Package ‘twoway’

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Type Package
Title Analysis of Two-Way Tables
Version 0.6.3
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Description Carries out analyses of two-way tables with one observation per cell, together with graphical displays for an additive fit and a diagnostic plot for removable 'non-additivity' via a power transformation of the response. It implements Tukey's Exploratory Data Analysis (1973) <ISBN: 978-0201076165> methods, including a 1-degree-of-freedom test for row*column 'non-additivity', linear in the row and column effects.

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R topics documented:

anova.twoway ................................................................. 2
Arizona ................................................................. 3
**Description**

Test for a 1-df interaction in two-way ANOVA table by the Tukey test.

**Usage**

```r
## S3 method for class 'twoway'
anova(object, ...)
```

**Arguments**

- `object` a class("two-way") object
- `...` other arguments passed down, but not used here

**Details**

At present, this function simply gives the results of the ANOVAs for the additive model, the model including the 1 df term for non-additivity, and an `anova()` comparison of the two. The analysis is based on row and column means.

**Author(s)**

Michael Friendly
Arizona

Examples

```r
data(sentRT)
sent.2way <- twoway(sentRT)
anova(sent.2way)
```

---

**Arizona**  
**Mean monthly temperatures in Arizona**

---

**Description**

This is the data set used by Tukey (1977) for the initial examples of twoway tables.

**Format**

A matrix of 7 rows (Month) and 3 columns (City) where the value is mean monthly temperature in degrees F. The matrix has a `responseName` attribute, "Temperature"

**References**


**Examples**

```r
data(Arizona)
(AR.2way <- twoway(Arizona, method="median"))
## plot(AR.2way)
```

---

**as.data.frame.twoway**  
*Convert a twoway object to a data frame*  
*This function converts a "twoway" object to a data.frame*

---

**Description**

The rows and columns of the data table are strung out in standard R order in a vector, joined with row and column labels. Additional columns are added, representing the calculated values used in the two-way display.

**Usage**

```r
## S3 method for class 'twoway'
as.data.frame(x, ...)
```
Arguments

x a "twoway" object
...
other arguments, presently ignored

Value

a data.frame with \( r \times c \) rows corresponding to the input data table, and the following columns

- **row** row labels
- **col** column labels
- **data** the data value in the cell
- **fit** the fitted value,
- **roweff** the row effect
- **coleff** the column effect
- **nonadd** the 1 df for non-additivity value

Examples

```r
data(sentRT)
sent.2way <- twoway(sentRT)
as.data.frame(sent.2way)
```

Description

Create an initial twoway object representing the data before fitting

Method for matrix input

Usage

```r
as.twoway(x, ...)
```

## S3 method for class 'matrix'
```r
as.twoway(x, ..., name = deparse(substitute(x)),
responseName = name, varNames = names(dimnames(x)))
```

Arguments

- **x** a numeric matrix or numeric data frame with rownames
- **...** other arguments, unused here
- **name** Name of the data matrix
- **responseName** Name of the response variable
- **varNames** Names of the row and column variables
Drugs

Value
An object of class c("twoway") with all effects(roweff, colef, overall) set to zero, and method="Initial"

Author(s)
Richard M. Heiberger
Richard M. Heiberger

Examples

data(taskRT)
as.twoway(taskRT)

<table>
<thead>
<tr>
<th>drugs</th>
<th>Scores for 5 subjects after being given each of 4 drugs</th>
</tr>
</thead>
</table>

Description
The original source is Winer (1971), p. 268. This was used as an example in Friendly (1991).

References

Examples

data(drugs)
twoway(drugs)

Hstart

Number of U.S. housing starts by month for the years 1965 – 1973

Description
Number of U.S. housing starts by month for the years 1965 – 1973

Format
a 9 x 12 matrix, where the entries are the number of housing starts, in thousands

References
**insectCounts**

**Examples**

```r
hstart.2way <- twoway(hstart, method="mean")
plot(hstart.2way)
```

<table>
<thead>
<tr>
<th>insectCounts</th>
<th>Counts of an insect for the combinations of 4 treatments and 6 areas of a field</th>
</tr>
</thead>
</table>

**Description**

Counts of numbers of an insect, *Leptinotarsa decemlineata* (the Colorado potato beetle), each of which is the sum for two plots treated alike, for all combinations of 4 treatments and 6 areas of the field chosen to be relatively homogeneous.

**Format**

a 4 x 6 matrix, where the rows are treatments and the columns are areas of a field.

