Package 'PASWR'

May 15, 2022

Type Package

Title Probability and Statistics with R

Version 1.3

Date 2022-05-14

Maintainer Alan T. Arnholt <arnholtat@appstate.edu>

Description Functions and data sets for the text Probability and Statistics with R.

Depends lattice

Imports MASS, e1071

LazyData TRUE

License GPL-2

RoxygenNote 7.1.2

Encoding UTF-8

NeedsCompilation no

Author Alan T. Arnholt [aut, cre]

Repository CRAN

Date/Publication 2022-05-15 11:50:02 UTC

R topics documented:

1

PASWR-package   *Probability and Statistics with R*

Description

Data and functions for the book *Probability and Statistics with R*

Details

Package:	PASWR
Type:	Package
Version:	1.2
Date:	2016-02-24
License:	GPL (>=2)

Comprehensive and engineering-oriented, *Probability and Statistics with R* provides a thorough treatment of probability and statistics, clear and accessible real-world examples, and fully detailed proofs. The text provides step-by-step explanations for numerous examples in R and S-PLUS for nearly every topic covered, including both traditional and nonparametric techniques. With a wide range of graphs to illustrate complex material as well as a solutions manual, the book also offers an accompanying website that features supporting information, including datasets, functions, and other downloadable material. It is ideal for undergraduate students and for engineers and scientists who must perform statistical analyses.

Author(s)

Alan T. Arnholt

Maintainer: <arnholtat@appstate.edu>

References

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Aggression   *TV and Behavior*

Description

Data regarding aggressive behavior in relation to exposure to violent television programs used in Example 10.5

Format

A data frame with 16 observations on the following 2 variables:

- violence (an integer vector)
- noviolence (an integer vector)

Details

This is data regarding aggressive behavior in relation to exposure to violent television programs from Gibbons (1997) with the following exposition:

. . . a group of children are matched as well as possible as regards home environment, genetic factors, intelligence, parental attitudes, and so forth, in an effort to minimize factors other than TV that might influence a tendency for aggressive behavior. In each of the resulting 16 pairs, one child is randomly selected to view the most violent shows on TV, while the other watches cartoons, situation comedies, and the like. The children are then subjected to a series of tests designed to produce an ordinal measure of their aggression factors. (pages 143-144)

Source

Gibbons, J. D. (1997) *Nonparametric Methods for Quantitative Analysis*. American Sciences Press.

References

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
with(data = Aggression,
wilcox.test(violence, noviolence, paired = TRUE,
alternative = "greater"))
```

Apple *Apple Hardness*

Description

An experiment was undertaken where seventeen recently picked (Fresh) apples were randomly selected and measured for hardness. Seventeen apples were also randomly selected from a warehouse (Warehouse) where the apples had been stored for one week. Data are used in Example 8.10.

Format

A data frame with 17 observations on the following 2 variables: #'

- Fresh (hardness rating measured in $kg/meter^2$)
- Warehouse (hardness rating measured in $kg/meter^2$)

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
# Figure 8.5
attach(Apple)
par(pty = "s")
Altblue <- "#A9E2FF"
Adkblue <- "#0080FF"
fresh <- qqnorm(Fresh)
old <- qqnorm(Warehouse)
plot(fresh, type = "n",ylab = "Sample Quantiles", xlab = "Theoretical Quantiles")
qqline(Fresh, col = Altblue)
qqline(Warehouse, col = Adkblue)
points(fresh, col = Altblue, pch = 16, cex = 1.2)
points(old, col = Adkblue, pch = 17)
legend(-1.75, 9.45, c("Fresh", "Warehouse"), col = c(Altblue, Adkblue),
text.col = c("black","black"), pch = c(16, 17), lty = c(1, 1), bg = "gray95", cex = 0.75)
title("Q-Q Normal Plots")
detach(Apple)
# Trellis approach
qqmath(~c(Fresh, Warehouse), type = c("p","r"), pch = c(16, 17),
cex = 1.2, col=c("#A9E2FF", "#0080FF"),
groups=rep(c("Fresh", "Warehouse"), c(length(Fresh), length(Warehouse))),
data = Apple, ylab = "Sample Quantiles", xlab = "Theoretical Quantiles")
```

AptSize *Apartment Size*

Description

Size of apartments in Mendebaldea, Spain and San Jorge, Spain

Format

A data frame with 8 observations on the following 2 variables:

Mendebaldea Mendebaldea apartment size in square meters

SanJorge San Jorge apartment size in square meters

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
with(data = AptSize,
boxplot(Mendebaldea, SanJorge) )
```

Baberuth   *George Herman Ruth*

Description

Baseball statistics for George Herman Ruth (The Bambino or The Sultan Of Swat)

Format

A data frame with 22 observations on the following 14 variables.

Year year in which the season occurred
Team team he played for `Bos-A`, `Bos-N`, or `NY-A`
G games played
AB at bats
R runs scored
H hits
X2B doubles
X3B triples
HR home runs
RBI runs batted in
SB stolen bases
BB base on balls or walks
BA batting average H/AB
SLG slugging percentage (total bases/at bats)

Source

<https://www.baseball-reference.com/about/bat_glossary.shtml>

References

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
with(data = Baberuth,
hist(RBI))
```

Bac   *Blood Alcohol Content*

Description

Two volunteers each consumed a twelve ounce beer every fifteen minutes for one hour. One hour after the fourth beer was consumed, each volunteer's blood alcohol was measured with a different breathalyzer from the same company. The numbers recorded in data frame `Bac` are the sorted blood alcohol content values reported with breathalyzers from company `X` and company `Y`. Data are used in Example 9.15.

Format

A data frame with 10 observations on the following 2 variables:

X blood alcohol content measured in g/L

Y blood alcohol content measured in g/L

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
with(data = Bac,
var.test(X, Y, alternative = "less"))
```

Battery   *Lithium Batteries*

Description

A manufacturer of lithium batteries has two production facilities, A and B. Fifty randomly selected batteries with an advertised life of 180 hours are selected, and tested. The lifetimes are stored in (`facilityA`). Fifty ramdomly selected batteries with an advertised life of 200 hours are selected, and tested. The lifetimes are stored in (`facilityB`).

Format

A data frame with 50 observations on the following 2 variables:

facilityA life time measured in hours

facilityB life time measured in hours

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
with(data = Battery,
qqnorm(facilityA))
with(data = Battery,
qqline(facilityA))
```

---

bino.gen	*Simulating Binomial Distribution*

Description

Function that generates and displays *m* repeated samples of *n* Bernoulli trials with a given probability of success.

Usage

```
bino.gen(samples, n, pi)
```

Arguments

samples	number of repeated samples to generate
n	number of Bernoulli trials
pi	probability of success for Bernoulli trial

Value

```
simulated.distribution
```
Simulated binomial distribution
```
theoretical.distribution
```
Theoretical binomial distribution

Author(s)

Alan T. Arnholt

Examples

```
bino.gen(1000, 20, 0.75)
```

---

biomass   *Beech Trees*

Description

Several measurements of 42 beech trees (*Fagus Sylvatica*) taken from a forest in Navarra (Spain).

Format

A data frame with 42 observations on the following 4 variables:

Dn diameter of the stem in centimeters

H height of the tree in meters

PST weight of the stem in kilograms

PSA aboveground weight in kilograms

Source

Gobierno de Navarra and *Gestion Ambiental Viveros y Repoblaciones de Navarra*, 2006. The data were obtained within the European Project FORSEE.

References

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
plot(log(PSA) ~ log(Dn), data = biomass)
```

Bodyfat   *Body Fat Composition*

Description

Values from a study reported in the *American Journal of Clinical Nutrition* that investigated a new method for measuring body composition

Format

A data frame with 18 observations on the following 3 variables:

age age in years

fat body fat composition

sex a factor with levels F for female and M for male

Source

Mazess, R. B., Peppler, W. W., and Gibbons, M. (1984) *Total Body Composition by Dual-Photon (153 Gd) Absorptiometry*. American Journal of Clinical Nutrition, **40**, **4**: 834-839.

References

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
boxplot(fat ~ sex, data = Bodyfat)
```

Calculus *Calculus Assessment Scores*

Description

Mathematical assessment scores for 36 students enrolled in a biostatistics course according to whether or not the students had successfully completed a calculus course prior to enrolling in the biostatistics course

Format

A data frame with 18 observations on the following 2 variables:

No.Calculus assessment score for students with no prior calculus

Yes.Calculus assessment score for students with prior calculus

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
with(data = Calculus,
z.test(x = Yes.Calculus, y = No.Calculus, sigma.x = 5, sigma.y = 12)$conf
)
```

Cars2004EU   *Cars in the European Union (2004)*

Description

The numbers of cars per 1000 inhabitants (cars), the total number of known mortal accidents (deaths), and the country population/1000 (population) for the 25 member countries of the European Union for the year 2004

Format

A data frame with 25 observations on the following 4 variables:

country a factor with levels Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, and United Kingdom

cars numbers of cars per 1000 inhabitants

deaths total number of known mortal accidents

population country population/1000

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
plot(deaths ~ cars, data = Cars2004EU)
```

---

checking.plots   *Checking Plots*

Description

Function that creates four graphs that can be used to help assess independence, normality, and constant variance

Usage

```
checking.plots(model, n.id = 3, COL = c("#0080FF", "#A9E2FF"))
```

Arguments

`model`	an aov or lm object
`n.id`	the number of points to identify
`COL`	vector of two colors

Author(s)

Alan T. Arnholt <arnholtat@appstate.edu>

See Also

twoway.plots, oneway.plots

Examples

```
mod.aov <- aov(StopDist ~ tire, data = Tire)
checking.plots(mod.aov)
rm(mod.aov)
```

Chips   *Silicon Chips*

Description

Two techniques of splitting chips are randomly assigned to 28 sheets so that each technique is applied to 14 sheets. The values recorded in Chips are the number of usable chips from each silicon sheet.

Format

A data frame with 14 observations on the following 2 variables:

techniqueI number of usable chips

techniqueII number of usable chips

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
par(mfrow = c(1, 2))
with(data = Chips, qqnorm(techniqueI))
with(data = Chips, qqline(techniqueI))
with(data = Chips, qqnorm(techniqueII))
with(data = Chips, qqline(techniqueII))
par(mfrow=c(1, 1))
# Trellis Approach
graph1 <- qqmath(~techniqueI, data = Chips, type=c("p", "r"))
graph2 <- qqmath(~techniqueII, data = Chips, type=c("p", "r"))
print(graph1, split=c(1, 1, 2, 1), more = TRUE)
print(graph2, split=c(2, 1, 2, 1), more = FALSE)
rm(graph1, graph2)
```

CircuitDesigns   *Circuit Design Lifetime*

Description

`CircuitDesigns` contains the results from an accelerated life test used to estimate the lifetime of four different circuit designs (lifetimes in thousands of hours).

Format

A data frame with 26 observations on the following 2 variables:

lifetime lifetimes in thousands of hours

design a factor with levels `Design1`, `Design2`, `Design3`, and `Design4`

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
bwplot(design ~ lifetime, data = CircuitDesigns)
```

CIsim   *Confidence Interval Simulation Program*

Description

This program simulates random samples from which it constructs confidence intervals for either the population mean, the population variance, or the population proportion of successes.

