
and metric delta statistics.

outputfile If a detailed report of the ordinal dominance analysis is wanted, a filename
should be given here. The report as standard text file is written to the current
working directory.

studdist By default, it is assumed that small samples are being examined. In this case, z-
values based on Student’s t-distribution are used for estimating upper and lower
limits of the confidence intervals (CI) as well as z-probabilities. If larger sample
sizes are used, these values approximate estimates based on normally distributed
z-values. In this case or if comparing with estimates calculated with orddom
versions <1.5 (where z-values based on the Standard Normal Distributions were
used), this parameter may be set to FALSE.

symmetric By default, asymmetric confidence intervals (CI) are being calculated to com-
pensate for positive correlations between the samples as generally recommended
by the literature on the delta statistics. To increase power in certain cases, how-
ever - e.g. in small paired samples (cf. Cliff 1996, p. 165) or fur purposes of
evaluating the CIs of a combined delta estimate in the paired case - symmetric
CIs may also be obtained by setting this argument to TRUE.

onetailed By default, calculation of p values and confidence intervals (CI) assumes two-
sided testing against the null hypothesis. Set to TRUE if the alternative hypo-
thesis targets at one-tailed testing.

t.welch By default, for calculation of the t-test scores and metric p and df values, the
Welch approximation is used. If set to FALSE, equal variances are assumed for
groups X and Y and a pooled variance is being calculated.
By default, the label of group x (i.e. 1st or control or pretest group) is taken from the column name of the x input matrix. This argument allows for assigning an alternative label.

This argument allows for assigning an alternative label for the y input matrix or group y (i.e. 2nd or experimental or posttest group).

This argument allows for assigning a string (as title or description) for the ordinal comparison outputs.

**Value**

**INDEPENDENT GROUPS** (*paired* argument set to FALSE)

In the case of independent groups or data sets X and Y (e.g. comparison group X vs. treatment group Y), a 2-column-matrix containing 29 rows with values is returned.

The ordinal statistics can be retrieved from the first column (named "ordinal") while the second column (named "metric") contains metric comparison data where appropriate.

- **1 or ["var1_X", col#]**
  Label assigned to group x (x.name or column name of the x input matrix) or a default "1st var (x)".

- **2 or ["var2_Y", col#]**
  Label assigned to group x (x.name or column name of the x input matrix) or a default "2nd var (y)".

- **3 or ["type_title", col#]**
  Column 1: Returns type of the comparison, in this case "indep".
  Column 2: In case a string header is defined by use of the *comp.name* argument, it is returned in column 2.

- **4 or ["n in X", col#]**
  Number of cases in x (i.e. group X sample size).

- **5 or ["n in Y", col#]**
  Number of cases in y (i.e. group Y sample size).

- **6 or ["N #Y>X", col#]**
  Number of occurrences of an observation from group y having a higher value than an observation from group x when comparing all x scores with all y scores: \( N_{#Y>X} = \#(y_i > x_j) \), where \# denotes "the number of times" whilst comparing each \( i = 1, 2, 3, \ldots n_y \) score in sample Y with each \( j = 1, 2, 3, \ldots n_x \) score in sample X (resulting in \( n_x \cdot n_y \) comparisons).

- **7 or ["N #Y=X", col#]**
  Number of occurrences of an observation from group y having the same value as an observation from group x: \( N_{#Y=X} = \#(y_i = x_j) \).
Number of occurrences of an observation from group y having a smaller value than an observation from group x: \( N_{Y<X} = \#(y_i < x_j) \).

Common Language CL effect size or Probability of Superiority (PS) of X over Y, see below.

Column 1: Discrete case Common Language CL effect size or Probability of Superiority (PS) of Y over X, PS(\( Y > X \)) = \#(y_i > x_j) \cdot n_y \cdot n_x (cf. Grissom, 1994, Grissom & Kim, 2005, McGraw & Wong, 1992). This effect size reflects the probability that a subject or case randomly chosen from group Y has a higher score than a randomly chosen subject or case from group X (cf. Acion et al., 2006).