**Details**

These data are used in Tukey (1977) Exhibit 1 of Ch 11 and throughout the chapter as examples of median polish. Because the data are counts, either a sqrt or log transformation would be reasonable.

**References**


**Examples**

```r
insect.2way <- twoway(insectCounts, method="median")
print(insect.2way, digits=2)
plot(insect.2way)
plot(insect.2way, which="diagnose")
```

# try sqrt transformation

```r
insect.sqrt <- twoway(sqrt(insectCounts), method="median")
print(insect.sqrt, digits=2)
plot(insect.sqrt)
plot(insect.sqrt, which="diagnose")
```
ladder_power

Find the nearest ladder-of-powers representation of a power transformation

Description

The input power value is rounded to the nearest integer or fractional powers, ±1/3, 1/2. The function is presently designed just for display purposes.

Usage

ladder_power(p)

Arguments

p

A numeric power, for use as a transformation of a response, y, of the form \( y^p \), where \( p=0 \) is interpreted to mean \( \log(y) \).

Details

In use, the transformation via the ladder of powers usually attaches a minus sign to the transformation when the power < 0, so that the order of the response values are preserved under the transformation. Thus, a result of power = -0.5 is interpreted to mean \( -1/\sqrt{y} \).

Value

A named list of two elements: power, the ladder-of-power value, and name, the name for the transformation.

References


Examples

ladder_power(0.6)
ladder_power(-0.6)
meanfit  

*Fit a two-way table using row and column means*

**Description**

Fit a two-way table using row and column means

**Usage**

```r
meanfit(x, ..., na.rm=FALSE)
```

**Arguments**

- `x`: a numeric matrix or data frame
- `...`: other arguments passed down
- `na.rm`: logical. Should missing values be removed?

**Value**

An object of class `c("twoway")` with the following named components:

- `overall`: the fitted constant term.
- `roweff`: the fitted row effects.
- `coleff`: the fitted column effects.
- `residuals`: the residuals.
- `name`: the name of the dataset.
- `rownames`: the names for the rows
- `colnames`: the names for the columns
- `method`: "median"

---

medianfit  

*Fit a two-way table using median polish*

**Description**

Fit a two-way table using median polish

**Usage**

```r
medianfit(x, trace.iter = FALSE, ...)
```
Arguments

x   a numeric matrix or data frame
trace.iter   whether to give verbose output of iteration history in median polish.
...   other arguments passed down

Value

An object of class `c("twoway","medpolish")` with the following named components:

overall   the fitted constant term.
roweff   the fitted row effects.
coleff   the fitted column effects.
residuals   the residuals.
name   the name of the dataset.
rownames   the names for the rows
colnames   the names for the columns
method   "median"

plot.twoway

Plot methods for two-way tables

Description

Plots either the fitted values and residuals under additivity or a diagnostic plot for removable non-additivity by a power transformation

Usage

```r
## S3 method for class 'twoway'
plot(x, which = c("fit", "diagnose"), ..., na.rm=any(is.na(x$residuals)))

## S3 method for class 'twoway.fit'
plot(x, main = paste0("Tukey two-way fit plot for ",
        x$name, " (method: ", x$method, ")"),
        xlab = expression(hat(mu) * + Column Effect - Row Effect"),
        ylab = expression("Fit = " * hat(mu)
        * " + Column Effect + Row Effect"),
        rfactor = 1, rcolor = c("blue", "red"),
        lwd = 3, ylim = NULL, ...,
        na.rm=any(is.na(x$residuals)))

## S3 method for class 'twoway.diagnose'
plot(x, annotate = TRUE, jitter = FALSE,
      smooth = FALSE, pch = 16, ...)
```
Arguments

- **x**: a class("twoway") object
- **which**: one of "fit" or "diagnose"
- **...**: other arguments, passed to plot
- **na.rm**: logical. Should missing values be removed?
- **main**: plot title
- **xlab**: X axis label
- **ylab**: Y axis label
- **rfactor**: draw lines for abs(residuals) > rfactor*sqrt(MSPE)
- **rcolor**: a vector of length 2 giving the color of lines for positive and negative residuals
- **lwd**: line width for residual lines in the fit plot
- **ylim**: Y axis limits
- **annotate**: A logical value; if TRUE, the slope and power are displayed in the diagnostic plot
- **jitter**: A logical value; if TRUE, the comparison values in the plot are jittered to avoid overplotting
- **smooth**: A logical value; if TRUE, a smoothed loess curve is added to the plot
- **pch**: Plot character for point symbols in the diagnostic plot

Details

For the **which="fit"** plot, the basic result comes from a plot of the row effects against the column fitted values, which appears as a rectangular grid in these coordinates. Rotating this 45 degrees counterclockwise give a plot in which the vertical coordinate is the fitted value for the two-way table, and the horizontal coordinate is the column fit minus the row effect. The spacing of the grid lines for the rows and columns of the table show the relative magnitudes of the row/column means or medians.

