Package ‘asbio’

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agrostis

Description

Percent cover of the grass *Agrostis variabilis* at 25 alpine snowbank sites in the Absaroka-Beartooth Mountains.

Usage

data(agrostis)

Format

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

- **site** Site number
- **cover** Percent cover

Source

**aids**

**Aids and veterans dataset**

**Description**

The veterans administration studied the effect of AZT on AIDS symptoms for 338 HIV-positive military veterans who were just beginning to express AIDS. AZT treatment was withheld on a random component until helper T cells showed even greater depletion while the other group received the drug immediately. The subjects were also classified by race.

**Usage**

data(aids)

**Format**

A data frame with 338 observations on the following 3 variables.

- `race` A factor with levels black, white.
- `AZT` A factor with levels N, Y.
- `symptoms` Presence/absence of AIDS symptoms.

**Source**


---

**alfalfa.split.plot**

**An agricultural split plot design**

**Description**

An experiment was conducted in Iowa in 1944 to see how different varieties of alfalfa responded to the last cutting day of the previous year (Snedecor and Cochran 1967). We know that in the fall alfalfa can either continue to grow, or stop growing and store resources belowground in roots for growth during the following year. Thus, we might expect that later cutting dates inhibits growth for the following year. On the other hand, if plants are cut after they have gone into senescence, there should be little effect on productivity during the following year. There are two factors: 1) variety of alfalfa (three varieties were planted in each of three randomly chosen whole plots), and 2) the date of last cutting (Sept 1, Sept. 20, or Oct. 7). The dates were randomly chosen split plots within the whole plots. Replication was accomplished using six blocks of fields.

**Usage**

data(alfalfa.split.plot)
Format

The dataframe contains four variables:

- **yield**: Alfalfa yield (tons per acre).
- **variety**: Alfalfa variety. A factor with three levels: "L" = Ladak, "C" = Cosack, and "R" = Ranger describing the variety of alfalfa seed used.
- **cut.time**: Time of last cutting. A factor with three levels: "None" = field not cut, "S1" = Sept 1, "S20" = Sept. 20, or "O7" = Oct. 7.
- **block**: The block (whole plot replicate). A factor with six levels: "1", "2", "3", "4", "5", and "6".

Source


---

**alpha.div**

*Functions for calculating alpha diversity.*

Description

Alpha diversity quantifies richness and evenness within a sampling unit (replicate).

The function `alpha.div` runs `Simp.index` or `SW.index` to calculate Simpson’s, Inverse Simpson’s or Shannon-Weiner diversities.

Simpson’s index has a straightforward interpretation. It is the probability of reaching into a plot and simultaneously pulling out two different species. Inverse Simpson’s diversity is equivalent to one over the probability that two randomly chosen individuals will be the same species. These measures have been attributed to Simpson (1949). While it does not allow straightforward interpretation of results, the Shannon-Weiner diversity ($H'$) is another commonly used alpha-diversity measure based on the Kullback-Leibler information criterion (Macarthur and Macarthur 1961).

Usage

```r
alpha.div(x, index)
Simp.index(x, inv)
SW.index(x)
```

Arguments

- **x**: A vector or matrix of species abundances (e.g. counts). The functions assume that species are in columns and sites are in rows.
- **index**: The type of alpha diversity to be computed. The function currently has three choices: `simp` = Simpson’s diversity, `inv.simp` = inverse Simpson’s, `shan` = Shannon-Weiner diversity.
- **inv**: Logical, indicating whether or not Simpson’s inverse diversity should be computed.
Value

A single diversity value is returned if \( x \) is a vector. A vector of diversities (one for each site) are returned if \( x \) is a matrix.

Author(s)

Ken Aho

References


Examples

```r
data(cliff.sp)
alpha.div(cliff.sp,"simp")
```

---

\[ anim.ci \]

*Animation demonstrations of confidence intervals.*

Description

Provides animated depictions of confidence intervals for \( \mu, \sigma^2 \), the population median, and the binomial parameter \( \pi \).

Usage

```r
anim.ci(parent=expression(rnorm(n)), par.val, conf = 0.95, sigma = NULL,
par.type = c("mu", "median", "sigma.sq", "p"), n.est = 100,
n = 50, err.col = 2, par.col = 4, interval = 0.1, ...)
```

Arguments

- **parent**: A parental distribution; ideally a distribution with known parameters.
- **par.val**: True parameter value which is being estimated.
- **conf**: Confidence level: \( 1-P(\text{type I error}) \).
- **sigma**: \( \sigma \) from the normal pdf, if known.
- **par.type**: The parameter whose confidence intervals to be estimated. There are currently four choices \( c("mu", "median", "sigma.sq", "p") \). These are the normal pdf parameters \( \mu \) and \( \sigma^2 \), the population median, and the binomial parameter, \( \pi \).
- **n.est**: The number of confidence intervals to be created.
The sample size used for each confidence interval.

err.col  The line color of the intervals which do not include the true value.

par.col  The line color denoting the parameter value.

interval The time interval for animation (in seconds). Smaller intervals speed up animation

... Additional arguments to plot.

Details

Provides an animated plot showing confidence intervals with respect to a known parameter. Intervals which do not contain the parameter are emphasized with different colors. Loading package tcltk allows use of function anm.ci.tck which provides an interactive GUI to run the function.

Value

Returns an animated plot.

Author(s)

Ken Aho

See Also

Additional documentation for methods provided in: ci.mu.t, ci.mu.z, ci.median, ci.sigma, and ci.p.

Examples

```r
# Not run:
parent<-rnorm(100000)
anm.ci(parent, par.val=0, conf =.95, sigma =1, par.type="mu")
anm.ci(parent, par.val=1, conf =.95, par.type="sigma.sq")
anm.ci(parent, par.val=0, conf =.95, par.type="median")
parent<-rbinom(100000,1,p=.65)
anm.ci(parent, par.val=0.65, conf =.95, par.type="p")
#Interactive GUI, requires package 'tcltk'
anm.ci.tck()

# End(Not run)
```
anm.coin

---

**anm.coin**

*Animated demonstration of frequentist binomial convergence of probability using a coin flip.*

---

**Description**

Creates an animated plot showing the results from coin flips, and the resulting convergence in \( P(\text{Head}) \) as the number of flips grows large.

**Usage**

```r
anm.coin(flips = 1000, p.head = 0.5, interval = 0.01, show.coin = TRUE, ...)
```

**Arguments**

- `flips`:
  The number of desired coin flips.
- `p.head`:
  User defined probability of a head; e.g., for a fair coin `p.head = 0.5`.
- `interval`:
  The time between animation frames, in seconds.
- `show.coin`:
  Logical if `show.coin=TRUE` shows a second plot with coin flip results (head or tail).
- `...`:
  Additional arguments to `plot`.

**Value**

If `show.coin=TRUE`, returns two plots configured as a single graphical object. The first plot shows convergence in estimated \( P(\text{Head}) \), i.e., number of heads/number of trials, as the number of trials grows large. The second plot shows individual outcomes of coin flips. The second (smaller) plot is not returned if `show.coin=TRUE` is specified. Loading `tcltk` allows use of the function `anm.coin.tck()`, which creates an interactive GUI to run `anm.coin`.

**Author(s)**

Ken Aho

**See Also**

`rbinom`

**Examples**

```r
## Not run: anm.coin()
```
Animated demonstration of density for a continuous pdf

**Description**
A continuous pdf is conceptually a histogram whose bin area sums to one. Infinite, infinitely small bins, however, are required to allow depiction of an infinite number of distinct continuous outcomes.

**Usage**

```r
anm.cont.pdf(part = "norm", interval = 0.3)

see.pdf.conc.tck()
```

**Arguments**
- **part**: Parent distribution, options are "norm" = \(N(0, 1)\), "t" = \(t(10)\), "exp" = EXP(1), and "unif" = UNIF(0,1)
- **interval**: Animation interval

**Note**
May not work every time because random values may exceed histogram range.

**Author(s)**
Ken Aho

---

**Animated depiction of six-sided die throws.**

**Description**
Convergence in probability for fair (or loaded) six-sided die.

**Usage**

```r
anm.die(reps = 300, interval = 0.1, show.die = TRUE, p = c(1/6, 1/6, 1/6, 1/6, 1/6, 1/6), cl = TRUE)

anm.die.tck()
```
Arguments

- **reps**: Number of die throws.
- **interval**: Animation interval in frames per second.
- **show.die**: Logical, indicating whether die outcomes should be shown.
- **p**: A vector of length six which sums to one indicating the probability of die outcomes.
- **cl**: Logical, indicating whether or not color should be used.

Author(s)

Ken Aho

See Also

- anm.coin

Examples

```r
## Not run:
anm.die()

## End(Not run)
```

Description

Describes random treatment allocation for fifteen experimental designs.

Usage

```r
anm.ExpDesign(method = "all", titles = TRUE, cex.text = 1, mp.col = NULL, lwda = 1, interval = 0.5, iter = 30)

ExpDesign(method = "all", titles = TRUE, cex.text = 1, mp.col = NULL, lwda = 1, ...)"n
anm.ExpDesign.tck()
```
Arguments

method: A character vector listing the experimental methods to be demonstrated (see Details below).

titles: A logical argument specifying whether or not plots should have main titles.

interval: Time length spent on each frame in animation (in seconds).

iter: Number of random iterations in animation.

cex.text: Text character expansion plots.

mp.col: Arrow colors in "matched" plot. Either a vector of length 3 or a single color.

lwda: Arrow line widths.

... Additional arguments from plot.

Details

The function returns a plot or series of plots illustrating the workings of experimental designs. Random apportionment of treatments of experimental units (EUs) is illustrated for each of twelve experimental designs. A character string can be specified in the method argument using a subset of any of the following:

"CRD": a one-way completely randomized design,
"factorial2by2": a 2 x 2 design with four EUs,
"factorial2by2by2": a 2 x 2 x 2 factorial designs with 8 EUs,
"nested": a nested design with two levels of nesting,
"RCBD" a randomized complete block design with two blocks, two treatments and four EUs,
"RIBD": a randomized incomplete block design with three blocks, three treatments, and six EUs,
"split": a split plot design with a whole plot (factor A) and a split plot (factor B),
"split.split": a split split-split plot design,
"SPRB": split plots in randomized blocks,
"strip.split": strip-split plot design,
"latin": a Latin squares design with $r = 3$, and
"pairs": a matched pairs design.

The function anm.ExpDesign. tck provides an interactive GUI. Details on these designs are given below.

Completely randomized design (CRD)

In a completely randomized design experimental units are each randomly assigned to factor levels without constraints like blocking. This approach can (and should) be implemented in one way ANOVAs, and in more complex formats like factorial and hierarchical designs.

Factorial design

Treatments can be derived by combining factor levels from the multiple factors. This is called a factorial design. In a fully crossed factorial design with two factors, A and B, every level in factor A is contained in every level of factor B.
Randomized block design (RBD)

In a **randomized block design** a researcher randomly assigns experimental units to treatments separately within units called blocks. If all treatments are assigned exactly once within each block this is known as a **randomized complete block design (RCBD)**.

Latin squares

**Latin squares designs** are useful when there are two potential blocking variables. These can figuratively or literally be represented by rows and columns. All treatments are assigned to each row and to each column, and for each row and column treatment assignments differ. Of course this stipulation limits the number of ways one can allocate treatments.

Nested design

In a **nested design** factor levels from one factor will be contained entirely in one factor level from another factor. Consider a design with two factors A and B. When every level of factor A appears with every level of factor B, and vice versa, then we have a fully crossed factorial design (see above). Conversely, when levels of B only occur within a single level of A, then B is nested in A.

Split plot design

A **split plot** design contains two nested levels of randomization. At the highest level are whole plots which are randomly assigned factor levels from one factor. At a second nested level whole plots are split to form split plots. The split plots are randomly assigned factor levels from a second factor. Split plot designs are replicated in units called blocks. **Split-split plot** design will have two levels of split plot nesting: C (split-split plots) are split plots within B (split plots), and B are split plots within A (whole plots). We can see obvious and confusing similarities here to nested designs.

A **split plot randomized block (SPRB)** design will have whole plots randomly assigned within blocks, and split plots randomly assigned within the whole plots. Thus, levels of A (whole plot) are assigned randomly to a block, and split plots containing levels of B (split plot) are assigned within a level of A.

Strip plot design

Closely related to split plot designs are strip plots. **Strip plots** can be used address situations when relatively large experimental units are required for each of two factors in an experiment. A strip plot will have a row and column structure. Let the number of columns equal to the number of levels in factor A, and let the number of rows be equal to the number of levels in factor B. Levels in A are randomly assigned to columns only (across all rows) in a RBD format, and levels in B are assigned to rows only (across all columns). Interestingly, the levels in A serve as split plots in B and vice versa. However, unlike a split plot design assignment of treatments at this level is not entirely random since rows are assigned single levels in A, while columns are assigned single levels in B. Compared to a factorial design strip plots allow for greater precision in the measurement of interaction effects while sacrificing precision in the measurement of main effects. **Split-block design** discussed by Littell et al. (2006), are indistinguishable from strip plots, described earlier, except that they are placed in the context of blocks. They are also indistinguishable from SPRBs except that the design has an explicit row/column structure (one level of A for each column, one level of B for each row), resulting in larger experimental units for A and B. Conversely, in a SPRB, different levels of A and B can be assigned within columns and rows respectively. A final type
of split/strip plot design is known as a **strip-split plot**. Strip-split plots are three way designs (cf. Hoshmand 2006, Milliken and Johnson 2009). In these models a conventional two factor strip plot is created (factors A and B) and split plots are placed in the resulting cells (levels in factor C). The design is indistinguishable from a split-split plot design except for the fact that “columns” always constitute the same levels in A, while “rows” always constitute the same levels in B, allowing larger experimental units for A and B, and reflecting the strip plot relationship of A and B. Other, even more complex variants of split and strip plots are possible. For instance, Littell et al. (2006) discuss a case study they describe as strip-split-split plot design!

**Matched pairs**

In a **matched pairs** design treatments are compared by using the same (or highly similar) experimental units. If treatments are assigned at particular time segments it is assumed that outcomes within an experimental unit are independent, i.e., there is no "carryover" effect from the previous treatment. Violation of this assumption may result in aspericity and prevent conventional approaches.

**Author(s)**

Ken Aho

**References**


**See Also**

sampNdesign

**Examples**

```r
ExpDesign()
## Not run: anm.ExpDesign()
```

---

**anm.geo.growth**

**Animated depictions of population growth**

---

**Description**

Animated depictions of geometric, exponential, and logistic growth.
Usage

```r
anm.geo.growth(n0, lambda, time = seq(0, 20), ylab = "Abundance",
               xlab = "Time", interval = 0.1, ...)

anm.exp.growth(n, rmax, time = seq(0, 20), ylab = "Abundance",
               xlab = "Time", interval = 0.1, ...)

anm.log.growth(n, rmax, K, time = seq(0, 60), ylab = "Abundance",
               xlab = "Time", interval = 0.1, ...)

anm.geo.growth.tck()

anm.exp.growth.tck()

anm.log.growth.tck()
```

Arguments

- `n0`: Population size at time zero for geometric population growth.
- `lambda`: Geometric growth rate.
- `time`: A time sequence, i.e. a vector of integers which must include 0.
- `ylab`: Y-axis label.
- `xlab`: X-axis label
- `interval`: Animation interval in seconds per frame.
- `...`: Additional arguments to `plot`
- `n`: Initial population numbers for exponential and logistic growth
- `rmax`: The maximum intrinsic rate of increase
- `K`: The carrying capacity

Details

Presented here are three famous population growth models from ecology. Geometric, exponential and logistic growth. The first two model growth in the presence of unlimited resources. Geometric growth is exponential growth assuming non-overlapping generations, and is computed as:

$$ N_t = N_0 \lambda^t, $$

where $N_t$ is the number of individuals at time $t$, $\lambda$ is the geometric growth rate, and $t$ is time.

Exponential growth allows simultaneous existence of multiple generations, and is computed as:

$$ \frac{dN}{dt} = r_{max} N, $$

where $r_{max}$ is the maximum intrinsic rate of increase.
where \( r_{max} \) is the maximum intrinsic rate of increase, i.e. \( \max(birth\ rate - death\ rate) \), and \( N \) is the population size. With logistic growth, exponential growth is slowed as \( N \) approaches the carrying capacity. It is computed as:

\[
\frac{dN}{dt} = r_{max}N \frac{K - N}{K},
\]

where \( r_{max} \) is the maximum rate of intrinsic increase, \( N \) is the population size, and \( K \) is the carrying capacity.

Package \texttt{tcltk} allows implementation of all three models using GUIs.

**Author(s)**

Ken Aho

**See Also**

\texttt{anm.LVexp, anm.LVcomp}

**Examples**

```r
## Not run:
anm.geo.growth(10, 2.4)

## End(Not run)
```

---

**Description**

Plots the normal, exponential, Poisson, binomial, and "custom" log-likelihood functions. By definition, likelihoods for parameter estimates are calculated by holding data constant and varying estimates. For the normal distribution a fixed value for the parameter which is not being estimated (\( \mu \) or \( \sigma^2 \)) is established using MLEs.

**Usage**

```r
anm.loglik(X, dist = c("norm", "poi", "bin", "exp", "custom"),
plot.likfunc = TRUE, parameter = NULL, func = NULL, poss = NULL,
plot.density = TRUE, plot.calc = FALSE, xlab = NULL, ylab = NULL,
conv = diff(range(X))/70, anim = TRUE, est.col = 2, density.leg = TRUE,
cex.leg = 0.9, interval = 0.01, ...)

loglik.norm.plot(X, parameter = c("mu", "sigma.sq"), poss = NULL,
plot.likfunc = TRUE, plot.density = TRUE, plot.calc = FALSE,
xlab = NULL, ylab = NULL, conv = 0.01, anim = TRUE, est.col = 2,
density.leg = TRUE, cex.leg = 0.9, interval = 0.01, ...)
```
Arguments

**X**  
A vector of quantitative data. The function does not currently handle extremely large datasets, \( n > 500 \). Data should be integers (counts) for the Poisson log-likelihood function, and binary responses (0,1) for the binomial log likelihood function. Data elements for the exponential log likelihood function must be greater than zero.

**parameter**  
The parameter for which ML estimation is desired in `loglik.norm.plot`. Specification of either "mu" or "sigma.sq" is required for the normal log-likelihood function. No specification is required for exponential, Poisson, and binomial log-likelihood functions since these distributions are generally specified with a single parameter, i.e., \( \theta \) for the exponential, \( \lambda \) for the Poisson distribution, and \( p \) (the probability of a success) for the binomial distribution.

**poss**  
An optional vector containing a sequence of possible parameter estimates. Elements in the vector must be distinct. If `poss` is not specified a vector of appropriate possibilities is provided by the function. This argument can be used to set `xlim` in the likelihood function and density plots.

**dist**  
The type of assumed distribution there are currently five possibilities: "norm", "poi", "binom", "exp", and "custom". Use of custom distributions requires specification of a custom likelihood function in the argument `func`.

**plot.likfunc**  
A logical command for indicating whether a graph of the log-likelihood function should be created.

**plot.density**  
A logical command for indicating whether a second graph, in which densities are plotted on the pdf, should be created.

**plot.calc**  
A logical command for indicating whether a third graph, in which log-densities are added to one another, should be created.

**xlab**  
Optional X-axis label.
ylab: Optional Y-axis label.

conv: Precision of likelihood function. Decreasing conv increases the smoothness and precision of the ML function. Decreasing conv will also slow the animation.

anim: A logical command indicating whether animation should be used in plots.

est.col: Color used in depicting estimation.

density.leg: Logical. Should the legend for density be shown?

cex.leg: Character expansion for legend.

interval: Speed of animation, in seconds per frame. May not work in all systems; see Sys.sleep.

func: Custom likelihood function to be specified when using loglik.custom.plot. The function should have two arguments. An optional call to data, and the likelihood function parameter (see example below).

... Additional arguments from plot can be specified for likelihood function plots.

Details

These plots are helpful in explaining the workings of ML estimation for parameters. Animation is included as an option to further clarify processes. When specifying poss be sure to include the estimate that you "want" the log-likelihood function to maximize in the vector of possibilities, e.g. mean(X) for estimation of \( \mu \).

Value

Three animated plots can be created simultaneously. The first plot shows the normal, Poisson, exponential, binomial, or custom log-likelihood functions. The second plot shows the pdf with ML estimates for parameters. On this graph densities of observations are plotted as pdf parameters are varied. By default these two graphs will be created simultaneously on a single graphics device. By specifying plot.calc = TRUE a third plot can also be created which shows that log-likelihood is the sum of the log-densities. Animation in this third plot will be automatically sped up, using a primitive routine, for large datasets, and slowed for small datasets. The third plot will not be created for the binomial pdf because there will only be a single outcome from the perspective of likelihood (e.g. 10 successes out of 22 trials). The second and third plots will not be created for custom likelihood functions. Loading package tcltk allows use of the function anm.loglik.tck which provides an interactive GUI to run anm.loglik.

Author(s)

Ken Aho

See Also

dnorm, dpois, dexp, dbinom
Examples

```
## Not run:
##Normal log likelihood estimation of mu.
X<-c(11.2,10.8,9.0,12.4,12.1,10.3,10.4,10.6,9.3,11.8)
anm.loglik(X,dist="norm",parameter="mu")

##Add a plot describing log-likelihood calculation.
anm.loglik(X,dist="norm",parameter="mu",plot.calc=TRUE)

##Normal log likelihood estimation of sigma squared.
X<-c(11.2,10.8,9.0,12.4,12.1,10.3,10.4,10.6,9.3,11.8)
anm.loglik(X,dist="norm",parameter="sigma.sq")

##Exponential log likelihood estimation of theta
X<-c(0.82,0.32,0.14,0.04,0.09,0.32,0.74,4.17,0.36,1.80,0.74,0.07,0.45,2.33,0.21,
0.79,0.29,0.75,3.45)
anm.loglik(X,dist="exp")

##Poisson log likelihood estimation of lambda.
X<-c(1,3,4,0,2,3,4,3,5)
anm.loglik(X,dist="pois")

##Binomial log likelihood estimation of p.
X<-c(1,1,0,0,0,1,0,0,0,0)#where 1 = a success
anm.loglik(X,dist="bin",interval=.2)

##Custom log-likelihood function
func<-function(X=NULL,theta)theta^5*(1-theta)^10
anm.loglik(X=NULL,func=func,dist="custom",poss=seq(0,1,0.01),
alpha="Possibilities",ylab="Log-likelihood")

##Interactive GUI, requires package 'tcltk'
anm.loglik.tck()

## End(Not run)
```

---

**Description**

Depicts the process of least squares estimation by plotting the least squares function with respect to a vector of estimate possibilities.

**Usage**

```
anm.ls(X, poss=NULL, parameter = "mu", est.lty = 2, est.col = 2,
```
conv=diff(range(X))/50, anim=TRUE, plot.lsfnc = TRUE, plot.res = TRUE,
interval=0.01, xlab=expression(paste("Estimates for ", italic(E), "("",italic(X),""), sep = "")),...

ann.ls.tck()

Arguments

X  A numeric vector containing sample data.
poss  An ordered numeric sequence of possible parameter estimates. Inclusion of the
      least squares estimate in the vector (e.g. \( \bar{X} \) for \( \mu \)) will cause the least squares
      function be minimized at this value.
parameter  Parameter to be estimated. Only estimation for \( E(X) \) is currently implemented.
      Note that if \( X \sim N(\mu, \sigma^2) \) then \( E(X) = \mu \).
est.lty  Line type to be used to indicate the least squares estimate.
est.col  Line color to be used to indicate the least squares estimate.
conv  Precision of LS function. Decreasing conv increases the smoothness and precision
      of the function.
anim  A logical command indicating whether animation should be used in plots.
plot.lsfnc  A logical command indicating whether the least-squares function should be plotted.
plot.res  A logical command indicating whether a plot of residuals should be created.
interval  Speed of animation (in frames per second). A smaller interval decreases speed.
      May not work in all systems; see Sys.sleep.
xlab  X-axis label.
...  Additional arguments to plot

Value

A plot of the least squares function is returned along with the least squares estimate for \( E(X) \) given
a set of possibilities. The function ann.ls.tck provides a GUI to run the function.

Author(s)

Ken Aho

See Also

loglik.plot

Examples

### Not run: X<-c(11.2,10.8,9.0,12.4,12.1,10.3,10.4,10.6,9.3,11.8)
ann.ls(X)
### End(Not run)
anm.ls.reg  Animated plot of the least squares function.

Description

Depicts the process of least squares estimation of simple linear regression parameters by plotting
the least squares function with respect to estimate possibilities for the intercept or slope.

Usage

anm.ls.reg(X, Y, parameter="slope", nmax=50, interval = 0.1, col = "red", ...)
anm.ls.reg.tck()

Arguments

X  A numeric vector containing explanatory data.
Y  A numeric vector containing response data.
parameter  Parameter to be estimated. Either "slope" or "intercept".
nmax  The number of parameter estimates to be depicted. The true LS estimate will
always be in the center of this sequence.
interval  Speed of animation (in frames per second). A smaller interval decreases speed.
May not work in all systems; see Sys.sleep.
col  Line color.
...  Additional arguments to plot

Value

An animated plot of the plot possible regression lines is created along with an animated plot of the
residual sum of squares. The function anm.ls.reg.tck provides a GUI to run the function.