Column 2: Assuming equal variances and population normality, the (para)metric version of the Common Language effect size is calculated as suggested by McGraw & Wong (1992, p. 361) as \( PS(\ Y > \ X) = \Phi(\frac{M_y - M_x}{\sqrt{s_x^2 + s_y^2}}) \) where \( \Phi(z) = \alpha \).

Vargha and Delaney’s A as stochastic superiority of X over Y, calculated as \( A_{X>Y} = PS(\ X > \ Y) + .5PS(\ X = \ Y) \) (cf. Vargha & Delaney, 1998, 2000, Delaney & Vargha, 2002). This modified probability of superiority effect size has also been called area under the the receiver operating characteristic curve or AUC by Kraemer and Kupfer (2006).

Vargha and Delaney’s A as stochastic superiority of Y over X.

For column 1 ("ordinal"): Cliff’s delta for independent groups (Cliff, 1996, Long et al., 2003):

\[
d = \frac{\#(y_i > x_j) - \#(y_i < x_j)}{n_y \cdot n_x} = \frac{\sum_i \sum_j d_{ij}}{n_y \cdot n_x}
\]

where \( d_{ij} = sign(y_i - x_j) \) across all score comparisons. Termed success rate difference (SRD) effect size by Kraemer and Kupfer, delta denotes the difference between the probability that a randomly chosen Y case or subject (or patient) has a higher score than a randomly chosen case or subject from group X and the probability for the opposite.

Put in simple terms, if higher values reflect better treatment outcomes of study participants, delta is the difference between the probability that a Y treatment group participant has a treatment outcome preferable to an X control group participant and the probability that a X patient has a treatment outcome preferable to a Y patient (cf. Kraemer & Kupfer, 2006, p. 994). In contrast to the PS and
A effect sizes, delta thus takes potentially worse or harmful treatment outcomes into account.

In column 2, the metric differences between the means are given: \( \bar{y} - \bar{x} = d_{ij} \) between all comparable x and y scores with \( d_{ij} = y_i - x_j \).

[14 or "1-alpha", col#]
Significance or \( \alpha \)-level for CI estimation, given as percentage between 0 and 100.

[15 or "CI low", col#]
Unless the default symmetric parameter is explicitly set to TRUE, improved formulas are used (Feng & Cliff, 2004) to calculate asymmetric confidence interval (CI) boundary estimates of delta or mean difference:

\[
CI_{lower/upper} = \frac{d - d^3 \pm t_{\alpha/2} s_d \sqrt{1 - 2d^2 + d^4 + t_{\alpha/2}^2 s_d^2}}{1 - d^2 + t_{\alpha/2}^2 s_d^2},
\]

with t-values at the given \( \alpha \)-level taken from Student’s t distribution by default (unless the studdist is set FALSE, in which case t-values are based on z-values from the Standard Normal Distribution).

In case the symmetric argument is explicitly set to TRUE, however, ordinary CIs are being calculated with \( CI_{lower/upper} = d \pm t_{\alpha/2} s_d \).

In any case, if Cliff’s \( d = \pm 1 \), one CI is assumed being equal to \( d \), the respective other is calculated as

\[
CI_{lower/upper} = ((n_b - t_{\alpha/2}^2))(n_b + t_{\alpha/2}^2)^{-1},
\]

where \( t_{\alpha/2} \) is the t-value or z-score at the selected \( \alpha \) level (2-tailed) of the respective studdist-controlled distribution, and \( n_b \) the number of observations or cases in the smaller of the two samples.

[16 or "CI high", col#]
Confidence interval upper boundary estimate of delta or mean difference.

[17 or "s delta", col#]
Unbiased sample estimate of the delta standard deviation in column 1.

In column 2 ("metric"): Pooled standard deviation of metric mean difference with \( s_{xy} = [(n_x - 1)s_x + (n_y - 1)s_y]/(n_x + n_y - 2) \)^{1/2}.

