

# Package ‘pseudorank’

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**Title** Pseudo-Ranks

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**Description** Efficient calculation of pseudo-ranks and (pseudo)-rank based test statistics. In case of equal sample sizes, pseudo-ranks and mid-ranks are equal. When used for inference mid-ranks may lead to paradoxical results. Pseudo-ranks are in general not affected by such a problem. See Happ et al. (2020, <[doi:10.18637/jss.v095.c01](https://doi.org/10.18637/jss.v095.c01)>) for details.

**License** GPL-3

**Encoding** UTF-8

**LazyData** true

**Depends** R (>= 3.5.0)

**Imports** Rcpp (>= 0.12.16), doBy

**LinkingTo** Rcpp

**URL** <https://github.com/happma/pseudorank/>

**BugReports** <https://github.com/happma/pseudorank/issues/>

**RoxygenNote** 7.3.2

**Suggests** testthat

**NeedsCompilation** yes

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pseudorank-package	<i>Pseudo-Ranks</i>
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## Description

This package provides functions to calculate pseudo-ranks. Rank based test statistics (e.g. Kruskal-Wallis test) may lead to paradoxical results as the weighted relative effects (based on ranks) depend on the sample sizes (Brunner, 2018). Pseudo-ranks do not have these problems.

## Author(s)

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## References

- Brunner, E., Konietschke, F., Bathke, A. C., & Pauly, M. (2018). Ranks and Pseudo-Ranks-Paradoxical Results of Rank Tests. arXiv preprint arXiv:1802.05650.
- Brunner, E., Bathke, A.C., and Konietschke, F. (2018a). Rank- and Pseudo-Rank Procedures for Independent Observations in Factorial Designs - Using R and SAS. Springer Series in Statistics, Springer, Heidelberg. ISBN: 978-3-030-02912-8.
- Happ M, Zimmermann G, Brunner E, Bathke AC (2020). Pseudo-Ranks: How to Calculate Them Efficiently in R. Journal of Statistical Software, Code Snippets, \*95\*(1), 1-22. doi: 10.18637/jss.v095.c01 (URL:<https://doi.org/10.18637/jss.v095.c01>).

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hettmansperger_norton_test	<i>Hettmansperger-Norton Trend Test for k-Samples</i>
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## Description

This function calculates the Hettmansperger-Norton trend test using pseudo-ranks under the null hypothesis  $H_0: F_1 = \dots = F_k$ .

**Usage**

```

hettmansperger_norton_test(x, ...)

## S3 method for class 'numeric'
hettmansperger_norton_test(
  x,
  y,
  na.rm = FALSE,
  alternative = c("decreasing", "increasing", "custom"),
  trend = NULL,
  pseudoranks = TRUE,
  ...
)

## S3 method for class 'formula'
hettmansperger_norton_test(
  formula,
  data,
  na.rm = FALSE,
  alternative = c("decreasing", "increasing", "custom"),
  trend = NULL,
  pseudoranks = TRUE,
  ...
)

```

**Arguments**

x	vector containing the observations
...	further arguments are ignored
y	vector specifying the group to which the observations from the x vector belong to
na.rm	a logical value indicating if NA values should be removed
alternative	either decreasing (trend k, k-1, ..., 1) or increasing (1, 2, ..., k) or custom (then argument trend must be specified)
trend	custom numeric vector indicating the trend for the custom alternative, only used if alternative = "custom"
pseudoranks	logical value indicating if pseudo-ranks or ranks should be used
formula	formula object
data	data.frame containing the variables in the formula (observations and group)

**Value**

Returns an object.

## References

Brunner, E., Bathke, A.C., and Konietschke, F. (2018a). Rank- and Pseudo-Rank Procedures for Independent Observations in Factorial Designs - Using R and SAS. Springer Series in Statistics, Springer, Heidelberg. ISBN: 978-3-030-02912-8.