Author(s)

Ken Aho

See Also

loglik.plot, anm.ls

Examples

## Not run:
X<-c(11.2,10.8,9.0,12.4,12.1,10.3,10.4,10.6,9.3,11.8)
Y<-log(X)
anm.ls.reg(X, Y, parameter = "slope")
## End(Not run)
Description

Creates animated plots of two famous abundance models from ecology; the Lotka-Volterra competition and exploitation models

Usage

```r
anm.LVcomp(n1, n2, r1, r2, K1, K2, a2.1, a1.2, time = seq(0, 200), ylab = "Abundance", xlab = "Time", interval = 0.1, ...)

anm.LVexp(nh, np, rh, con, p, d.p, time = seq(0, 200), ylab = "Abundance", xlab = "Time", interval = 0.1, circle = FALSE, ...)```

Arguments

- `n1`: Initial abundance values for species one. To be used in the competition function `anm.LVcomp`, i.e., $N_1$ in the competition equations below.
- `n2`: Initial abundance values for species two in the competition function, i.e., $N_2$ in the competition equations below.
- `r1`: Maximum intrinsic rate of increase for species one, i.e., $r_{max1}$.
- `r2`: Maximum intrinsic rate of increase for species two in the competition model `anm.LVcomp`, i.e., $r_{max2}$.
- `K1`: Carrying capacity for species one, i.e., $K_1$.
- `K2`: Carrying capacity for species two, i.e., $K_2$.
- `a2.1`: The interspecific effect of species one on species two, i.e., the term $\alpha_{21}$.
- `a1.2`: The interspecific effect of species two on species one, i.e., the term $\alpha_{12}$.
- `nh`: Initial abundance values for the host (prey) species. To be used in the the exploitation model `anm.LVexp`, i.e., the term $N_h$ at $t = 1$.
- `np`: Initial abundance values for the predator species in the the exploitation model, i.e., the term $N_p$ at $t = 1$.
- `rh`: The intrinsic rate of increase for the host (prey) species, i.e., the term $r_h$.
- `con`: The conversion rate of prey to predator, i.e., the term $c$.
- `p`: The predation rate, i.e., the term $p$.
- `d.p`: The death rate of predators, i.e., the term $d_p$.
- `time`: A time sequence for which competition or exploitation is to be evaluated.
The Lotka-Volterra competition and exploitation models require simultaneous solutions for two differential equations. These are solved using the function \texttt{rk4} from \texttt{odesolve}.

The interspecific competition model is based on:

\[
\begin{align*}
\frac{dN_1}{dt} &= r_{\text{max}1}N_1 \left( \frac{K_1 - N_1 - \alpha_{12}}{K_1} \right), \\
\frac{dN_2}{dt} &= r_{\text{max}2}N_2 \left( \frac{K_2 - N_2 - \alpha_{21}}{K_2} \right),
\end{align*}
\]

where \(N_1\) is the number of individuals from species one, \(K_1\) is the carrying capacity for species one, \(r_{\text{max}1}\) is the maximum intrinsic rate of increase of species one, and \(\alpha_{12}\) is the interspecific competitive effect of species two on species one.

The exploitation model is based on:

\[
\begin{align*}
\frac{dN_h}{dt} &= r_h N_h - p N_h N_p, \\
\frac{dN_p}{dt} &= c p N_h N_p - d_p N_p,
\end{align*}
\]

where \(N_h\) is the number of individuals from the host (prey) species, \(N_p\) is the number of individuals from the predator species, \(r_h\) is the intrinsic rate of increase for the host (prey) species, \(p\) is the rate of predation, \(c\) is a conversion factor which describes the rate at which prey are converted to new predators, and \(d_p\) is the death rate of the predators.

The term \(r_h N_h\) describes exponential growth for the host (prey) species. This will be opposed by deaths due to predation, i.e. the term \(p N_h N_p\). The term \(c p N_h N_p\) is the rate at which predators destroy prey. This in turn will be opposed by \(d_p N_p\), i.e. predator deaths. Loading package \texttt{tcltk} allows one to run the GUIs in \texttt{anm.LV} and \texttt{anm.LVc}.

**Value**

The functions return descriptive animated plots.

**Author(s)**

Ken Aho, based on a concept elucidated by M. Crawley.
References


Examples

```r
## Not run:

# ----------------------- Competition ----------------------#
#Species 2 drives species 1 to extinction
anm.LVcomp(n1=150,n2=50,r1=.7,r2=.8,K1=200,K2=1000,a2.1=.5,a1.2=.7,time=seq(0,200))
#Species coexist with numbers below carrying capacities
anm.LVcomp(n1=150,n2=50,r1=.7,r2=.8,K1=750,K2=1000,a2.1=.5,a1.2=.7,time=seq(0,200))

# ----------------------- Exploitation ----------------------#
#Fast cycles
anm.LVexp(nh=300,np=50, rh=.7, con=.4, p=.006, d=.2, time=seq(0,200))
## End(Not run)
```

---

**Description**

The algorithm can use three different variants on MCMC random walks: Gibbs sampling, the Metropolis algorithm, and the Metropolis-Hastings algorithms to move through univariate and bivariate normal probability space. The jumping distribution is also bivariate normal with a mean vector at the current bivariate coordinates. The jumping kernel modifies the jumping distribution through multiplying the variance covariance of this distribution by the specified constant.

**Usage**

```r
anm.mc.bvn(start = c(-4, -4), mu = c(0, 0), sigma = matrix(2, 2, data = c(1, 0, 0, 1)), length = 1000, sim = "M", jump.kernel = 0.2, xlim = c(-4, 4), ylim = c(-4, 4), interval = 0.01, show.leg = TRUE, cex.leg = 1, ...)

anm.mc.norm(start = -4, mu = 0, sigma = 1, length = 2000, sim = "M", jump.kernel = 0.2, xlim = c(-4, 4), ylim = c(0, 0.4), interval = 0.01, show.leg = TRUE, ...)

anm.mc.bvn.tck()
```

**Arguments**

- `start`: A two element vector specifying the bivariate starting coordinates.
- `mu`: A two element vector specifying the mean vector for the proposal distribution.
**Sigma**
A 2 x 2 matrix specifying the variance covariance matrix for the proposal distribution.

**Length**
The length of the MCMC chain.

**Sim**
Simulation method used. Must be one of "G" indicating Gibbs sampling, "M" indicating the Metropolis algorithm, or "MH" indicating the Metropolis-Hastings algorithm (Gibbs sampling is not implemented for `anm.mc.norm`).

**Jump.Kernel**
A number > 0 that will serve as a (squared) multiplier for the proposal variance covariance. The result of this multiplication will be used as the variance covariance matrix for the jumping distribution.

**Xlim**
A two element vector describing the upper and lower limits of the x-axis.

**Ylim**
A two element vector describing the upper and lower limits of the y-axis.

**Interval**
Animation interval

**Show.Leg**
Logical. Indicating whether or not the chain length should be shown.

**Cex.Leg**
Character expansion for legend.

**...**
Additional arguments from `plot`.

**Value**
The function returns two plots. These are: 1) the proposal bivariate normal distribution in which darker shading indicates higher density, and 2) an animated plot showing the MCMC algorithm walking through the probability space.

**Author(s)**
Ken Aho

**References**

---

**Description**
Animated Comparisons of outcomes from simple random sampling, stratified random sampling and cluster sampling.

**Usage**

```r
anm.samp.design(n=20, interval = 0.5 ,iter = 30, main = "", lwd = 2, lcol = 2)
samp.design(n = 20, main = "", lwd = 2, lcol = 2)
anm.samp.design.tck()
```
Arguments

- **n**: The number of samples to be randomly selected from a population of 400.
- **interval**: Time length spent on each frame in animation (in seconds).
- **iter**: Number of random iterations in animation.
- **main**: Main heading.
- **lwd**: Line width to distinguish strata in stratified and cluster designs.
- **lcol**: Line width to distinguish strata in stratified and cluster designs.

Details

Returns a plot comparing outcomes of random sampling, stratified random sampling and cluster sampling from a population of size 400. For stratified random sampling the population is subdivided into four equally strata of size 100, and n/4 samples are taken within each strata. For cluster sampling the population is subdivided into four equally sized clusters and a census is taken from two clusters (regardless of specification of n). The function `anmNsampNdesign` depicts random sampling using animation.

Value

A plot is returned with four subplots. (a) shows the population before sampling, (b) shows simple random sampling, (c) shows stratified random sampling, (d) shows cluster sampling. The function `anm.samp.design.tck` provides interaction with a `tcltk` GUI.

Author(s)

Ken Aho

Examples

```r
samp.design(20)

#Animated demonstration
## Not run: anm.samp.design(20)
```

anolis  

Anolis lizard contingency table data

Description

Schoener (1968) examined the resource partitioning of anolis lizards on the Caribbean island of South Bimini. He cross-classified lizard counts in habitats (branches in trees) with respect to three variables: lizard species *A. sargei* and *A. distichus*, branch height high and low, and branch size small and large.

Usage

data(anolis)
Format

A data frame with 8 observations on the following 4 variables.

height  Brach height. A factor with levels H, L.
size    Brach size. A factor with levels L, S.
species Anolis species. A factor with levels distichus, sagrei.
count   Count at the cross classification.

Source


---

**anscombe**  
*Anscombe's quartet*

Description

A set of four bivariate datasets with the same conditional means, conditional variances, linear regressions, and correlations, but with dramatically different forms of association.

Usage

data(anscombe)

Format

A data frame with 11 observations on the following 8 variables.

x1  The first conditional variable in the first bivariate dataset.
y1  The second conditional variable in the first bivariate dataset.
x2  The first conditional variable in the second bivariate dataset.
y2  The second conditional variable in the second bivariate dataset.
x3  The first conditional variable in the third bivariate dataset.
y3  The second conditional variable in the third bivariate dataset.
x4  The first conditional variable in the fourth bivariate dataset.
y4  The second conditional variable in the fourth bivariate dataset.

Details

Anscombe (1973) used these datasets to demonstrate that summary statistics are inadequate for describing association.
Ant honeydew data

Description
Wright et al. (2000) examined behavior of red wood ants (*Formica rufa*), a species that harvests honeydew in aphids. Worker ants traveled from their nests to nearby trees to forage honeydew from homopterans. Ants descending trees were laden with food and weighed more, given a particular ant head width, than unladen, ascending ants. The authors were interested in comparing regression parameters of the ascending and descending ants to create a predictive model of honeydew foraging load for a given ant size.

Usage
`data(ant.dew)`

Format
A data frame with 72 observations on the following 3 variables.

head.width Ant head width in mm

ant.mass Ant mass in mg
direction Direction of travel A = ascending, D = descending
Details

Data approximated from Fig. 1 in Wright et al. (2002)

Source


Table

| AP.test | Agresti-Pendergrast test |

Description

Provides a more powerful alternative to Friedman’s test for blocked (dependent) data with a single replicate.

Usage

AP.test(Y)

Arguments

Y A matrix with treatments in columns and blocks (e.g. subjects) in rows.

Details

The Agresti-Pendergrast test is more powerful than Friedman’s test, given normality, and remains powerful in heavier tailed distributions (Wilcox 2005).

Value

Returns a dataframe showing the numerator and denominator degrees of freedom, F test statistic, and p-value.

Note

code based on Wilcox (2005).

Author(s)

Ken Aho

References

See Also

friedman.test, MS.test

Examples

```r
temp <- c(2.58, 2.63, 2.62, 2.85, 3.01, 2.7, 2.83, 3.15, 3.43, 3.47, 2.78, 2.71, 3.02, 3.14, 3.35, 2.36, 2.49, 2.58, 2.86, 3.1, 2.67, 2.96, 3.08, 3.32, 3.41, 2.43, 2.5, 2.85, 3.06, 3.07)
Y <- matrix(nrow=6, ncol=5, data=temp, byrow=TRUE)
ap.test(Y)
```

Description

This dataset was used by Littell (2002) to demonstrate repeated measures analyses. The effect of two asthma drugs and a placebo were measured on 24 asthmatic patients. Each patient was randomly given each drug using an approach to minimize carry-over effects. Forced expiratory volume (FEV1), the volume of air that can be expired after taking a deep breath in one second, was measured. FEV1 was measured hourly for eight hours following application of the drug. A baseline measure of FEV1 was also taken 11 hours before application of the treatment.

Usage

```r
data(asthma)
```

Format

The dataframe has 11 columns:

- **PATIENT**: The subjects (there were 24 patients).
- **BASEFEV1**: A numerical variable; the baseline forced expiratory volume.
- **FEV11H**: Forced expiratory volume at 11 hours.
- **FEV12H**: Forced expiratory volume at 12 hours.
- **FEV13H**: Forced expiratory volume at 13 hours.
- **FEV14H**: Forced expiratory volume at 14 hours.
- **FEV15H**: Forced expiratory volume at 15 hours.
- **FEV16H**: Forced expiratory volume at 16 hours.
- **FEV17H**: Forced expiratory volume at 17 hours.
- **FEV18H**: Forced expiratory volume at 18 hours.
- **DRUG**: A factor with three levels "a" = a standard drug treatment, "c" = the drug under development, and "p" = a placebo.

Source

Area under a receiver operating characteristic (ROC) curve

Description

A simple algorithm for calculating AUC.

Usage

\[
\text{auc} \langle \text{obs, fit, plot = FALSE} \rangle
\]

Arguments

- **obs**: Dichotomous 0, 1 outcomes (i.e. response values for binomial GLM).
- **fit**: Fitted probabilities from some model.
- **plot**: Logical, indicating whether or not ROC curve plot should be created.

Author(s)

Ken Aho

References


Examples

```r
obs <- rbinom(30, 1, 0.5)
fit <- rbeta(30, 1, 2)
auc(obs, fit)
```

Baby walking times experimental data

Description

In general, mammals are able to walk within minutes or hours after birth. Human babies, however, generally don’t begin to walk until they are between 10 and 18 months of age. This occurs because, although humans are born with rudimentary reflexes for walking, they are unused, and thus largely disappear by the age of eight weeks. As a result these movements must be relearned by an infant following significant passage of time, through a process of trial and error. Zelazo et al. (1972) performed a series of experiments to determine whether certain exercises could allow infants to maintain their walking reflexes, and allow them to walk at an earlier age. Study subjects were 24 white male infants from middle class families, and were assigned to one of four exercise treatments.
Active exercise (AE): Parents were taught and were told to apply exercises that would strengthen the walking reflexes of their infant. Passive exercise (PE): Parents were taught and told to apply exercises unrelated to walking. Test-only (TO): The investigators did not specify any exercise, but visited and tested the walking reflexes of infants in weeks 1 through 8. Passive and active exercise infants were also tested in this way. Control (C): No exercises were specified, and infants were only tested at weeks one and eight. This group was established to account for the potential effect of the walking reflex tests themselves.

Usage
data(baby.walk)

Format
A data frame with 22 observations on the following 2 variables.
date Age when baby first started walking (in months)
treatment A factor with levels AE C PE TO

Source

References

Bat forearm length as a function of bat age

Description
Data from northern myotis bats (*Myotis septentrionalis*) captured in the field in Vermillion County Indiana in 2000.

Usage
data(bats)

Format
The dataframe has 2 columns:
days The age of the bats in days.
forearm.length The length of the forearm in millimeters.

Source
Bayes.disc

Bayesian graphical summaries for discrete or categorical data.

Description

An simple function for summarizing a Bayesian analysis given discrete or categorical variables and priors.

Usage

Bayes.disc(Likelihood, Prior, data.name = "data", plot = TRUE, c.data = seq(1, length(Prior)), ...)

Bayes.disc.tck()

Arguments

Likelihood A vector of sample distribution probabilities. This must be in the same order as Prior, i.e. if $\theta_1$ is the first element in Prior, then $data|\theta_1$ must be the first element in Data.

Prior A vector of prior probabilities, or weights.

data.name A name for data in conditional statements.

plot Logical, indicating whether a plot should be made.

c.data A character string of names for discrete classes

... Additional arguments to plot.

Author(s)

Ken Aho

bayes.lm

Bayesian linear models with uniform priors

Description

Gelman et al. (2002) describe general methods for Bayesian implementation of simple linear models (e.g. simple and multiple regression and fixed effect one way ANOVA) with standard non-informative priors uniform on $\alpha, \sigma^2$. The function is not yet suited for multifactor or multivariate (random effect) ANOVAs.

Usage

bayes.lm(Y, X, model = "anova", length = 1000, cred = 0.95)
Arguments

Y  An \( n \times 1 \) column vector (a matrix with one column) containing the response variable.

X  The \( n \times p \) design matrix

model One of "anova" or "reg". Parameter output labels are changed depending on choice.

length Number of draws for posterior.

cred  Level for credible interval.

Value

Provides the median and central credible intervals for model parameters.

Author(s)

Ken Aho

References


See Also

mcmc.norm.hier

Examples

```r
## Not run:
data(Fbird)
X <- with(Fbird, cbind(rep(1, 18), vol))
Y <- Fbird$freq
bayes.lm(Y, X, model = "reg")

## End(Not run)
```

Description

This dataset, lifted from vegan, contains tree counts in 1-hectare plots in Barro Colorado Island, Panama.

Usage

data(BCI.count)
**Format**

A data frame with 50 plots (rows) of 1 hectare with counts of trees on each plot with total of 225 species (columns). Full Latin names are used for tree species.

**Details**

Data give the numbers of trees at least 10 cm in diameter at breast height (1.3 m above the ground) in each one hectare square of forest. Within each one hectare square, all individuals of all species were tallied and are recorded in this table.

The data frame contains only the Barro Colorado Island subset of the original data.

The quadrats are located in a regular grid. See examples for the coordinates.

**Source**

[http://www.sciencemag.org/cgi/content/full/295/5555/666/DC1](http://www.sciencemag.org/cgi/content/full/295/5555/666/DC1). Documentation here follows directly from vegan.

**References**


---

**BCI.plant**

Tree presence/absence data from Barro Colorado island

**Description**

The presence of the tropical trees *Alchornea costaricensis* and *Anacardium excelsum* with diameter at breast height equal or larger than 10 cm were recorded on along with environmental factors at Barro Colorado Island in Panama (Kindt and Coe 2005). These data were originally from (Pyke et al. 2001).

**Usage**

data(BCI.plant)

**Format**

A data frame with 43 observations on the following 9 variables.

- **UTM.E**: UTM easting.
- **UTM.N**: UTM northing.
precip  Precipitation in mm/year.
elev   Elevation in m above sea level.
age   A categorical vector describing age.
geology A factor describing geology with levels pT Tb Tbo Tc Tcm Tct Tgo Tl Tcl.
Alchornea.costaricensis  Plant presence/absence.
Anacardium.excelsum  Plant presence/absence.

Source

http://www.sciencemag.org/cgi/content/full/295/5555/666/DC1

References


---

**BDM.test**  
*Brunner-Dette-Munk test*

**Description**

One and two way heteroscedastic rank-based permutation tests. Two way designs are assumed to be factorial, i.e., interactions are tested.

**Usage**

BDM.test(Y, X)

BDM.2way(Y, X1, X2)

**Arguments**

- **Y**  
  Vector of response data. A quantitative vector
- **X**  
  A vector of factor levels for a one-way analysis. To be used with BDM.test
- **X1**  
  A vector of factor levels for the first factor in a two-way factorial design. To be used with BDM.2way.
- **X2**  
  A vector of factor levels for the second factor in a two-way factorial design. To be used with BDM.2way.
Details

A problem with the Kruskal-Wallis test is that, while it does not assume normality for groups, it still assumes homoscedasticity (i.e. the groups have the same distributional shape). As a solution Brunner et al. (1997) proposed a heteroscedastic version of the Kruskal-Wallis test which utilizes the $F$-distribution. Along with being robust to non-normality and heteroscedasticity, calculations of exact $P$-values using the Brunner-Dette-Munk method are not made more complex by tied values. This is another obvious advantage over the traditional Kruskal-Wallis approach.

Value

Returns a list with two components

\[
Q \quad \text{The "relative effects" for each group.}
\]

Table \quad \text{An ANOVA type table with hypothesis test results.}

Note

Code based on Wilcox (2005)

Author(s)

Ken Aho

References


See Also

kruskal.test, trim.test

Examples

\[
\begin{align*}
\text{rye} & \leftarrow \text{c}(50,49.8,52.3,44.5,62.3,74.8,72.5,80.2,47.6,39.5,47.7,50.7) \\
\text{nutrient} & \leftarrow \text{factor(c(rep(1,4),rep(2,4),rep(3,4))))} \\
\text{BDM.test(Y=rye,X=nutrient)}
\end{align*}
\]
bears 

Grizzly bear litter sizes

Description

Counts of grizzly bear (Ursus arctos) litter sizes from the Greater Yellowstone Ecosystem from 1973-2010.

Usage
data(bear)

Format

A data frame with 38 observations on the following 5 variables.

Year Year.
X1.cub The number of litters with one cub.
X2.cub The number of litters with two cubs.
X3.cub The number of litters with three cubs.
X4.cub The number of litters with four cubs.

Source


beetle

Wood boring beetle data.

Description

Saint Germain et al. (2007) modeled the presence absence of a saprophytic wood boring beetle (Anthophylax attenuatus) as a function of the wood density of twenty-four decaying aspen trees (Populus tremuloides) in Western Quebec Canada.

Usage
data(beetle)
**Format**

A data frame with 24 observations on the following 4 variables.

- **Snag**  Snag identifier
- **Yrs.since.death**  The number of years since death, determined using dendrochronological methods.
- **Wood.density**  The density of the decaying wood (dry weight/volume) in units of g cm\(^{-3}\).
- **ANAT**  Beetle presence/absence (1/0)

**Source**


---

**bin2dec**  
*Conversion of binary digits to decimal numbers*

**Description**

Converts binary representations to digital numbers (e.g., 10101011 = 171). Fractions, (e.g., 0.11101) will be evaluated to the number of bits provided. The function will handle whole number and fractions, but not whole numbers with fractional parts, (e.g., 111.100110).

**Usage**

```
bin2dec(digits, round = 4)
```

**Arguments**

- **digits**  A string of binary digits.
- **round**  Rounding for fractional results, defaults to 4.

**Author(s)**

Ken Aho

**Examples**

```
bin2dec(1011001101) # 717
```
Bone development data

Description

Neter et al. (1996) described an experiment in which researchers investigated the confounding effect of gender and bone development on growth hormone therapy for prepubescent children. Gender had two levels: "M" and "F". The bone development factor had three levels indicating the severity of growth impediment before therapy: 1 = severely depressed, 2 = moderately depressed, and 3 = mildly depressed. At the start of the experiment 3 children were assigned to each of the six treatment combinations. However 4 of the children were unable to complete the experiment, resulting in an unbalanced design.

Usage

data(bone)
Format

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

- **gender**: A factor with levels F M
- **devel**: A factor with levels 1 2 3
- **growth**: A numeric vector describing the growth difference before and after hormone therapy

Source


Description

Provides a pulldown GUI menus to allow access to `asbio` statistical and biological graphical demos, e.g. `anm.ci, samp.dist, anm.loglik`, etc. The function demos is deprecated. The function `book.menu` currently provides links to over 100 distinct GUIs (many of these are slaves to other GUIs), which in turn provide distinct graphical demonstrations. The GUIs work best with an SDI R interface.

Usage

`book.menu()`

Author(s)

Ken Aho and Roy Hill (Roy created the `book.menu` GUI)

See Also

`anm.coin, anm.ci, anm.die, anm.exp.growth, anm.geo.growth, anm.log.growth, anm.loglik, anm.LVcomp, anm.LVexp, anm.ls, anm.ls.reg, anm.transM, see.lmu.tck, samp.dist, see.HW, see.logic, see.M, see.move, see.nlm, see.norm.tck, see.power, see.regression.tck, see.typeI_II, selftest.se.tck, shade.norm, Venn`

Examples

```r
## Not run:
book.menu()
```

## End(Not run)
boot.ci.M

*Bootstrap CI of M-estimators differences of two samples*

**Description**

Creates a bootstrap confidence interval for location differences for two samples. The default location estimator is the Huber one-step estimator, although any estimator can be used. The function is based on a function written by Wilcox (2005). Note, importantly, that *P*-values may be in conflict with the confidence interval bounds.

**Usage**

```r
boot.ci.M(X1, X2, alpha = 0.05, est = huber.one.step, R = 1000)
```

**Arguments**

- `X1`: Sample from population one.
- `X2`: Sample from population two.
- `alpha`: Significance level.
- `est`: Location estimator; default is the Huber one step estimator.
- `R`: Number of bootstrap samples.

**Value**

Returns a list with one component, a dataframe containing summary information from the analysis:

- `R.used`: The number of bootstrap samples used. This may not = *R* if NAs occur because *MAD* = 0.
- `ci.type`: The method used to construct the confidence interval.
- `conf`: The level of confidence used.
- `se`: The bootstrap distribution of differences standard error.
- `original`: The original, observed difference.
- `lower`: Lower confidence bound.
- `upper`: Upper confidence bound.

**Author(s)**

Ken Aho and R. R. Wilcox from whom I stole liberally from code in the function m2ci on R-forge

**References**


**bootstrap**

**See Also**

`bootstrap, ci.boot`

**Examples**