[18 or "var delta", col#]
Column 1: Variance of delta (unbiased sample estimate), calculated as

\[
s_d^2 = \frac{n_x^2 \sum (d_i - d)^2 + n_y^2 \sum (d_j - d)^2 - \sum \sum (d_{ij} - d)^2}{n_x n_y (n_x - 1)(n_y - 1)},
\]

or, using the partial variances

\[
s_d^2 = \frac{n_x^2 (n_x - 1)s_{d,x}^2 + n_y^2 (n_y - 1)s_{d,y}^2 - (n_x n_y - 1)s_{d_{ij}}^2}{n_x n_y (n_x - 1)(n_y - 1)},
\]
which can also alternatively be put as

$$s_{d}^2 = \frac{n_y s_{d_i}^2}{n_x(n_y - 1)} + \frac{n_x s_{d_j}^2}{n_y(n_x - 1)} - \frac{(n_x n_y - 1)s_{d_{ij}}^2}{n_x n_y(n_x - 1)(n_y - 1)}.$$

(For differences to Cliff’s (1996, p. 138) formula see notes to Row 28 (“var dij”) below.)

In case this calculation of $s_{d}^2$ yields values of less than $(1 - d^2)/(n_x n_y - 1)$, this latter formula is used for calculating the variance of delta.

Column 2 contains the pooled $s_{xy}^2$.

[19 or ["se delta", col#]
Column 2 only: metric Standard error of mean difference:

$$SE_{xy} = s_{xy} \sqrt{1/n_x + 1/n_y}.$$ 

[20 or ["z/t score", col#]
Column 1: z score of delta on the of the respective studdist-controlled distribution (Student’s t or standard normal).

Column 2: Metric z/t-score ($= \bar{d}_{ij}/SE_{xy}$). In the metric case, the t.welch decides upon assumption of equal variances for X and Y.

[21 or ["H1 tails p/CI", col#]
Equals 1 for one-tailed and 2 for two-tailed testing of alternative or $H_1$-hypothesis, affecting CI and p values.

[22 or ["p", col#]
Probability of z/t score (1-sided or 2-sided comparison as shown in row 21).

[23 or ["Cohen’s d", col#]
Cohen’s $d$ effect size estimate of delta. For Cliff’s delta inferred from distributional non-overlap as suggested by Grissom & Kim (2005, p. 106 f.) as well as Romano, Kromrey, Coraggio, & Skowronek (2006, p. 14-15), relating to the relative positions of the distributions of X and Y. When Cliff’s delta equals 0, there is no effect, and the Y and X distributions overlap completely. If there are effects, a certain percentage of non-overlap between X and Y is created, and the relative positions of the X and Y distributions shift. The degree of non-overlap thus is a measure of effect size and is expressed as Cohen’s $d$ in terms of non-overlap between two normal distributions (based on U1 in Table 2.2.1, Cohen, 1988, p.22). See delta2cohd manual of orddom package.
Column 2 returns Cohen’s d assuming a pooled variance for t. See metric_t for details.

[24 or ["d CI low", col#]
Column 1: Cohen’s $d$ effect size estimate of the lower boundary of confidence interval (row 15) by using the non-overlap strategy.
Column 2: Confidence bands for metric Cohen’s $d$ are constructed based on the estimated standard deviation of Cohen’s $d$’s theoretical sampling distribution, assuming asymptotic normality (Hedges & Olkin, 1985), calculated as $CI_{lower/upper} = d \pm zs_{d}$, where $z$ is the z-score at the selected $\alpha$ level (2-
tailed) of the standard normal distribution, and

\[ s_d = \sqrt{\frac{n_x + n_y}{n_x n_y} + \frac{d^2}{2(n_x + n_y)}} \]

[25 or ["d CI high", col#]
Column 1: Cohen’s d estimate of upper boundary of confidence interval (row 16).
Column 2: see row 24 for details.

[26 or ["var d.i", col#]
Row variance of dominance/difference matrix, calculated as
\((n_x - 1)^{-1} \sum (d_i - d)^2\). The metric descriptive in column 2 is the variance of
\(x\) (or \(s^2_x\)).