Usage

```
CIsim(
  samples = 100,
  n = 30,
  parameter = 0.5,
  sigma = 1,
  conf.level = 0.95,
  type = c("Mean", "Var", "Pi")
)
```

Arguments

samples	the number of samples desired.
n	the size of each sample
parameter	If constructing confidence intervals for the population mean or the population variance, parameter is the population mean (i.e., type is one of either "Mean" or "Var"). If constructing confidence intervals for the population proportion of successes, the value entered for parameter represents the population proportion of successes (Pi), and as such, must be a number between 0 and 1.
sigma	is the population standard deviation. sigma is not required if confidence intervals are of type "Pi".
conf.level	confidence level for the graphed confidence intervals, restricted to lie between zero and one
type	character string, one of "Mean", "Var", or "Pi", or just the initial letter of each, indicating the type of confidence interval simulation to perform

Details

Default is to construct confidence intervals for the population mean. Simulated confidence intervals for the population variance or population proportion of successes are possible by selecting the appropriate value in the type argument.

Value

Performs specified simulation and draws the resulting confidence intervals on a graphical device.

Author(s)

Alan T. Arnholt <arnholtat@appstate.edu>

Examples

```
CIsim(samples = 100, n = 30, parameter = 100, sigma = 10, conf.level = 0.90)
# Simulates 100 samples of size 30 from  a normal distribution with mean 100
# and a standard deviation of 10.  From the 100 simulated samples, 90% confidence
# intervals for the Mean are constructed and depicted in the graph.

CIsim(100, 30, 100, 10, type = "Var")
# Simulates 100 sample of size 30 from a normal distribution with mean 100
# and a standard deviation of 10.  From the 100 simulated samples, 95% confidence
# intervals for the variance are constructed and depicted in the graph.

CIsim(100, 50, 0.5, type = "Pi", conf.level = 0.92)
# Simulates 100 samples of size 50 from a binomial distribution where the
# population proportion of successes is 0.5.  From the 100 simulated samples,
# 92% confidence intervals for Pi are constructed and depicted in the graph.
```

Combinations   *Combinations*

Description

Computes all possible combinations of n objects taken k at a time.

Usage

```
Combinations(n, k)
```

Arguments

n	a number
k	a number less than or equal to n

Value

Returns a matrix containing the possible combinations of n objects taken k at a time.

See Also

[SRS](#)

Examples

```
Combinations(5,2)
    # The columns in the matrix list the values of the 10 possible
    # combinations of 5 things taken 2 at a time.
```

CosAma   *Cosmed Versus Amatek*

Description

The Cosmed is a portable metabolic system. A study at Appalachian State University compared the metabolic values obtained from the Cosmed to those of a reference unit (Amatek) over a range of workloads from easy to maximal to test the validity and reliability of the Cosmed. A small portion of the results for VO2 (ml/kg/min) measurements taken at a 150 watt workload are stored in CosAma.

Format

A data frame with 14 observations on the following 3 variables:

subject subject number

Cosmed measured VO2 with Cosmed

Amatek measured VO2 with Amatek

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
bwplot(~(Cosmed - Amatek), data = CosAma)
```

Cows   *Butterfat of Cows*

Description

Random samples of ten mature (five-year-old and older) and ten two-year-old cows were taken from each of five breeds. The average butterfat percentage of these 100 cows is stored in the variable butterfat with the type of cow stored in the variable breed and the age of the cow stored in the variable age.

Format

A data frame with 100 observations on the following 3 variables:

butterfat average butterfat percentage

age a factor with levels 2 years old and Mature

breed a factor with levels Ayrshire, Canadian, Guernsey, Holstein-Friesian, and Jersey

Source

Canadian record book of purebreed diary cattle.

References

Sokal, R. R. and Rohlf, F. J. (1994) *Biometry*. W. H. Freeman, New York, third edition.

Examples

```
summary(aov(butterfat ~ breed + age, data = Cows))
```

Depend   *Number of Dependent Children for 50 Families*

Description

Number of dependent children for 50 families.

Format

A data frame with 50 observations on the following 4 variables.

C1 a numeric vector

number a numeric vector

Count a numeric vector

Percent a numeric vector

Source

Kitchens, L. J. (2003) *Basic Statistics and Data Analysis*. Duxbury

Examples

```
with(data = Depend, table(C1))
```

Drosophila   *Drosophila Melanogaster*

Description

`Drosophila` contains per diem fecundity (number of eggs laid per female per day for the first 14 days of life) for 25 females from each of three lines of *Drosophila melanogaster*. The three lines are Nonselected (control), Resistant, and Susceptible. Data are used in Example 11.5.

Format

A data frame with 75 observations on the following 2 variables:

Fecundity number of eggs laid per female per day for the first 14 days of life

Line a factor with levels `Nonselected`, `Resistant`, and `Susceptible`

Source

The original measurements are from an experiment conducted by R. R. Sokal (Sokal and Rohlf, 1994, p. 237).

References

Sokal, R. R. and Rohlf, F. J. (1994) *Biometry*. W. H. Freeman, New York, third edition.

Examples

```
summary(aov(Fecundity ~ Line, data = Drosophila))
```

EDA   *Exploratory Data Analysis*

Description

Function that produces a histogram, density plot, boxplot, and Q-Q plot

Usage

```
EDA(x, trim = 0.05, dec = 3)
```

Arguments

x   is a numeric vector where NAs and Infs are allowed but will be removed.

trim   is a fraction (between 0 and 0.5, inclusive) of values to be trimmed from each
                end of the ordered data such that if trim = 0.5, the result is the median.

dec   is a number specifying the number of decimals

Details

The function EDA() will not return console window information on data sets containing more than
5000 observations. It will, however, still produce graphical output for data sets containing more
than 5000 observations.

Value

Function returns various measures of center and location. The values returned for the quartiles
are based on the default **R** definitions for quartiles. For more information on the definition of the
quartiles, type ?quantile and read about the algorithm used by type = 7.

Author(s)

Alan T. Arnholt <arnholtat@appstate.edu>

Examples

```
EDA(x = rnorm(100))
# Produces four graphs for the 100 randomly
# generated standard normal variates.
```

Engineer   *Engineer Salaries*

Description

Salaries for engineering graduates 10 years after graduation

Format

A data frame with 51 observations on the following 2 variables:

salary salary 10 years after graduation in thousands of dollars

university one of three different engineering universities

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
boxplot(salary ~ university, data = Engineer, horizontal = TRUE)
# Trellis Approach
bwplot(university ~ salary, data = Engineer)
```

EPIDURAL   *Traditional Sitting Position Versus Hamstring Stretch Position*

Description

Initial results from a study to determine whether the traditional sitting position or the hamstring stretch position is superior for administering epidural anesthesia to pregnant women in labor as measured by the number of obstructive (needle to bone) contacts (OC)

Format

A data frame with 85 observations on the following 7 variables:

Doctor a factor with levels `Dr. A`, `Dr. B`, `Dr. C`, and `Dr. D`

kg weight in kg of patient

cm height in cm of pateint

Ease a factor with levels `Difficult`, `Easy`, and `Impossible` indicating the physician's assessment of how well bone landmarks can be felt in the patient

Treatment a factor with levels `Hamstring Stretch` and `Traditional Sitting`

OC number of obstructive contacts

Complications a factor with levels `Failure - person got dizzy`, `Failure - too many OCs`, `None`, `Paresthesia`, and `Wet Tap`

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
EPIDURAL$Teasy <-  factor(EPIDURAL$Ease,
levels = c("Easy", "Difficult", "Impossible"))
X <- table(EPIDURAL$Doctor, EPIDURAL$Teasy)
X
par(mfrow = c(2, 2)) # Figure 2.12
barplot(X,
main = "Barplot where Doctor is Stacked \n within Levels of Palpitation")
barplot(t(X),
main = "Barplot where Levels of Palpitation \n is Stacked within Doctor")
barplot(X, beside = TRUE,
main = "Barplot where Doctor is Grouped \n within Levels of Palpitation")
barplot(t(X), beside = TRUE,
main = "Barplot where Levels of Palpitation \n is Grouped within Doctor")
par(mfrow = c(1, 1))
rm(X)
```

EPIDURALf *Traditional Sitting Position Versus Hamstring Stretch Position*

Description

Intermediate results from a study to determine whether the traditional sitting position or the hamstring stretch position is superior for administering epidural anesthesia to pregnant women in labor as measured by the number of obstructive (needle to bone) contacts (OC)

Format

A data frame with 342 observations on the following 7 variables:

Doctor a factor with levels `Dr. A`, `Dr. B`, `Dr. C`, and `Dr. D`

kg weight in kg of patient

cm height in cm of pateint

Ease a factor with levels `Difficult`, `Easy`, and `Impossible` indicating the physician's assessment of how well bone landmarks can be felt in the patient

Treatment a factor with levels `Hamstring Stretch` and `Traditional Sitting`

OC number of obstructive contacts

Complications a factor with levels `Failure – person got dizzy`, `Failure – too many OCs`, `None`, `Paresthesia`, and `Wet Tap`

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
boxplot(OC ~ Treatment, data = EPIDURALf)
```

EURD   *European Union Research and Development*

Description

A random sample of 15 countries' research and development investments for the years 2002 and 2003 is taken and the results in millions of euros are stored in EURD.

Format

A data frame with 15 observations on the following 3 variables:

Country a factor with levels `Bulgaria`, `Croatia`, `Cyprus`, `Czech Republic`, `Estonia`, `France`, `Hungary`, `Latvia`, `Lithuania`, `Malta`, `Portugal`, `Romania`, `Slovakia`, and `Slovenia`

RD2002 research and development investments in millions of euros for 2002

RD2003 research and development investments in millions of euros for 2003

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
qqmath(~(RD2003 - RD2002), data = EURD, type=c("p", "r"))
```

---

fagus   *Retained Carbon in Beech Trees*

Description

The carbon retained by leaves measured in kg/ha is recorded for forty-one different plots of mountainous regions of Navarra (Spain), depending on the forest classification: areas with 90% or more beech trees (*Fagus Sylvatica*) are labeled monospecific, while areas with many species of trees are labeled multispecific.

Format

A data frame with 41 observations on the following 3 variables:

Plot plot number

carbon carbon retained by leaves measured in kg/ha

type a factor with levels monospecific and multispecific

Source

Gobierno de Navarra and *Gestion Ambiental Viveros y Repoblaciones de Navarra*, 2006. The data were obtained within the European Project FORSEE.

References

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
boxplot(carbon ~ type, data=fagus)
```

FCD   *Fat Cats*

Description

In a weight loss study on obese cats, overweight cats were randomly assigned to one of three groups and boarded in a kennel. In each of the three groups, the cats' total caloric intake was strictly controlled (1 cup of generic cat food) and monitored for 10 days. The difference between the groups was that group A was given 1/4 of a cup of cat food every six hours, group B was given 1/3 a cup of cat food every eight hours, and group C was given 1/2 a cup of cat food every twelve hours. The weight of the cats at the beginning and end of the study was recorded and the difference in weights (grams) is stored in the variable Weight of the data frame FCD. Data are used in Example 11.4.