Happ M, Zimmermann G, Brunner E, Bathke AC (2020). Pseudo-Ranks: How to Calculate Them Efficiently in R. Journal of Statistical Software, Code Snippets, \*95\*(1), 1-22. doi: 10.18637/jss.v095.c01 (URL:<https://doi.org/10.18637/jss.v095.c01>).

Hettmansperger, T. P., & Norton, R. M. (1987). Tests for patterned alternatives in k-sample problems. Journal of the American Statistical Association, 82(397), 292-299

## Examples

```
# create some data, please note that the group factor needs to be ordered
df <- data.frame(data = c(rnorm(40, 3, 1), rnorm(40, 2, 1), rnorm(20, 1, 1)),
  group = c(rep(1,40),rep(2,40),rep(3,20)))
df$group <- factor(df$group, ordered = TRUE)

# you can either test for a decreasing, increasing or custom trend
hettmansperger_norton_test(df$data, df$group, alternative="decreasing")
hettmansperger_norton_test(df$data, df$group, alternative="increasing")
hettmansperger_norton_test(df$data, df$group, alternative="custom", trend = c(1, 3, 2))
```

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kruskal\_wallis\_test    *Kruskal-Wallis Test*

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## Description

This function calculates the Kruskal-Wallis test using pseudo-ranks under the null hypothesis  $H_0: F_1 = \dots = F_k$ .

## Usage

```
kruskal_wallis_test(x, ...)

## S3 method for class 'numeric'
kruskal_wallis_test(x, grp, na.rm = FALSE, pseudoranks = TRUE, ...)

## S3 method for class 'formula'
kruskal_wallis_test(formula, data, na.rm = FALSE, pseudoranks = TRUE, ...)
```

## Arguments

x	numeric vector containing the data
...	further arguments are ignored
grp	factor specifying the groups
na.rm	a logical value indicating if NA values should be removed

pseudoranks	logical value indicating if pseudo-ranks or ranks should be used
formula	optional formula object
data	optional data.frame of the data

**Value**

Returns an object of class 'pseudorank'

**References**

Brunner, E., Bathke, A.C., and Konietschke, F. (2018a). Rank- and Pseudo-Rank Procedures for Independent Observations in Factorial Designs - Using R and SAS. Springer Series in Statistics, Springer, Heidelberg. ISBN: 978-3-030-02912-8.

**Examples**

```
x = c(1, 1, 1, 1, 2, 3, 4, 5, 6)
grp = as.factor(c('A', 'A', 'B', 'B', 'B', 'D', 'D', 'D', 'D'))

# calculate Kruskal-Wallis test using pseudo-ranks
kruskal_wallis_test(x, grp, na.rm = FALSE, pseudoranks = TRUE)
```

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ParadoxicalRanks      *Artificial data of 54 subjects*

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**Description**

An artificial dataset containing data of 54 subjects where where a substance was administered in three different concentrations (1,2 and 3). This data set can be used to show the paradoxical results obtained from rank tests, i.e., the Hettmansperger-Norton test.

**Usage**

```
data(ParadoxicalRanks)
```

**Format**

A data frame with 54 rows and 2 variables.

**Details**

The columns are as follows:

- conc. Grouping variable specifying which concentration was used. This factor is ordered, i.e.,  $1 < 2 < 3$ .
- score. The response variable.

## References

Happ M, Zimmermann G, Brunner E, Bathke AC (2020). Pseudo-Ranks: How to Calculate Them Efficiently in R. *Journal of Statistical Software, Code Snippets*, \*95\*(1), 1-22. doi: 10.18637/jss.v095.c01 (URL:<https://doi.org/10.18637/jss.v095.c01>).