```r
### Not run:
x1 <- rnorm(100, 2, 2.5)
x2 <- rnorm(100, 3, 3)
boot.ci::M(x1, x2)

### End(Not run)
```

---

**bootstrap**  
*A simple function for bootstrapping*

**Description**

The function serves as a simplified alternative to the function `boot` from the library `boot`.

**Usage**

```r
bootstrap(data, statistic, R = 1000, prob = NULL, matrix = FALSE)
```

**Arguments**

- **data**: Raw data to be bootstrapped. A vector or quantitative data or a matrix if `matrix = TRUE`.
- **statistic**: A function whose output is a statistic (e.g. a sample mean). The function must have only one argument, a call to data.
- **R**: The number of bootstrap iterations.
- **prob**: A vector of probability weights for parametric bootstrapping.
- **matrix**: A logical statement. If `matrix = TRUE` then rows in the matrix are sampled as multivariate observations.

**Details**

With bootstrapping we sample with replacement from a dataset of size `n` with `n` samples `R` times. At each of the `R` iterations a statistical summary can be created resulting in a bootstrap distribution of statistics.

**Value**

Returns a list. The utility function `asbio::print.bootstrap` returns summary output. Invisible items include the resampling distribution of the statistic, the data, the statistic, and the bootstrap samples.
bound.angle

Author(s)

Ken Aho

References


See Also

boot, ci.boot

Examples

data(vs)
# A partial set of observations from a single plot for a Scandinavian
# moss/vascular plant/lichen survey.
site18<-t(vs[1,])

# Shannon-Weiner diversity
SW<-function(data){
d<-data[data!=0]
p<-d/sum(d)
-1*sum(p*log(p))
}

bootstrap(site18[,1],SW,R=1000,matrix=FALSE)

bound.angle Angle of azimuth to a boundary.

Description

The function calculates the angle of azimuth from a Cartesian coordination given in X and Y to a nearest neighbor coordinate given by nX and nY. The nearest neighbor coordinates can be obtained using the function near.bound.

Usage

bound.angle(X, Y, nX, nY)

Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>Cartesian X coordinate of interest.</td>
</tr>
<tr>
<td>Y</td>
<td>Cartesian Y coordinate of interest.</td>
</tr>
<tr>
<td>nX</td>
<td>Cartesian X coordinate of nearest neighbor point on a boundary.</td>
</tr>
<tr>
<td>nY</td>
<td>Cartesian Y coordinate of nearest neighbor point on a boundary.</td>
</tr>
</tbody>
</table>
**Details**

The function returns the nearest neighbor angles (in degrees) with respect to a four coordinate system ala ARC-GIS Near(Analysis). Output angles range from $-180^\circ$ to $180^\circ$: $0^\circ$ to the East, $90^\circ$ to the North, $180^\circ$ (or $-180^\circ$) to the West, and $-90^\circ$ to the South.

**Value**

Returns a vector of nearest neighbor angles.

**Author(s)**

Ken Aho

**See Also**

near.bound, prp

**Examples**

```r
bx<-seq(0,49)/46
by<-c(4.89000,4.88200,4.87400,4.87300,4.88000,4.87900,4.87900,4.90100,4.90800,
4.91000,4.93300,4.94000,4.91100,4.90000,4.91700,4.93000,4.93500,4.93700,
4.93300,4.94500,4.95900,4.95400,4.95100,4.95800,4.95810,4.95811,4.95810,
4.96100,4.96200,4.96300,4.96500,4.96600,4.96700,4.96540,4.96400,
4.97600,4.97900,4.98000,4.98800,4.98100,4.97900,4.98000,4.97800,4.97600,
4.97700,4.97400,4.97300,4.97100,4.97000)
X<-c(0.004166667,0.108333333,0.316666667,0.525000000,0.483333333,0.608333333,
0.662500000,0.683333333,0.900000000,1.070833333)
Y<-c(4.67,4.25,4.26,4.50,4.90,4.10,4.70,4.40,4.20,4.30)
nn<-near.bound(X,Y,bx,by)
bound.angle(X,Y,nn[,1],nn[,2])
```
Usage

bplot(y, x, bar.col = "gray", loc.meas = mean, sort = FALSE, order = NULL, int = "SE",
conf = 0.95, uiw = NULL, liw = NULL, sfrac = 0.1, slty = 1, scol = 1,
slwd = 1, exp.fact = 1.5, simlett = FALSE, lett.side = 3, lett = NULL,
cex.lett = 1, names.arg = NULL, ylim = NULL, horiz = FALSE, xpd = FALSE,
print.summary = TRUE, ...)

Arguments

y
A quantitative vector representing the response variable.
x
A categorical vector representing treatments (e.g. factor levels).
bar.col
Color of bar.
loc.meas
Measure of location or other summary statistic, e.g. mean, median, etc.
sort
Logical, if TRUE, then treatments are ordered by their location statistics.
order
A vector of length equal to the number of factor levels, specifying the order of
bars with respect to the alphanumeric order of their names.
int
Type of error bar to be drawn, must be one of "SE", "CI", "IQR", "MAD", "IQR.CI"
or "bootSE". IQR-derived confidence intervals are based on $\pm 1.58IQR/\sqrt{n}$
and provide an approximate 95% confidence interval for the difference in two
medians. The measure can be attributed to Chambers et al. (1983, p. 62), given
McGill et al. (1978, p. 16). It is based on asymptotic normality of the median
and assumes roughly equal sample sizes for the two medians being compared.
The interval is apparently insensitive to the underlying distributions of the sam-
ples. The specification "bootSE" gives bootstrap SEs for the location measure
using the function bootstrap

conf
Level of confidence, 1 - P(type I error).
uiw
Upper y-coordinate for the error bar, if NULL then this will be computed from
int.
liw
Lower y-coordinate for the error bar, if NULL then this will be computed from
int.
sfrac
Scaling factor for the size of the "serifs" (end bars) on the confidence bars, in
x-axis units.
slty
Line type for error bars.
scol
Line color for error bars.
slwd
Line width for error bars.
exp.fact
A multiplication factor indicating how much extra room is made for drawing
letters in top of graph. Only used if simlett = TRUE.
simlett
A logical statement indicating whether or not letters should be shown above
bars indicating that populations means have been determined to be significantly
different.
lett.side
Side that letters will be drawn on, 1 = bottom, 2 = left, 3 = top, 4 = right.
lett
A vector of letters or some other code to display multiple comparison results.
cex.lett
Character expansion for multiple comparison result letters.
names.arg  A vector of names to be plotted below each bar or error bar. If this argument is omitted, then the names are taken from the names attribute of y.

ylim  Upper and lower limits of the Y-axis

horiz  Logical value. If FALSE, then bars are drawn vertically with the first bar to the left. If TRUE, then bars are drawn horizontally with the first at the bottom.

xpd  Logical value. If FALSE, this overrides barplot designation xpd = TRUE, which may cause bars to extend off the plot if ylim is modified.

print.summary  Logical value. If TRUE a summary of the location and dispersion measures used in the plot is printed.

Additional arguments from barplot.

Details

It is often desirable to display the results of a pairwise comparison procedure using sample measures of location and error bars. This functions allows these sorts of plots to be made. The function is essentially a wrapper for the function barplot.

Value

A plot is returned.

Author(s)

Ken Aho

References


See Also

mad, barplot, pairw.anova, pairw.kw, pairw.fried

Examples

eggs<-c(11,17,16,14,15,12,10,15,19,11,23,20,18,17,27,33,22,26,28)
trt<-c(1,1,1,1,1,1,2,2,2,2,3,3,3,3,4,4,4,4,4)
bplot(y=eggs, x=factor(trt),int="SE",xlab="Treatment",ylab="Mean number of eggs", simlett=TRUE, lett=c("b","b","b","a"))
Description
Cheatgrass (*Bromus tectorum*) is an introduced annual graminoid that has invaded vast areas of sagebrush steppe in the intermountain west. Because it completes its vegetative growth stage relatively early in the summer, it leaves behind senescent biomass that burns easily. As a result areas with cheatgrass often experience a greater frequency of summer fires. A number of dominant shrub species in sagebrush steppe are poorly adapted to fire. As a result, frequent fires can change a community formerly dominated by shrubs to one dominated by cheatgrass. Nitrogen can also have a strong net positive effect on the cheatgrass biomass. A study was conducted at the Barton Road Long Term Experimental Research site (LTER) in Pocatello Idaho to simultaneously examine the effect of shrub removal and nitrogen addition on graminoid productivity.

Usage
data(bromus)

Format
The dataframe has 3 columns:

- **Plot** Plot number.
- **Biomass** Grass biomass in grams per meter squared.
- **Trt** Treatment. C = Control, LN = Low nitrogen, HN = High Nitrogen, SR = Shrub removal.

Description
Creates diagnostic bivariate quelplot ellipses (bivariate boxplots) using the method of Goldberg and Iglewicz (1992). The output can be used to check assumptions of bivariate normality and to identify multivariate outliers. The default robust=TRUE option relies on on a biweight correlation estimator function written by Everitt (2006). Quelplots, are potentially asymmetric, although the method currently employed here uses a single "fence" definition and creates symmetric ellipses.

Usage

```r
bv.boxplot(X, Y, robust = TRUE, D = 7, xlab = "X", ylab="Y", pch = 21,
pch.out = NULL, bg = "gray", bg.out = NULL, hinge.col = 1, fence.col = 1,
hinge.lty = 2, fence.lty = 3, xlim = NULL, ylim = NULL, names = 1:length(X),
ID.out = FALSE, cex.ID.out = 0.7, uni.CI = FALSE, uni.conf = 0.95,
uni.CI.col = 1, uni.CI.lty = 1, uni.CI.lwd = 2, show.points = TRUE, ...)
```
Arguments

- **x**: First of two quantitative variables making up the bivariate distribution.
- **y**: Second of two quantitative variables making up the bivariate distribution.
- **robust**: Logical. Robust estimators, i.e. robust = TRUE are recommended.
- **D**: The default D = 7 lets the fence be equal to a 99 percent confidence interval for an individual observation.
- **xlab**: Caption for X axis.
- **ylab**: Caption for Y axis.
- **pch**: Plotting character(s) for scatterplot.
- **pch.out**: Plotting character for outliers.
- **hinge.col**: Hinge color.
- **fence.col**: Fence color.
- **hinge.lty**: Hinge line type.
- **fence.lty**: Fence line type.
- **xlim**: A two element vector defining the X-limits of the plot.
- **ylim**: The Y-limits of the plot.
- **bg**: Background color for points in scatterplot, defaults to black if pch is not in the range 21:26.
- **bg.out**: Background color for outlying points in scatterplot, defaults to black if pch is not in the range 21:26.
- **names**: An optional vector of names for X, Y coordinates.
- **id.out**: Logical. Whether or not outlying points should be given labels (from argument name in plot.
- **cex.id.out**: Character expansion for outlying ID labels.
- **uni.CI**: Logical. If true, univariate confidence intervals for the true median at confidence uni.CI are shown.
- **uni.conf**: Univariate confidence, only used if CI.uni = TRUE.
- **uni.CI.col**: Univariate confidence bound line color, only used if CI.uni = TRUE.
- **uni.CI.lty**: Univariate confidence bound line type, only used if CI.uni = TRUE.
- **uni.CI.lwd**: Univariate confidence bound line width, only used if CI.uni = TRUE.
- **show.points**: Logical. Whether points should be shown in graph.
- **...**: Additional arguments from points.

Details

Two ellipses are drawn. The inner is the "hinge" which contains 50 percent of the data. The outer is the "fence". Observations outside of the "fence" constitute possible troublesome outliers. The function bivariate from Everitt (2004) is used to calculate robust biweight measures of correlation, scale, and location if robust = TRUE (the default). We have the following form to the quelplot model:
\[ E_i = \sqrt{\frac{X_{si}^2 + Y_{si}^2 - 2R^*X_iY_i}{1 - R^*}}. \]

where \( X_{si} = (X_i - T_X^*)/S_X^* \) and \( Y_{si} = (Y_i - T_Y^*)/S_Y^* \) are standardized values for \( X_i \) and \( Y_i \), respectively. \( T_X^* \) and \( T_Y^* \) are location estimators for \( X \) and \( Y \), \( S_X^* \) and \( S_Y^* \) are scale estimators for \( X \) and \( Y \), and \( R^* \) is a correlation estimator for \( X \) and \( Y \). We have:

\[ E_m = \text{median}\{E_i : i = 1, 2, ..., n\}, \]

and

\[ E_{max} = \text{max}\{E_i : E_i^2 < DE_m^2\}, \]

where \( D \) is a constant that regulates the distance of the "fence" and "hinge".

To draw the "hinge" we have:

\[ R_1 = E_m \sqrt{\frac{1 + R^*}{2}}, \]
\[ R_2 = E_m \sqrt{\frac{1 - R^*}{2}}. \]

To draw the "fence" we have:

\[ R_1 = E_{max} \sqrt{\frac{1 + R^*}{2}}, \]
\[ R_2 = E_{max} \sqrt{\frac{1 - R^*}{2}}. \]

For \( \theta = 0 \) to 360, let:

\[ \Theta_1 = R_1 \cos(\theta), \]
\[ \Theta_2 = R_2 \sin(\theta). \]

The Cartesian coordinates of the "hinge" and "fence" are:

\[ X = T_X^* = (\Theta_1 + \Theta_2)S_X^*, \]
\[ Y = T_Y^* = (\Theta_1 - \Theta_2)S_Y^*. \]

Quelplots, are potentially asymmetric, although the current (and only) method used here defines a single value for \( E_{max} \) and hence creates symmetric ellipses. Under this implementation at least one point will define \( E_{max} \), and lie on the "fence".

**Value**

A diagnostic plot is returned. Invisible objects from the function include location, scale and correlation estimates for \( X \) and \( Y \), estimates for \( E_m \) and \( E_{max} \), and a list of outliers (that exceed \( E_{max} \)).
Author(s)

Ken Aho, the function relies on an Everitt (2006) function for robust M-estimation.

References


See Also

boxplot

Examples

Y1<-rnorm(100, 17, 3)
Y2<-rnorm(100, 13, 2)
bv.boxplot(Y1, Y2)

X <- c(-0.24, 2.53, -0.3, -0.26, 0.021, 0.81, -0.85, -0.95, 1.0, 0.89, 0.59,
0.61, -1.79, 0.60, -0.05, 0.39, -0.94, -0.89, -0.37, 0.18)
Y <- c(-0.83, -1.44, 0.33, -0.41, -1.0, 0.53, -0.72, 0.33, 0.27, -0.99, 0.15,
-1.17, -0.61, 0.37, -0.96, 0.21, -1.29, 1.40, -0.21, 0.39)
b <- bv.boxplot(X, Y, ID.out = TRUE, bg.out = "red")
b

bvn.plot

Make plots of bivariate normal distributions

Description

The function uses functions from lattice and mvtnorm to make wireframe plots of bivariate normal distributions. Remember that the covariance must be less than the product of the marginal standard deviations (square roots of the diagonal elements).

Usage

bvn.plot(mu = c(0, 0), cv = 0, vr = c(1, 1), res = 0.3, xlab = expression(y[1]),
ylab = expression(y[2]), zlab = expression(paste("f", y[1], ",", y[2], "))), ...)

Arguments

mu  A vector containing the joint distribution means.
cv  A number, indicating the covariance of the two variables.
vr  The diagonal elements in the variance covariance matrix.
res  Plot resolution. Smaller values create a more detailed wireframe plot.
xlab  X-axis label.
ylab \ Y-axis label.

zlab \ Z-axis label.

... \ Additional arguments from wireframe.

Author(s)

Ken Aho

C.isotope \ Atmospheric carbon and $D^{14}C$ measurements

Description

Atmospheric $\delta^{14}C$ (per mille) and CO$_2$ (ppm) measurements for La Jolla Pier, California. Latitude: 32.9 Degrees N, Longitude: 117.3 Degrees W. Elevation: 10m; $\delta^{14}C$ derived from flask air samples

Usage

data(C.isotope)

Format

A data frame with 280 observations on the following 5 variables.

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<th>01-Jul-93</th>
<th>02-Feb-96</th>
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<td>26-Jan-05</td>
<td>26-Jan-05</td>
</tr>
</tbody>
</table>
caribou

31-Oct-91  31-Oct-93

Decimal1.date  A numeric vector
CO2  CO2 concentration (in ppm)
D14C  δ 14C (in per mille)
D14C.uncertainty  measurement uncertainty for D14C(in per mille)

Source

H. D. Graven, R. F. Keeling, A. F. Bollenbacher Scripps CO2 Program (http://scrippsc02.ucsd.edu) Scripps Institution of Oceanography (SIO) University of California La Jolla, California USA 92093-0244

and

T. P. Guilderson Center for Accelerator Mass Spectrometry (CAMS) Lawrence Livermore National Laboratory (LLNL) Livermore, California USA 94550

References


caribou  Caribou count data

Description

Stratified random sampling was used to estimate the size of the Nelchina herd of Alaskan caribou (*Rangifer tarandus*) in February 1962 (Siniff and Skoog 1964). The total population of sample units (for which responses would be counts of caribou) consisted of 699 four mile² areas. This population was divided into six strata, and each of these was randomly sampled.

Usage

data(caribou)

Format

A data frame with 6 observations on the following 5 variables.

stratum  Strata; a factor with levels A B C D E F
N.h  Strata population size
n.h  Strata sample size
x.bar.h  Strata means
var.h  Strata variances
Source


---

case0902  Dataset of mammal traits from Ramsey and Schaefer (1997)

Description

These data were used by Ramsey and Schaefer (1997) to demonstrate multiple regression. The dataset was originally collected by Sacher and Stafeldt (1974) and provided (for varying sample sizes) average values of brain weight, body weight, gestation period and litter size for 96 placental mammal species.

Usage

data("case0902")

Format

A data frame with 96 observations on the following 5 variables.

- `xs` A factor defining common names for mammal species under examination.
- `y` Brain weight (in grams).
- `xb` Body weight (in kilograms).
- `xg` Gestation period length (in days).
- `xl` Litter size.

Source


References


Examples

data(case0902)
Description

Ramsey and Schafer (1997) used this dataset to illustrate considerations in model selection. The data describe attributes of 61 female and 32 male clerical employees hired between 1965 and 1975 by a bank sued for sexual harassment.

Usage

data("case1202")

Format

A data frame with 93 observations on the following 7 variables.

Yhire  Annual salary upon hire (US dollars).
Y77   Annual salary in 1977 (US dollars).
Xsex  Sex; a factor with the levels FEMALE and MALE.
Xsen  Seniority (months since first hired).
Xage  Age (in months).
Xed   Education (in years).
Xexp  Experience previous to being hired by the bank (in months).

Source


Examples

data(case1202)
chi.plot

Chi plots for diagnosing multivariate independence.

Description

Chi-plots (Fisher and Switzer 1983, 2001) provide a method to diagnose multivariate non-independence among Y variables.

Usage

chi.plot(Y1, Y2, ...)

Arguments

Y1 A Y variable of interest. Must be quantitative vector.
Y2 A second Y variable of interest. Must also be a quantitative vector.
... Additional arguments from plot.

Details

The method relies on calculating all possible pairwise differences within y1 and within y2. Let pairwise differences associated with the first observation in y1 that are greater than zero be transformed to ones and all other differences be zeros. Take the sum of the transformed values, and let this sum divided by (1 - n) be be the first element in the 1 x n vector z. Find the rest of the elements (2,...,n) in z using the same process.

Perform the same transformation for the pairwise differences associated with the first observation in y2. Let pairwise differences associated with the first observation in y2 that are greater than zero be transformed to ones and all other differences be zeros. Take the sum of the transformed values, and let this sum divided by (1 - n) be be the first element in the 1 x n vector g. Find the rest of the elements (2,...,n) in g using the same process.

Let pairwise differences associated with the first observation in y1 and the first observation in y2 that are both greater than zero be transformed to ones and all other differences be zeros. Take the sum of the transformed values, and let this sum divided by (1 - n) be be the first element in the 1 x n vector h. Find the rest of the elements (2,...,n) in h using the same process. We let:

\[ S = \text{sign}((z - 0.5)(g - 0.5)) \]
\[ \chi = (h - z \times g) / \sqrt{z \times (1 - z) \times g \times (1 - g)} \]
\[ \lambda = 4 \times S \times \max[(z - 0.5)^2, (g - 0.5)^2] \]

We plot the resulting paired \( \chi \) and \( \lambda \) values for values of \( \lambda \) less than \( 4(1/(n - 1) - 0.5)^2 \). Values outside of \( \frac{1.78}{\sqrt{n}} \) can be considered non-independent.

Value

Returns a chi-plot.
Author(s)

Ken Aho and Tom Taverner (Tom provided modified original code to eliminate looping)

References


See Also

* bv.boxplot

Examples

```r
Y1<-rnorm(100, 15, 2)
Y2<-rnorm(100, 18, 3.2)
chi.plot(Y1, Y2)
```

**chronic**

*Chronic ailment counts for urban and rural women in Australia*

Description

Brown et al (1996) showed that Australian women who live in rural areas tended to have fewer visits with general practitioners. It was not clear from this data, however, whether this was because they were healthier or because of other factors (e.g. shortage of doctors, higher costs of visits, longer distances to travel for visits, etc.). To address this Dobson issue (2001) compiled data describing the number of chronic medical conditions for women visiting general practitioners in New South Wales. Women were divided into two groups; those from rural areas, and those from urban areas. All of the women were age 70-75, had the same socioeconomic status and reported to general practitioners three or fewer times in 1996. The question of central interest was: "do women who have the same level of general practitioner visits have the same medical need?"

Usage

```r
data(chronic)
```

Format

A data frame with 49 observations on the following 4 variables.

subject  The subject number.

count  The number of chronic conditions in a subject.

setting  a factor with levels RURAL URBAN.
Source


References


ci.boot

**Bootstrap confidence intervals**

Description

Bootstrap confidence intervals for the output of function `bootstrap`. Up to five different interval estimation methods can be called simultaneously: the normal approximation, the basic bootstrap, the percentile method, the bias corrected and accelerated method (BCa), and the studentized bootstrap method.

Usage

```r
ci.boot(x, method = "all", sigma.t = NULL, conf = 0.95)
```

Arguments

- `x` For `ci.boot` the list output from `bootstrap`.
- `method` CI interval method to be used. One of "all", "norm", "basic", "perc", "BCa", or "student". Partial matches are allowed.
- `sigma.t` Vector of standard errors in association with studentized intervals.
- `conf` Confidence level; 1 - P(Type I error).

Author(s)

Ken Aho

References


See Also

`boot`, `bootstrap`
Examples

data(vs)
# A partial set of observations from a single plot for a Scandinavian
# moss/vascular plant/lichen survey.
site18<-t(vs[,1])

# Shannon-Weiner diversity
SW<-function(data){
d<-data[data!=0]
p<-d/sum(d)
-1*sum(p*log(p))
}

b <- bootstrap(site18[,1],SW)
ci.boot(b)

---

ci.impt  

*Confidence interval for the product of two proportions*

Description

Provides one and two-tailed confidence intervals for the true product of two proportions.

Usage

ci.impt(y1, n1, y2 = NULL, n2 = NULL, avail.known = FALSE, pi.2 = NULL, conf = .95, x100 = TRUE, alternative = "two.sided", bonf = TRUE, wald = FALSE)

Arguments

- **y1**: The number of successes associated with the first proportion.
- **n1**: The number of trials associated with the first proportion.
- **y2**: The number of successes associated with the second proportion. Not used if avail.known = TRUE.
- **n2**: The number of trials associated with the first proportion. Not used if avail.known = TRUE.
- **avail.known**: Logical. Are the proportions π2i known? If avail.known = TRUE these proportions should specified in the pi.2 argument.
- **pi.2**: Proportions for π2i. Required if avail.known = TRUE.
- **conf**: Confidence level, i.e., 1 - α.
- **x100**: Logical. If true, estimate is multiplied by 100.
alternative

One of "two.sided", "less", "greater". Allows lower, upper, and two-tailed confidence intervals. If alternative = "two.sided" (the default), then a conventional two-sided confidence interval is given. The specifications alternative = "less" and alternative = "greater" provide lower and upper tailed CIs, respectively.

bonf

Logical. If bonf = TRUE, and the number of requested intervals is greater than one, then Bonferroni-adjusted intervals are returned.

wald

Logical. If avail.known = TRUE one can apply one of two standard error estimators. The default is a delta-derived estimator. If wald = TRUE is specified a modified Wald standard error estimator is used.

Details

Let \( Y_1 \) and \( Y_2 \) be multinomial random variables with parameters \( n_1, \pi_1 ; \) and \( n_2, \pi_2 ; \) respectively; where \( i = 1,2,\ldots,r \). Under delta derivation, the log of the products of \( \pi_1 \) and \( \pi_2 \) (or the log of a product of \( \pi_1 \) and \( \pi_2 \) and a constant) is asymptotically normal with mean \( \log(\pi_1 \times \pi_2) \) and variance \( (1 - \pi_1)/\pi_1 n_1 + (1 - \pi_2)/\pi_2 n_2 \). Thus, an asymptotic \((1 - \alpha)\)100 percent confidence interval for \( \pi_1 \times \pi_2 \) is given by:

\[
\hat{\pi}_1 \times \hat{\pi}_2 \times \exp(\pm z_{1-(\alpha/2)} \hat{\sigma}_1)
\]

where: \( \hat{\sigma}_1^2 = (1 - \hat{\pi}_1)/\pi_1 n_1 + (1 - \hat{\pi}_2)/\pi_2 n_2 \) and \( z_{1-(\alpha/2)} \) is the standard normal inverse CDF at probability \( 1 - \alpha \).

Value

Returns a list of class = "ci". Printed results are the parameter estimate and confidence bounds.

Note

Method will perform poorly given unbalanced sample sizes.

Author(s)

Ken Aho

References


See Also

\texttt{ci.prat, ci.p}

Examples

\texttt{ci.impt(30,40, 25,40)}
ci.median

Confidence interval for the median

Description
Calculates the upper and lower confidence bounds for the true median, and calculates true coverage of the interval.

Usage

\[
\text{ci.median}(x, \text{conf} = 0.95)
\]

Arguments

- **x**: A vector of quantitative data.
- **conf**: The desired level of confidence \(1 - P\text{(type I error)}\).

Value
Returns a list of class = "ci". Default printed results are the parameter estimate and confidence bounds. Other invisible objects include:

- coverage: The true coverage of the interval.

Author(s)
Ken Aho

References


See Also

median

Examples

\[
x <- \text{rnorm}(28)
ci.median(x)
\]
ci.mu.oneside  

One sided confidence interval for mu.

Description

In some situations we may wish to quantify confidence in the region above or below a mean estimate. For instance, a biologist working with an endangered species may be interested in saying: "I am 95 percent confident that the true mean number of offspring is above a particular threshold." In a one-sided situation, we essentially let our confidence be 1 - 2α (instead of 1 - α). Thus, if our significance level for a two-tailed test is α, our one-tailed significance level will be 2α.

Usage