Format

A data frame with 36 observations on the following 2 variables:

Weight difference in weights (grams)

Diet a factor with levels A, B, and C

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
# Figure 11.12
FCD.aov <- aov(Weight ~ Diet, data = FCD)
checking.plots(FCD.aov)
rm(FCD.aov)
```

Fertilize   *Cross and Auto Fertilization*

Description

Plants' heights in inches obtained from two seeds, one obtained by cross fertilization and the other by auto fertilization, in two opposite but separate locations of a pot are recorded.

Format

A data frame with 15 observations on the following 2 variables:

cross height of plant in inches

self height of plant in inches

Source

Darwin, C. (1876) *The Effect of Cross and Self-Fertilization in the Vegetable Kingdom*

References

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
with(data = Fertilize,
t.test(cross, self))
```

---

food	*Carrot Shear*

Description

Shear measured in kN on frozen carrots from four randomly selected freezers

Format

A data frame with 16 observations on the following 2 variables:

shear carrot shear measured in kN

freezer a factor with levels A, B, C, and D

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
summary(aov(shear ~ freezer, data = food))
```

Formula1	*Pit Stop Times*

Description

Pit stop times for two teams at 10 randomly selected Formula 1 races

Format

A data frame with 10 observations on the following 3 variables:

Race number corresponding to a race site

Team1 pit stop times for team one

Team2 pit stop times for team two

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
with(data = Formula1,
boxplot(Team1, Team2))
```

GD   *Times Until Failure*

Description

Contains time until failure in hours for a particular electronic component subjected to an accelerated stress test.

Format

A data frame with 100 observations on the following variable:

attf times until failure in hours

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
with(data = GD,
hist(attf, prob = TRUE))
with(data = GD,
lines(density(attf)))
# Trellis Approach
histogram(~attf, data = GD, type = "density",
panel = function(x, ...) {
panel.histogram(x, ...)
panel.densityplot(x, col = "blue", plot.points = TRUE, lwd = 2)
} )
```

---

glucose   *Blood Glucose Levels*

Description

Fifteen diabetic patients were randomly selected, and their blood glucose levels were measured in mg/100 ml with two different devices.

Format

A data frame with 15 observations on the following 3 variables:

Patient patient number

Old blood glucose level in mg/100 ml using old device

New blood glucose level in mg/100 ml using new device

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
with(data = glucose,
boxplot(Old, New))
```

Grades   *GPA and SAT Scores*

Description

The admissions committee of a comprehensive state university selected at random the records of 200 second semester freshmen. The results, first semester college GPA and SAT scores, are stored in the data frame Grades. Data are used in Example 12.6.

Format

A data frame with 200 observations on the following 2 variables:

sat SAT score

gpa grade point average

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
# traditional scatterplot
plot(gpa ~ sat, data = Grades)
# trellis scatterplot
xyplot(gpa ~ sat, data = Grades, type=c("p", "smooth"))
```

Grocery   *Grocery Spending*

Description

The consumer expenditure survey, created by the U.S. Department of Labor, was administered to 30 households in Watauga County, North Carolina, to see how the cost of living in Watauga county with respect to total dollars spent on groceries compares with other counties. The amount of money each household spent per week on groceries is stored in the variable groceries. Data are used in Example 8.3.

Format

A data frame with 30 observations on the following variable:

groceries total dollars spent on groceries

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
with(data = Grocery,
z.test(x = groceries, sigma.x = 30, conf.level = 0.97)$conf)
```

HardWater   *Mortality and Water Hardness*

Description

Mortality and drinking water hardness for 61 cities in England and Wales.

Format

A data frame with 61 observations on the following 4 variables.

location a factor with levels `North South` indicating whether the town is as north as Derby

town the name of the town

mortality averaged annual mortality per 100,000 males

hardness calcium concentration (in parts per million)

Details

These data were collected in an investigation of environmental causes of disease. They show the annual mortality rate per 100,000 for males, averaged over the years 1958-1964, and the calcium concentration (in parts per million) in the drinking water supply for 61 large towns in England and Wales. (The higher the calcium concentration, the harder the water.)

Source

D. J. Hand, F. Daly, A. D. Lunn, K. J. McConway and E. Ostrowski (1994) *A Handbook of Small Datasets*. Chapman and Hall/CRC, London.

Examples

```
plot(mortality ~ hardness, data = HardWater)
```

House   *House Prices*

Description

Random sample of house prices (in thousands of dollars) for three bedroom/two bath houses in Watauga County, NC

Format

A data frame with 14 observations on the following 2 variables:

Neighborhood a factor with levels `Blowing Rock`, `Cove Creek`, `Green Valley`, `Park Valley`, `Parkway`, and `Valley Crucis`

Price price of house (in thousands of dollars)

Examples

```
with(data = House,
t.test(Price))
```

`HSwrestler`   *High School Wrestlers*

Description

The body fat of 78 high school wrestlers was measured using three separate techniques, and the results are stored in the data frame `HSwrestler`. The techniques used were hydrostatic weighing (`HWFAT`), skin fold measurements (`SKFAT`), and the Tanita body fat scale (`TANFAT`). Data are used in Examples 10.11, 12.11, and 12.12.

Format

A data frame with 78 observations on the following 9 variables:

AGE age of wrestler in years

HT height of wrestler in inches

WT weight ofwrestler in pounds

ABS abdominal fat

TRICEPS tricep fat

SUBSCAP subscapular fat

HWFAT hydrostatic fat

TANFAT Tanita fat

SKFAT skin fat

Source

Data provided by Dr. Alan Utter, Department of Health Leisure and Exercise Science, Appalachian State University.

References

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
FAT <- c(HSwrestler$HWFAT, HSwrestler$TANFAT, HSwrestler$SKFAT)
GROUP <- factor(rep(c("HWFAT", "TANFAT", "SKFAT"), rep(78, 3)))
BLOCK <- factor(rep(1:78, 3))
friedman.test(FAT ~ GROUP | BLOCK)
```

Hubble   *Hubble Telescope*

Description

The Hubble Space Telescope was put into orbit on April 25, 1990. Unfortunately, on June 25, 1990, a spherical aberration was discovered in Hubble's primary mirror. To correct this, astronauts had to work in space. To prepare for the mission, two teams of astronauts practiced making repairs under simulated space conditions. Each team of astronauts went through 15 identical scenarios. The times to complete each scenario were recorded in days.

Format

A data frame with 15 observations on the following 2 variables:

Team1 days to complete scenario

Team2 days to complete scenario

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
with(data = Hubble,
qqnorm(Team1 - Team2))
with(data = Hubble,
qqline(Team1 - Team2))
# Trellis Approach
qqmath(~(Team1 - Team2), data = Hubble, type=c("p", "r"))
```

InsurQuotes	*Insurance Quotes*

Description

Insurance quotes for two insurers of hazardous waste jobs

Format

A data frame with 15 observations on the following 2 variables:

companyA quotes from company A in euros

companyB quotes from company B in euros

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
with(data = InsurQuotes,
t.test(companyA, companyB))
```

---

interval.plot	*Interval Plot*

Description

Function to graph intervals

Usage

```
interval.plot(ll, ul, parameter = 0)
```

Arguments

ll	vector of lower values
ul	vector of upper values
parameter	value of the desired parameter (used when graphing confidence intervals)

Value

Draws user-given intervals on a graphical device.

Author(s)

Alan T. Arnholt <arnholtat@appstate.edu>

Examples

```
set.seed(385)
samples <- 100
n <- 625
ll <- numeric(samples)
ul <- numeric(samples)
xbar <- numeric(samples)
for (i in 1:samples){
  xbar[i] <- mean(rnorm(n, 80, 25))
  ll[i] <- xbar[i] - qnorm(.975)*25/sqrt(n)
  ul[i] <- xbar[i] + qnorm(.975)*25/sqrt(n)
  }
interval.plot(ll, ul, parameter = 80)
```

---

janka   *Australian Eucalypt Hardwoods*

Description

The dataset consists of density and hardness measurements from 36 Australian Eucalypt hardwoods.

Format

A data frame with 36 observations on the following 2 variables.

Density a measure of density of the timber

Hardness the Janka hardness of the timber

Details

Janka Hardness is an importance rating of Australian hardwood timbers. The test measures the force required to imbed a steel ball into a piece of wood.

Source

Williams, E.J. (1959) *Regression Analysis*. John Wiley & Sons, New York.

Examples

```
with(data = janka, plot(Hardness ~ Density, col = "blue"))
```

Kinder   *Kindergarten Class*

Description

The data frame `Kinder` contains the height in inches and weight in pounds of 20 children from a kindergarten class. Data are used in Example 12.17.

Format

A data frame with 20 observations on the following 2 variables:

ht   height in inches of child

wt   weight in pounds of child

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
# Figure 12.10
with(data = Kinder,
plot(wt, ht))
# Trellis Approach
xyplot(ht ~ wt, data = Kinder)
```

---

ksdist   *Simulated Distribution of D_n (Kolmogorov-Smirnov)*

Description

Function to visualize the sampling distribution of D_n (the Kolmogorov-Smirnov one sample statistic) and to find simulated critical values.

Usage

```
ksdist(n = 10, sims = 10000, alpha = 0.05)
```

Arguments

n	sample size
sims	number of simulations to perform
alpha	desired α level

Author(s)

Alan T. Arnholt <arnholtat@appstate.edu>

See Also

ksLdist

Examples

```
ksdist(n = 10, sims = 15000, alpha =0.05)
```

---

ksLdist   *Simulated Lilliefors' Test of Normality Values*

Description

Function to visualize the sampling distribution of D_n (the Kolmogorov-Smirnov one sample statistic) for simple and composite hypotheses

Usage

```
ksLdist(n = 10, sims = 10000, alpha = 0.05)
```

Arguments

n	sample size
sims	number of simulations to perform
alpha	desired α level

Author(s)

Alan T. Arnholt <arnholtat@appstate.edu>

See Also

ksdist

Examples

```
ksLdist(n = 10, sims = 1500, alpha = 0.05)
```

Leddiode	*LED Diodes*

Description

The diameter in millimeters for a random sample of 15 diodes from each of the two suppliers is stored in the data frame `Leddiode`.