[27 or ["var dj.", col#]
Column variance of dominance/difference matrix, calculated as
\((n_y - 1)^{-1} \sum (d_j - d)^2\). The metric descriptive in column 2 is the variance of
\(y\) (or \(s^2_y\)).

[28 or ["var dij", col#]
Variance of dominance/difference matrix as sample estimate according to Long
et al. (2003, section 3.3 before eqn. 67):

\[ s_{dij}^2 = \frac{\sum \sum (d_{ij} - d)^2}{n_x n_y - 1} = \frac{\sum d_{ij}^2 - (\sum d_{ij})^2}{n_x n_y - 1}, \]

thus avoiding Cliff’s original (1996, p. 138) suggestion to use \((n_x - 1)(n_y - 1)\)
as the denominator.

[29 or ["df", col#]
If the \textit{studdist} parameter is not set to FALSE, column 1 returns the degrees of
freedom (df) used for CI as well as z/t-score and z-probability estimates.
In column 2 ("metric") df as used for metric t-test.

[30 or ["NNT", col#]
The \textit{number needed to treat} effect size (NNT, cf. Cook & Sackett, 1995) is
returned based on the delta statistic as

\[ \text{delta}^{-1} \]

as suggested by Kraemer & Kupfer, 2006, p. 994.
In column 2, the NNT is returned based on Cohen’s d of the metric between-
group comparison.
**DEPENDENT/PAIRED GROUPS** *(paired argument set to TRUE)*

In the case of paired data (e.g. pretest-posttest comparisons of the \( n_x = n_y \) same subjects), a 4-column-matrix containing 29 rows with values is returned.

The ordinal statistics for \( d_{ij} \) can be retrieved from the first three columns (named

- **within [.,1]** for the \( n_x = n_y \) within-pair changes (where \( i = j \) in all cases);
- **between [.,2]** for the overall distribution changes, based on all \( n^2-n = n(n-1) \) comparisons where \( i \neq j \), and
- **combined [.,3]** for combined inferences \( d_w + d_b \).

Here, the fourth column (named "metric") contains metric comparison data.

- [1 or ["var1_X_pre", col#] Original column name of the x (or pretest) input matrix.
- [2 or ["var2_Y_post", col#] Original column name of the y (or posttest) input matrix.
- [3 or ["type_title", col#] Columns 1-3: Return type of the comparison, in this case "paired".
  Column4: In case a string header is defined by use of the *comp.name* argument, it is returned in column 4.
- [4 or ["N #Y>X", col#] Number of occurrences (\#) of a posttest observation \( y_i \) having a higher value than a pretest observation \( x_j \): \( N_{#Y>X} = \#(y_i > x_j) \), limited to the respective pairs under observation in within, between or combined.
  Column 4 equals column 3.
- [5 or ["N #Y=X", col#] Number of occurrences of a posttest observation having the same value as a pretest observation, limited to the respective pairs under observation in within, between or combined.
  Column 4 equals column 3.
- [6 or ["N #Y<X", col#] Number of occurrences of a posttest observation having a smaller value than a pretest observation, limited to the respective pairs under observation in within, between or combined.
  Column 4 equals column 3.
- [7 or ["PS X>Y", col#] Common Language CL effect size or Probability of Superiority (PS) of X over Y (Grissom, 1994,Grissom & Kim, 2005) (limited to the respective pairs under observation in within, between or combined):

\[
PS(Y > X) = \frac{\#(y_i > x_j)}{n_y \cdot n_x}.
\]
This effect size reflects the probability that a subject or case randomly chosen from the X- or pre-test-scores under observation has a higher score than than a randomly chosen case from the respective Y- or post-test-subsample (cf. Acion et al., 2006).

Column 4: Assuming equal variances and population normality, the (para)metric version of the Common Language effect size is calculated as suggested by McGraw & Wong (1992, p. 363) for correlated samples by using the variance sum law to adjust the variance on the difference scores with

\[ PS(Y > X) = \Phi\left( \frac{M_y - M_x}{\sqrt{s_x^2 + s_y^2 - 2r_{xy} s_x s_y}} \right) \]

where \( \Phi \) is the cumulative normal distribution function with \( \Phi(z_\alpha) = \alpha \).