```
ci.mu.oneside(data, conf = 0.95, n = NULL, Var = NULL, xbar = NULL, summarized = FALSE, N = NULL, fpc = FALSE, tail = "upper")
```

Arguments

- **data**: A vector of quantitative data. Required if summarized=TRUE.
- **conf**: Level of confidence; 1 - P(type I error).
- **n**: Sample size. Required if summarized=TRUE.
- **Var**: Sample variance. Required if summarized=TRUE.
- **xbar**: Sample mean. Required if summarized=TRUE.
- **summarized**: Logical. Indicates whether summary statistics instead of raw data should be used.
- **N**: Population size. Required if summarized=TRUE.
- **fpc**: Logical. Indicating whether finite population corrections should be made.
- **tail**: Indicates what side the one sided confidence limit should be calculated for. Choices are "upper" or "lower".

Value

Returns a list of class = "ci". Default output is a matrix with the sample mean and either the upper or lower confidence limit.

Author(s)

Ken Aho

References

ci.mu.z

See Also
   ci.mu.t

Examples
   ci.mu.oneside(rnorm(100))

---

Z and t confidence intervals for mu.

Description

These functions calculate \( t \) and \( z \) confidence intervals for \( \mu \). \( Z \) confidence intervals require specification (and thus knowledge) of \( \sigma \). Both methods assume underlying normal distributions although this assumption becomes irrelevant for large sample sizes. Finite population corrections are provided if requested.

Usage

\[
\text{ci.mu.z(data, conf} = 0.95, \text{sigma} = 1, \text{summarized} = \text{FALSE, xbar} = \text{NULL, fpc} = \text{FALSE, N} = \text{NULL, n} = \text{NULL)}
\]

\[
\text{ci.mu.t(data, conf} = 0.95, \text{summarized} = \text{FALSE, xbar} = \text{NULL, sd} = \text{NULL, fpc} = \text{FALSE, N} = \text{NULL, n} = \text{NULL)}
\]

Arguments

data
   A vector of quantitative data. Required if summarized = FALSE.

conf
   Confidence level; 1 - \( P \) (type I error).

sigma
   The population standard deviation.

summarized
   A logical statement specifying whether statistical summaries are to be used. If summarized = FALSE, then the sample mean and the sample standard deviation (t.conf only) are calculated from the vector provided in data. If summarized = FALSE then the sample mean xbar, the sample size n, and, in the case of ci.mu.t, the sample standard deviation st.dev, must be provided by the user.

xbar
   The sample mean. Required if summarized = TRUE.

fpc
   A logical statement specifying whether a finite population correction should be made. If fpc = TRUE then both the sample size n and the population size N must be specified.

N
   The population size. Required if fpc=TRUE

sd
   The sample standard deviation. Required if summarized=TRUE.

n
   The sample size. Required if summarized = TRUE.
Details

ci.muz and ci.mut calculate confidence intervals for either summarized data or a dataset provided in data. Finite population corrections are made if a user specifies fpc=TRUE and provides some value for N.

Value

Returns a list of class = "ci". Default printed results are the parameter estimate and confidence bounds. Other invisible objects include:

Margin the confidence margin.

Author(s)

Ken Aho

References


See Also

pnorm, pt

Examples

#With summarized=FALSE
x<-c(5,10,5,20,30,15,20,25,0,5,10,5,7,10,20,40,30,40,10,5,0,3,20,30)
cl.mu.z(x,conf=.95,sigma=4,summarized=FALSE)
cl.mu.t(x,conf=.95,summarized=FALSE)
#With summarized = TRUE
cl.mu.z(x,conf=.95,sigma=4,xbar=14.6,n=25,summarized=TRUE)
cl.mu.t(x,conf=.95,sd=4,xbar=14.6,n=25,summarized=TRUE)
#With finite population correction and summarized = TRUE
cl.mu.z(x,conf=.95,sigma=4,xbar=14.6,n=25,summarized=TRUE,fpc=TRUE,N=100)
cl.mu.t(x,conf=.95,sd=4,xbar=14.6,n=25,summarized=TRUE,fpc=TRUE,N=100)

---

Confidence interval estimation for the binomial parameter pi using five popular methods.

Description

Confidence interval formulae for \( \mu \) are not appropriate for variables describing binary outcomes. The function p.conf calculates confidence intervals for the binomial parameter \( \pi \) (probability of success) using raw or summarized data. By default Agresti-Coull point estimators are used to estimate \( \pi \) and \( \sigma_{\pi} \). If raw data are to be used (the default) then successes should be indicated as ones and failures as zeros in the data vector. Finite population corrections can also be specified.
Usage

ci.p(data, conf = 0.95, summarized = FALSE, phat = NULL, fpc = FALSE, n = NULL, N = NULL, method="agresti.coull", plot = TRUE)

Arguments

data A vector of binary data. Required if summarized = FALSE.
conf Level of confidence 1 - P(type I error).
summarized Logical; indicate whether raw data or summary stats are to be used.
phat Estimate of \( \pi \). Required if summarized = TRUE.
fpc Logical. Indicates whether finite population corrections should be used. If fpc = TRUE then N must be specified. Finite population corrections are not possible for method = "exact" or method = "score".
n Sample size. Required if summarized = TRUE.
N Population size. Required if fpc = TRUE.
method Type of method to be used in confidence interval calculations, method ="agresti.coull" is the default. Other procedures include method="asymptotic" which provides the conventional normal (Wald) approximation, method = "score", method = "LR", and method="exact" (see Details below). Partial names can be used. The "exact" method cannot be implemented if summarized=TRUE.
plot Logical. Should likelihood ratio plot be created with estimate from method = "LR".

Details

For the binomial distribution, the parameter of interest is the probability of success, \( \pi \). ML estimators for the parameter, \( \pi \), and its standard deviation, \( \sigma_\pi \), are:

\[
\hat{\pi} = \frac{x}{n},
\]

\[
\hat{\sigma}_\pi = \sqrt{\frac{\hat{\pi}(1 - \hat{\pi})}{n}}
\]

where \( x \) is the number of successes and \( n \) is the number of observations.

Because the sampling distribution of any ML estimator is asymptotically normal, an "asymptotic" 100(1 - \( \alpha \))\% confidence interval for \( \pi \) is found using:

\[
\hat{\pi} \pm z_{1-(\alpha/2)} \hat{\sigma}_\pi.
\]

This method has also been called the Wald confidence interval.

These estimators can create extremely inaccurate confidence intervals, particularly for small sample sizes or when \( \pi \) is near 0 or 1 (Agresti 2012). A better method is to invert the Wald binomial test statistic and vary values for \( \pi_0 \) in the test statistic numerator and standard error. The interval consists of values of \( \pi_0 \) in which result in a failure to reject null at \( \alpha \). Bounds can be obtained by finding the roots of a quadratic expansion of the binomial likelihood function (See Agresti 2012). This has
been called a "score" confidence interval (Agresti 2012). An simple approximation to this method can be obtained by adding \( z_{1-(\alpha/2)} \approx 2 \) to the number of successes and failures (Agresti and Coull 1998). The resulting Agresti-Coull estimators for \( \pi \) and \( \sigma_\pi \) are:

\[
\hat{\pi} = \frac{x + z^2/2}{n + z^2},
\]

\[
\hat{\sigma}_\pi = \sqrt{\frac{\hat{\pi}(1 - \hat{\pi})}{n + z^2}}.
\]

where \( z \) is the standard normal inverse cdf at probability 1 - \( \alpha/2 \).

As above, the 100(1 - \( \alpha \))% confidence interval for the binomial parameter \( \pi \) is found using:

\[
\hat{\pi} \pm z_{1-(\alpha/2)} \hat{\sigma}_\pi.
\]

The likelihood ratio method finds points in the binomial log-likelihood function where the difference between the maximum likelihood and likelihood function is closest to \( \chi^2_{1}(1 - \alpha)/2 \) for support given in \( \pi_0 \). As support the function uses seq(0.00001, 0.99999, by = 0.00001).

The "exact" method of Clopper and Pearson (1934) is bounded at the nominal limits, but actual coverage may be well below this level, particularly when \( n \) is small and \( \pi \) is near 0 or 1.

Agresti (2012) recommends the Agresti-Coull method over the normal approximation, the score method over the Agresti-Coull method, and the likelihood ratio method over all others. The Clopper Pearson has been repeatedly criticized as being too conservative (Agresti and Coull 2012).

Value

Returns a list of class = "ci".

\( \text{pi.hat} \)  Estimate for \( \pi \).
\( \text{S.p.hat} \)  Estimate for \( \sigma_\pi \).
\( \text{margin} \)  Confidence margin.
\( \text{ci} \)  Confidence interval.

Note

This function contains only a few of the many methods that have been proposed for confidence interval estimation for \( \pi \).

Author(s)

Ken Aho. thanks to Simon Thelwall for finding an error with summarized data under fpc.
References


See Also
ci.mu.z

Examples

```r
# In 2001, it was estimated that 56,200 Americans would be diagnosed with
# non-Hodgkin's lymphoma and that 26,300 would die from it (Cernan et al. 2002).
# Here we find the 95% confidence interval for the probability of diagnosis, pi.

ci.p(c(rep(0, 56200-26300),rep(1,26300))) # Agresti-Coull

ci.p(c(rep(0, 56200-26300),rep(1,26300)), method = "LR") # Likelihood Ratio

# summarized = TRUE
n = 56200
x = 26300
phat = x/n

ci.p(summarized = TRUE, phat = phat, n = n) # Agresti-Coull

# Use 2001 US population size as N
N <- 285 x 10^6

ci.p(c(rep(0, 56200-26300),rep(1,26300)), fpc = TRUE, N = N) # Agresti-Coull

ci.p(summarized = TRUE, phat = phat, n = n, N = N, fpc = TRUE) # Agresti-Coull
```

**ci.prat**

*Confidence intervals for the ratio of binomial and multinomial proportions*

Description

A number of methods have been developed for obtaining confidence intervals for the ratio of two binomial proportions. These include the Wald/Katz-log method (Katz et al. 1978), adjusted-log (Walter 1975, Pettigrew et al. 1986), Koopman asymptotic score (Koopman 1984), Inverse hyperbolic sine transformation (Newman 2001), the Bailey method (Bailey 1987), and the Noether (1957) procedure. Koopman results are found iteratively for most intervals using root finding.
Usage

```r
ci.prat(y1, n1, y2, n2, conf = 0.95, method = "katz.log",
       bonf = FALSE, tol = .Machine$double.eps^0.25, R = 1000, r = length(y1))
```

Arguments

- `y1`: The ratio numerator number of successes. A scalar or vector.
- `n1`: The ratio number of trials. A scalar or vector of `length(y1)`.
- `y2`: The ratio denominator number of successes. A scalar or vector of `length(y1)`.
- `n2`: The ratio denominator number of trials. A scalar or vector of `length(y1)`.
- `conf`: The level of confidence, i.e. `1 - P(type I error)`.
- `method`: Confidence interval method. One of "adj.log", "bailey", "boot", "katz.log", "koopman", "sinh-1" or "noether". Partial distinct names can be used.
- `bonf`: Logical, indicating whether or not Bonferroni corrections should be applied for simultaneous inference if `y1`, `y2`, `n1` and `n2` are vectors.
- `tol`: The desired accuracy (convergence tolerance) for the iterative root finding procedure when finding Koopman intervals. The default is taken to be the smallest positive floating-point number of the workstation implementing the function, raised to the 0.25 power, and will normally be approximately 0.0001.
- `R`: If method "boot" is chosen, the number of bootstrap iterations.
- `r`: The number of ratios to which family-wise inferences are being made. Assumed to be `length(y1)`.

Details

Let $Y_1$ and $Y_2$ be multinomial random variables with parameters $n_1, \pi_{1i},$ and $n_2, \pi_{2i}$, respectively; where $i = \{1, 2, 3, \ldots, r\}$. This encompasses the binomial case in which $r = 1$. We define the true selection ratio for the $i$th resource of $r$ total resources to be:

$$\theta_i = \frac{\pi_{1i}}{\pi_{2i}}$$

where $\pi_{1i}$ and $\pi_{2i}$ represent the proportional use and availability of the $i$th resource, respectively. Note that if $r = 1$ the selection ratio becomes relative risk. The maximum likelihood estimators for $\pi_{1i}$ and $\pi_{2i}$ are the sample proportions:

$$\hat{\pi}_{1i} = \frac{y_{1i}}{n_1},$$

and

$$\hat{\pi}_{2i} = \frac{y_{2i}}{n_2}$$

where $y_{1i}$ and $y_{2i}$ are the observed counts for use and availability for the $i$th resource. The estimator for $\theta_i$ is:

$$\hat{\theta}_i = \frac{\hat{\pi}_{1i}}{\hat{\pi}_{2i}}$$
Method

Katz-log

\[ \hat{\theta}_i \times \exp(\pm z_1 - \alpha/2\hat{\sigma}_W), \]
where \( \hat{\sigma}_W^2 = \frac{(1-\hat{\pi}_{1i})}{\hat{\pi}_{1i}\hat{\pi}_{2i}} + \frac{(1-\hat{\pi}_{2i})}{\hat{\pi}_{2i}/n_2}. \]

Adjusted-log

\[ \hat{\theta}_{Ai} \times \exp(\pm z_1 - \alpha/2\hat{\sigma}_A), \]
where \( \hat{\theta}_{Ai} = \frac{y_{1i} + 0.5/n_1 + 0.5}{y_{2i} + 0.5/n_2 + 0.5} \),
\( \hat{\sigma}_A^2 = \frac{1}{y_{1i} + 0.5} - \frac{1}{n_1 + 0.5} + \frac{1}{y_{2i} + 0.5} - \frac{1}{n_2 + 0.5}. \)

Bailey

\[ \hat{\theta}_i \left[ \left( \frac{1}{y_{1i}} - \frac{(\alpha/2)(\hat{\pi}_{1i} + \hat{\pi}_{2i} - z_1 - (\alpha/2)^2\hat{\pi}_{1i}^2 + 9y_{1i}y_{2i})^{1/2}}{\hat{\pi}_{1i}^2 + 3} \right) \right]^{1/2}, \]
where \( \hat{\pi}_{1i} = 1 - \hat{\pi}_{1i} \), and \( \hat{\pi}_{2i} = 1 - \hat{\pi}_{2i}. \)

Inv. hyperbolic sine

\[ \ln(\hat{\theta}_i) \pm \left[ 2\sinh^{-1}\left( \frac{z(1-\alpha/2)}{2} \right) \left( \frac{1}{y_{1i}} - \frac{1}{n_1} + \frac{1}{y_{2i}} - \frac{1}{n_2} \right) \right]. \]

Koopman

Find \( X^2(\theta_0) = \chi^2(1 - \alpha) \), where
\( \hat{\pi}_{1i} = \frac{\theta_0(n_1 + y_{1i}) + y_{1i} + n_2 - [\theta_0(n_1 + y_{2i}) + y_{1i} + n_2]^2 - 4\theta_0(n_1 + n_2)(y_{1i} + y_{2i})}{6}, \)
\( \hat{\pi}_{2i} = \frac{\theta_0}{\theta_0(n_1 + y_{1i})}, \) and \( X^2(\theta_0) = \frac{(y_{1i} - n_1\hat{\pi}_{1i})^2}{n_2\hat{\pi}_{1i}(1-\hat{\pi}_{1i})} \left[ 1 + \frac{n_1(\theta_0 - \hat{\pi}_{1i})}{y_{2i}(1-\hat{\pi}_{1i})} \right]. \)

Noether

\[ \hat{\theta}_i \pm z_1 - \alpha/2\hat{\sigma}_N, \]
where \( \hat{\sigma}_N^2 = \hat{\sigma}_i^2 \left( \frac{1}{y_{1i}} - \frac{1}{n_1} + \frac{1}{y_{2i}} - \frac{1}{n_2} \right). \)

Exception handling strategies are generally necessary in the cases \( y_1 = 0, n_1 = y_1, y_2 = 0, \) and \( n_2 = y_2 \) (see Aho and Bowyer 2015).

The bootstrap method currently employs percentile confidence intervals.

Value

Returns a list of class = "ci". Default output is a matrix with the point and interval estimate.

Author(s)

Ken Aho

References


See Also

`ci.p, ci.prat.ak`

Examples

```r
# From Koopman (1984)
CI1 <- ci.prat(y1 = 36, n1 = 40, y2 = 16, n2 = 80, method = "katz")
CI2 <- ci.prat(y1 = 36, n1 = 40, y2 = 16, n2 = 80, method = "koop")
```

---

### Description

It is increasingly possible that resource availabilities on a landscape will be known. For instance, in remotely sensed imagery with sub-meter resolution, the areal coverage of resources can be quantified to a high degree of precision, at even large spatial scales. Included in this function are six methods for computation of confidence intervals for a true ratio of proportions when the denominator proportion is known. The first (adjusted-Wald) results from the variance of the estimator \( \hat{\sigma}_\pi \) after multiplication by a constant. Similarly, the second method(Agresti-Coull-adjusted) adjusts the variance of the estimator \( \hat{\sigma}_{\hat{\pi}_{AC}} \), where \( \hat{\pi}_{AC} = (y + 2)/(n + 4) \). The third method (fixed-log) is based on delta derivations of the logged ratio. The fourth method is Bayesian and based on the beta posterior distribution derived from a binomial likelihood function and a beta prior distribution. The fifth procedure is an older method based on Noether (1959). Sixth, bootstrapping methods can also be implemented.

### Usage

```r
CI <- ci.prat(y1 = 10, n1 = 40, pi2 = NULL, method = "ac", conf = 0.95, bonf = FALSE, bootCI.method = "perc", R = 1000, sigma.t = NULL, r = length(y1), gamma.hyper = 1, beta.hyper = 1)
```
Arguments

\texttt{y1}  
The ratio numerator number of successes. A scalar or vector.

\texttt{n1}  
The ratio numerator number of trials. A scalar or vector of \texttt{length(y1)}

\texttt{pi2}  
The denominator proportion. A scalar or vector of \texttt{length(y1)}

\texttt{method}  
One of \texttt{"ac"}, \texttt{"wald"}, \texttt{"noether-fixed"}, \texttt{"boot"}, \texttt{"fixed-log"} or \texttt{"bayes"}
for the Agresti-Coull-adjusted, adjusted Wald, noether-fixed, bootstrapping, fixed-
log and Bayes-beta, methods, respectively. Partial distinct names can be used.

\texttt{conf}  
The level of confidence, i.e. \(1 - P\text{(type I error)}\).

\texttt{bonf}  
Logical, indicating whether or not Bonferroni corrections should be applied for
simultaneous inference if \texttt{y1}, \texttt{y2}, \texttt{n1} and \texttt{n2} are vectors.

\texttt{bootCI.method}  
If \texttt{method = "boot"} the type of bootstrap confidence interval to calculate. One
of \texttt{"norm"}, \texttt{"basic"}, \texttt{"perc"}, \texttt{"BCa"}, or \texttt{"student"}. See \texttt{ci.boot} for more
information.

\texttt{R}  
If \texttt{method = "boot"} the number of bootstrap samples to take. See \texttt{ci.boot} for
more information.

\texttt{sigma.t}  
If \texttt{method = "boot"} and \texttt{bootCI.method = "student"} a vector of standard
errors in association with studentized intervals. See \texttt{ci.boot} for more information.

\texttt{r}  
The number of ratios to which family-wise inferences are being made. Assumed
to be \texttt{length(y1)}.

\texttt{gamma.hyper}  
If \texttt{method = "bayes"}. A scalar or vector. Value(s) for the first hyperparameter
for the beta prior distribution.

\texttt{beta.hyper}  
If \texttt{method = "bayes"}. A scalar or vector. Value(s) for the second hyperparam-
eter for the beta prior distribution.

Details

Koopman et al. (1984) suggested methods for handling extreme cases of \(y_1, n_1, y_2,\) and \(n_2\) (see
below). These are applied through exception handling here (see Aho and Bowyer 2015).

Let \(Y_1\) and \(Y_2\) be multinomial random variables with parameters \(n_1, \pi_{1i},\) and \(n_2, \pi_{2i},\) respectively;
where \(i = \{1, 2, 3, \ldots, r\}\). This encompasses the binomial case in which \(r = 1\). We define the true
selection ratio for the \(i\)th resource of \(r\) total resources to be:

\[
\theta_i = \frac{\pi_{1i}}{\pi_{2i}}
\]

where \(\pi_{1i}\) and \(\pi_{2i}\) represent the proportional use and availability of the \(i\)th resource, respectively. If
\(r = 1\) the selection ratio becomes relative risk. The maximum likelihood estimators for \(\pi_{1i}\) and \(\pi_{2i}\)
are the sample proportions:

\[
\hat{\pi}_{1i} = \frac{y_{1i}}{n_1},
\]

and

\[
\hat{\pi}_{2i} = \frac{y_{2i}}{n_2}
\]
where \( y_{1i} \) and \( y_{2i} \) are the observed counts for use and availability for the \( i \)th resource. If \( \pi_{2i} \)s are known, the estimator for \( \theta_i \) is:

\[
\hat{\theta}_i = \frac{\hat{\pi}_{1i}}{\pi_{2i}}
\]

The function \texttt{ci.prat.ak} assumes that selection ratios are being specified (although other applications are certainly possible). Therefore it assume that \( y_{1i} \) must be greater than 0 if \( \pi_{2i} = 1 \), and assumes that \( y_{1i} \) must = 0 if \( \pi_{2i} = 0 \). Violation of these conditions will produce a warning message.

**Method**

**Agresti Coull-Adjusted**

\[
\hat{\theta}_{ACi} \pm z_{1-(\alpha/2)} \sqrt{\hat{\pi}_{AC1i}(1 - \hat{\pi}_{AC1i})/(n_1 + 4)\hat{\pi}_{AC1i}\pi_{2i}},
\]

where \( \hat{\pi}_{AC1i} = \frac{y_{1i} + z^2/2}{n_1 + z^2/2} \), and \( \hat{\theta}_{ACi} = \frac{\hat{\pi}_{AC1i}}{\pi_{2i}} \),

where \( z \) is the standard normal inverse cdf at probability \( 1 - \alpha/2 \) (\( \approx 2 \) when \( \alpha = 0.05 \)).

**Bayes-beta**

\[
(\frac{X_{\alpha/2}}{\pi_{2i}}, \frac{X_{1-(\alpha/2)}\pi_{2i}}{\pi_{2i}}),
\]

where \( X \sim \text{BETA}(y_{1i} + \gamma_i, n_1 + \beta - y_{1i}) \).

**Fixed-log**

\[
\hat{\theta}_i \times \exp\left(\pm \frac{z_1}{\sigma F} \right),
\]

where \( \sigma^2_F = (1 - \hat{\pi}_{1i})/\hat{\pi}_{1i}n_1 \).

**Noether-fixed**

\[
\frac{\hat{\pi}_{1i} / \pi_2}{1 + \frac{z_1^2}{2y_{1i}} \pm \frac{z_1^2}{2y_{1i}} \sqrt{\frac{\hat{\sigma}^2_{NF}}{4y_{1i}} + \frac{z_1^2}{4y_{1i}}}},
\]

where \( \hat{\sigma}^2_{NF} = \frac{1 - \hat{\pi}_{1i}}{n_1 \hat{\pi}_{1i}} \).

**Wald-adjusted**

\[
\hat{\theta}_i \pm z_{1-(\alpha/2)} \sqrt{\hat{\pi}_{1i}(1 - \hat{\pi}_{1i})/n_1 \hat{\pi}_{1i}\pi_{2i}},
\]

**Value**

Returns a list of \texttt{class = "ci"}. Default output is a matrix with the point and interval estimate.

**Author(s)**

Ken Aho

**References**


**See Also**

\texttt{ci.prat}, \texttt{ci.p}
ci.sigma

Examples

ci.prat.ak(3,4,.5)

---

ci.sigma  Confidence interval for sigma squared.

Description

The function calculates confidence intervals for $\sigma^2$. We assume that the parent population is normal.

Usage

ci.sigma(data, conf = 0.95, S.sq = NULL, n = NULL, summarized = FALSE)

Arguments

data  A vector of quantitative data. Required if summarized=FALSE.
conf  Level of confidence. 1 - $P$(type I error).
S.sq  Sample variance, required if summarized=TRUE.
n    Sample size, required if summarized=TRUE.
summarized  Logical. If summarized=TRUE then the user must supply S.sq and n

Value

Returns a list of class = "ci". Default printed results are the point estimate and confidence bounds. Other objects are invisible.

Author(s)

Ken Aho

References


See Also

ci.mu.z

Examples

ci.sigma(rnorm(20))
ci.strat

Confidence intervals for stratified random samples.

Description
A statistical estimate along with its associated confidence interval can be considered to be an inferential statement about the sampled population. However this statement will only be correct if the method of sampling is considered in the computations of standard errors. The function ci.strat provides appropriate computations given stratified random sampling.

Usage

ci.strat(data, strat, N.h, conf = 0.95, summarized = FALSE, use.t = FALSE, n.h = NULL, x.bar.h = NULL, var.h = NULL)

Arguments

data A vector of quantitative data. Required if summarized=FALSE.
strat A vector describing strata.
N.h A vector describing the number of experimental units for each of the k strata.
conf Level of confidence; 1 - P(type I error).
summarized Logical. Indicates whether summarized data are to be used.
use.t Logical. Indicates whether t or z confidence intervals should be built.
n.h A vector indicating the number of experimental units sampled in each of the k strata. Required if summarized=TRUE.
x.bar.h A vector containing the sample means for each of the k strata. Required if summarized=TRUE.
var.h A vector containing the sample variances for each of the k strata. Required if summarized=TRUE.

Details
The conventional formula for the sample standard error assumes simple random sampling. There are two other general types of sampling designs: stratified random sampling and cluster sampling. Since cluster sampling is generally used for surveys involving human demographics we will only describe corrections for stratified random sampling here. For more information on sample standard error adjustments for cluster sampling see Lohr (1999).

For a stratified random sampling design let N be the known total number of units in the defined population of interest, and assume that the population can be logically divided into k strata; \( N = N_1 + N_2 + N_3 + \ldots + N_k \) (i.e. we are assuming that we know both the total population size, and the population size of each stratum). We sample each of the k strata with \( n_h \) observations; \( h = 1, 2, \ldots, k \).
We estimate the variance in the $h$th stratum as:

$$S_h^2 = \frac{1}{n_h - 1} \sum_{i=1}^{n_h} (X_{hi} - \bar{X}_h)^2$$

where $X_{hi}$ is the $i$th observation from the $h$th strata and $\bar{X}_h$ is the $h$th sample mean. We estimate the true population total, $T$, with:

$$\hat{T} = \sum_{h=1}^{k} N_h \bar{X}_h$$

We estimate the population mean, $\mu$, with:

$$\bar{X}_{str} = \frac{\hat{T}}{N}$$

An unbiased estimator for the standard error of $\bar{X}_{str}$ is:

$$S_{\bar{X}_{str}} = \sqrt{\frac{\sum_{h=1}^{k} \left(1 - \frac{n_h}{N_h}\right) \left(\frac{N_h}{N}\right)^2 \left(\frac{S_h^2}{n_h}\right)}}$$

The standard error of $\hat{T}$ is also of interest. Here is an unbiased estimator:

$$S_{\hat{T}} = \sqrt{\sum_{h=1}^{k} \left(1 - \frac{n_h}{N_h}\right) \frac{N_h}{N} \left(\frac{S_h^2}{n_h}\right)}$$

Note that these standard errors have both a finite population correction and adjustments for stratification built into them. Assuming that sample sizes within each stratum are large or that the sampling design has a large number of strata, a 100(1 - $\alpha$)percent confidence interval for $\mu$ and $T$ can be constructed using:

$$\bar{X}_{str} \pm z_{1-\alpha/2} S_{\bar{X}_{str}}$$

$$\hat{T} \pm z_{1-\alpha/2} S_{\hat{T}}$$

In situations where sample sizes or the number of strata are small, a $t(n - k)$ distribution can (and should) be used for calculation of confidence intervals, where $n = n_1 + n_2 + \ldots + n_k$.

Value

Returns a list with two items:

- strat.summary A matrix with columns: n.h, n.h, x.bar.h and var.h
- CI Confidence intervals for $\mu$ and $T$

Author(s)

Ken Aho
References


See Also

ci.mu.z

Examples