Format

A data frame with 15 observations on the following 2 variables:

supplierA diameter in millimeters of diodes from supplier A

supplierB diameter in millimeters of diodes from supplier B

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
with(data = Leddiode,
boxplot(supplierA, supplierB, col = c("red", "blue")))
```

LostR	*Lost Revenue Due to Worker Illness*

Description

Data set containing the lost revenue in dollars/day and number of workers absent due to illness for a metallurgic company

Format

A data frame with 25 observations on the following 2 variables:

NumberSick number of absent workers due to illness

LostRevenue lost revenue in dollars

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
xyplot(LostRevenue ~ NumberSick, data = LostR, type=c("p", "r"))
```

MilkCarton   *Milk Carton Drying Times*

Description

A plastics manufacturer makes two sizes of milk containers: half gallon and gallon sizes. The time
required for each size to dry is recorded in seconds in the data frame `MilkCarton`.

Format

A data frame with 40 observations on the following 2 variables:

Hgallon drying time in seconds for half gallon containers

Wgallon drying time in seconds for whole gallon containers

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman
& Hall/CRC.

Examples

```
with(data = MilkCarton,
boxplot(Hgallon, Wgallon))
```

---

normarea   *Normal Area*

Description

Function that computes and draws the area between two user specified values in a user specified
normal distribution with a given mean and standard deviation

Usage

```
normarea(lower = -Inf, upper = Inf, m = 0, sig = 1)
```

Arguments

lower	the desired lower value
upper	the desired upper value
m	the mean for the population (default is the standard normal with m = 0)
sig	the standard deviation of the population (default is the standard normal with sig = 1)

Value

Draws the specified area in a graphics device

Author(s)

Alan T. Arnholt <arnholtat@appstate.edu>

Examples

```
# Finds and graphically illustrates P(70 < X < 130) given X is N(100, 15)
normarea(lower = 70, upper = 130, m = 100, sig = 15)
```

---

nsize	*Required Sample Size*

Description

Function to determine required sample size to be within a given margin of error

Usage

```
nsize(b, sigma = NULL, p = 0.5, conf.level = 0.95, type = c("mu", "pi"))
```

Arguments

b	the desired bound
sigma	population standard deviation; not required if using type "pi"
p	estimate for the population proportion of successes; not required if using type "mu"
conf.level	confidence level for the problem, restricted to lie between zero and one
type	character string, one of "mu" or "pi", or just the initial letter of each, indicating the appropriate parameter; default value is "mu"

Details

Answer is based on a normal approximation when using type "pi".

Author(s)

Alan T. Arnholt <arnholtat@appstate.edu>

Examples

```
nsize(b = 0.015, p = 0.5, conf.level = 0.95, type = "pi")
# Returns the required sample size (n) to estimate the population
# proportion of successes with a 0.95 confidence interval
# so that the margin of error is no more than 0.015 when the
# estimate of the population propotion of successes is 0.5.
nsize(b = 0.02, sigma = 0.1, conf.level = 0.95, type = "mu")
# Returns the required sample size (n) to estimate the population
# mean with a 0.95 confidence interval so that the margin
# of error is no more than 0.02.
```

---

ntester   *Normality Tester*

Description

Q-Q plots of randomly generated normal data of the same sample size as the tested data are generated and plotted on the perimeter of the graph while a Q-Q plot of the actual data is depicted in the center of the graph.

Usage

```
ntester(actual.data)
```

Arguments

actual.data   is a numeric vector. Missing and infinite values are allowed, but are ignored
                  in the calculation. The length of actual.data must be less than 5000 after
                  dropping nonfinite values.

Details

Q-Q plots of randomly generated normal data of the same size as the tested data are generated and plotted on the perimeter of the graph sheet while a Q-Q plot of the actual data is depicted in the center of the graph. The p-values are calculated based on the Shapiro-Wilk W-statistic. Function will only work on numeric vectors containing less than or equal to 5000 observations. Best used for moderate sized samples ($n < 50$).

Author(s)

Alan T. Arnholt <arnholtat@appstate.edu>

References

Shapiro, S.S. and Wilk, M.B. 1965. *An analysis of variance test for normality (complete samples)*. Biometrika **52**: 591-611.

Examples

```
ntester(actual.data = rexp(40, 1))
# Q-Q plot of random exponential data in center plot
# surrounded by 8 Q-Q plots of randomly generated
# standard normal data of size 40.
```

---

oneway.plots *Exploratory Graphs for Single Factor Designs*

Description

Function to create dotplots, boxplots, and design plot (means) for single factor designs

Usage

```
oneway.plots(Y, fac1, COL = c("#A9E2FF", "#0080FF"))
```

Arguments

Y	response variable for a single factor design
fac1	predictor variable (factor)
COL	a vector with two colors

Author(s)

Alan T. Arnholt <arnholtat@appstate.edu>

See Also

twoway.plots, checking.plots

Examples

```
with(data = Tire, oneway.plots(StopDist, tire))
```

Phenyl   *Phenylketonuria*

Description

The data frame `Phenyl` records the level of Q10 at four different times for 46 patients diagnosed with phenylketonuria. The variable `Q10.1` contains the level of Q10 measured in micromoles for the 46 patients. `Q10.2`, `Q10.3`, and `Q10.4` are the values recorded at later times respectively for the 46 patients.

Format

A data frame with 46 observations on the following 4 variables.

Q10.1 level of Q10 at time 1 in micromoles

Q10.2 level of Q10 at time 2 in micromoles

Q10.3 level of Q10 at time 3 in micromoles

Q10.4 level of Q10 at time 4 in micromoles

Details

Phenylketonuria (PKU) is a genetic disorder that is characterized by an inability of the body to utilize the essential amino acid, phenylalanine. Research suggests patients with phenylketonuria have deficiencies in coenzyme Q10.

Source

Artuch, R., *et. al.* (2004) "Study of Antioxidant Status in Phenylketonuric Patients." *Clinical Biochemistry*, **37**: 198-203.

References

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
with(data = Phenyl,
t.test(Q10.1, conf.level = 0.99))
```

Phone	*Telephone Call Times*

Description

Phone contains times in minutes of long distance telephone calls during a one month period for a small business. Data are used in Example 10.1.

Format

A data frame with 23 observations on the following variable:

call.time time spent on long distance calls in minutes

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
with(data = Phone,
SIGN.test(call.time, md = 2.1))
```

Rat	*Rat Survival Time*

Description

The survival time in weeks of 20 male rats exposed to high levels of radiation.

Format

A data frame with 20 observations on the following variable:

survival.time number of weeks survived

Source

Lawless, J. (1982) *Statistical Models and Methods for Lifetime Data*. John Wiley, New York.

References

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
with(data = Rat,
EDA(survival.time))
```

Ratbp   *Rat Blood Pressure*

Description

Twelve rats were chosen, and a drug was administered to six rats, the treatment group, chosen at random. The other six rats, the control group, received a placebo. The drops in blood pressure (mmHg) for the treatment group (with probability distribution F) and the control group (with probability distribution G) are stored in the variables Treat and Cont, respectively. Data are used in Example 10.18.

Format

A data frame with 6 observations on the following 2 variables:

Treat drops in blood pressure in mmHg for treatment group

Cont drops in blood pressure in mmHg for control group

Source

The data is originally from Ott and Mendenhall (1985, problem 8.17).

References

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
with(data = Ratbp,
boxplot(Treat, Cont))
```

Refrigerator   *Refrigerator Energy Consumption*

Description

Thirty 18 cubic feet refrigerators were randomly selected from a company's warehouse. The first
fifteen had their motors modified while the last fifteen were left intact. The energy consumption
(kilowatts) for a 24 hour period for each refrigerator was recorded and stored in the data frame
`Refrigerator`. The refrigerators with the design modification are stored in the variable `modelA`,
and those without the design modification are stored in the variable `modelB`.

Format

A data frame with 30 observations on the following 2 variables.

modelA energy consumption in kilowatts for a 24 hour period

modelB energy consumption in kilowatts for a 24 hour period

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman
& Hall/CRC.

Examples

```
with(data = Refrigerator,
boxplot(modelA, modelB))
```

Roacheggs   *Oriental Cockroaches*

Description

A laboratory is interested in testing a new child friendly pesticide on *Blatta orientalis* (oriental
cockroaches). Scientists apply the new pesticide to 81 randomly selected Blatta orientalis oothecae
(eggs). The results from the experiment are stored in the data frame Roacheggs in the variable
`eggs`. A zero in the variable `eggs` indicates that nothing hatched from the egg while a 1 indicates
the birth of a cockroach. Data is used in Example 7.16.

Format

A data frame with 81 observations on the following variable:

eggs numeric vector where a 0 indicates nothing hatched while a 1 indicates the birth of a cock-
roach.

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
p <- seq(0.1, 0.9, 0.001)
negloglike <- function(p){
-(sum(Roacheggs$eggs)*log(p) + sum(1 - Roacheggs$eggs)*log(1 - p))
}
nlm(negloglike, 0.2)
rm(negloglike)
```

Salinity   *Surface Water Salinity*

Description

Surface-water salinity measurements were taken in a bottom-sampling project in Whitewater Bay, Florida. These data are stored in the data frame `Salinity`.

Format

A data frame with 48 observations on the following variable:

salinity surface-water salinity measurements

Source

Davis, J. (1986) *Statistics and Data Analysis in Geology*. John Wiley, New York.

References

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
with(data = Salinity,
EDA(salinity))
```

---

satfruit	*Fruit Trees*

Description

To estimate the total surface occupied by fruit trees in 3 small areas (R63, R67, and R68) of Navarra (Spain) in 2001, a sample of 47 square segments has been taken. The experimental units are square segments or quadrats of 4 hectares, obtained by random sampling after overlaying a square grid on the study domain. Data are used in Case Study: Fruit Trees, Chapter 12.

Format

A data frame with 47 observations on the following 17 variables:

QUADRAT number of the sampled segment or quadrat

SArea the small area, a factor with levels R63, R67, and R68

WH area classified as wheat in sampled segment

BA area classified as barley in sampled segment

NAR area classified as non arable in sampled segment

COR area classified as corn in sampled segment

SF area classified as sunflower in sampled segment

VI area classified as vineyard in sampled segment

PS area classified as grass in sampled segment

ES area classified as asparagus in sampled segment

AF area classified as lucerne in sampled segment

CO area classified as rape (*Brassica Napus*) in sampled segment

AR area classified as rice in sampled segment

AL area classified as almonds in sampled segment

OL area classified as olives in sampled segment

FR area classified as fruit trees in sampled segment

OBS the observed area of fruit trees in sampled segment

Source

Militino, A. F., *et. al.* (2006) "Using Small Area Models to Estimate the Total Area Occupied by Olive Trees." *Journal of Agricultural, Biological and Environmental Statistics, **11**: 450-461.*

References

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
with(data = satfruit,
pairs(satfruit[ , 15:17]))
# Trellis Approach
splom(~data.frame(satfruit[ , 15:17]), data = satfruit)
```

SBIQ   *County IQ*

Description

A school psychologist administered the Stanford-Binet intelligence quotient (IQ) test in two counties. Forty randomly selected, gifted and talented students were selected from each county. The Stanford-Binet IQ test is said to follow a normal distribution with a mean of 100 and standard deviation of 16.

Format

A data frame with 40 observations on the following 2 variables:

County1 IQ scores for county one

County2 IQ scores for county two

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
with(data = SBIQ, qqnorm(County1))
with(data = SBIQ, qqline(County1))
# Trellis Approach
qqmath(~County1, data = SBIQ, type=c("p", "r"))
```

Schizo	*Dopamine Activity*

Description

Twenty-five patients with schizophrenia were classified as psychotic or nonpsychotic after being treated with an antipsychotic drug. Samples of cerebral fluid were taken from each patient and assayed for dopamine b-hydroxylase (DBH) activity. The dopamine measurements for the two groups are in nmol/(ml)(h)/(mg) of protein.