Common Language CL effect size or Probability of Superiority (PS) of Y over X (Grissom, 1994,Grissom & Kim, 2005) (limited to the respective pairs under observation in within, between or combined).

Column 4: CL (para)metric version for the correlated samples case (see row 7 above for details on calculation).

Vargha and Delaney’s A as stochastic superiority of X over Y, limited to the respective pairs under observation in within, between or combined. (See codedmes of this orddom package for details.)

Column 4 equals column 3.

Vargha and Delaney’s A as stochastic superiority of Y over X, limited to the respective pairs under observation in within, between or combined. (See codedmes of this orddom package for details.)

Column 4 equals column 3.

For columns 1 to 3 ("ordinal"), the respective delta for dependent groups (Cliff, 1996,Long et al., 2003,Feng, 2007) is reported. With

\[ d_{ij} = \text{sign}(y_i - x_j), \]

Column 1 reports the (within) value, which is the "difference between the proportion of individual subjects who change in one direction and the proportion of individuals who change in the other" (Cliff, 1996, p. 159), calculated as

\[ d_w = \frac{\left( \sum_i \sum_j d_{ij} \right)}{n}, \]

where \( i = j \) in the \( n = n_x = n_y \) possible paired comparisons.

"The extent to which the overall distribution has moved, except for the self-comparisons" (Cliff, 1996, p. 160) is given in column 2, the delta-(between) statistic. It is estimated by the average between-subject dominance, calculated as

\[ d_b = \frac{\left( \sum_i \sum_{j \neq i} d_{ij} \right)}{n(n - 1)}, \]

where \( i \neq j \).
Column 3 reports the combination effect $d_w + d_b$.

In column 4 ("metric"), the differences between subsample means are reported: $ar{y} - \bar{x}$.

[12 or "1-alpha", col#] Significance or $\alpha$-level for CI estimation, given as percentage between 0 and 100.

[13 or "CI low", col#] Confidence interval (CI) lower boundary estimate. Unless the default symmetric parameter is explicitly set to TRUE, asymmetric confidence interval (CI) boundary estimates for ordinal differences are calculated (Feng & Cliff, 2004; Feng, 2007) as

$$CI_{lower/upper} = \frac{d - d^3 \pm t_{\alpha/2}s_d \sqrt{1 - 2d^2 + d^4 + t_{\alpha/2}^2 s_d^2}}{1 - d^2 + t_{\alpha/2}^2 s_d^2},$$

with $t$-values at the respective significance level based on either Student’s t or on z-values from the Standard Normal Distribution, depending on the studdist argument.

However, using an asymmetric CI is not advisable when the combined delta estimate (column 3) is to be used for inferences. An asymmetric CI may also reduce power of $d_b$ value given in ‘[1PLR]’, especially in small paired samples (Cliff, 1996, p. 165). To obtain symmetric CI estimates with $CI_{lower/upper} = d \pm t_{\alpha/2}s_d$, the default symmetric argument must be set to TRUE.

In any case, if $d = \pm 1$, one CI is set as equal to $d$, the other is calculated as

$$CI_{lower/upper} = ((n_b - t_{\alpha/2}^2))/(n_b + t_{\alpha/2}^2)^{-1},$$

where $t_{\alpha/2}$ is the $t$-value or z-score at the selected $\alpha$ level (1- or 2-tailed) of the respective studdist-controlled distribution, and $n_b$ the number of observations or cases in the smaller of the two samples.

[14 or "CI high", col#] Confidence interval upper boundary estimate (see row 13).

[15 or "s delta", col#] Estimated standard deviation of the respective delta statistic. Column 4 reports the metric standard deviation of the paired (within) differences.

[16 or "var delta", col#] Unbiased estimates of the variances of the respective delta statistic.