```r
#Data from Siniff and Skoog (1964)
Caribou<-data.frame(Stratum=c("A","B","C","D","E"),N.h=c(400,30,61,18,70,120),
n.h=c(98,10,37,6,39,21),x.bar.h=c(24.1,25.6,267.6,179,293.7,33.2),
var.h=c(5575,4064,34756,22798,123578,9795))
attach(Caribou)
ci.strat(data,strat=Stratum,N.h=N.h,conf=.95,summarized=TRUE,use.t=FALSE,n.h=n.h,
x.bar.h=x.bar.h, var.h=var.h)
```

data(cliff.env)

Description

The data here are a subset of a dataset collected by Aho (2006) which describe the distribution of communities of lichens and vascular and avascular plant species on montane cliffs in Northeast Yellowstone National Park. Of particular interest was whether substrate (limestone or andesitic conglomerate) or water supply influenced community composition.

Usage

data(cliff.env)

Format

This data frame contains the following columns:

- `sub` a factor with 2 levels "Andesite" and "Lime" describing substrate type.
- `water` a factor with 3 levels "W" "I" "D" indicating wet, intermediate, or dry conditions.

Details

Two categorical environmental variables are described for 54 sites. `sub` describes the substrate; there are two levels: "Andesite" and "Lime". `water` describes distance of samples from waterfalls which drain the cliff faces; there are three levels "W" indicating wet, "I" indicating intermediate, and "D" indicating dry.
cliff.sp

Source


cliff.sp | Yellowstone NP cliff community data

Description

A subset of a dataset collected by Aho (2006) which describes the distribution of communities of lichens and vascular and avascular plant species on montane cliffs in Northeast Yellowstone National Park. Of particular interest was whether substrate (limestone or andesitic conglomerate) or water supply influenced community composition.

Usage
data(cliff.sp)

Details

Responses are average counts from two 10 x 10 point frames at 54 sites. Abundance data are for eleven species, 9 lichens, 3 mosses, and 2 vascular plants. Data were gathered in the summer of 2004 on two andesitic/volcanic peaks (Barronette and Abiathar) with sedimentary layers at lower elevations.

Source


cement

Description

The actual concrete compressive strength (MPa) for a given mixture under a specific age (days) was determined from laboratory assays. Data are in raw form (not scaled).

Usage
data("concrete")
Format

A data frame with 1030 observations on the following 9 variables.

X1 kg of cement in a m$^3$ mixture.
X2 kg of blast furnace slag in a m$^3$ mixture.
X3 kg of fly ash in a m$^3$ mixture.
X4 kg of water in a m$^3$ mixture.
X5 kg of superplasticizer in a m$^3$ mixture.
X6 kg of coarse aggregate in a m$^3$ mixture.
X7 kg of fine aggregate in a m$^3$ mixture.
X8 Age: day(1-365), a numeric vector
Y Concrete compressive strength in MPa, a numeric vector

Details

The order of variables corresponds to the order in the original data.

Source

Prof. I-Cheng Yeh Department of Information Management Chung-Hua University, Hsin Chu, Taiwan 30067, R.O.C. e-mail: icyeh@chu.edu.tw TEL: 886-3-5186511

References

Past Usage:
Primary

Others

Acknowledgements, Copyright Information, and Availability:

NOTE: Reuse of this database is unlimited with retention of copyright notice for Prof. I-Cheng Yeh.
ConDis.matrix  Calculation and display of concordant and discordant pairs

Description

Calculates whether pairs of observations from two vectors are concordant discordant or neither. These are displayed in the lower diagonal of a symmetric output matrix as 1, -1 or 0.

Usage

ConDis.matrix(Y1, Y2)

Arguments

Y1  A vector of quantitative data.
Y2  A vector of quantitative data. Observations are assumed to be paired with respective observations from Y1.

Details

Consider all possible combinations of \((Y_{1i}, Y_{ij})\) and \((Y_{2i}, Y_{ij})\) where \(1 \leq i < j \leq n\). A pair is concordant if \(Y_{1i} > Y_{1j}\) and \(Y_{2i} > Y_{2j}\) or if \(Y_{1i} < Y_{1j}\) and \(Y_{2i} < Y_{2j}\). Conversely, a pair is discordant if \(Y_{1i} < Y_{1j}\) and \(Y_{2i} > Y_{2j}\) or if \(Y_{1i} > Y_{1j}\) and \(Y_{2i} < Y_{2j}\). This information has a number of important uses including calculation of Kendall’s \(\tau\).

Value

A matrix is returned. Elements in the lower triangle indicate whether observations are concordant (element = 1), discordant (element = -1) or neither (element = 0).

Author(s)

Ken Aho

References


See Also

cor
Examples

```r
# Crab data from Sokal and Rohlf (1998)
crab <- data.frame(gill.wt=c(159,179,100,45,384,230,100,320,80,220,320,210),
                   body.wt=c(14.4,15.2,11.3,2.5,22.7,14.9,1.41,15.81,4.19,15.39,17.25,9.52))
attach(crab)
crabh <- ConDis.matrix(gill.wt, body.wt)
```

Corn yield data

Description

Hoshmand (2006) described a split plot design to test grain yield of corn with respect to corn hybrids (split plots) and nitrogen (in whole plots). The experiment was replicated at two blocks.

Usage

data(corn)

Format

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

- **yield**: Corn yield in bushels per acre.
- **hybrid**: Type of hybrid, P = pioneer, levels were: A632xLH38 LH74xLH51 Mo17xA634 P3732 P3747.
- **N**: Nitrogen addition in lbs/acre 0 70 140 210.
- **block**: A blocking factor with levels 1 2.

Source


Crab gill and body weight data

Description

Gill weight and body weight data for 12 striped shore crabs (*Pachygrapsus crassipes*).

Usage

data(crab.weight)
**crabs**

**Format**

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

- `gill.wt` Gill weight in mg
- `body.wt` Body weight in grams

**Source**


---

**Agresti crabs dataset**

**Description**

Horseshoe crab satellite counts as a function of crab phenotype.

**Usage**

data(crabs)

**Format**

A data frame with 173 observations on the following 5 variables.

- `color` A factor with levels `1 = light medium, 2 = medium, 3 = dark medium, 4 = dark`
- `spine` A factor with levels `1 = both good, 2 = one worn or broken, 3 = both worn or broken`
- `width` Crab carapace width in cm.
- `satell` Number of satellites.
- `weight` Crab weight in kg.

**Source**


**References**

cuckoo  

*Tippett cuckoo egg data*

### Description

Part of a dataset detailing cuckoo egg lengths found in other birds nests. Units are millimeters

### Usage

data(cuckoo)

### Format

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

- **TP**  Tree pipit
- **HS**  Hedge sparrow
- **RB**  Robin

### Source


---

D.sq  

*Mahalanobis distance for two sites using a pooled covariance matrix*

### Description

Allows much easier multivariate comparisons of groups of sites then provided by the function `mahalanobis` in the base library.

### Usage

D.sq(g1, g2)

### Arguments

- **g1**  Community vector for site 1
- **g2**  Community vector for site 2

### Author(s)

Ken Aho
References


See Also

mahalanobis

Examples

```r
# Create examples
G1 <- matrix(ncol=3, nrow=3, data=c(1,0,1,2,3,4,0,2))
G2 <- matrix(ncol=3, nrow=3, data=c(1,2,4,5,2,3,4,3,1))
D.sq(G1, G2)$D.sq
```

---

**death.penalty**  
*Florida state death penalty data*

**Description**

Dataset detailing death penalty 674 homicide trials in the state of Florida from 1976-1987 with respect to verdict, and victim and defendant race. The data were previously used (Agresti 2012) to demonstrate Simpson’s Paradox.

**Usage**

```r
data(death.penalty)
```

**Format**

A data frame with 8 observations on the following 4 variables.

- **count** Counts from cross classifications.
- **verdict** Death penalty verdict No Yes.
- **d.race** Defendant’s race Black White.
- **v.race** Victims’ race Black White.

**Details**

A reversal of associations or comparisons may occur as a result of lurking variables or aggregating groups. This is called Simpson’s Paradox.
Source


---

deer

Maternal deer data

Description

Monteith et al. (2009) examined the maternal life history characteristics of white-tailed deer (*Odocoileus virginianus*) originating from the Black Hills in southwestern South Dakota and from eastern South Dakota. Because litter size and dam size affects offspring weight the investigators used proportional birth mass (dam mass/total litter mass) as a measure of reproductive investment by deer.

Usage

data(deer)

Format

The dataframe contains 6 columns

- Birth.Yr Year of birth.
- Litter.size Number of offspring.
- Region Categorical variable with two factor levels. BH = Black Hills, ER = Eastern Region.
- Dam.weight Dam weight in kg.
- Total.birth.mass Mass of litter in kg.
- Prop.mass Total birth mass divided by dam weight.

Source

**deer.296**

*Mule deer telemetry data*

**Description**

Telemetry data for mule deer #296 from the Starkey Experimental Forest in Northeastern Oregon. Data are high resolution (10 minute) radio collar readings from 8/20/2008 to 11/6/2008. Also included are data for nearest neighbor locations of forest/grassland boundaries.

**Usage**

`data(deer.296)`

**Format**

A data frame with 5423 observations on the following 7 variables.

- **time**  Unit of time measurement used at the Starkey Experimental Forest
- **x**  Mule Deer X-coordinate, UTM Easting
- **y**  Mule Deer Y-coordinate, UTM Northing
- **near_x**  Nearest boundary location X coordinate
- **near_y**  Nearest boundary location Y coordinate
- **hab_type**  Type of habitat
- **near_angle**  A numeric vector containing the angle of azimuth to the nearest point on the boundary with respect to a four quadrant system. NE = 0° to 90°, NW is > 90° and ≤ 180°, SE is < 0° and ≤ −90° is > −90° and ≤ −180°.

---

**depression**

*Hamilton depression scores before and after drug treatment*

**Description**

Hollander and Wolfe (1999) presented Hamilton depression scale factor measurements for 9 patients with mixed anxiety and depression. Measurements were taken at a time preceding administration of tranquilizer, and a time after tranquilizer administration.

**Usage**

`data(depression)`
Format
A data frame with 18 observations on the following 3 variables.

subject Experimental subject.
scale Hamilton depression scale score. 0-7 is considered to be normal. Scores of 20 or higher indicate moderate to very severe depression
time A factor with levels post pre indicating before and after tranquilizer treatment.

Source

<table>
<thead>
<tr>
<th>DH.test</th>
<th>Doornik-Hansen test for multivariate normality.</th>
</tr>
</thead>
</table>

Description
The Doornik-Hansen test for multivariate normality is a powerful alternative to the Shapiro-Wilk test.

Usage
DH.test(Y, Y.names = NULL)

Arguments
Y An n x p dataframe of dependent variables.
Y.names Names of Y variables; should be a 1 x p character string.

Details
An assumption of multivariate normality is exceedingly difficult to verify. Hypothesis tests tend to be too stringent, and multivariate diagnostic plots only allow viewing of two variables at a time. Univariate normality of course can be verified using normal probability plots. However while marginal non-normality indicates multivariate non-normality, marginal normality does not insure that Y variables collectively follow a multivariate normal distribution.

The Doornik-Hansen test for multivariate normality (Doornik and Hansen 2008) is based on the skewness and kurtosis of multivariate data that is transformed to insure independence. The DH test is more powerful than the Shapiro-Wilk test for most tested multivariate distributions (Doornik and Hansen 2008). The function DH.test also runs the Doornik-Hansen test for both multivariate and univariate normality. The later test follows directly from the work of Bowman and Shenton (1975), Shenton and Bowman (1977) and D’Agostino (1970).
**dO2**

<table>
<thead>
<tr>
<th>Value</th>
<th>Returns a list with two objects.</th>
</tr>
</thead>
<tbody>
<tr>
<td>multi</td>
<td>A dataframe containing multivariate results, i.e. the test statistic, $E$, the degrees of freedom and the $p$-value.</td>
</tr>
<tr>
<td>comp2</td>
<td>A dataframe with $p$ rows detailing univariate tests. Columns in the dataframe contain the test statistics, degrees of freedom and $P$-values.</td>
</tr>
</tbody>
</table>

**Note**

As with all inferential normality tests our null hypothesis is that the underlying population is normal, in this case multivariate normal.

**Author(s)**

Ken Aho

**References**


**See Also**

`shapiro.test`, `bv.boxplot`

**Examples**

```r
data(iris)# The ubiquitous multivariate iris data.
DH.test(iris[,1:4],Y.names=names(iris[,1:4]))
```

**Description**

Dissolved $O_2$ readings in ppm for 15 random locations above and below a riverside community.

**Usage**

```r
data(dO2)
```
**Format**

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

- `Dissolved O2` levels in ppm.
- `location` River flow location with respect to town. Levels are `Above` `Below`.

**Source**


---

| drugs | Contingency data for high school marijuana, alcohol, and cigarette use |

**Description**

Agresti (2012) included a three way contingency table describing cigarette, alcohol, and marijuana use of high school students in Dayton Ohio.

**Usage**

data(drugs)

**Format**

A data frame with 8 observations on the following 4 variables.

- `alc` Alcohol use. A factor with levels `N` `Y`.
- `cig` Cigarette use. A factor with levels `N` `Y`.
- `mari` Marijuana use. A factor with levels `N` `Y`.
- `count` Counts for the cross-classification.

**Source**

e.cancer

Esophageal cancer data modified slightly to create a balanced three-way factorial design

Description
Breslow and Day (1980) studied the effect of age, tobacco, and alcohol on esophageal cancer rates at Ile-et-Vilaine, France. Data are altered slightly to make the design balanced, and to allow enough degrees of freedom to perform a fully factorial three way ANOVA.

Usage
data(e.cancer)

Format
The dataset contains four variables:

- **age grp.** age group, a factor with four levels: "25-34", "35-44", "45-54", "55-64", and "65-74".
- **alcohol** alcohol consumed (g/day).
- **tobacco** tobacco consumed (g/day).
- **cases** number of esophageal cancer cases.

Source

eff.rbd

Efficiency of a randomized block design compared to a CRD

Description
Calculates the RCBD efficiency ratio for a linear model with one main factor and one blocking factor. Values greater than 1 indicate that the RCBD has greater efficiency compared to a CRD.

Usage
eff.rbd(lm)

Arguments

- **lm** An object of class lm. The blocking factor must be called "block".
**Author(s)**
Ken Aho

**References**

---

**Enzymatic rate data for the phospholipase protein ExoU**

**Description**
The bacterium *Pseudomonas aeruginosa* causes disease in human hosts leading to sepsis and even death in part by secreting lipases (proteins that break down lipids) into cellular environments. The protein ExoU is a phospholipase produce by particularly virulent strains of *P. aeruginosa*. Benson et al. (2009) measured of ExoU enzymatic activity under varying levels of the fluorescent phospholipase substrate PED6.

**Usage**
data(enzyme)

**Format**
A data frame with 10 observations on the following 3 variables.

- **substrate** PED6 concentration (in micromoles).
- **rate** enzymatic rate (nmol of cleaved of PED6 per mg ExoU).
- **sd** standard deviation of rate for each level of substrate.

**Source**
May and Beverton (1990) created the effective specialization index to quantify the degree of specialization of insects with potential host plants.

ES.May(mat, digs = 3)

A symmetric matrix with potential specialist hosts in rows and and the number species specializing on each of the host species in columns (see details below).

The number of significant digits in output.

The structure of the object `mat` is nonintuitive. In the rows of the matrix are species which can be selected by potential specialists (i.e. hosts). May and Beverton (1990) used four oak species. The columns indicate the degree of specialization of potential specialists. May and Beverton (1990) were interested in the specialization of beetles. The first element (row 1, column 1) in their 4 x 4 matrix contained only beetle species found on host 1. The second element (row 1, column 2) contained the number of beetle species found on host 1 and one other host. The third element (row 1, column 3) contained the number of beetle species found on host 1 and two other hosts. The fourth element (row 1, column 4) contained the number of beetle species occurring on all four hosts.

Output is a list

E.S.coefficients

- Nk: The number of distinct specialists.
- Pki.matrix: The proportion of potential specialists on the kth host.
- N.matrix: The raw data.
- fk.matrix: For the kth host, the proportion of species which are effectively specialized.
- fk.vector: The number of species which are effectively specialized on the kth host.

Ken Aho and Jessica Fultz
References


Examples

```r
#data from May and Beverton (1990)
beetle <- matrix(ncol=4,nrow=4,data=c(5,8,7,8,20,10,9,8,16,15,11,8,15,15,12,8),
byrow=TRUE)
ES.May(beetle)
```

```
exercise.repeated  Repeated measures data for an exercise experiment.
```

Description

Freund et al. (1986) listed data for a longitudinal study of exercise therapies. The data were analyzed using AR1 covariance matrices in mixed models by Fitzmaurice et al. (2004). In the study 37 patients were randomly assigned to one of two weightlifting programs. In the first program (TRT 1), repetitions with weights were increased as subjects became stronger. In the second program (TRT 2), the number of repetitions was fixed but weights were increased as subjects became stronger. An index measuring strength was created and recorded at day 0, 2, 4, 6, 8, 10, and 12.

Usage

```r
data(exercise.repeated)
```

Format

The dataframe contains a repeated measures dataset describing the strength of 37 subjects with respect to two weightlifting programs. There are four columns:

- **ID**  Subject ID.
- **TRT**  The type of weightlifting treatment (a factor with two levels, 1 and 2).
- **strength**  A strength index.
- **day**  The day that strength was measured on a subject, measured from the start of the experiment.

Source

**Description**

These data concern posts published during the year 2014 on the Facebook page of a popular cosmetics brand. The data here are 500 of the 790 rows and part of the features analyzed by Moro et al. (2016). The remaining data points were omitted due to confidentiality issues.

**Usage**

data(facebook)

**Format**

A data frame with 500 observations on the following 19 variables.

- **x1**: Total number of likes of the page containing a post.
- **x2**: Type of content; a factor with levels *Link*, *Photo*, *Status*, and *Video*.
- **x3**: Manual content category; a factor with levels: *action* (special offers and contests), *product* (direct advertisement, explicit brand content), and *inspiration* (non-explicit brand related content).
- **x4**: Month the post was posted.
- **x5**: Weekday the post was published.
- **x6**: Hour the post was posted
- **x7**: An binary variable indicating if the company paid to Facebook for advertising.
- **y1**: Lifetime post total reach: the number of people who saw a page post.
- **y2**: Lifetime number of total impressions: the number of times a post from a page is displayed, whether the post is clicked or not.
- **y3**: Lifetime engaged users: the total number of people who clicked anywhere in a post (unique users).
- **y4**: Lifetime number of post consumers: the number of people who clicked anywhere in a post after purchasing something on the page.
- **y5**: Lifetime number of post consumptions: the number of clicks anywhere in a post by people after purchasing something on the page.
- **y6**: Lifetime number of post impressions by people who have liked the page.
- **y7**: Lifetime post reach by people who like the page.
- **y8**: Lifetime number of people who have liked the page and engaged with the post.
- **y9**: Number of "comments" on the post.
- **y10**: Number of "likes" on the post.
- **y11**: Number of times the post was "shared."
- **y12**: Total interactions: the sum of "likes," "comments," and "shares" of the post.
**Fbird**

**Frigatebird drumming frequency data**

**Description**

Male magnificent frigatebirds (*Fregata magnificens*) have an enlarged red throat pouch that has probably evolved as the result of sexual selection. During courtship displays males attract females by displaying this pouch and using it to make a drumming sound. Madsen et al. (2004) noted that conditions (e.g. oblique viewing angles) often limit females’ ability to appraise pouch size exactly. Since females choose mates based on pouch size, a question of interest is whether females could use the pitch of the pouch drumming as an indicator of pouch size. Madsen et al. (2004) estimated the pouch volume and fundamental drumming frequency for forty males at Isla Isabel in Nayarit Mexico. Eighteen of these observations are in this dataset.

**Usage**

data(Fbird)

**Format**

The dataframe contains two variables:

- **vol** Pouch volume (in cm$^3$).
- **freq** Frequency of drumming (in Hz)

**Source**

**fire**  

*Fire data from Yellowstone National Park*

**Description**

Fires from 1988 constituted the largest conflagration in the history of Yellowstone National Park. This dataframe lists burned areas for ten Yellowstone stream catchments (Robinson et al. 1994).

**Usage**

`data(fire)`

**Format**

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

- `fire` Burn area in, in hectares$^2$.
- `stream` A factor with levels Blacktail Cache EF. Blacktail Fairy Hellroaring Iron. Springs Pebble Rose SF. Cache Twin

**Source**


---

**fly.sex**  

*Fly sex and longevity*

**Description**

Partridge and Farquar (1981) studied the effect of the number of mating partners on the longevity of fruit flies. Five different mating treatments were applied to single male fruit flies. As a concomitant variable thorax length was measured.

**Usage**

`data(fly.sex)`

**Format**

A data frame with 125 observations on the following 3 variables.

- `treatment` a factor with levels 1 = One virgin female per day, 2 = eight virgin females per day, 3 = a control group with one newly inseminated female per day, 4 = a control group with eight newly inseminated females per day, and 5 a control group with no added females.
- `longevity` Age in days.
- `thorax` Thorax length in mm.
Source


References


--------------------

frog

*Australian frog calls following fire*

--------------------

Description

Driscoll and Roberts (1997) examined the impact of fire on the Walpole frog (*Geocrinia lutea*) in catchments in Western Australia by counting the number of calling males in six paired burn and control sites for three years following spring burning in 1991.

Usage

data(frog)

Format

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

catchment  A factor with levels angove logging newpipe newquin newquinw oldquin.

trogs  The difference in the number of male frog calls for control - burned sites.

year  Year.

Source


References

Fruit weight data from Littell et al. (2002)

**Description**

Valencia orange tree fruit weights are measured at harvest with respect to five irrigation treatment applied in eight blocks in a RCBD.

**Usage**

data(fruit)

**Format**

A data frame with 40 observations on the following 3 variables.

- **block**: a factor describing eight blocks
- **irrig**: a factor with levels basin flood spray sprinkler trickle
- **fruitwt**: a numeric vector

**Source**


---

**G.mean**

*Geometric mean*

**Description**

Calculates the geometric mean.

**Usage**

G.mean(x)

**Arguments**

- **x**: A vector of quantitative data.

**Value**

Returns the geometric mean.

**Author(s)**

Ken Aho
Likelihood ratio test for tabular data

Description

Provides likelihood ratio tests for one way and multiway tables.

Usage