Format

A data frame with 15 observations on the following 2 variables:

nonpsychotic dopamine activity level for patients classified nonpsychotic

psychotic dopamine activity level for patients classified psychotic

Source

Sternberg, D. E., Van Kammen, D. P., and Bunney,W. E. (1982) "Schizophrenia: Dopamine b-Hydroxylase Activity and Treatment Response." *Science*, **216**: 1423-1425.

References

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
with(data = Schizo, boxplot(nonpsychotic, psychotic,
names = c("nonpsychotic", "psychotic"), col = c("green", "red")))
```

Score	*Standardized Test Scores*

Description

Standardized test scores from a random sample of twenty college freshmen.

Format

A data frame with 20 observations on the following variable:

scores standardized test score

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
qqmath(~scores, data = Score, type=c("p", "r"))
```

SDS4   *M1 Motorspeedway Times*

Description

The times recorded are those for 41 successive vehicles travelling northwards along the M1 motorway in England when passing a fixed point near Junction 13 in Bedfordshire on Saturday, March 23, 1985. After subtracting the times, the following 40 interarrival times reported to the nearest second are stored in SDS4 under the variable Times. Data are used in Example 10.17.

Format

A data frame with 40 observations on the following variable:

Times interarrival times to the nearest second

Source

Hand, D. J., *et. al.* (1994) *A Handbook of Small Data Sets*. Chapman & Hall, London.

References

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
with(data = SDS4, hist(Times))
```

SIGN.test   *Sign Test*

Description

This function will test a hypothesis based on the sign test and reports linearly interpolated confidence intervals for one sample problems.

Usage

```
SIGN.test(
  x,
  y = NULL,
  md = 0,
  alternative = "two.sided",
  conf.level = 0.95,
  ...
)
```

Arguments

x	numeric vector; NAs and Infs are allowed but will be removed.
y	optional numeric vector; NAs and Infs are allowed but will be removed.
md	a single number representing the value of the population median specified by the null hypothesis
alternative	is a character string, one of "greater", "less", or "two.sided", or the initial letter of each, indicating the specification of the alternative hypothesis. For one-sample tests, alternative refers to the true median of the parent population in relation to the hypothesized value of the median.
conf.level	confidence level for the returned confidence interval, restricted to lie between zero and one
...	further arguments to be passed to or from methods

Details

Computes a "Dependent-samples Sign-Test" if both x and y are provided. If only x is provided, computes the "Sign-Test."

Value

A list of class htest_S, containing the following components:

statistic	the S-statistic (the number of positive differences between the data and the hypothesized median), with names attribute "S".
p.value	the p-value for the test

conf.int	is a confidence interval (vector of length 2) for the true median based on linear interpolation. The confidence level is recorded in the attribute `conf.level`. When the alternative is not `"two.sided"`, the confidence interval will be half-infinite, to reflect the interpretation of a confidence interval as the set of all values k for which one would not reject the null hypothesis that the true mean or difference in means is k. Here infinity will be represented by `Inf`.
estimate	is avector of length 1, giving the sample median; this estimates the corresponding population parameter. Component `estimate` has a names attribute describing its elements.
null.value	is the value of the median specified by the null hypothesis. This equals the input argument `md`. Component `null.value` has a names attribute describing its elements.
alternative	records the value of the input argument alternative: `"greater"`, `"less"`, or `"two.sided"`
data.name	a character string (vector of length 1) containing the actual name of the input vector x
Confidence.Intervals	
	a 3 by 3 matrix containing the lower achieved confidence interval, the interpolated confidence interval, and the upper achived confidence interval

Null Hypothesis

For the one-sample sign-test, the null hypothesis is that the median of the population from which x is drawn is md. For the two-sample dependent case, the null hypothesis is that the median for the differences of the populations from which x and y are drawn is md. The alternative hypothesis indicates the direction of divergence of the population median for x from md (i.e., `"greater"`, `"less"`, `"two.sided"`.)

Assumptions

The median test assumes the parent population is continuous.

Note

The reported confidence interval is based on linear interpolation. The lower and upper confidence levels are exact.

Author(s)

Alan T. Arnholt <arnholtat@appstate.edu>

References

- Gibbons, J.D. and Chakraborti, S. 1992. *Nonparametric Statistical Inference*. Marcel Dekker Inc., New York.
- Kitchens, L.J. 2003. *Basic Statistics and Data Analysis*. Duxbury.
- Conover, W. J. 1980. *Practical Nonparametric Statistics, 2nd ed*. Wiley, New York.
- Lehmann, E. L. 1975. *Nonparametrics: Statistical Methods Based on Ranks*. Holden and Day, San Francisco.

See Also

z.test, zsum.test, tsum.test

Examples

```
with(data = Phone, SIGN.test(call.time, md = 2.1))
# Computes two-sided sign-test for the null hypothesis
# that the population median is 2.1.  The alternative
# hypothesis is that the median is not 2.1.  An interpolated
# upper 95% upper bound for the population median will be computed.
```

SimDataST   *Simulated Data (Predictors)*

Description

Simulated data for five variables. Data are used with Example 12.21.

Format

A data frame with 200 observations on the following 5 variables:

Y1 a numeric vector

Y2 a numeric vector

x1 a numeric vector

x2 a numeric vector

x3 a numeric vector

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
xyplot(Y1 ~ x1, data = SimDataST, type=c("p", "smooth"))
```

SimDataXT   *Simulated Data (Logarithms)*

Description

Simulated data for four varaibles. Data are used with Example 12.18.

Format

A data frame with 200 observations on the following 4 variables:

Y a numeric vector

x1 a numeric vector

x2 a numeric vector

x3 a numeric vector

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
xyplot(Y ~ x1, data = SimDataXT, type=c("p", "smooth"))
```

Soccer   *World Cup Soccer*

Description

Soccer contains how many goals were scored in the regulation 90 minute periods of World Cup soccer matches from 1990 to 2002. Data are used in Example 4.4.

Format

A data frame with 575 observations on the following 3 variables:

CGT cumulative goal time in minutes

Game game in which goals were scored

Goals number of goals scored in regulation period

Details

The World Cup is played once every four years. National teams from all over the world compete. In 2002 and in 1998, thirty-six teams were invited; whereas, in 1994 and in 1990, only 24 teams participated. The data frame Soccer contains three columns: CGT, Game, and Goals. All of the information contained in Soccer is indirectly available from the FIFA World Cup website, located at https://www.fifa.com/.

Source

Chu, S. (2003) "Using Soccer Goals to Motivate the Poisson Process." *INFORMS* Transaction on Education, **3**, **2**: 62-68.

References

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
with(data = Soccer,
table(Goals))
```

SRS   *Simple Random Sample*

Description

Computes all possible samples from a given population using simple random sampling

Usage

```
SRS(popvalues, n)
```

Arguments

popvalues   are values of the population. NAs and Infs are allowed but will be removed from the population.

n   the sample size

Details

If non-finite values are entered as part of the population, they are removed; and the returned simple random sample computed is based on the remaining finite values.

Value

The function srs() returns a matrix containing the possible simple random samples of size n taken from a population of finite values popvalues.

Author(s)

Alan T. Arnholt <arnholtat@appstate.edu>

See Also

combn

Examples

```
SRS(popvalues = c(5, 8, 3, NA, Inf), n = 2)
```

StatTemps   *Student Temperature*

Description

In a study conducted at Appalachian State University, students used digital oral thermometers to record their temperatures each day they came to class. A randomly selected day of student temperatures is provided in StatTemps. Information is also provided with regard to subject gender and the hour of the day when the students' temperatures were measured.

Format

A data frame with 34 observations on the following 3 variables:

temperature temperature in farenheit

gender a factor with levels Female and Male

class a factor with levels 8 a.m. and 9 a.m.

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
bwplot(gender ~ temperature, data = StatTemps)
```

Stschool *School Satisfaction*

Description

A questionnaire is randomly administered to 11 students from State School X and to 15 students from State School Y (the results have been ordered and stored in the data frame Stschool). Data are used in Example 9.11.

Format

A data frame with 26 observations on the following 4 variables:

X satisfaction score

Y satisfaction score

Satisfaction combined satisfaction scores

School a factor with levels X and Y

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
with(data = Stschool,
t.test(X, Y, var.equal = TRUE))
```

Sundig *Workstation Comparison*

Description

To compare the speed differences between two different brands of workstations (Sun and Digital), the times each brand took to complete complex simulations was recorded. Five complex simulations were selected, and the five selected simulations were run on both workstations. The resulting times in minutes for the five simulations are stored in data frame Sundig.

Format

A data frame with 5 observations on the following 3 variables:

SUN time in seconds for a Sun workstation to complete a simulation

DIGITAL time in seconds for a Digital workstation to complete a simulation

d difference between Sun and Digital

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
with(data = Sundig,
t.test(SUN, DIGITAL, paired = TRUE)$conf)
```

---

sunflower   *Sunflower Defoliation*

Description

Seventy-two field trials were conducted by applying four defoliation treatments (non defoliated control, 33%, 66%, and 100%) at different growth stages (stage) ranging from pre-flowering (1) to physiological maturity (5) in four different locations of Navarra, Spain: Carcastillo (1), Melida (2), Murillo (3), and Unciti (4). There are two response variables: yield in kg/ha of the sunflower and numseed, the number of seeds per sunflower head. Data are stored in the data frame sunflower. Data used in Case Study: Sunflower defoliation from Chapter 11.

Format

A data frame with 72 observations on the following 5 variables:

location a factor with levels A, B, C, and D for locations Carcastillo, Melida, Murillo, and Unciti respectively

stage a factor with levels stage1, stage2, stage3, stage4, and stage5

defoli a factor with levels control, treat1, treat2, and treat3

yield sunflower yield in kg/ha

numseed number of seeds per sunflower head

Source

Muro, J., *et. al.* (2001) "Defoliation Effects on Sunflower Yield Reduction." Agronomy Journal, **93**: 634-637.

References

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
summary(aov(yield ~ stage + defoli + stage:defoli, data = sunflower))
```

SurfaceSpain *Surface Area for Spanish Communities*

Description

Surface area (km^2) for seventeen autonomous Spanish communities.