Column 1 reports the within value, calculated as

$$s_{d_w}^2 = (n(n - 1))^{-1}(\sum(d_{i} - d_w)^2).$$

Please note that in various pieces of the available research literature (e.g. Cliff, 1996, eq. 6.8, p. 161), $s_{d_w}^2$ is erroneously reported to be calculated as $s_{d_w}^2 =$
\[(n - 1)^{-1}(\sum(d_{ii} - d_w)^2)\]. The denominator, however must read \(n(n - 1)\) as "using just \((n - 1)\) would give the variance of the individual \(d_{ii}\) whereas we want the variance of \(d_w\), which is a kind of mean" (Feng, 07.02.2011, personal communication).

The \((between)\) unbiased estimate in column 2 is calculated as

\[s_{db}^2 = \frac{1}{n(n-1)(n-2)(n-3)} \left[ \sum \left( d_{ij} - d_{bi} \right) \left( d_{ji} - d_{bj} \right) \right] - \left( \sum \sum \left( d_{ij} - d_{bi} \right) \left( d_{ji} - d_{bj} \right) \right) \left( \frac{1}{n(n-1)(n-2)(n-3)} \right)^{-1} - \left( \sum \sum \left( d_{ij} - d_{bi} \right) \left( d_{ji} - d_{bj} \right) \right) \left( \frac{1}{n(n-1)(n-2)(n-3)} \right)^{-1}.

In case this formula renders negative variance estimates for \(s_{db}^2\) estimates by use of this formula, the \(between\) variance is alternatively calculated as

\[s_{db}^2 = \frac{1 - d_b^2}{n^2 - n - 1}\]

(see Long et al. (2003, par after eqn. 66) for a related discussion).

Since \(d_w\) and \(d_b\) are interdependent, the \(combined\) effect involves taking into account their estimated covariance when calculating the unbiased estimate for the variance for the sum of \(d_w\) and \(d_b\), which is reported in column 3 as

\[s_{d_w+d_b}^2 = s_{d_w}^2 + s_{db}^2 + 2\hat{\text{cov}}(d_b, d_w),\]

with

\[\hat{\text{cov}}(d_b, d_w) = \left( \sum_i d_{ii} [\sum_j (d_{ij} + \sum_j (d_{ji})] - 2n(n-1)d_b d_w \right) \left( \frac{1}{n(n-1)(n-2)} \right)^{-1}.

Column 4 reports the metric variance of the paired (within) differences.
tailed) of the standard normal distribution, and

\[ s_d = \sqrt{\frac{n_x + n_y}{n_x n_y} + \frac{d^2}{2(n_x + n_y)}} \]

[22 or ["d CI high", col#]
Cohen’s \( d \) estimate of upper boundary of the respective confidence interval (see row 21 for calculation details).

[23,3] or ["var d.i",combined]
Component of \( s^2_{d_x + d_i} : s^2_{d_i} \) (Available for the combined analyses in column 3 only.) The metric descriptive in column 4 is the variance of \( x \) (or \( s^2_{x} \).

[24,3] or ["var d.j",combined]
Component of \( s^2_{d_x + d_i} : s^2_{d_j} \) (Third column only.) The metric descriptive in column 4 is the variance of \( y \) (or \( s^2_{y} \).

[25,3] or ["cov(di,dj)",combined]
Component of \( s^2_{d_x + d_i} : \text{cov}(d_i, d_j) \) (Third column only.)

[26,3] or ["var dij",combined]
Component of \( s^2_{d_x + d_i} : s^2_{d_{ij}} \) (Third column only.)

[27,3] or ["cov(dih,dhi)",combined]
Component of \( s^2_{d_x + d_i} : \text{cov}(d_{ih}, d_{hi}) \) (Third column only.)

[28,3] or ["cov(db,dw)",combined]
Estimated covariance between \( d_b \) and \( d_w \): \( \hat{\text{cov}}(d_b, d_w) \) (for purposes of combined inferences). (Third column only.)

[29 or ["df", col#]
Unless the \texttt{studdist} argument is not set to FALSE, the degrees of Freedom \( df \) used for the CI and z-score calculations are reported in column 1.

Column 2 returns the \( df \) used for the metric t-test for dependent samples.