```r
g.test(y, correct = FALSE, pi.null = NULL)
```

Arguments

- `y`: A vector of at least 2 elements, or a matrix. Must contain only non-negative integers.
- `correct`: Logical. Indicating whether Yates correction for continuity should be used.
- `pi.null`: Optional vector or matrix of null proportions. Must sum to one.

Author(s)

Ken Aho

Examples

```r
obs <- c(6022, 2001)
g.test(obs, pi.null = c(0.75, 0.25))
```
garments

Garment Latin square data from Littell et al. (2002)

Description

Four materials (A, B, C, D) used in permanent press garments were subjected to a test for shrinkage. The four materials were placed in a heat chamber with with four settings (pos). The test was then conducted in four runs (run).

Usage
data(garments)

Format

A data frame with 16 observations on the following 4 variables.

- run Test run, a factor with levels 1 2 3 4
- pos Heat position, a factor with levels 1 2 3 4
- mat Fabric materials, a factor with levels A B C D
- shrink Shrinkage measure, a numeric vector

Source


---

Glucose2

Glucose Levels Following Alcohol Ingestion

Description

The Glucose2 data frame has 196 rows and 4 columns.

Format

This data frame contains the following columns:

- Subject a factor with levels 1 to 7 identifying the subject whose glucose level is measured.
- Date a factor with levels 1 2 indicating the occasion in which the experiment was conducted.
- Time a numeric vector giving the time since alcohol ingestion (in min/10).
- glucose a numeric vector giving the blood glucose level (in mg/dl).
Details

Hand and Crowder (Table A.14, pp. 180-181, 1996) describe data on the blood glucose levels measured at 14 time points over 5 hours for 7 volunteers who took alcohol at time 0. The same experiment was repeated on a second date with the same subjects but with a dietary additive used for all subjects.

Note

Descriptions and details are from the library nlme.

Source


---

**goats**

*Mountain goat data from Yellowstone National Park*

Description

Mount goat (*Oreomnos americanus*) feces data and soil nutrient data for eight different mountains in the Northern Absarokas in Yellowstone National Park.

Usage

data(goats)

Format

The dataframe has 3 columns:

- **feces** feces concentration (Percent occurrence per 0.1, m^2 plot).
- **NO3** Nitrate concentration in ppm.
- **organic.matter** Organic matter concentration (LOI) as a percentage.

Source

Description
Littell et al. (2006) describe an experiment to distinguish the effects of three seed growing methods on the yield of five turf grass varieties. The seed growing methods were applied to seed from each grass variety. Six pots were planted with each variety × method combination. The pots were placed in a growth chamber with uniform conditions and dry matter (in grams) was weighed from above ground clips after four weeks.

Usage
data(grass)

Format
The dataframe has three columns:
yield Refers to grass yield.
method Seed growing method. A factor with three levels: a, b, c.
variety Grass variety. A factor with five levels: 1, 2, 3, 4, 5.

Source

H.mean Harmonic mean

Description
Calculates the harmonic mean.

Usage
H.mean(x)

Arguments
x Vector of quantitative data.

Value
Returns the harmonic mean.
Author(s)
Ken Aho

See Also
G.mean, HL.mean

Examples
x<-c(2,1,4,5,6,2.4,7,2.2,.002,15,17,.001)
H.mean(x)

heart Heart rate data from Milliken and Johnson (2009)

Description
A repeated measures demonstration dataset from Milliken and Johnson (1999). Heart rate was measured for twenty four subject at four time periods following administration of a treatment. The treatment types were two active heart drugs and a control. One treatment was assigned to each subject. Thus each drug was administered to eight subjects.

Usage
data(heart)

Format
A data frame with 96 observations on the following 4 variables.
rate A numeric vector describing heart rate (bpm).
time A factor with levels t1 t2 t3 t4
drug A factor with levels AX23 BWW9 Ctrl1
subject A factor describing which subject (in drug) that measurements were made on.

Source

Examples
## Not run:
data(heart)
aov(rate ~ drug * time + Error(subject%in%drug), data = heart)
## End(Not run)
**HL.mean**

*Hodges-Lehman estimator of location*

**Description**

Calculates the Hodges-Lehman estimate of location—which is consistent for the true pseudomedian—using Walsh averages (Hollander and Wolfe 1999, pgs. 51-55). If requested, the function also provides confidence intervals for the true pseudomedian. In a symmetric distribution the mean, median, and pseudomedian will be identical.

**Usage**

```r
HL.mean(x, conf = NULL, method = "exact")
```

**Arguments**

- `x`: A vector of quantitative data.
- `conf`: A proportion specifying 1 - P(type I error).
- `method`: method for confidence interval calculation. One of "approx", which uses a normal approximation, or "exact", which uses the Wilcoxon sign-rank quantile function (see Hollander and Wolfe 1999).

**Author(s)**

Ken Aho

**References**


**See Also**

`h.mean`, `g.mean`

**Examples**

```r
# Hamilton depression scale (Hollander and Wolfe 1999)
x<-c( -0.952, 0.147, -1.022, -0.430, -0.620, -0.590, -0.490, 0.080, -0.010)
HL.mean(x, conf = .96)
```
**Description**

The Huber M-estimator is a robust high efficiency estimator of location that has probably been under-utilized by biologists. It is based on maximizing the likelihood of a weighting function. This is accomplished using an iterative least squares process. The Newton Raphson algorithm is used here. The function usually converges fairly quickly (< 10 iterations). The function uses the Median Absolute Deviation function, `mad`. Note that if MAD = 0, then `NA` is returned.

**Usage**

`huber.mu(x, c = 1.28, iter = 20, conv = 1e-07)`

**Arguments**

- `x`: A vector of quantitative data.
- `c`: Stop criterion. The value `c = 1.28` gives 95% efficiency of the mean given normality.
- `iter`: Maximum number of iterations.
- `conv`: Convergence criterion.

**Value**

Returns Huber’s M-estimator of location.

**Author(s)**

Ken Aho

**References**


**See Also**

`huber.one.step, huber.NR, mad`

**Examples**

```r
x <- rnorm(100)
huber.mu(x)
```
**huber.NR**

*Huber M-estimator iterative least squares algorithm*

---

**Description**

Algorithm for calculating fully iterated or one step Huber $M$-estimators of location.

**Usage**

`huber.NR(x, c = 1.28, iter = 20)`

**Arguments**

- **x**: A vector of quantitative data
- **c**: Bend criterion. The value $c = 1.28$ gives 95% efficiency of the mean given normality.
- **iter**: Maximum number of iterations

**Details**

The Huber $M$-estimator is a robust high efficiency estimator of location that has probably been under-utilized by biologists. It is based on maximizing the likelihood of a weighting function. This is accomplished using an iterative least squares process. The Newton Raphson algorithm is used here. The function usually converges fairly quickly < 10 iterations. The function uses the Median Absolute Deviation function, $\text{mad}$. Note that if $\text{MAD} = 0$, then $\text{NA}$ is returned.

**Value**

Returns iterative least squares iterations which converge to Huber’s $M$-estimator. The first element in the vector is the sample median. The second element is the Huber one-step estimate.

**Author(s)**

Ken Aho

**References**


**See Also**

`huber.one.step, huber.mu, mad`
huber.one.step

**Examples**

```r
x <- rnorm(100)
huber.NR(x)
```

---

**Description**

Returns the first Raphson-Newton iteration of the function `huber.NR`.

**Usage**

```r
huber.one.step(x, c = 1.28)
```

**Arguments**

- `x`: Vector of quantitative data
- `c`: Bend criterion. The value `c = 1.28` gives 95% efficiency of the mean given normality.

**Details**

The Huber $M$-estimator function usually converges fairly quickly, hence the justification of the Huber one step estimator. The function uses the Median Absolute Deviation function, `mad`. If MAD = 0, then NA is returned.

**Value**

Returns the Huber one step estimator.

**Author(s)**

Ken Aho

**References**


**See Also**

`huber.mu`, `huber.NR`, `mad`

**Examples**

```r
x <- rnorm(100)
huber.one.step(x)
```
illusions

Visual illusions illustrating human perception errors.

Description

In development, currently displays three illusions. Illusion 3 is from Yihui Xie’s package `animation`.

Usage

`illusions(ill.no = 1)`

Arguments

ill.no Numeric describing which illusion number to view.

Author(s)

Ken Aho

Examples

`illusions(2)`
`illusions(3)`

ipomopsis

Ipomopsis fruit yield data

Description

The following question is based on data from Crawley (2007). We are interested in the effect of grazing on seed production in the plant scarlet gilia *Ipomopsis aggregata*. Forty plants were allocated to two treatments, grazed and ungrazed. Grazed plants were exposed to rabbits during the first two weeks of stem elongation. They were then protected from subsequent grazing by the erection of a fence and allowed to continue growth. Because initial plant size may influence subsequent fruit production, the diameter of the top of the rootstock was measured before the experiment began. At the end of the experiment, fruit production (dry weight in milligrams) was recorded for each of the forty plants.

Usage

`data(ipomopsis)`
Format

A data frame with 40 observations on the following 3 variables.

- root  Rootstock diameter in mm
- fruit  Fruit dry weight in mg
- grazing a factor with levels Grazed Ungrazed

Source


---

**joint.ci.bonf**

Calculates joint confidence intervals for parameters in linear models using a Bonferroni procedure.

**Description**

Creates widened confidence intervals to allow joint consideration of parameter confidence intervals.

**Usage**

```r
joint.ci.bonf(model, conf = 0.95)
```

**Arguments**

- **model**  A linear model created by `lm`
- **conf** level of confidence 1 - P(type I error)

**Details**

As with all Bonferroni-based methods for joint confidence the resulting intervals are exceedingly conservative and thus are prone to type II error.

**Value**

Returns a dataframe with the upper and lower confidence bounds for each parameter in a linear model.

**Author(s)**

Ken Aho

**References**

See Also

confint, p.adjust

Examples

Soil.C<-(13,20,10,11,2,25,30,25,23)
Soil.N<-(1.2,2,1.5,1.0,3,2,3,2.7,2.5)
Slope<-(15,14,16,12,10,18,25,24,28)
Aspect<-(45,120,100,56,5,20,5,15,15)
Y<-as.vector(c(20,30,10,15,5,45,60,55,45))
model<-lm(Y~Soil.C+Soil.N+Slope+Aspect)
joint.ci.bonf(model)

<table>
<thead>
<tr>
<th>K</th>
<th>Soil potassium analyses from 8 laboratories</th>
</tr>
</thead>
</table>

Description

Jacobsen et al. (2002) sent nine "identical" soil samples to eight soil testing laboratories in the Great Plains region of the Central United States over a three year period of time. Among other characteristics the labs were paid to measure soil potassium. A question of interest was whether the labs would produce identical analytical results.

Usage

data(K)

Format

A data frame with 72 observations on the following 2 variables.

K Soil K in mg/kg
lab Laboratories, a factor with levels B D E F G H I J

Source

Description

The kappa statistic, along with user and producer error rates are conventionally used in the remote sensing to describe the effectiveness of ground cover classifications. Since it simultaneously considers both errors of commission and omission, kappa can be considered a more conservative measure of classification accuracy than the percentage of correctly classified items.

Usage

Kappa(class1, reference)

Arguments

class1  
A vector describing a classification of experimental units.

reference  
A vector describing the "correct" classification of the experimental units in class1

Value

Returns a list with 4 items

ttl_agreement  
The percentage of correctly classified items.

user_accuracy  
The user accuracy for each category of the classification.

producer_accuracy  
The producer accuracy for each category of the classification.

kappa  
The kappa statistic.

table  
A two way contingency table comparing the user supplied classification to the reference classification.

Author(s)

Ken Aho

References


Examples

reference<-c("hi","low","low","hi","low","med","med")  
class1<-c("hi","hi","low","hi","med","med","med")  
Kappa(class1,reference)
**km**  

*Kaplan-Meier survivorship.*

**Description**

Calculates survivorship for individuals in a population over time based on the method of Kaplan-Meier; cf. Pollock et al. (1989).

**Usage**

```r
df <- km(r, d, var = "O", conf = 0.95, age.seq = seq(1, length(r)), ylab = "Survivorship", xlab = "Age class", type = "b", plot.km = TRUE, plot.CI = TRUE, ...)
```

**Arguments**

- `r`: Numbers of individuals at risk in each age or time class.
- `d`: Vector of the number of deaths in each age or time class.
- `var`: Type of procedure used to calculate variance in confidence intervals; "O" = Oakes, "G" = Greenwood.
- `conf`: Level of confidence for confidence interval calculations; 1 - \( P(\text{type I error}) \).
- `age.seq`: A sequence of numbers indicating the age classes used.
- `ylab`: Y-axis label.
- `xlab`: X-axis label.
- `type`: Type argument from `plot`.
- `plot.km`: Logical. Should plot be created?
- `plot.CI`: Logical. Should confidence interval be overlaid on plot?
- `...`: Additional arguments from `plot`.

**Details**

Details for this index are given in Pollock et al. (1989).

**Value**

Returns a list with the following components

- `s.hat`: A vector of estimated survivorship probabilities from the 1st age class onward.
- `Greenwood.Var`: The estimated Greenwood variance for each age class.
- `Oakes.Var`: The estimated Oakes variance for each age class.
- `CI`: Upper and lower confidence bound to the true survivorship.

**Author(s)**

Ken Aho
References

Examples
```r
## Example from Pollock (1989)
r <- c(18,18,16,16,15,15,13,13,8,8,7)
d <- c(0,0,2,0,0,1,0,1,1,0,0)
km(r,d)
```

Description
Provides Kullback’s (1959) test for multivariate homoscedasticity.

Usage
```r
Kullback(Y, X)
```

Arguments
- `Y` An $n \times p$ matrix of quantitative variables
- `X` An $n \times 1$ vector of categorical assignments (e.g. factor levels)

Details
Multivariate general linear models assume equal covariance matrices for all factor levels or factor level combinations. Legendre and Legendre (1998) recommend this test for verifying homoscedasticity. $P$-values concern a null hypothesis of equal population covariance matrices. $P$-values from the test are conservative with respect to type I error.

Value
Returns a dataframe with the test statistic (which follows a chi-square distribution if $H_0$ is true), the chi-square degrees of freedom, and the calculated $p$-value. Invisible objects include the within group dispersion matrix.

Author(s)
Pierre Legendre is the author of the most recent version of this function asbio ver >= 1.0. Stephen Ousley discovered an error in the original code. Ken Aho was the author of the original function.
larrea

References


Examples

Y1 <- rnorm(100, 10, 2)
Y2 <- rnorm(100, 15, 2)
Y3 <- rnorm(100, 20, 2)
Y <- cbind(Y1, Y2, Y3)
X <- factor(c(rep(1, 50), rep(2, 50)))
Kullback(Y, X)

larrea  Creosote bush counts

Description

Phillips and MacMahon (1981) conducted an extensive study of Larrea tridentata (creosote bush) distributions in the Mojave and Sonoran deserts from several life stage classes based on areal coverage: Life stage 1 (102 - 103 cm²) Life stage 2 (103 - 104 cm²), and Life stage 3 (104 - 105 cm²). Data were generated (using variance and mean values, and the function rpois to approximate the results of the authors.

Usage

data(larrea)

Format

A data frame with 25 observations on the following 3 variables.

class1  Counts from life stage 1
class2  Counts from life stage 2
class3  Counts from life stage 3

References

Mouse life expectancy data

Description

Weindruch et al. (1986) compared life expectancy of field mice given different diets. To accomplish this, the authors randomly assigned 244 mice to one of four diet treatments.

Usage

data(life.exp)

Format

A data frame with 244 observations on the following 2 variables.

lifespan Lifespan in months

treatment a factor with levels N/N85: Mice were fed normally both before and after weaning (the slash distinguishes pre and post weaning). After weaning the diet consisted of 85kcal/week, a conventional total for mice rearing, N/R40: Mice were fed normally before weaning, but were given a severely restricted diet of 40 kcal per week after feeding, N/R50: Mice were restricted to 50kcal per week before and after weaning, R/R50: Mice were fed normally before weaning, but their diet was restricted to 50 kcal per week after weaning.

Source


References


Examples

data(life.exp)

## maybe str(life.exp); plot(life.exp) ...
Description

The function provides model selection summaries using AIC, AICc, BIC, Mallow’s Cp, and PRESS for a list of objects of class lm.

Usage

```
lm.select(lms, deltaAIC = FALSE)
```

Arguments

- `lms`: A list containing linear models.
- `deltaAIC`: Logical; Should a Δ AIC summary be given with relative likelihoods and Akaike weights?

Note

Mallow’s Cp assumes that all models are nested within the first model in the argument lms. Non-nesting will produce a warning message.

Author(s)

Ken Aho

See Also

AIC, press

Examples

```r
Y <- rnorm(100)
X1 <- rnorm(100)
X2 <- rnorm(100)

lms <- list(lm(Y ~ X1), lm(Y ~ X1 + X2))
lm.select(lms)
```
Description

The function serves as wrapper for \texttt{loess} and lets one make 2D or 3D smoother plots using \texttt{loess} specifications.

Usage

\begin{verbatim}
loess.surf(Y, X, span = 0.75, degree = 1, family = "gaussian", phi = 20,
theta = 50, xlab = "X", ylab = "Y", zlab = "Fit", line.col = 1,
line.type = 1, scale = TRUE, duplicate = "error", expand = 0.5, ...)
\end{verbatim}

Arguments

\begin{itemize}
  \item \textit{Y} \hspace{1cm} A numeric response vector.
  \item \textit{X} \hspace{1cm} A numeric explanatory vector or a two column matrix for 3D smooths.
  \item \textit{span} \hspace{1cm} Span parameter, i.e. the size of the local neighborhood.
  \item \textit{degree} \hspace{1cm} Indicates whether linear \texttt{degree = 1} or quadratic models \texttt{degree = 2} are to be applied to each local neighborhood.
  \item \textit{family} \hspace{1cm} Type of error distribution to be optimized in fitting. The default, "gaussian" is fitting with least squares. Fitting with Tukey's biweight \textit{M}-Estimator is used if \texttt{family = "symmetric"}.
  \item \textit{phi} \hspace{1cm} Parameter from \texttt{persp}, \textit{phi} provides the colatitude viewing angle.
  \item \textit{theta} \hspace{1cm} Parameter from \texttt{persp}, \textit{theta} gives the azimuthal direction.
  \item \textit{xlab} \hspace{1cm} \textit{X}-axis label.
  \item \textit{ylab} \hspace{1cm} \textit{Y}-axis label.
  \item \textit{zlab} \hspace{1cm} \textit{Z}-axis label
  \item \textit{line.col} \hspace{1cm} Color of loess fit line.
  \item \textit{line.type} \hspace{1cm} Line type for loess fit.
  \item \textit{scale} \hspace{1cm} Logical from \texttt{persp}. If \texttt{scale} is \texttt{TRUE} the \texttt{x}, \texttt{y} and \texttt{z} coordinates are transformed separately. If \texttt{scale} is \texttt{FALSE} the coordinates are scaled so that aspect ratios are retained.
  \item \textit{duplicate} \hspace{1cm} Argument from \texttt{interp} from library \texttt{akima}. Consists of a character string indicating how to handle duplicate data points. The default, \texttt{duplicate = "error"} produces an error message.
  \item \textit{expand} \hspace{1cm} Argument from \texttt{persp}, a expansion factor applied to the \texttt{z} coordinates.
  \item ... \hspace{1cm} Additional arguments from \texttt{plot}
\end{itemize}
Value

Output is a 2D or 3D smooth plot.

Author(s)

Ken Aho

References


See Also

loess

Examples

```r
X1<-sort(rnorm(100))
X2<-rexp(100)
Y<-rgamma(100,1,2)
loess.surf(Y,cbind(X1,X2))
```

---

**magnets**

*Magnet pain relief data*

---

Description

Magnets have long been used as an alternative medicine, particularly in the Far East, for speeding the recovery of broken bones and to aid in pain relief. Vallbona et al. (1997) tested whether chronic pain experienced by post-polio patients could be treated with magnetic fields applied directly to pain trigger points. The investigators identified fifty subjects who not only had post-polio syndrome, but who also experienced muscular or arthritic pain. Magnets were applied to pain trigger points in 29 randomly selected subjects, and in the other 21 a placebo was applied. The patients were asked to subjectively rate pain on a scale from one to ten before and after application of the magnet or placebo.

Usage

data(magnets)

Format

The dataframe contains 4 columns

- **Score_1** Reported pain level before application of treatment.
- **Score_2** Reported pain level after application of treatment.
- **Active** Categorical variable indicating whether the device applied was active (magnet) or inactive (placebo).
Source

---

**MC**

*Simple functions for MCMC demonstrations*

Description
Function **MC** creates random Markov Chain from a transitions matrix. Function **Rf** presents proportional summaries of discrete states from **MC**. Function **mat.pow** finds the exponential expansion of a matrix. Required for finding the expectations of a transition matrix.

Usage

```
MC(T, start, length)
Rf(res)
mat.pow(mat, pow)
```

Arguments

- **T** A symmetric transition matrix.
- **start** Starting state
- **length** Length of the chain to be created
- **res** Results from **MC**.
- **mat** A symmetric matrix.
- **pow** Power the matrix is to be raised to.

Author(s)
Ken Aho

Examples

```
A <- matrix(nrow = 4, ncol = 4, c(0.5, 0.5, 0, 0, 0.25, 0.5, 0.25, 0, 0, 0.5, 0.5), byrow = TRUE)
pi.0 <- c(1, 0, 0, 0)
Tp10 <- mat.pow(A, 10)
chain <- MC(A, 1, 100)
Rf(chain)
```
**Description**

MC.test calculates a permutation of test statistics from an pooled variance \( t \)-test. It compares this distribution to an initial test statistic calculated using non-permuted data to derive a \( P \)-value.

**Usage**