For the **which="diagnose"** plot, the interaction residuals from an additive model, \( y_{ij} = \mu + \alpha_i + \beta_j \), are plotted against the estimated components \( \alpha_i \beta_j / \mu \). If this plot shows a substantially non-zero slope, \( b \), this analysis suggests that a power transformation, \( y \rightarrow y^{1-b} \) might reduce the apparent interaction effects.

For both plots, if you want to directly compare the result of method="mean" and method="median", it is essential to set the same xlim and ylim axes in the call.

Value

The diagnostic plot invisibly returns a list with elements c("slope","power")

Examples

```r
data(taskRT)
tw <- twoway(taskRT)
tw
twmed <- twoway(taskRT, method="median")
twmed
```
print.twoway

plot(tw, xlim=c(2,7), ylim=c(2,7)) ## use the same xlim and ylim, for comparison
plot(twmed, xlim=c(2,7), ylim=c(2,7))

plot(tw, which="diagnose", xlim=c(-.19, .19), ylim=c(-.5, .55))
plot(twmed, which="diagnose", xlim=c(-.19, .19), ylim=c(-.5, .55))

data(insectCounts)
twi <- twoway(insectCounts)
twimed <- twoway(insectCounts, method="median")

plot(twi, xlim=c(-250, 700), ylim=c(-180, 900))
plot(twimed, xlim=c(-250, 700), ylim=c(-180, 900))

plot(twi, which="diagnose", xlim=c(-160, 170), ylim=c(-200, 400)) ## power = .1
plot(twimed, which="diagnose", xlim=c(-160, 170), ylim=c(-200, 400)) ## power = .3

print.twoway

Description

Print method for two-way tables

Usage

## S3 method for class 'twoway'
print(x, digits = getOption("digits"), border = 2,
      zapsmall = TRUE, ...)

Arguments

x a numeric matrix
digits number of digits to print
border if 0, the components "twoway" object ("overall","roweff","coleff","residuals")
are printed separately; if 1, the row, column and overall effects are joined to the
residuals in a single table. if 2, row, column, overall and residuals are joined, and
decorated with horizontal and vertical rules
zapsmall a logical value; if TRUE small residuals are printed as 0.
... other arguments passed down

Author(s)

Michael Friendly, Richard Heiberger
Examples

data(taskRT)
  task.2way <- twoway(taskRT)
  print(task.2way)
  print(task.2way, border=0)

data(sentRT)
  sent.2way <- twoway(sentRT)
  print(sent.2way)
  print(sent.2way, border=1)

residuals.twoway
Extract residuals from a twoway object

Description

Extract residuals from a twoway object
Extract fitted values from a twoway object

Usage

## S3 method for class 'twoway'
residuals(object, nonadd = FALSE, ...)

## S3 method for class 'twoway'
fitted(object, nonadd = FALSE, ...)

Arguments

  object          A class="twoway" object
  nonadd          If TRUE, the 1 degree of freedom term for non-additivity is subtracted from the
                  additive residuals
  ...             other arguments (unused)

Value

A numeric matrix of residuals corresponding to the data supplied to twoway
A numeric matrix of fitted values corresponding to the data supplied to twoway

Examples

  data(taskRT)
  task.2way <- twoway(taskRT)
  residuals(task.2way)
  residuals(task.2way, nonadd=TRUE)
sentRT

Reaction times for T/F judgments

Description

A demonstration 3 x 3 two-way table composed of reaction times for three subjects making T/F judgments on three types of sentences

References


Examples

data(sentRT)
twoway(sentRT)

taskRT

Data on reaction times for various tasks and topics

Description

A demonstration 3 x 4 two-way table composed of reaction times for tasks varying in difficulty, with content on different topics.