Format

A data frame with 17 observations on the following 2 variables:

community a factor with levels Andalucia, Aragon, Asturias, Baleares, C.Valenciana, Canarias, Cantabria, Castilla-La Mancha, Castilla-Leon, Cataluna, Extremadura, Galicia, La Rioja, Madrid, Murcia, Navarra, and P.Vasco

surface surface area in km^2

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
with(data = SurfaceSpain,
barplot(surface, names.arg = community, las = 2))
# Trellis Approach
barchart(community ~ surface, data = SurfaceSpain)
```

Swimtimes *Swim Times*

Description

Swimmers' improvements in seconds for two diets are stored in the data frame Swimtimes. The values in highfat represent the time improvement in seconds for swimmers on a high fat diet, and the values in lowfat represent the time improvement in seconds for swimmers on a low fat diet. Data are used in Example 10.9.

Format

A data frame with 14 observations on the following 2 variables:

lowfat time improvement in seconds

highfat time improvement in seconds

Details

Times for the thirty-two swimmers for the 200 yard individual medley were taken right after the swimmers' conference meet. The swimmers were randomly assigned to follow one of the diets. The group on diet 1 followed a low fat diet the entire year but lost two swimmers along the way. The group on diet 2 followed the high fat diet the entire year and also lost two swimmers.

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
with(data = Swimtimes,
wilcox.test(highfat, lowfat))
```

Tennis   *Speed Detector*

Description

The Yonalasee tennis club has two systems to measure the speed of a tennis ball. The local tennis pro suspects one system (Speed1) consistently records faster speeds. To test her suspicions, she sets up both systems and records the speeds of 12 serves (three serves from each side of the court). The values are stored in the data frame Tennis in the variables Speed1 and Speed2. The recorded speeds are in kilometers per hour.

Format

A data frame with 12 observations on the following 2 variables:

Speed1 speed in kilometers per hour

Speed2 speed in kilometers per hour

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
with(data = Tennis,
boxplot(Speed1, Speed2))
```

TestScores	*Statistics Grades*

Description

Test grades of 29 students taking a basic statistics course

Format

A data frame with 29 observations on the following variable:

grade test score

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
with(data = TestScores,
EDA(grade))
```

Tire	*Tire Stopping Distances*

Description

The data frame `Tire` has the stopping distances measured to the nearest foot for a standard sized car to come to a complete stop from a speed of sixty miles per hour. There are six measurements of the stopping distance for four different tread patterns labeled A, B, C, and D. The same driver and car were used for all twenty-four measurements. Data are used in Example 11.1 and 11.2.

Format

A data frame with 24 observations on the following 2 variables:

StopDist stopping distance measured to the nearest foot

tire a factor with levels A, B, C, and D

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
summary(aov(StopDist ~ tire, data = Tire))
```

TireWear   *Tire Wear*

Description

The data frame `TireWear` contains measurements for the amount of tread loss after 10,000 miles of driving in thousandths of an inch. Data are used in Example 11.8.

Format

A data frame with 16 observations on the following 3 variables:

Wear tread loss measured in thousandths of an inch

Treat a factor with levels A, B, C, and D

Block a factor with levels Car1, Car2, Car3, and Car4

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
par(mfrow = c(1, 2), cex = 0.8)
with(data = TireWear,
interaction.plot(Treat, Block, Wear, type = "b", legend = FALSE))
with(data = TireWear,
interaction.plot(Block, Treat, Wear, type = "b", legend = FALSE))
par(mfrow = c(1, 1), cex = 1)
```

| titanic3 | *Titanic Survival Status* |

Description

The `titanic3` data frame describes the survival status of individual passengers on the Titanic. The `titanic3` data frame does not contain information for the crew, but it does contain actual and estimated ages for almost 80% of the passengers.

Format

A data frame with 1309 observations on the following 14 variables:

pclass a factor with levels `1st`, `2nd`, and `3rd`

survived Survival (0 = No; 1 = Yes)

name Name

sex a factor with levels `female` and `male`

age age in years

sibsp Number of Siblings/Spouses Aboard

parch Number of Parents/Children Aboard

ticket Ticket Number

fare Passenger Fare

cabin Cabin

embarked a factor with levels `Cherbourg`, `Queenstown`, and `Southampton`

boat Lifeboat

body Body IdentificationNumber

home.dest Home/Destination

Details

Thomas Cason of UVa has greatly updated and improved the `titanic` data frame using the *Encyclopedia Titanica* and created a new dataset called `titanic3`. This dataset reflects the state of data available as of August 2, 1999. Some duplicate passengers have been dropped, many errors have been corrected, many missing ages have been filled in, and new variables have been created.

Source

https://hbiostat.org/data/repo/titanic.html

References

Harrell, F. E. (2001) *Regression Modeling Strategies with Applications to Linear Models, Logistic Regression, and Survival Analysis*. Springer.

Examples

```
with(titanic3,
table(pclass, sex))
```

TOE	*Nuclear Energy*

Description

Nuclear energy (in TOE, tons of oil equivalent) produced in 12 randomly selected European countries during 2003

Format

A data frame with 12 observations on the following variable:

energy nuclear energy measured in tons of oil equivalent

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
with(TOE,
plot(density(energy)))
```

Top20	*Tennis Income*

Description

Top20 contains data (in millions of dollars) corresponding to the earnings of 15 randomly selected tennis players whose earnings fall somewhere in positions 20 through 100 of ranked earnings.

Format

A data frame with 15 observations on the following variable:

income yearly income in millions of dollars

Source

<https://www.atptour.com/>

References

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
with(data = Top20,
EDA(income))
```

---

tsum.test	*Summarized t-test*

Description

Performs a one-sample, two-sample, or a Welch modified two-sample t-test based on user supplied summary information. Output is identical to that produced with `t.test`.

Usage

```
tsum.test(
  mean.x,
  s.x = NULL,
  n.x = NULL,
  mean.y = NULL,
  s.y = NULL,
  n.y = NULL,
  alternative = c("two.sided", "less", "greater"),
  mu = 0,
  var.equal = FALSE,
  conf.level = 0.95,
  ...
)
```

Arguments

mean.x	a single number representing the sample mean of x
s.x	a single number representing the sample standard deviation of x
n.x	a single number representing the sample size of x
mean.y	a single number representing the sample mean of y
s.y	a single number representing the sample standard deviation of y

n.y   a single number representing the sample size of y

alternative   is a character string, one of "greater", "less", or "two.sided", or just the
                   initial letter of each, indicating the specification of the alternative hypothesis.
                   For one-sample tests, alternative refers to the true mean of the parent pop-
                   ulation in relation to the hypothesized value mu. For the standard two-sample
                   tests, alternative refers to the difference between the true population mean
                   for x and that for y, in relation to mu. For the one-sample and paired t-tests,
                   alternative refers to the true mean of the parent population in relation to the
                   hypothesized value mu. For the standard and Welch modified two-sample t-tests,
                   alternative refers to the difference between the true population mean for x
                   and that for y, in relation to mu. For the one-sample t-tests, alternative refers to
                   the true mean of the parent population in relation to the hypothesized value mu.
                   For the standard and Welch modified two-sample t-tests, alternative refers to the
                   difference between the true population mean for x and that for y, in relation to
                   mu.

mu   is a single number representing the value of the mean or difference in means
                   specified by the null hypothesis.

var.equal   logical flag: if TRUE, the variances of the parent populations of x and y are as-
                   sumed equal. Argument var.equal should be supplied only for the two-sample
                   tests.

conf.level   is the confidence level for the returned confidence interval; it must lie between
                   zero and one.

...   Other arguments passed onto tsum.test()

Details

If y is NULL, a one-sample t-test is carried out with x. If y is not NULL, either a standard or Welch
modified two-sample t-test is performed, depending on whether var.equal is TRUE or FALSE.

Value

A list of class htest, containing the following components:

statistic   the t-statistic, with names attribute "t"

parameters   is the degrees of freedom of the t-distribution associated with statistic. Compo-
                   nent parameters has names attribute "df".

p.value   the p-value for the test

conf.int   is a confidence interval (vector of length 2) for the true mean or difference in
                   means. The confidence level is recorded in the attribute conf.level. When
                   alternative is not "two.sided", the confidence interval will be half-infinite, to
                   reflect the interpretation of a confidence interval as the set of all values k for
                   which one would not reject the null hypothesis that the true mean or difference
                   in means is k . Here infinity will be represented by Inf.

estimate   is a vector of length 1 or 2, giving the sample mean(s) or mean of differences;
                   these estimate the corresponding population parameters. Component estimate
                   has a names attribute describing its elements.

null.value	is the value of the mean or difference in means specified by the null hypothesis. This equals the input argument mu. Component null.value has a names attribute describing its elements.
alternative	records the value of the input argument alternative: "greater" , "less" or "two.sided".
data.name	is a character string (vector of length 1) containing the names x and y for the two summarized samples.

Null Hypothesis

For the one-sample t-test, the null hypothesis is that the mean of the population from which x is drawn is mu. For the standard and Welch modified two-sample t-tests, the null hypothesis is that the population mean for x less that for y is mu.

The alternative hypothesis in each case indicates the direction of divergence of the population mean for x (or difference of means for x and y) from mu (i.e., "greater", "less", or "two.sided").

Test Assumptions

The assumption of equal population variances is central to the standard two-sample t-test. This test can be misleading when population variances are not equal, as the null distribution of the test statistic is no longer a t-distribution. If the assumption of equal variances is doubtful with respect to a particular dataset, the Welch modification of the t-test should be used.

The t-test and the associated confidence interval are quite robust with respect to level toward heavy-tailed non-Gaussian distributions (e.g., data with outliers). However, the t-test is non-robust with respect to power, and the confidence interval is non-robust with respect to average length, toward these same types of distributions.

Confidence Intervals

For each of the above tests, an expression for the related confidence interval (returned component conf.int) can be obtained in the usual way by inverting the expression for the test statistic. Note that, as explained under the description of conf.int, the confidence interval will be half-infinite when alternative is not "two.sided" ; infinity will be represented by Inf.

Author(s)

Alan T. Arnholt <arnholtat@appstate.edu>

References

- Kitchens, L.J. 2003. *Basic Statistics and Data Analysis*. Duxbury.

- Hogg, R. V. and Craig, A. T. 1970. *Introduction to Mathematical Statistics, 3rd ed.* Toronto, Canada: Macmillan.

- Mood, A. M., Graybill, F. A. and Boes, D. C. 1974. *Introduction to the Theory of Statistics, 3rd ed.* New York: McGraw-Hill.

- Snedecor, G. W. and Cochran, W. G. 1980. *Statistical Methods, 7th ed.* Ames, Iowa: Iowa State University Press.