```r
MC.test(Y, X, perm = 1000, alternative = "not.equal", var.equal = TRUE, paired = FALSE)
```

**Arguments**

- **Y**
  - Response data.
- **X**
  - Categorical explanatory variable.
- **perm**
  - Number of iterations.
- **var.equal**
  - Logical: Should equal variances be assumed?
- **paired**
  - Logical: Are sample paired?
- **alternative**
  - Alternative hypothesis. One of three options: "less", "greater", or "not.equal". These provide lower-tail, upper-tail, and two-tailed tests.

**Details**

The method follows the description of Manly (1998) for a two-sample test. Upper and lower tailed tests are performed by finding the portion of the distribution greater than or equal to the observed \( t \) test statistic (upper-tailed) or less than or equal to the observed test statistic (lower-tailed). A two tailed test is performed by multiplying the portion of the null distribution above the absolute value of the observed test statistic by two. Results from the test will be similar to oneway.test from the library coin since it is based on an equivalent test statistic. The function oneway.test allows additional options including blocking.

**Value**

Returns a list with the following items:

- **observed.test.statistic**
  - \( t \)-statistic calculated from non-permuted (original) data.
- **no_of_permutations_exceeding_observed_value**
  - The number of times a Monte Carlo derived test statistic was more extreme than the initial observed test statistic.
- **p.value**
  - Empirical \( P \)-value
- **alternative**
  - The alternative hypothesis
Author(s)

Ken Aho

References


See Also

t.test

Examples

Y <- c(rnorm(100, 1, 3), rnorm(100, 1.2, 3.2))
X <- factor(c(rep(1, 100), rep(2, 100)))
mctest(Y, X, alternative = "less")

mcmc.norm.hier

Gibbs sampling of normal hierarchical models

Description

These functions are designed for Gibbs sampling comparison of groups with normal hierarchical models (see Gelman 2003), and for providing appropriate summaries.

Usage

mcmc.norm.hier(data, length = 1000, n.chains = 5)
norm.hier.summary(M, burn.in = 0.5, cred = 0.95, conv.log = TRUE)

Arguments

data A numerical matrix with groups in columns and observations in rows.
length An integer specifying the length of MCMC chains.
n.chains The number of chains to be computed for each parameter
M An output array from mcmc.norm.hier.
burn.in The burn in period for the chains. The default value, 0.5, indicates that only the latter half of chains should be used for calculating summaries.
cred Credibility interval width.
conv.log A logical argument indicating whether convergence for \( \sigma \) and \( \tau \) should be considered on a log scale.
An important Bayesian application is the comparison of groups within a normal hierarchical model. We assume that the data from each group are independent and from normal populations with means \( \theta[j] \), \( j = (1, \ldots, J) \), and a common variance, \( \sigma^2 \). We also assume that group means, are normally distributed with an unknown mean, \( \mu \), and an unknown variance, \( \tau^2 \). A uniform prior distribution is assumed for \( \mu, \log \sigma \) and \( \tau \); \( \sigma \) is logged to facilitate conjugacy. The function \texttt{mcmc.norm.hier} provides posterior distributions of \( \theta[j] \)'s, \( \mu, \sigma \) and \( \tau \). The distributions are derived from univariate conditional distributions from the multivariate likelihood function. These conditional distributions provide a situation conducive to MCMC Gibbs sampling. Gelman et al. (2003) provide excellent summaries of these sorts of models.

The function \texttt{mcmc.summary} provides statistical summaries for the output array from \texttt{mcmc.norm.hier} including credible intervals (empirically derived directly from chains) and the Gelman/Rubin convergence criterion, \( \hat{R} \).

The function \texttt{mcmc.norm.hier} returns a three dimensional (step x variable x chain) array. The function \texttt{mcmc.summary} returns a summary table containing credible intervals and the Gelman/Rubin convergence criterion, \( \hat{R} \).

Ken Aho


\texttt{rhat}
Maximum likelihood algorithm for determining the binomial dispersal coefficient

Description

The function uses the maximum likelihood method described by Bliss and R. A. Fisher (1953) to determine maximum likelihood estimates for the binomial parameters $m$ (the mean) and $k$ (a parameter describing aggregation/dispersion).

Usage

```r
ML.k(f, x, res = 1e-06)
```

Arguments

- **f**: A vector of frequencies for objects in x (must be integers).
- **x**: A vector of counts, must be sequential integers.
- **res**: Resolution for the ML estimator.

Value

Returns a list with two items

- **k**: The negative binomial dispersion parameter, $k$
- **m**: The negative binomial distribution mean, $m$

Note

The program is slow at the current resolution. Later iterations will use linear interpolation, or Fortran loops, or both.

Author(s)

Ken Aho

References


See Also

dnbinom
Mode

Examples

mites <- seq(0, 8)
freq <- c(70, 38, 17, 10, 9, 3, 2, 1, 0)
ML.k(freq, mites)

<table>
<thead>
<tr>
<th>Mode</th>
<th>Sample mode</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Description

Calculates the sample mode; i.e. the most frequent outcome in a dataset. Non-existence of the mode will return a message. Several errors in earlier versions were corrected in asbio 0.4.

Usage

Mode(x)

Arguments

x

A vector of quantitative data.

Value

Returns the sample mode or an error message if the mode does not exist.

Author(s)

Ken Aho

References


See Also

H.mean, HL.mean, mean, median, huber.mu

Examples

x<-round(rnorm(100000,mean=10,sd=2),0)
Mode(x)
modlevene.test

Modified Levene’s test

Description

Conducts the modified Levene’s test for homoscedastic populations.

Usage

modlevene.test(x, groups)

Arguments

x
Vector of residuals from a linear model.

groups
Vector of factor levels.

Details

The modified Levene’s test is a test for homoscedasticity that (unlike the classic $F$-test) is robust to violations of normality (Conover et al. 1981). In a Modified Levene’s test we calculate $d_{ij} = |e_{ij} - \tilde{e}_i|$ where $\tilde{e}_i$ is the $i$th factor level residual median. We then run an ANOVA on the $d_{ij}$’s. If the $p$-value is $< \alpha$, we reject the null and conclude that the population error variances are not equal.

Value

An ANOVA table is returned with the modified Levene’s test results.

Author(s)

Ken Aho

References


See Also

fligner.test

Examples

eggs<-c(11,17,16,14,15,12,10,15,19,23,20,18,17,27,33,22,26,28)
trt<-as.factor(c(1,1,1,1,1,2,2,2,2,2,3,3,3,4,4,4,4,4,4))
mlm<-lm(eggs~trt)
modlevene.test(residuals(mlm),trt)
montane.island  

Description
Lomolino et al. (1989) investigated the relationship between the area of montane forest patches (islands) and the richness of mammal fauna in the Southwestern United States. This dataset contains richness and area information for 27 montane islands.

Usage
data(montane.island)

Format
A data frame with 27 observations on the following 3 variables.

- Richness: A numeric vector; the number of species.
- Area: A numeric vector; area in km².

Source

moose.sel  

Description
A collection of datasets which can be used to calculate and compare selection ratios. Datasets are: goat.sel, mule.sel, quail.sel, elk.sel, bighorn.sel, bighornAZ.sel, juniper.sel and are described (briefly) in Manly et al. (2002) and Aho and Bowyer (2015).

Usage
data(moose.sel)
data(goat.sel)
data(quail.sel)
data(elk.sel)
data(bighorn.sel)
data(bighornAZ.sel)
data(juniper.sel)
Format

Dataframes with observations on the following variables.

resources A factor listing resource types.

avail Proportional availability (for datasets without n2 and y2).

y1 A numeric vector: number of times the resource was used.

y2 A numeric vector: number of times the resource was observed.

n1 A numeric vector: number of times that all resources were used.

n2 A numeric vector: number of times that all resources were observed.

Source


References


mosquito Mosquito wing length data

Description

Sokal and Rohlf (2012) describe an experiment to gauge the variability in wing length in female mosquitos (Aedes intrudens). Four females were randomly selected from three cages and two measurements were made on the left wing of each female. Both cage and female (in cage) can be seen as random effects.

Usage

data(mosquito)

Format

A data frame with 24 observations on the following 4 variables.

length Wing length in micrometers
cage Cage number.
female Female (in cage) number
measures Measurement (in female in cage) number, i.e. pseudoreplicates in female.

Source

### MS.test

**Mack-Skillings test**

**Description**

Runs a Mack-Skillings test for situations applicable to rank-based permutation procedures with blocking and more than one replicate for treatments in a block.

**Usage**

```r
MS.test(Y, X, reps)
```

**Arguments**

- **Y**: A matrix of response data. The `MS.test` function requires that response data are organized in columns (see example below).
- **X**: A vector of treatments. The length of the vector should be equal to the number of rows in the response matrix.
- **reps**: The number of replicates in each treatment (unbalanced designs cannot be analyzed).

**Details**

When we have more than one replication within a block, and the number of replications is equal for all treatments, we can use the Mack-Skillings test (Mack and Skillings 1980) as a rank based permutation procedure to test for main effect differences. If ties occur the value of the significance level is only approximate. Hollander and Wolfe (1996) provide a method for finding exact \( P \)-values by deriving a test statistic distribution allowing ties.

**Value**

Returns a dataframe summarizing the degrees of freedom, test statistic and \( p \)-value.

**Author(s)**

Ken Aho

**References**

See Also

friedman.test

Examples

```r
# data from Campbell and Pelletier (1962)
Niacin0 <- c(7.58, 7.87, 7.71, 8.00, 8.27, 8.76, 7.3, 7.82, 8.03, 7.35, 7.66)
Niacin4 <- c(11.63, 11.87, 11.40, 12.20, 11.70, 11.80, 11.04, 11.50, 11.49, 11.50, 10.10, 11.70)
Niacin8 <- c(15.00, 15.92, 15.58, 16.60, 16.40, 15.90, 15.87, 15.91, 16.28, 15.10, 14.80, 15.70)
Niacin <- cbind(Niacin0, Niacin4, Niacin8)
lab <- c(rep(1, 3), rep(2, 3), rep(3, 3), rep(4, 3))
MS.test(Niacin, lab, reps=3)
```

---

myeloma  

Patient responses to myeloma drug treatments

Description

Murakami et al. (1997) studied the effect of drugs treatments on levels of serum beta-2 microglobulin in patients with multiple myeloma. Serum beta-2 microglobulin is produced in the body as a result of myelomas, and thus can be used as an indicator of the severity of disease.

Usage

```r
data(myeloma)
```

Format

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

- `mglobulin` Levels of serum beta-2 microglobulin in mg/l

Source


References

Description

Finds nearest neighbor boundary Cartesian coordinates for use as arguments in function `prp`.

Usage

```r
nearbound(X, Y, bX, bY)
```

Arguments

- `X` A vector of Cartesian X-coordinates (e.g., UTMs) describing an animal’s locations (e.g., telemetry data).
- `Y` A vector of Cartesian Y-coordinates (e.g., UTMs) describing an animal’s locations (e.g., telemetry data).
- `bX` A vector of boundary X-coordinates.
- `bY` A vector of boundary Y-coordinates.

Value

Returns Cartesian X,Y coordinates of nearest neighbor locations on a boundary.

Author(s)

Ken Aho

See Also

`prp`, `boundangle`

Examples

```r
bx <- seq(0, 49)/46
bY <- c(4.89000, 4.88200, 4.87400, 4.87300, 4.88000, 4.87900, 4.87900, 4.90100, 4.90800,
        4.91000, 4.93300, 4.94000, 4.91100, 4.90000, 4.91700, 4.93000, 4.93500, 4.93700,
        4.93300, 4.94500, 4.95900, 4.95400, 4.95100, 4.95800, 4.95810, 4.95811, 4.95810,
        4.96100, 4.96200, 4.96300, 4.96500, 4.96600, 4.96700, 4.96540, 4.96400,
        4.97600, 4.97900, 4.98000, 4.98000, 4.98100, 4.97900, 4.98000, 4.97800, 4.97600,
        4.97700, 4.97400, 4.97300, 4.97100, 4.97000)

X <- c(0.004166667, 0.108333333, 0.316666667, 0.525000000, 0.483333333, 0.608333333,
      0.662500000, 0.683333333, 0.900000000, 1.070833333)

Y <- c(4.67, 4.25, 4.26, 4.58, 4.90, 4.10, 4.70, 4.40, 4.20, 4.30)
nearbound(X, Y, bX, bY)
```
one.sample.t

One sample t-test

Description

Provides a one-sample hypothesis test. The test assumes that the underlying population is normal.

Usage

one.sample.t(data = NULL, null.mu = 0, xbar = NULL, sd, n = NULL, alternative = "two.sided", conf = 0.95)

Arguments

data A vector of quantitative data. Not required if xbar and n are supplied by the user.
null.mu The expectation for the null distribution.
xbar Sample mean. Not required if is.null(data)==FALSE
sd The sample standard deviation. Not required if is.null(data)==FALSE
n The sample size. Not required if is.null(data)==FALSE
alternative Type of test. One of three must be specified "two.sided", "less", or "greater"
conf Confidence level.

Details

The function can use either raw data is.null(data)==FALSE or summarized data if is.null(data)==TRUE. With the later xbar, and n must be specified by the user.

Value

Returns a test statistic and a p-value.

Author(s)

Ken Aho. Thanks to Samuel Hale for identifying a function bug.

See Also

pt

Examples

one.sample.t(null.mu = 131, xbar = 126, sd = 12, n = 85, alternative = "two.sided")
Description

Provides a one-sample hypothesis test. The test assumes that the underlying population is normal and furthermore that $\sigma$ is known.

Usage

one.sample.z(data = NULL, null.mu = 0, xbar = NULL, sigma, n = NULL, alternative = "two.sided", conf = 0.95)

Arguments

data A vector of quantitative data. Not required if xbar and n are supplied by the user.
null.mu The expectation for the null distribution.
xbar Sample mean. Not required if is.null(data)==FALSE
sigma The null distribution standard deviation
n The sample size. Not required if is.null(data)==FALSE
alternative Type of test. One of three must be specified "two.sided", "less", or "greater"
conf Confidence level.

Details

The function can use either raw data is.null(data)==FALSE or summarized data if is.null(data)==TRUE. With the later xbar and n must be specified by the user.

Value

Returns a test statistic and a $p$-value.

Author(s)

Ken Aho

See Also

pnorm

Examples

one.sample.z(null.mu=131,xbar=126,sigma=12,n=85,alternative="two.sided")
Description

Paik diagrams for the representation of Simpson's Paradox in three way tables.

Usage

paik(formula, counts, resp.lvl = 2, data, circle.mult = 0.4, xlab = NULL, ylab = NULL, leg.title = NULL, leg.loc = NULL, show.mname = FALSE,...)

Arguments

- **formula**: A two sided formula, e.g. Y ~ X1 + X2, with cross-classified categorical variables. The second explanatory variable, i.e. X2, is used as the trace variable whose levels are distinguished in the graph with different colors. Interactions and nested terms are not allowed.
- **counts**: A vector of counts for the associated categorical variables in formula.
- **resp.lvl**: The level in Y of primary interest. See example below.
- **data**: Dataframe containing variables in formula.
- **circle.mult**: Multiplier for circle radii in the diagram.
- **xlab**: X-axis label. By default this is defined as the categories in the first explanatory variable, X1.
- **ylab**: Y-axis label. By default these will be proportions with respect to the specified level of interest in the response.
- **leg.title**: Legend title. By default the conditioning variable name.
- **leg.loc**: Legend location. A legend location keyword: "bottomright", "bottom", "bottomleft", "left", "topleft", "top", "topright", "right" or "center".
- **show.mname**: Logical, indicating whether or not the words "Marginal prop" should printed in the graph above the dotted line indicating marginal proportions.
- **...**: Additional arguments from plot.

Author(s)

Ken Aho

References


Examples

```r
require(tcltk)

data(death.penalty)# from Agresti 2012

op <- par(mfrow=c(1,2), mar=c(4,4,0,0))
pair(verdict ~ d.race + v.race, counts = count, data = death.penalty, 
  legend = "Victims race", xlab = "Defendants race", 
  ylab = "Proportion receiving death penalty")
par(mar=c(4,2,0,2))
pair(verdict ~ v.race + d.race, counts = count, data = death.penalty, 
  legend = "Victims race", xlab = "Defendants race", 
  ylab = "", yaxt = "n")

message("Type: vignette("simpson") for more information about this figure")
par(op)
```

**pairw.anova**

Conducts pairwise post hoc and planned comparisons associated with an ANOVA

Description

The function `pairw.anova` replaces the defunct Pairw.test. Conducts all possible pairwise tests with adjustments to $P$-values using one of five methods: Least Significant difference (LSD), Bonferroni, Tukey-Kramer honest significantly difference (HSD), Scheffe's method, or Dunnett's method. Dunnett's method requires specification of a control group, and does not return adjusted $P$-values. The functions scheffe.cont and bonf.cont allow Bonferroni and Scheffe's family-wise adjustment of individual planned pairwise contrasts.

Usage

```r
pairw.anova(y, x, conf.level = 0.95, method = "tukey", 
  MSE = NULL, df.err = NULL, control = NULL)
lsdCI(y, x, conf.level = 0.95, MSE = NULL, df.err = NULL)
bonfCI(y, x, conf.level = 0.95, MSE = NULL, df.err = NULL)
tukeyCI(y, x, conf.level = 0.95, MSE = NULL, df.err = NULL)
scheffeCI(y, x, conf.level = 0.95, MSE = NULL, df.err = NULL)
dunnettCI(y, x, conf.level = 0.95, control = NULL)
scheffe.cont(y, x, lv1 = c("x1", "x2"), conf.level = 0.95, 
  MSE = NULL, df.err = NULL)
```
bonf.cont(y, x, lvl = c("x1", "x2"), conf.level = 0.95, MSE = NULL, df.err = NULL, comps = 1)

Arguments

y A quantitative vector containing the response variable
x A categorical vector containing the groups (e.g. factor levels or treatments)
conf.level 1 - \( P \) (type I error)
method One of five possible choices: "lsd", "bonf", "tukey", "scheffe", "dunnett"
MSE Value of MSE from the ANOVA model. Default = NULL
df.err Degrees of freedom error from the omnibus ANOVA. Default = NULL
control Control group for Dunnett’s test.
lvl A two element vector defining two factor levels to be compared using Scheffe’s and the Bonferroni method.
comps The number of comparisons to be made in the Bonferroni method.

Details

Adjustment of comparison type I error for simultaneous inference is a contentious subject and will not be discussed here. For description of methods go to Kutner et al. (2005). For models where the number of factors is \( \geq 2 \), MSE and the residual degrees of freedom (used in the computation of confidence intervals for all pairwise methods used here) will vary depending on the experimental design and the number of factors. Thus, for multifactor designs the user should specify the residual degrees of freedom and MSE from the overall ANOVA. This will be unnecessary for one-way ANOVAs.

Value

The function `pairw.anova` and the confidence interval functions it calls return a list of `class = "pairw"`. For all but the LSD test (which also returns LSD) and Dunnett’s test (which does not return adjusted \( P \)-values), the utility function `print.pairw` returns a descriptive head and a six column summary dataframe containing:

1) the type of contrast (names are taken from levels in \( x \)),
2) the mean difference,
3) the lower confidence bound of the true mean difference,
4) the upper confidence bound of the true mean difference,
5) the hypothesis decision, given the prescribed significance level, and
6) the adjusted \( P \)-value.

Other invisible objects include:

cont A vector of contrasts.
conf The confidence level.
band

A two column matrix containing the lower and upper confidence bounds.

The `pairw` class also has a utility function `plot.pairw` which provides either a barplot of location measures with errors and letters indicating whether true effects are significant and the defined significance level (argument type = 1) or confidence intervals for the true difference of each comparison (argument type = 2). See code below and `plot.pairw` for examples.

**Note**

Different forms of these functions have existed for years without implementation into libraries. My version here, based on the function `outer` is unique.

**Author(s)**

Ken Aho

**References**


**See Also**

`plot.pairw`. Functions from library `mult.comp` provide more sophisticated comparisons including customized contrasts and one tailed tests.

**Examples**

```r
eggs <- c(11,17,16,14,15,12,10,15,11,23,20,18,17,27,33,22,26,28)
trt <- as.factor(c(1,1,1,1,1,2,2,2,2,2,3,3,3,4,4,4,4,4))

pairw.anova(y = eggs, x = trt, method = "lsd")##LSD method
pairw.anova(y = eggs, x = trt, method = "bonf")##Bonferroni
pairw.anova(y = eggs, x = trt, method = "scheffe")##Sheffe
tukey <- pairw.anova(y = eggs, x = trt, method = "tukey")##Tukey HSD

plot(tukey)
#you can also try plot(tukey, type = 2)

blood.count <- data.frame(bc = c(7.4,8.5,7.2,8.24,9.84,8.32,9.76,8.8,7.68,9.36,12.8,9.68,12.16,9.2,10.55), trt = c(rep("C",6),rep("A",4),rep("B",5)))
with(blood.count,pairw.anova(y = bc,x = trt,control = "C",method = "dunnett"))##Dunnett

scheffe.cont(y = eggs, x = trt, lvl = c(1,3))
scheffe.cont(y = eggs, x = trt, lvl = c(1,2))

bonf.cont(y = eggs, x = trt, lvl = c(1,3), comps = 2)
bonf.cont(y = eggs, x = trt, lvl = c(1,2), comps = 2)
```
Multiple pairwise comparison procedure to accompany a Friedman test.

Description

Replaces now defunct `fr.muti.comp`. As with ANOVA we can examine multiple pairwise comparisons from a Friedman test after we have rejected the overall null hypothesis. However we will need to account for family-wise type I error in these comparisons which will be non-orthogonal. A conservative multiple comparison method used here is based on the Bonferroni procedure.

Usage

```r
pairw.fried(y, x, blocks, nblocks, conf = 0.95)
```

Arguments

- `y`: A vector of responses, i.e. quantitative data.
- `x`: A categorical vector of factor levels.
- `blocks`: A categorical vector of blocks.
- `nblocks`: The number of blocks.
- `conf`: The level of confidence. 1 - \( P \) (type I error).

Value

Returns a list of class = "pairw". The utility print function returns a descriptive head and a six column summary dataframe containing:

1. the type of contrast (names are taken from levels in `x`),
2. the mean rank difference,
3. the lower confidence bound of the true mean rank difference,
4. the upper confidence bound of the true mean rank difference,
5. the hypothesis decision given the prescribed significance level, and
6. the adjusted \( P \)-value.

Author(s)

Ken Aho

References


pairw.kw

Multiple pairwise comparison procedure to accompany a Kruskal-Wallis test

Description

Replaces the defunct kw.multi.comp. As with ANOVA we can examine multiple pairwise comparisons from a Kruskal-Wallis test after we have rejected our omnibus null hypothesis. However we will need to account for the fact that these comparisons will be non-orthogonal. A conservative multiple comparison method used here is based on the Bonferroni inequality.

Usage

pairw.kw(y, x, conf)

Arguments

y
The response variable. A vector of quantitative responses.

x
An explanatory variable. A vector of factor levels.

conf
The level of desired confidence, 1 - P(type I error).

Value

Returns a list of class = "pairw". The utility print function returns a descriptive head and a six column summary dataframe containing:

1) the type of contrast (names are taken from levels in x),
2) the mean rank difference,
3) the lower confidence bound of the true mean rank difference,
4) the upper confidence bound of the true mean rank difference.
5) the hypothesis decision given the prescribed significance level,
6) the adjusted $P$-value.

**Author(s)**

Ken Aho and Richard Boyce [http://www.nku.edu/~boycer/](http://www.nku.edu/~boycer/). Richard provided an adjustment for ties. Thanks to Paule Bodson-Clermont for pointing out issues with the default behaviour of `rank`, leading to incorrect answers from `pair.kw` given missing values.

**References**


**See Also**

`pairw.anova`, `pairw.fried`, `plot.pairw`

**Examples**

```r
rye.data <- data.frame(rye = c(50, 49.8, 52.3, 44.5, 62.3, 74.8, 72.5, 80.2,
47.6, 39.5, 47.7, 50.7), nutrient = factor(c(rep(1, 4), rep(2, 4), rep(3, 4))))
kw <- with(rye.data, pairw.kw(y = rye, x = nutrient, conf = .95))
plot(kw, loc.meas = median, int = "IQR")
# you can also try: plot(kw, type = 2)
```

---

**pairw.oneway**

*Welch tests controlled for simultaneous inference*

**Description**

Conducts all possible pairwise Welch tests with adjustments to $P$-values using methods from `p.adjust`

**Usage**

```r
pairw.oneway(y, x, conf = 0.95, digits = 5, method = "holm")
```

**Arguments**

- `y` Response variable
- `x` Explanatory variable
- `conf` Confidence level
- `digits` Number of digits in results
- `method` Generalized method for controlling family wise type one error. These must be methods from `p.adjust`, i.e., "holm", "hochberg", "hommel", "bonferroni", "BH", "BY", "fdr", "none". Names can be abbreviated.
The function `pairw.oneway` and the confidence interval functions it calls return a list of class = "pairw".

1) the type of contrast (names are taken from levels in x),
2) the mean difference,
3) the lower confidence bound of the true mean difference,
4) the upper confidence bound of the true mean difference,
5) the hypothesis decision, given the prescribed significance level, and
6) the adjusted P-value.

Other invisible objects include:

- `cont` a vector of contrasts.
- `conf` The confidence level.
- `band` A two column matrix containing the lower and upper confidence bounds.

Note

Note that while P-values will be adjusted for simultaneous inference (unless method = "none"), confidence interval width are generally not adjusted. In particular, CI widths correspond to Welch SEs and Satterthwaite t degrees of freedoms. Thus they control for heteroscedasticity, however they do not control for family-wise levels of α unless method = "bonferroni", under which the restrictive confidence level $1 - (\alpha/2r)$ is used, where $r$ is the number of comparisons.

Author(s)

Ken Aho and Peter Eckert

References


See Also

`p.adjust`, `pairw.anova`

Examples

```r
y <- rnorm(30)
x <- as.factor(c(rep(1,10), rep(2,10), rep(3, 10)))
p <- pairw.oneway(y,x)
p
plot(p)
```
panel.cor.res

Functions for customizing correlation matrices

Description

The functions here can be used to customize upper and lower triangles in correlation matrices. In particular, `panel.cor.res` provides correlation coefficients (any alternative from `cor` can be used) and p-values for correlation tests. The function `panel.lm` puts linear fitted lines from simple linear regression in scatterplots. Note that the function `panel.smooth` provides a smoother fit.

Usage