Format

A matrix of 3 rows and 4 columns, where the rows are the task difficulty levels and the columns are the topics. The cell values are average reaction times (in sec.). The matrix has a responseName attribute, "RT"

Examples

data(taskRT)
twoway(taskRT)
twoway(taskRT, method="median")
to_long Reshape a data.frame or matrix to a long data.frame

Description
Reshape a data.frame or matrix to a long data.frame
Reshape a data.frame or matrix to a wide data.frame

Usage
to_long(wide, rowname = NULL, colname = NULL,
responseName = deparse(substitute(wide)), varNames = c("Row", "Col"))
to_wide(long, row = 1, col = 2, response = 3)

Arguments
wide A data.frame or matrix in wide form
rowname Name for the row variable
colname Name for the column variable
responseName Name for the response variable. If wide is a matrix with an attribute that begins
with "response", that value is taken as the responseName. Otherwise, the name
of the wide object is used.
varNames Default names for the row and column variables if not passed as rowname or
colname
long A data.frame in long form
row Column index or quoted name of the row variable
col Column index or quoted name of the column variable
response Column index or quoted name of the response variable

Value
A data.frame in long format

Author(s)
Michael Friendly and Richard M. Heiberger
Michael Friendly and Richard M. Heiberger

Examples
Arizona.long <- to_long(Arizona, varNames=c("Month", "City"))
Arizona.long

Arizona.long <- to_long(Arizona, varNames=c("Month", "City"))
# back the other way
to_wide(Arizona.long)
Description

Fits an additive model using either row and column means or Tukey’s median polish procedure.

Usage

twoway(x, ...)

## Default S3 method:
twoway(x, method = c("mean", "median"), ..., 
  name = deparse(substitute(x)), responseName = attr(x, "response"), 
  varNames = names(dimnames(x))

Arguments

x a numeric matrix or data frame.
...
other arguments passed down
method one of "mean" or "median"
name name for the input dataset
responseName name for the response variable
varNames names for the Row and Column variables

Details

The rownames(x) are used as the levels of the row factor and the colnames(x) are the levels of the column factor. For a numeric matrix, the function uses the names(dimnames(x)) as the names of these variables, and, if present, a responseName attribute as the name for the response variable.

Value

An object of class c("twoway") with the following named components:

overall the fitted constant term.
roweff the fitted row effects.
coleff the fitted column effects.
residuals the residuals.
name the name of the dataset.
rownames the names for the rows
colnames the names for the columns
method the fitting method
varNames the names of the row and column variables
responseName  the name of the response variable  
compValue  the comparison values, for the diagnostic plot  
slope  the slope value, for the diagnostic plot  
power  the suggested power transformation, \(1-slope\)

An object of class "twoway", but supplemented by additional components used for labeling

Author(s)

Michael Friendly

References


See Also

codetwoway.formula, codedmedpolish  
medianfit, meanfit

Examples

data(taskRT)  
twoway(taskRT)

twoway.formula  
*Formula method for twoway analysis using a dataset in long format*

Description

The formula method reshapes the data set from long to wide format and calls the default method.

Usage

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

Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>formula</td>
<td>A formula of the form <code>response ~ rowvar + colvar</code>, where <code>response</code> is numeric</td>
</tr>
<tr>
<td>data</td>
<td>The name of the data set, containing a row vector, column factor and a numeric response</td>
</tr>
<tr>
<td>subset</td>
<td>An expression to subset the data (unused)</td>
</tr>
<tr>
<td>na.action</td>
<td>What to do with NAs? (unused)</td>
</tr>
<tr>
<td>...</td>
<td>other arguments, passed down</td>
</tr>
</tbody>
</table>
twoway.formula

Author(s)
Michael Friendly and Richard Heiberger

References
the conversion of long to wide in a formula method was suggested on https://stackoverflow.com/questions/50469320/how-to-write-a-formula-method-that-converts-long-to-wide

Examples
longRT <- to_long(taskRT)
twoway(RT ~ Task + Topic, data=longRT)
Index

*Topic data
  Arizona, 3
drugs, 5
hstart, 5
insectCounts, 6
sentRT, 13
taskRT, 13

anova.twoway, 2
Arizona, 3
as.data.frame.twoway, 3
as.twoway, 4
drugs, 5
fitted.twoway(residuals.twoway), 12
hstart, 5
insectCounts, 6
ladder_power, 7
loess, 10
meanfit, 8, 16
medianfit, 8, 16
medpolish, 16
plot.twoway, 9
print.twoway, 11
residuals.twoway, 12
sentRT, 13
taskRT, 13
to_long, 14
to_wide (to_long), 14
twoway, 15
twoway.formula, 16, 16