[30 or ["NNT", col#]
In column 1 and 2, the \textit{number needed to treat} effect size (NNT, cf. Cook & Sackett, 1995) are returned, based on the underlying delta statistics with NNT = \( \frac{\text{delta}}{\text{inverse}} \)

as suggested by Kraemer & Kupfer, 2006, p. 994. (Column 3 is empty.).
In column 4, the NNT is returned based on Cohen’s \( d \) of the metric comparison.
Author(s)

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References


Romano, J., Kromrey, J. D., Coraggio, J., & Skowronek, J. (2006). Appropriate statistics for ordi-

See Also

orddom_f and orddom_p.

Examples

```r
# Not run:
#Independent Samples (Data taken from Long et al. (2003), Table 3
x<-t(matrix(c(3,3,4,5,6,12,12,13,14,15,15,15,15,15,15,15,18,18,18,23,23,27,28,28,43),1))
colnames(x)<-c("Nonalcohol."")
y<-t(matrix(c(1,4,6,7,14,14,18,19,20,21,24,25,26,26,27,28,28,30,33,33,44,45,50),1))
colnames(y)<-c("Alcoholic")
orddom(x,y,paired=FALSE, outfile="tmp_r.txt")

# Not run:
#Paired Comparison with data written to file (Data taken from Long et al. (2003), Table 4
x<-t(matrix(c(2,6,6,7,8,8,9,9,10,10,10,11,11,12,13,14,15,16,1),1))
colnames(x)<-c("Incidental")
y<-t(matrix(c(4,11,8,9,10,11,11,5,14,12,13,10,14,16,14,13,15,15,16,10,1),1))
colnames(y)<-c("Intentional")
orddom_f(y,x,paired=TRUE, symmetric=FALSE)

# Not run:
#Directly returns d_b of the paired comparison
orddom(x,y,,TRUE,,)[11,2]
```

**orddom_f**  
*Ordinal Dominance Statistics: File output of statistics for multiple comparisons*

**Description**

Writes ordinal dominance statistics to tailored target output file, e.g. for purposes of multiple comparisons.

**Usage**

```r
orddom_f(x,y,..., outputfile="orddom_csv.txt", quotechar=TRUE, decimalpt=".", separator="\t", notavailable="NA", endofline="\n")
```
Arguments

x  A 1-column matrix with optional column name containing all \( n_x \) values or scores of group X or 1 (e.g. control or pretest group); see \texttt{orddom} for details.

y  A 1-column matrix with optional column name containing all \( n_y \) values of group Y or 2 (e.g. treatment or post-test group); see \texttt{orddom} for details.

... Other arguments to be passed on to the \texttt{orddom} function (such as e.g. \texttt{paired, studdist, symmetric, x.name, description} etc.; see \texttt{orddom} for details.)

outputfile  A filename for the report should be given here. The report as standard text file is written to the current working directory. All data are appended to this file. If the file does not exist initially, row headers are produced.

quotechar  By default, string outputs are quoted.

decimalpt  By default, numeric outputs use the colon as decimal point. Where commas are used instead, this argument should be set to ...,\texttt{decimalpt=","},... .

separator  By default, field entries are separated by tabulators (...\texttt{separator=\\"\tab\"},...). If, for example, .csv files are to be produced using the semicolon as the field separator, this argument should be set to ...,\texttt{separator=\\";\"},...

notavailable  By default, if field entries are not available, "NA" is printed to the file. Other values to be printed can be given, e.g. ...,\texttt{notavailable=\\"\"},... or ...,\texttt{notavailable=\\"NULL\"},....

deloopline  By default, a carriage return denotes the end of the single output line. Other values may be given, such as the IETF standard for csv files (...\texttt{endofline=\\"\n\n\"},...).