See Also

z.test, zsum.test

Examples

```
# 95% Confidence Interval for mu1 - mu2, assuming equal variances
round(tsum.test(mean.x = 53/15, mean.y = 77/11, s.x=sqrt((222 - 15*(53/15)^2)/14),
s.y = sqrt((560 - 11*(77/11)^2)/10), n.x = 15, n.y = 11, var.equal = TRUE)$conf, 2)
# One Sample t-test
tsum.test(mean.x = 4, s.x = 2.89, n.x = 25, mu = 2.5)
```

---

twoway.plots   *Exploratory Graphs for Two Factor Designs*

Description

Function creates side-by-side boxplots for each factor, a design plot (means), and an interaction plot.

Usage

```
twoway.plots(Y, fac1, fac2, COL = c("#A9E2FF", "#0080FF"))
```

Arguments

Y	response variable
fac1	factor one
fac2	factor two
COL	a vector with two colors

Author(s)

Alan T. Arnholt <arnholtat@appstate.edu>

See Also

oneway.plots, checking.plots

Examples

```
with(data = TireWear, twoway.plots(Wear, Treat, Block))
```

URLaddress   *Megabytes Downloaded*

Description

The manager of a URL commercial address is interested in predicting the number of megabytes downloaded, `megasd`, by clients according to the number minutes they are connected, `mconnected`. The manager randomly selects (megabyte, minute) pairs, and records the data. The pairs (`megasd`, `mconnected`) are stored in the data frame `URLaddress`.

Format

A data frame with 30 observations on the following 2 variables:

megasd   megabytes dowloaded

mconnected   number of minutes connected

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
xyplot(mconnected ~ megasd, data = URLaddress, type=c("p", "r"))
```

---

vit2005   *Apartments in Vitoria*

Description

Descriptive information and the appraised total price (in Euros) for apartments in Vitoria, Spain.

Format

A data frame with 218 observations on the following 16 variables:

row.labels   the number of the observation

totalprice   the market total price (in Euros) of the apartment including garage(s) and storage room(s)

area   the total living area of the apartment in square meters

zone   a factor indicating the neighborhood where the apartment is located with levels Z11, Z21, Z31, Z32, Z34, Z35, Z36, Z37, Z38, Z41, Z42, Z43, Z44, Z45, Z46, Z47, Z48, Z49, Z52, Z53, Z56, Z61, and Z62.

category a factor indicating the condition of the apartment with levels 2A, 2B, 3A, 3B, 4A, 4B, and 5A. The factors are ordered so that 2A is the best and 5A is the worst.

age age of the aprtment

floor floor on which the apartment is located

rooms total number of rooms including bedrooms, dining room, and kitchen

out a factor indicating the percent of the apartment exposed to the elements. The levels E100, E75, E50, and E25, correspond to complete exposure, 75% exposure, 50% exposure, and 25% exposure respectively.

conservation is an ordered factor indicating the state of conservation of the apartment. The levels 1A, 2A, 2B, and 3A are ordered from best to worst conservation.

toilets the number of bathrooms

garage the number of garages

elevator indicates the absence (0) or presence (1) of elevators.

streetcategory an ordered factor from best to worst indicating the category of the street with levels S2, S3, S4, and S5

heating a factor indicating the type of heating with levels 1A, 3A, 3B, and 4A which correspond to: no heating, low-standard private heating, high-standard private heating, and central heating respectively.

tras the number of storage rooms outside of the apartment

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
modTotal <- lm(totalprice ~ area + as.factor(elevator) +
area:as.factor(elevator), data = vit2005)
modSimpl <- lm(totalprice ~ area, data = vit2005)
anova(modSimpl,modTotal)
rm(modSimpl, modTotal)
```

Wait	*Waiting Time*

Description

A statistician records how long he must wait for his bus each morning. Data are used in Example 10.4.

Format

A data frame with 15 observations on the following variable:

wt waiting time in minutes

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
with(data = Wait,
wilcox.test(wt, mu = 6, alternative = "less"))
```

Washer   *Washer Diameter*

Description

Diameter of washers.

Format

A data frame with 20 observations on the following variable:

diameters diameter of washer in cm

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
with(data = Washer,
EDA(diameters))
```

Water   *Sodium Content of Water*

Description

An independent agency measures the sodium content in 20 samples from source X and in 10 samples
from source Y and stores them in data frame Water. Data are used in Example 9.12.

Format

A data frame with 30 observations on the following 4 variables:

X sodium content measured in mg/L

Y sodium content measured in mg/L

Sodium combined sodium content measured in mg/L

Source a factor with levels X and Y

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman
& Hall/CRC.

Examples

```
with(data = Water,
t.test(X, Y, alternative = "less"))
```

WCST   *Wisconsin Card Sorting Test*

Description

The following data are the test scores from a group of 50 patients from the *Virgen del Camino*
Hospital (Pamplona, Spain) on the Wisconsin Card Sorting Test.

Format

A data frame with 50 observations on the following variable:

score score on the Wisconsin Card Sorting Test

Details

The "Wisconsin Card Sorting Test" is widely used by psychiatrists, neurologists, and neuropsychologists with patients who have a brain injury, neurodegenerative disease, or a mental illness such as schizophrenia. Patients with any sort of frontal lobe lesion generally do poorly on the test.

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
densityplot(~score, data = WCST, ref = TRUE)
```

WeightGain   *Weight Gain in Rats*

Description

The data come from an experiment to study the gain in weight of rats fed on four different diets, distinguished by amount of protein (low and high) and by source of pretein (beef and cereal).

Format

A data frame with 40 observations on the following 4 variables.

ProteinSource a factor with levels Beef Cereal

ProteinAmount a factor with levels High Low

weightgain weight gain in grams

Details

The design of the experiment is acompletely randomized with ten rats on each of the four treatments.

Source

D. J. Hand, F. Daly, A. D. Lunn, K. J. McConway and E. Ostrowski (1994) *A Handbook of Small Datasets*. Chapman and Hall/CRC, London.

Examples

```
aov(weightgain ~ ProteinSource*ProteinAmount, data = WeightGain)
```

WheatSpain   *Wheat Surface Area in Spain*

Description

Seventeen Spanish communities and their corresponding surface area (in hecatares) dedicated to growing wheat

Format

A data frame with 17 observations on the following 3 variables:

community a factor with levels Andalucia, Aragon, Asturias, Baleares, C.Valenciana, Canarias, Cantabria, Castilla-La Mancha, Castilla-Leon, Cataluna, Extremadura, Galicia, La Rioja, Madrid, Murcia, Navarra, and P.Vasco

hectares surface area measured in hectares

acres surface area measured in acres

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
with(data = WheatSpain,
boxplot(hectares))
```

---

wheatUSA2004   *USA Wheat Surface 2004*

Description

USA's 2004 harvested wheat surface by state

Format

A data frame with 30 observations on the following 2 variables.

STATES a factor with levels AR, CA, CO, DE, GA, ID, IL, IN, KS, KY, MD, MI, MO, MS, MT, NC, NE, NY, OH, OK, OR, Other, PA, SC, SD, TN, TX, VA, WA, and WI

ACRES wheat surface area measured in 1000s of acres

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
with(data = wheatUSA2004,
hist(ACRES))
```

---

wilcoxE.test   *Wilcoxon Exact Test*

Description

Performs exact one sample and two sample Wilcoxon tests on vectors of data

Usage

```
wilcoxE.test(
  x,
  y = NULL,
  mu = 0,
  paired = FALSE,
  alternative = c("two.sided", "less", "greater"),
  conf.level = 0.95
)
```

Arguments

x	is a numeric vector of data values. Non-finite (i.e. infinite or missing) values will be omitted.
y	an optional numeric vector of data values
mu	a number specifying an optional parameter used to form the null hypothesis
paired	a logical indicating whether you want a paired test
alternative	a character string specifying the alternative hypothesis, must be one of "two.sided" (default), "less", or "greater". You can specify just the initial letter.
conf.level	confidence level of the interval

Details

If only x is given, or if both x and y are given and paired = TRUE, a Wilcoxon signed rank test of the null hypothesis that the distribution of x (in the one sample case) or of x − y (in the paired two sample case) is symmetric about mu is performed.

Otherwise, if both x and y are given and paired = FALSE, a Wilcoxon rank sum test is done. In this case, the null hypothesis is that the distribution of x and y differ by a location shift mu, and the alternative is that they differ by some other location shift (and the one-sided alternative "greater" is that x is shifted to the right of y).

Value

A list of class htest, containing the following components:

statistic	the value of the test statistic with a name describing it
p.value	the p-value for the test
null.value	the location parameter mu
alternative	a character string describing the alternative hypothesis
method	the type of test applied
data.name	a character string giving the names of the data
conf.int	a confidence interval for the location parameter
estimate	an estimate of the location parameter

Note

The function is rather primitive and should only be used for problems with fewer than 19 observations as the memory requirements are rather large.

Author(s)

Alan T. Arnholt <arnholtat@appstate.edu>

References

- Gibbons, J.D. and Chakraborti, S. 1992. *Nonparametric Statistical Inference*. Marcel Dekker Inc., New York.

- Hollander, M. and Wolfe, D.A. 1999. *Nonparametric Statistical Methods*. New York: John Wiley & Sons.

See Also

[wilcox.test](#)

Examples

```
# Wilcoxon Signed Rank Test
PH <- c(7.2, 7.3, 7.3, 7.4)
wilcoxE.test(PH, mu = 7.25, alternative = "greater")
# Wilcoxon Signed Rank Test (Dependent Samples)
with(data = Aggression,
wilcoxE.test(violence, noviolence, paired = TRUE, alternative = "greater"))
# Wilcoxon Rank Sum Test
x <- c(7.2, 7.2, 7.3, 7.3)
y <- c(7.3, 7.3, 7.4, 7.4)
wilcoxE.test(x, y)
rm(PH, x, y)
```

Wool   *Wool Production*

Description

Random sample of wool production in kilograms on 5 different days at two different locations

Format

A data frame with 15 observations on the following 2 variables:

textileA wool production in thousands of kilograms

textileB wool production in thousands of kilograms

Source

Ugarte, M. D., Militino, A. F., and Arnholt, A. T. (2008) *Probability and Statistics with R*. Chapman & Hall/CRC.

Examples

```
with(data = Wool,
t.test(textileA, textileB))
```

---

z.test   *z-Test*

Description

This function is based on the standard normal distribution and creates confidence intervals and tests hypotheses for both one and two sample problems.

Usage