## Examples

```
data("ParadoxicalRanks")
dat <- ParadoxicalRanks

set.seed(1)
n <- c(60, 360, 120)
x1 <- sample(subset(dat, dat$conc == 1)$score, n[1], replace = TRUE)
x2 <- sample(subset(dat, dat$conc == 2)$score, n[2], replace = TRUE)
x3 <- sample(subset(dat, dat$conc == 3)$score, n[3], replace = TRUE)

dat <- data.frame(score = c(x1, x2, x3),
  conc = factor(c( rep(1,n[1]), rep(2,n[2]), rep(5,n[3]) ), ordered=TRUE) )

# Hettmansperger-Norton test with ranks (pseudoranks = FALSE) returns a small p-value (0.011).
# In contrast, the pseudo-rank test returns a large p-value (0.42). By changing the ratio of
# group sizes, we can also obtain a significant decreasing trend with ranks, e.g.
# n <- c(260,20,260) and the same seed.
hettmansperger_norton_test(score ~ conc, data = dat, pseudoranks = FALSE,
  alternative = "increasing")
hettmansperger_norton_test(score ~ conc, data = dat, pseudoranks = TRUE,
  alternative = "increasing")
```

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pseudorank

*Calculation of Pseudo-Ranks*

---

## Description

Calculation of (mid) pseudo-ranks of a sample. In case of ties (i.e. equal values), the average of min pseudo-ranks and max-pseudo-ranks are taken (similar to rank with ties.method="average").

## Usage

```
pseudorank(x, ...)

## S3 method for class 'numeric'
pseudorank(x, y, na.last = NA, ties.method = c("average", "max", "min"), ...)

## S3 method for class 'formula'
pseudorank(
  formula,
  data,
```

```

    na.last = NA,
    ties.method = c("average", "max", "min"),
    ...
  )

```

### Arguments

x	vector containing the observations
...	further arguments
y	vector specifying the group to which the observations from the x vector belong to
na.last	for controlling the treatment of NAs. If TRUE, missing values in the data are put last; if FALSE, they are put first; if NA, they are removed (recommended).
ties.method	type of pseudo-ranks: either 'average' (recommended), 'min' or 'max'.
formula	formula object
data	data.frame containing the variables in the formula (observations and group)

### Value

Returns a numerical vector containing the pseudo-ranks.

### References

Brunner, E., Bathke, A.C., and Konietschke, F. (2018a). Rank- and Pseudo-Rank Procedures for Independent Observations in Factorial Designs - Using R and SAS. Springer Series in Statistics, Springer, Heidelberg. ISBN: 978-3-030-02912-8.

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### Examples

```

df <- data.frame(data = round(rnorm(100)), group = c(rep(1,40),rep(2,40),rep(3,20)))
df$group <- as.factor(df$group)

## two ways to calculate pseudo-ranks

# Variant 1: use a vector for the data and a group vector
pseudorank(df$data,df$group)

# Variant 2: use a formula object, Note that only one group factor can be used
# that is, in data~group*group2 only 'group' will be used
pseudorank(data~group,df)

```

---

psrank

*Calculation of Pseudo-Ranks (Deprecated)*

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### Description

Calculation of (mid) pseudo-ranks of a sample. In case of ties (i.e. equal values), the average of min pseudo-ranks and max-pseudo-ranks are taken (similar to rank with ties.method="average").

### Usage

```
psrank(x, ...)
```

### Arguments

x                    vector containing the observations  
...                   further arguments (see help for pseudorank)

### Value

Returns a numerical vector containing the pseudo-ranks.

### References

Happ M, Zimmermann G, Brunner E, Bathke AC (2020). Pseudo-Ranks: How to Calculate Them Efficiently in R. Journal of Statistical Software, Code Snippets, \*95\*(1), 1-22. doi: 10.18637/jss.v095.c01 (URL:<https://doi.org/10.18637/jss.v095.c01>).

### Examples

```
df <- data.frame(data = round(rnorm(100)), group = c(rep(1,40),rep(2,40),rep(3,20)))
df$group <- as.factor(df$group)

## two ways to calculate pseudo-ranks

# Variant 1: use a vector for the data and a group vector
pseudorank(df$data,df$group)

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# that is, in data~group*group2 only 'group' will be used
pseudorank(data~group,df)
```



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