Author(s)

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See Also

\texttt{orddom}

Examples

```R
## Not run:
# Example: Experiment with experimental group "ex" and control group "con"
# Data sets:
ex_pre<-c(52,53,55,59,57)
con_pre<-c(51,56,54,60,56)
ex_post<-c(58,62,63,64,69)
con_post<-c(48,58,57,62,55)
# Two independent and two paired comparisons are possible
# These are to be written to a csv-file
# Alpha-level = 10
orddom_f(con_pre,ex_pre,alpha=0.025,decimalpt=","\n,description="EXP 01: Between groups at time 01")
# result delta=-.04
orddom_f(con_post,ex_post,alpha=0.025,decimalpt=","\n,description="EXP 01: Between groups at time 02")
```
### orddom_p

**Ordinal Dominance Matrices and Statistics: Printer-friendly Tab-Delimited Report Output File**

**Description**

Generates a sectioned report file with ordinal dominance matrices and statistics.

**Usage**

```r
orddom_p(x, y, alpha=0.05, paired=FALSE, sections="1234a4b5a5b", header="Y", sorted="XY", outfile="orddom.csv.tab.txt", appendfile=FALSE, show=1, description="")
```

**Arguments**

**x**

A 1-column matrix with optional column name containing all $n_x$ values or scores of group X or 1 (e.g. control or pretest group); see orddom for details.

**y**

A 1-column matrix with optional column name containing all $n_y$ values of group Y or 2 (e.g. experimental or post-test group); see orddom for details.

**alpha**

Significance or $\alpha$-level used for the calculation of the confidence intervals; see orddom for details.

**paired**

By default, independence of the two groups or data sets is assumed. For paired comparisons, set to TRUE; see orddom for details.

**sections**

By default all of the following report sections are written to the file. If only a selection of all sections is needed, a string should be given containing all section numbers needed in the output, e.g. ...,sections="135a",... for sections 1, 3 and 5a.

The following sections are available for output:

- "1" - Raw data of the x and y data sets
- "2" - Metric descriptives for x and y
- "3" - Metric difference tests
- "4a" - Metric difference matrix with x in rows and y in columns
- "4b" - Metric difference matrix with y in rows and x in columns
- "5a" - Ordinal dominance matrix with x in rows and y in columns
- "5b" - Ordinal dominance matrix with y in rows and x in columns

**header**

By default, section headers are part of the output. If headers are to be omitted, this argument should be set to FALSE.
sorted  All outputs in sections 1.4a, 4b, 5a and 5b may be automatically sorted ascendingly for the x data set (string is to contain "X") and/or for the y data set (string is to contain "Y"). This is the default option.

outfile  A filename for the report should be given here. The report as standard text file is written to the current working directory.

appendfile  By default, new report files are created. If a given report file is to be appended, set to TRUE.

show  By default, the generated file is displayed. Set to FALSE to avoid the resulting file to be shown.

description  This argument allows for assigning a string (as title or description) for the ordinal comparison outputs.

Author(s)
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See Also
orddom.

Examples

CC not run:
Independent Samples (Data taken from Long et al. (2003), Table 4
# End(Not run)
x <- t(matrix(c(3,3,3,4,5,6,12,12,13,14,15,15,15,15,15,16,18,18,18,18,23,23,27,28,28,43),1))
colnames(x) <- c("Nonalcohol."")
y <- t(matrix(c(1,4,6,7,7,14,14,18,19,20,21,24,25,26,26,27,28,28,30,33,33,44,45,50),1))
colnames(y) <- c("Alcoholic")
orddom_p(x,y,,paired=FALSE,outfile="orddom_csv_tab.txt")

return1colmatrix  Convert vectors, data frames, lists, or arrays to 1-column matrix for use in orddom

Description
 Converts vectors, data frames, lists, and arrays to 1-column matrix with optional column name and sorting option for use in various orddom functions

Usage
return1colmatrix(x,grp.name="",sortx=FALSE)
Arguments

- **x**: Vector, data frame, list or array with \( n_x \) values and an optional header or name
- **grp.name**: A name or column title for x may be assigned. By default, the variable name is returned as \( \text{var}(x) \).
- **sortx**: If argument is set to **TRUE**, the function will return a matrix with sorted scores.

Value

Returns a 1-column matrix with \( n \) scores in \( n \) rows with X columnname.

Author(s)

Jens Rogmann

See Also

oroddom
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