```
z.test(
  x,
  sigma.x = NULL,
  y = NULL,
  sigma.y = NULL,
  sigma.d = NULL,
  alternative = c("two.sided", "less", "greater"),
  mu = 0,
  paired = FALSE,
  conf.level = 0.95,
  ...
)
```

Arguments

x	a (non-empty) numeric vector of data values
sigma.x	a single number representing the population standard deviation for x
y	an optional (non-empty) numeric vector of data values
sigma.y	a single number representing the population standard deviation for y
sigma.d	a single number representing the population standard deviation for the paired differences
alternative	character string, one of "greater", "less", or "two.sided", or the initial letter of each, indicating the specification of the alternative hypothesis. For one-sample tests, alternative refers to the true mean of the parent population in relation to the hypothesized value mu. For the standard two-sample tests, alternative refers to the difference between the true population mean for x and that for y, in relation to mu.
mu	a single number representing the value of the mean or difference in means specified by the null hypothesis
paired	a logical indicating whether you want a paired z-test
conf.level	confidence level for the returned confidence interval, restricted to lie between zero and one
...	Other arguments passed onto z.test()

Details

If y is NULL, a one-sample z-test is carried out with x provided sigma.x is not NULL. If y is not NULL, a standard two-sample z-test is performed provided both sigma.x and sigma.y are finite. If paired = TRUE, a paired z-test where the differences are defined as x − y is performed when the user enters a finite value for sigma.d (the population standard deviation for the differences).

Value

A list of class htest, containing the following components:

statistic	the z-statistic, with names attribute z
p.value	the p-value for the test
conf.int	is a confidence interval (vector of length 2) for the true mean or difference in means. The confidence level is recorded in the attribute conf.level. When alternative is not "two.sided," the confidence interval will be half-infinite, to reflect the interpretation of a confidence interval as the set of all values k for which one would not reject the null hypothesis that the true mean or difference in means is k . Here, infinity will be represented by Inf.
estimate	vector of length 1 or 2, giving the sample mean(s) or mean of differences; these estimate the corresponding population parameters. Component estimate has a names attribute describing its elements.
null.value	the value of the mean or difference of means specified by the null hypothesis. This equals the input argument mu. Component null.value has a names attribute describing its elements.
alternative	records the value of the input argument alternative: "greater", "less", or "two.sided".
data.name	a character string (vector of length 1) containing the actual names of the input vectors x and y

Null Hypothesis

For the one-sample z-test, the null hypothesis is that the mean of the population from which x is drawn is mu. For the standard two-sample z-test, the null hypothesis is that the population mean for x less that for y is mu. For the paired z-test, the null hypothesis is that the mean difference between x and y is mu.

The alternative hypothesis in each case indicates the direction of divergence of the population mean for x (or difference of means for x and y) from mu (i.e., "greater", "less", or "two.sided").

Test Assumptions

The assumption of normality for the underlying distribution or a sufficiently large sample size is required along with the population standard deviation to use Z procedures.

Confidence Intervals

For each of the above tests, an expression for the related confidence interval (returned component `conf.int`) can be obtained in the usual way by inverting the expression for the test statistic. Note that, as explained under the description of `conf.int`, the confidence interval will be half-infinite when alternative is not `"two.sided"`; infinity will be represented by `Inf`.

Author(s)

Alan T. Arnholt <arnholtat@appstate.edu>

References

- Kitchens, L.J. 2003. *Basic Statistics and Data Analysis*. Duxbury.
- Hogg, R. V. and Craig, A. T. 1970. *Introduction to Mathematical Statistics, 3rd ed.* Toronto, Canada: Macmillan.
- Mood, A. M., Graybill, F. A. and Boes, D. C. 1974. *Introduction to the Theory of Statistics, 3rd ed.* New York: McGraw-Hill.
- Snedecor, G. W. and Cochran, W. G. 1980. *Statistical Methods, 7th ed.* Ames, Iowa: Iowa State University Press.

See Also

zsum.test, tsum.test

Examples

```
with(data = Grocery, z.test(x = groceries, sigma.x = 30, conf.level = 0.97)$conf)
# Example 8.3 from PASWR.
x <- rnorm(12)
z.test(x, sigma.x = 1)
# Two-sided one-sample z-test where the assumed value for
# sigma.x is one. The null hypothesis is that the population
# mean for 'x' is zero. The alternative hypothesis states
# that it is either greater or less than zero. A confidence
# interval for the population mean will be computed.
x <- c(7.8, 6.6, 6.5, 7.4, 7.3, 7., 6.4, 7.1, 6.7, 7.6, 6.8)
y <- c(4.5, 5.4, 6.1, 6.1, 5.4, 5., 4.1, 5.5)
z.test(x, sigma.x=0.5, y, sigma.y=0.5, mu=2)
# Two-sided standard two-sample z-test where both sigma.x
# and sigma.y are both assumed to equal 0.5. The null hypothesis
# is that the population mean for 'x' less that for 'y' is 2.
# The alternative hypothesis is that this difference is not 2.
# A confidence interval for the true difference will be computed.
z.test(x, sigma.x = 0.5, y, sigma.y = 0.5, conf.level = 0.90)
# Two-sided standard two-sample z-test where both sigma.x and
# sigma.y are both assumed to equal 0.5. The null hypothesis
# is that the population mean for 'x' less that for 'y' is zero.
# The alternative hypothesis is that this difference is not
# zero.  A 90\% confidence interval for the true difference will
# be computed.
```

```
rm(x, y)
```

---

zsum.test   *Summarized z-test*

Description

This function is based on the standard normal distribution and creates confidence intervals and tests hypotheses for both one and two sample problems based on summarized information the user passes to the function. Output is identical to that produced with z.test.

Usage

```
zsum.test(
  mean.x,
  sigma.x = NULL,
  n.x = NULL,
  mean.y = NULL,
  sigma.y = NULL,
  n.y = NULL,
  alternative = c("two.sided", "less", "greater"),
  mu = 0,
  conf.level = 0.95,
  ...
)
```

Arguments

mean.x	a single number representing the sample mean of x
sigma.x	a single number representing the population standard deviation for x
n.x	a single number representing the sample size for y
mean.y	a single number representing the sample mean of y
sigma.y	a single number representing the population standard deviation for y
n.y	a single number representing the sample size for y
alternative	is a character string, one of "greater", "less", or "two.sided", or the initial letter of each, indicating the specification of the alternative hypothesis. For one-sample tests, alternative refers to the true mean of the parent population in relation to the hypothesized value mu. For the standard two-sample tests, alternative refers to the difference between the true population mean for x and that for y, in relation to mu.
mu	a single number representing the value of the mean or difference in means specified by the null hypothesis
conf.level	confidence level for the returned confidence interval, restricted to lie between zero and one
...	Other arguments passed onto z.test()

Details

If y is NULL , a one-sample z-test is carried out with x provided sigma.x is finite. If y is not NULL, a standard two-sample z-test is performed provided both sigma.x and sigma.y are finite.

Value

A list of class htest, containing the following components:

statistic	the z-statistic, with names attribute z
p.value	the p-value for the test
conf.int	is a confidence interval (vector of length 2) for the true mean or difference in means. The confidence level is recorded in the attribute conf.level. When alternative is not "two.sided," the confidence interval will be half-infinite, to reflect the interpretation of a confidence interval as the set of all values k for which one would not reject the null hypothesis that the true mean or difference in means is k . Here, infinity will be represented by Inf.
estimate	vector of length 1 or 2, giving the sample mean(s) or mean of differences; these estimate the corresponding population parameters. Component estimate has a names attribute describing its elements.
null.value	the value of the mean or difference in means specified by the null hypothesis. This equals the input argument mu. Component null.value has a names attribute describing its elements.
alternative	records the value of the input argument alternative: "greater", "less", or "two.sided".
data.name	a character string (vector of length 1) containing the names x and y for the two summarized samples.

Null Hypothesis

For the one-sample z-test, the null hypothesis is that the mean of the population from which x is drawn is mu. For the standard two-sample z-test, the null hypothesis is that the population mean for x less that for y is mu.

The alternative hypothesis in each case indicates the direction of divergence of the population mean for x (or difference of means for x and y) from mu (i.e., "greater", "less", or "two.sided").

Test Assumptions

The assumption of normality for the underlying distribution or a sufficiently large sample size is required along with the population standard deviation to use Z procedures.

Confidence Intervals

For each of the above tests, an expression for the related confidence interval (returned component conf.int) can be obtained in the usual way by inverting the expression for the test statistic. Note that, as explained under the description of conf.int, the confidence interval will be half-infinite when alternative is not "two.sided"; infinity will be represented by Inf.

Author(s)

Alan T. Arnholt <arnholtat@appstate.edu>

References

- Kitchens, L.J. 2003. *Basic Statistics and Data Analysis*. Duxbury.
- Hogg, R. V. and Craig, A. T. 1970. *Introduction to Mathematical Statistics, 3rd ed.* Toronto, Canada: Macmillan.
- Mood, A. M., Graybill, F. A. and Boes, D. C. 1974. *Introduction to the Theory of Statistics, 3rd ed.* New York: McGraw-Hill.
- Snedecor, G. W. and Cochran, W. G. 1980. *Statistical Methods, 7th ed.* Ames, Iowa: Iowa State University Press.

See Also

`z.test`, `tsum.test`

Examples

```
zsum.test(mean.x = 56/30,sigma.x = 2, n.x = 30, alternative="greater", mu = 1.8)
# Example 9.7 part a. from PASWR.
x <- rnorm(12)
zsum.test(mean(x), sigma.x = 1, n.x = 12)
# Two-sided one-sample z-test where the assumed value for
# sigma.x is one. The null hypothesis is that the population
# mean for 'x' is zero. The alternative hypothesis states
# that it is either greater or less than zero. A confidence
# interval for the population mean will be computed.
# Note: returns same answer as:
z.test(x, sigma.x = 1)

x <- c(7.8, 6.6, 6.5, 7.4, 7.3, 7.0, 6.4, 7.1, 6.7, 7.6, 6.8)
y <- c(4.5, 5.4, 6.1, 6.1, 5.4, 5.0, 4.1, 5.5)
zsum.test(mean(x), sigma.x = 0.5, n.x = 11 ,mean(y), sigma.y = 0.5, n.y = 8, mu = 2)
# Two-sided standard two-sample z-test where both sigma.x
# and sigma.y are both assumed to equal 0.5. The null hypothesis
# is that the population mean for 'x' less that for 'y' is 2.
# The alternative hypothesis is that this difference is not 2.
# A confidence interval for the true difference will be computed.
# Note: returns same answer as:
z.test(x, sigma.x = 0.5, y, sigma.y = 0.5)
#
zsum.test(mean(x), sigma.x = 0.5, n.x = 11, mean(y), sigma.y = 0.5, n.y = 8,
conf.level=0.90)
# Two-sided standard two-sample z-test where both sigma.x and
# sigma.y are both assumed to equal 0.5. The null hypothesis
# is that the population mean for 'x' less that for 'y' is zero.
# The alternative hypothesis is that this difference is not
# zero.  A 90% confidence interval for the true difference will
```

```
# be computed.  Note: returns same answer as:
z.test(x, sigma.x=0.5, y, sigma.y=0.5, conf.level=0.90)
rm(x, y)
```

Index