```r
panel.cor.res(x, y, digits = 2, meth = "pearson", cex.cor=1)
panel.lm(x, y, col = par("col"), bg = NA, pch = par("pch"), cex = 1,
col.line = 2,lty = par("lty"))
```

Arguments

- `x`: variable 1 in correlation
- `y`: variable 2 in correlation
- `digits`: number of digits in text for `panel.cor.res`
- `meth`: type of correlation coefficient from `panel.cor.res`, one of "pearson", "spearman", "kendall"
- `cex.cor`: size of text in `panel.lm`
- `col`: color of points in `panel.lm`
- `bg`: background color of points in `panel.lm`
- `pch`: type of symbols for points in `panel.lm`
- `cex`: symbol size in `panel.lm`
- `lty`: line type in `panel.lm`
- `col.line`: color of lines in `panel.lm`

Author(s)

Ken Aho

See Also

- `cor`, `cor.test`, `panel.smooth`

Examples

```r
data(asthma)
attach(asthma)
pairs(asthma,cex.labels=1,cex=.95,gap=.1,lower.panel=panel.cor.res,
upper.panel=panel.lm)
```
Description

Calculates the partial correlation of determination for a variable of interest in a multiple regression.

Usage

```r
partial.R2(nested.lm, ref.lm)
```

Arguments

- `nested.lm`: A linear model without the variable of interest.
- `ref.lm`: A linear model with the variable of interest.

Details

Coefficients of partial determination measure the proportional reduction in sums of squares after a variable of interest, $X$, is introduced into a model. We can see how this would be of interest in a multiple regression.

Value

The partial $R^2$ is returned.

Author(s)

Ken Aho

References


See Also

`cor`, `partial.resid.plot`

Examples

```r
Soil.C<-c(13,20,10,11,2,25,30,25,23)
Soil.N<-c(1.2,2,1.5,1,0.3,2,3,2,7,2.5)
Slope<-c(15,14,16,12,10,18,25,24,20)
Aspect<-c(45,120,100,56,5,20,5,15,15)
Y<-as.vector(c(20,30,10,15,5,45,60,55,45))
```
partial.resid.plot

The function creates partial residual plots which help a user graphically determine the effect of a single predictor with respect to all other predictors in a multiple regression model.

Usage

\begin{verbatim}
partial.resid.plot(x, smooth.span = 0.8, l.f.col = 2, sm.col = 4,...)
\end{verbatim}

Arguments

- **x**: A output object of class \texttt{lm} or class \texttt{glm}
- **smooth.span**: Degree of smoothing for smoothing line.
- **l.f.col**: Color for linear fit.
- **sm.col**: Color for smoother fit.
- **...**: Additional arguments from \texttt{plot}.

Details

Creates partial residual plots (see Kutner et al. 2002). Smoother lines from \texttt{lowess} and linear fits from \texttt{lm} are imposed over plots to help an investigator determine the effect of a particular \textit{X} variable on \textit{Y} with all other variables in the model. The function automatically inserts explanatory variable names on axes.

Value

Returns \textit{p} partial residual plots, where \textit{p} = the number of explanatory variables.

Author(s)

Ken Aho

References


See Also

partial.R2
Examples

Soil.C<-c(13,20,10,11,2,25,30,25,23)
Soil.N<-c(1,2,2,1,5,1,0,3,2,3,7,2,5)
Slope<-c(15,14,16,12,10,18,25,24,20)
Aspect<-c(45,120,100,56,5,20,5,15,15)
Y<-c(20,30,10,15,5,45,60,55,45)
x <- lm(Y ~ Soil.N + Soil.C + Slope + Aspect)
op <- par(mfrow=c(2,2),mar=c(5,4,1,1.5))
partial.resid.plot(x)
par(op)

<table>
<thead>
<tr>
<th>PCB</th>
<th>PCBs and herring egg thickness</th>
</tr>
</thead>
</table>

Description

Thirteen sites in the Great Lakes were selected for a study to quantify PCB concentrations in 1982 and 1996 (Hughes et al. 1998). At each site 9-13 American herring gull (*Larus smithsonianus*) eggs were randomly collected and tested for PCB content.

Usage

data(PCB)

Format

A data frame with 26 observations on the following 3 variables.

- nest  Nest number
- level  PCB levels microgram/gram of dry weight
- year  a numeric vector

Source


References

perm.fact.test

Permutation test for two and three way factorial designs

Description

Provides permutation tests for two and three way designs, using permutations of the response vector with respect to factor levels. One way permutation tests are provided by \texttt{MC.test}, and the function \texttt{oneway.test} in \texttt{coin}.

Usage

\begin{verbatim}
perm.fact.test(y, X1, X2, X3 = NA, perm = 100, method = "a")
\end{verbatim}

Arguments

\begin{itemize}
\item \textbf{y} A vector of response data. A quantitative vector.
\item \textbf{X1} A vector of factor levels describing factor one.
\item \textbf{X2} A vector of factor levels describing factor two.
\item \textbf{X3} If necessary, a vector of factor levels describing factor three.
\item \textbf{perm} Number of permutations.
\item \textbf{method} Either "a" or "b", see below.
\end{itemize}

Details

Manly (1997) describes five factorial permutation methods which allow testing of interactions. None of these should be considered to be extensively tested or strongly supported by the statistical literature. (a) In the first method observations are randomly allocated to factorial treatments preserving the sample size for each treatment. Permutation distributions of the $F$ statistics for A, B, and AB are used for statistical tests. (b) In the second method observations are randomized as above but permutation distributions of MSA, MSB and MSAB are obtained. (c) Edgington (1995) recommended a restricted randomization procedure where observations within a main effect are randomized while holding other effects constant. Either mean squares or $F$ statistics can be used to create permutation distributions. Edgington emphasized that testing interactions with this method are not possible, but that by randomizing over all AB combinations (as in alternative "a" above) provides a test statistic sensitive to interactions. (d) Still and White (1981) recommended a restricted testing procedure (as in (c) above) but recommended testing interactions after "subtracting" main effects. (e) Ter Braak (1992) recommended replacing observations by their residuals from the initial linear model. These are then permuted, assuming that sample sizes were equal to original sample sizes across interactions of treatments. Permutation distributions of the $F$ statistics for A, B, and AB are then used for statistical tests. Manly (1997) recommends methods a, b, d, or e. Methods a and b are currently implemented.

Value

A dataframe is returned describing initial $F$ test statistics for main effects and interactions, degrees of freedom, and permutation $P$-values.
pika

Author(s)

Ken Aho

References


See Also

MC.test

Examples

lizard<-data.frame(ants=c(13,242,105,8,59,20,515,488,88,18,44,21,182,21,7,24,312,68, 460,1223,900,140,40,27),size=factor(c(rep(1,12),rep(2,12))), month=factor(rep(rep(c(1,2,3,4),each=2),2)))
attach(lizard)
perm.fact.test(ants,month,size,perm=100, method = "b")

pika Nitrogen content of soils under pika haypiles

Description

Aho (1998) hypothesized that pikas worked as ecosystem engineers by building relatively rich soils (via decomposing haypiles and fecal accumulations) in otherwise barren scree. Soils from twenty one paired on-haypile and off-haypile sites were gathered from Rendezvous Peak Grand Teton National Park to determine if the habitats differed in total soil nitrogen.

Usage

data(pika)

Format

A data frame with 22 observations on the following 2 variables.

Haypile a numeric vector
On.Off..N a numeric vector
References


---

**plantTraits**

*Plant traits for 136 species*

**Description**

This dataset, from the library `cluster`, describes 136 plant species according to biological attributes (morphological or reproductive).

**Usage**

data(plantTraits)

**Format**

A data frame with 136 observations on the following 31 variables.

- `pdias`: Diaspore mass (mg).
- `longindex`: Seed bank longevity.
- `durflow`: Flowering duration.
- `height`: Plant height, an ordered factor with levels '1' < '2' < ... < '8'.
- `begflow`: Time of first flowering, an ordered factor with levels '1' < '2' < '3' < '4' < '5' < '6' < '7' < '8' < '9'.
- `mycor`: Mycorrhizae, an ordered factor with levels '0'never < '1' sometimes< '2'always.
- `vegaer`: Aerial vegetative propagation, an ordered factor with levels '0'never < '1' present but limited< '2'important.
- `vegsout`: Underground vegetative propagation, an ordered factor with 3 levels identical to 'vegaer' above.
- `autopoll`: Selfing pollination, an ordered factor with levels '0'never < '1'rare < '2' often< the rule'3'.
- `insects`: Insect pollination, an ordered factor with 5 levels '0' < ... < '4'.
- `wind`: Wind pollination, an ordered factor with 5 levels '0' < ... < '4'.
- `lign`: A binary factor with levels '0:1', indicating if plant is woody.
- `piq`: A binary factor indicating if plant is thorny.
- `ros`: A binary factor indicating if plant is rosette.
- `semiros`: Semi-rosette plant, a binary factor ('0': no; '1': yes).
- `leafy`: Leafy plant, a binary factor.
- `suman`: Summer annual, a binary factor.
- `winan`: Winter annual, a binary factor.
monocarp  Monocarpic perennial, a binary factor.
polycarp  Polycarpic perennial, a binary factor.
seasaes  Seasonal aestival leaves, a binary factor.
seashiv  Seasonal hibernal leaves, a binary factor.
seasver  Seasonal vernal leaves, a binary factor.
everalw  Leaves always evergreen, a binary factor.
everparti  Leaves partially evergreen, a binary factor.
elaio  Fruits with an elaiosome (dispersed by ants), a binary factor.
endozoo  Endozoochorous fruits, a binary factor.
epizoo  Epizoochorous fruits, a binary factor.
aquat  Aquatic dispersal fruits, a binary factor.
windgl  wind dispersed fruits, a binary factor.
unsp  Unspecialized mechanism of seed dispersal, a binary factor.

Details
Most of factor attributes are not disjunctive. For example, a plant can be usually pollinated by insects but sometimes self-pollination can occur.

Note
The description here follows directly from that in cluster.

Source

plot.pairw
Plots confidence intervals and/or bars with letters indicating significant differences for objects from class pairw

Description
Provides a utility confidence interval plotting function for objects of class = "pairw", e.g., objects from pairw.anova, pair.fried, and pairw.kw.

Usage
```
## S3 method for class 'pairw'
plot(x, type = 1, lcol = 1, lty = NULL, lwd = NULL,
cap.length = 0.1, xlab = "", main = NULL, ...
```
Arguments

- **x**: An object of class `pairw`.
- **type**: Two types of plots can be made. Type 1 is a barplot with identical letters over bars if the differences are not significant after adjustment for simultaneous inference. Type 1 plots can be modified using `bplot` arguments. A type 2 plot shows confidence intervals for true differences.
- **lcol**: Confidence bar line color for a type 2 plot, see `par`.
- **lty**: Confidence bar line type, see `par`.
- **lwd**: Confidence bar line width, see `par`.
- **cap.length**: Widths for caps on interval bars (in inches).
- **xlab**: X-axis label.
- **main**: Main caption. Defaults to a descriptive head.
- **...**: Additional arguments from `bplot` or `barplot` for type 1 and 2 graphs, respectively.

Author(s)

Ken Aho. Letters for type 1 graphs obtained using the function `multcompletters` from package `multcompView` which uses the algorithm of Peipho (2004).

References


See Also

`pairw.anova`, `pairw.fried`, `pairw.kw`, `barplot`, `bplot`, `multcompletters`

Examples

eggs <- c(11,17,16,14,15,12,10,15,19,11,23,20,18,17,27,33,22,26,28)
trt <- as.factor(c(1,1,1,1,2,2,2,2,3,3,3,4,4,4,4,4))

# Type 1 plot
plot(pairw.anova(y = eggs, x = trt, method = "scheffe", conf = .8), int = "CI", conf = .8)

# Type 2 plot
plot(pairw.anova(y = eggs, x = trt, method = "scheffe", conf = .8), type = 2)

# Data from Fox and Randall (1970)
tremors <- data.frame(freq = c(2.58, 2.63, 2.62, 2.85, 3.01, 2.7, 2.83, 3.15, 3.43, 3.47, 2.78, 2.71, 3.02, 3.14, 3.35, 2.36, 2.49, 2.58, 2.86, 3.1, 2.67, 2.96, 3.08, 3.32, 3.41, 2.43, 2.5, 2.85, 3.06, 3.07), weights = factor(rep(c(7.5, 5, 2.5, 1.25, 0), 6)), block = factor(rep (1 : 6, each = 5)))

plot(with(tremors, pairw.fried(y = freq, x = weights, blocks = block, nblocks = 6, conf = .95)), loc.meas = median, int = "IQR", bar.col = "lightgreen")
plotAncova

`plotAncova`  

Creates plots for one way ANCOVAs

Description

ANCOVA plots are created, potentially with distinct line types and/or symbols and colors for treatments. A legend relating ciphers to treatments is also included.

Usage

```
plotAncova(model, pch = NULL, lty = NULL, col = NULL, leg.loc = "topright", leg.cex = 1, leg.bty = "o", leg.bg = par("bg"), legend.title = NULL,...)
```

Arguments

- `model` Result from `lm`. An additive model results in a common slope plot. An interaction model results in distinct slopes for treatments
- `pch` A scalar, or a vector of length \( n \) defining symbols for treatments.
- `lty` A scalar, or a vector of length \( n \) defining line types for treatments.
- `col` A scalar, or a vector of length \( n \) defining color for symbols and lines.
- `leg.loc` Location of the legend. "n" suppresses the legend.
- `leg.cex` Character expansion from `legend`.
- `leg.bty` Box type from `legend`.
- `leg.bg` Background color from `legend`.
- `legend.title` Legend title from `legend`.
- `...` Additional arguments from `plot`

Value

Returns an ANCOVA plot and model coefficients.

Author(s)

Ken Aho

See Also

`lm`
Examples

x <- rnorm(20)
y <- 3 * x + rnorm(20)
l <- lm(y ~ x * cat)
plotAncova(l, leg.loc = "bottomright")

Description

Plots the fitted line from a simple linear regression (y ~ x) and (if requested) confidence and prediction intervals.

Usage

plotCI.reg(x, y, conf = 0.95, CI = TRUE, PI = TRUE, resid = FALSE, reg.col = 1,
CI.col = 2, PI.col = 4, reg.lty = 1, CI.lty = 2, PI.lty = 3, reg.lwd = 1,
CI.lwd = 1, resid.lty = 3, resid.col = 4,...)

Arguments

x The explanatory variable, a numeric vector.
y The response variable, a numeric vector.
conf The level of confidence; 1 - \( P(\text{type I error}) \).
CI Logical; should the confidence interval be plotted?
PI Logical; should the prediction interval be plotted?
resid Logical; should residuals be plotted?
reg.col Color of the fitted regression line.
CI.col Color of the confidence interval lines.
PI.col Color of the prediction interval lines.
reg.lty Line type for the fitted regression line.
CI.lty Line type for the confidence interval.
PI.lty Line type for the confidence interval.
reg.lwd Line width for the regression line.
CI.lwd Line widths for the confidence and prediction intervals.
resid.lty Line width for the regression line.
resid.col Line color for residual lines.
... Additional arguments from \texttt{plot}
Value

Returns a plot with a regression line and (if requested) confidence and prediction intervals

Author(s)

Ken Aho

See Also

plot, predict

Examples

```R
y <- c(1, 2, 1, 3, 4, 2, 3, 4, 3, 5, 6)
x <- c(2, 3, 1, 4, 5, 4, 5, 6, 7, 6, 8)
plotCI.reg(x, y)
```

---

PM 2.5 pollutant data from Pocatello Idaho.

Description

PM 2.5 pollutants (those less than 2.5 microns in diameter) can be directly emitted from sources such as forest fires, or can form when gases discharged from power plants, industries and automobiles react in the air. Once inhaled, these particles can affect the heart and lungs and cause serious health problems. The DEQ began monitoring PM 2.5 pollutants in Pocatello Idaho in November 1998.

Usage

data(PM2.5)

Format

A data frame with 65 observations on the following 2 variables.

- `pmN`: A numeric vector describing PM 2.5 pollutant levels in $\mu g/m^2$.

Source

Idaho department of Environmental Quality
Polyamine data from Hollander and Wolfe (1999)

Description
Polyamines are a class of organic compounds having two or more primary amino groups. They appear to have a number of important functions including regulation of cell proliferation, cell differentiation, and cell death. Polyamine plasma levels taken for healthy children of different ages were summarized by Hollander and Wolfe (1999).

Usage
data(polyamine)

Format
A data frame with 25 observations on the following 2 variables.

age Child age in years (0 indicates newborn)
p.amine Polyamine level in blood

Source

Portneuf River longitudinal N and P data

Description
Portneuf River data from the Siphon Road site near Pocatello Idaho, downstream from an elemental P refinery.

Usage
data(portneuf)

Format
A data frame with 176 observations on the following 3 variables.

date Dates from 1998-01-15 to 2011-08-16
TKN Total Kjeldahl nitrogen (measured as a percentage)
total.P Total phosphorous (mg/L)
potash

Source
Idaho State Department of Environmental Quality

Description
An oft-cited RCBD example is an agricultural experiment which evaluates the effect of levels of soil K\textsubscript{2}O (potash) on the breaking strength of cotton fibers (Cochran and Cox 1957). Five levels of K\textsubscript{2}O were used in the soil subplots (36, 54, 72, 108, and 144 lbs per acre) and a single sample of cotton was taken from each of five subplot. The experiment had three blocks, and each of the K\textsubscript{2}O treatments was randomly assigned to the five subplots within each block.

Usage
data(potash)

Format
A data frame with 15 observations on the following 3 variables.

- treatment: a factor with levels SV UT WR QPX QTT
- block: a factor with levels 1 2 3
- strength: a numeric vector

Source

potato

Description
In his "Statistical Methods for Research Workers" Fisher (1925) introduced the world to ANOVA using data from the famous Rothamsted Agricultural Experimental Station. In one example Fisher compared potato yield (per plant) for twelve potato varieties and three fertilizer treatments (a basal manure application, along with sulfur and chloride addition). Three replicates were measured for each of the 12 x 3 = 36 treatment combinations.

Usage
data(potato)
power.z.test

Format

A data frame with 108 observations on the following 4 variables.

Yield  Potato yield in lbs per plant
Variety  Potato variety: Ajax Arran comrade British queen Duke of York Epicure Great Scot
         Iron duke K of K Kerrs pink Nithsdale Tinwald perfection Up-to-date
Fert  Fertilizer type: B = basal manure, Cl = chloride addition, S = sulfur addition.
Patch  Feld patch number 1 2 3 4 5 6 7 8 9

Source


power.z.test  Power analysis for a one sample z-test

Description

A power analysis for a one sample z-test. The function requires $\alpha$, $\sigma$, the effect size, the type of test
(one tailed or two-tailed), and either power $(1 - \beta)$ or $n$ (sample size). If $n$ is provided, then power
is calculated. Conversely, if one provides power, but not $n$, then the required $n$ is calculated.

Usage

power.z.test(sigma = 1, n = NULL, power = NULL, alpha = 0.05, effect = NULL, test = c("two.tail", "one.tail"), strict = FALSE)

Arguments

sigma  The population standard deviation.
n  The sample size. Not required if power is specified.
power  The desired power. Not required if n is specified.
alpha  Probability of type I error.
effect  Effect size.
test  One of two choices: "two.tail" or "one.tail".
strict  Causes the function to use a strict interpretation of power in a two-sided test. If
        strict = TRUE then power for a two sided test will include the probability of
        rejection in the opposite tail of the true effect. If strict = FALSE (the default)
        power will be half the value of $\alpha$ if the true effect size is zero.
Value

Returns a list

- **sigma**: The prescribed population variance.
- **n**: The sample size.
- **power**: The power.
- **alpha**: The type I error probability.
- **test**: The type of test prescribed.
- **effect**: The effect size.

Author(s)

Ken Aho

References


See Also

- `pnorm`

Examples

```
power.z.test(sigma=6, effect=5, power=.9, test="one.tail")
```

---

**Description**

Calculates PREdiction Sum of Squares (*PRESS*) for a linear model.

**Usage**

```
press(lm, as.R2 = FALSE)
```

**Arguments**

- **`lm`**: An object of class `lm`.
- **as.R2**: Logical. Whether or not output should be expressed as predicted $R^2$, i.e., $PRESS/TSS$. 

Details

The press statistic is calculated as:

\[ \sum_{i=1}^{n} d_i^2 \]

where

\[ d_i = \frac{e_i}{1 - h_{ii}} \]

where \( h_{ii} \) is the \( i \)th diagonal element in the hat matrix.

Value

Returns the \( PRESS \) statistic.

Author(s)

Ken Aho

References


See Also

\texttt{cor}

Examples

```r
Y <- rnorm(100)
X <- rnorm(100)
press(lm(Y ~ X))
```

Preston.dist Preston diversity analysis

Description

A diversity and richness analysis method based on the Preston (1948) log-normal distribution.

Usage

\texttt{Preston.dist(counts, start = 0.2, cex.octave = 1, cex.legend = 1, cex.pt = 1, \ldots)}
Arguments

 counts Vector of counts for species in a community dataset.
 start Starting value for non-linear least squares estimation of $a$ in $n = n_0 \times e^{-aR^2}$.
 cex.octave Character expansion for octave labels.
 cex.legend Character expansion for legend.
 cex.pt Character expansion for symbols.
 ... Additional arguments from plot.

Details

Preston (1948) proposed that after a log$_2$ transformation species abundances, grouped in bins representing a doubling of abundance (octaves), would be normally distributed. Thus, after this transformation most species in a sample would have intermediate abundance, and there would be relatively few rare or ubiquitous species. The Preston model is based on the Gaussian function: $n = n_0 \times e^{-aR^2}$, where, $n_0$ is the number of species contained in the modal octave, $n$ is the number of species contained in an octave $R$ octaves from the modal octave, and $a$ is an unknown parameter. The parameter $a$ is estimated using the function nls, using a starting value, 0.2, recommended by Preston. The area under Preston curve provides an extrapolated estimate of richness and thus an indication of the adequacy of a sampling effort. Preston called a line placed at the 0th octave the veil line. He argued that species with abundances below the veil line have not been detected due to inadequate sampling.

Value

Graph of the Preston log-normal distribution for a dataset given by "counts", and a summary of the analysis including the fitted Gaussian equation, the estimated number of species, and an estimate for the percentage of sampling that was completed i.e. \([\text{length(counts)}/\text{Est.no.of.spp}]\times 100\).

Author(s)

Ken Aho

References


See Also

dnorm, nls

Examples

data(BCI.count)
BCI.ttl<-apply(BCI.count,2,sum)
preston.dist(BCI.ttl)
### Prostate cancer data

**Description**

Hastie et al. (2001) describe a cancer research study that attempted to associate prostate specific antigens and a number of prognostic measures in the context of advanced prostate cancer. Data in the experiment were collected from 97 men who were about to undergo radial prostectomies.

**Usage**

```r
data(prostate)
```

**Format**

A data frame with 97 observations on the following 4 variables.

- **psa** Serum prostate-specific albumin level (mg/ml).
- **vol** Tumor volume (cc).
- **weight** Prostate weight (g).
- **gleason** Pathologically determined grade of disease. Summed scores were either 6, 7, or 8 with higher scores indicating worse prognosis.

**Source**


**References**


---

### Perpendicularity

**Description**

Calculates a perpendicularity index, $\eta$, for animal spatial movements. The index has a [0, 1] range with 0 indicating a perfectly parallel movement with respect to boundary or edge and 1 indicating perfectly perpendicular movement. Other summaries are also provided.
Usage

prp(Time, S.X, S.Y, N.X, N.Y, habitat = NULL, near.angle = NULL, F.0.NA = TRUE)

Arguments

Time A numeric vector containing the times when spatial coordinates were recorded.
S.X X-coordinates of animal.
S.Y Y-coordinates of animal.
N.X X-coordinate of nearest point on boundary. These data can be obtained from function near.bound or from ARCGIS Near output.
N.Y Y-coordinate of nearest point on boundary. These data can be obtained from function near.bound or from ARCGIS Near output.
habitat A character vector of habitat categories.
near.angle A numeric vector containing the angle of azimuth to the nearest point on the boundary with respect to a four quadrant system. NE = 0° to 90°, NW is > 90° and ≤ 180°, SE is < 0° and ≤ −90° is > −90° and ≤ −180°. This output can be obtained from function bound.angle or from ARCGIS Near output.
F.0.NA A logical argument specifying whether or not a time interval in which F = 0 should be made NA (see Figure from examples)

Details

This index for perpendicularity, \( \eta \) is based on the following rules:

if \( \delta \leq 90^\circ \) then \( \eta = \delta/90^\circ \); if \( 90^\circ < \delta \leq 135^\circ \) then \( \eta = [90^\circ - (\delta - 90^\circ)]/90^\circ \); if \( 135^\circ < \delta \leq 180^\circ \) then \( \eta = (\delta - 90^\circ)/90^\circ \)

For notation create Figures from examples.

Value

Returns a list with four or five items.

lines A matrix with \( n - 1 \) rows containing line lengths for the lines A, B, C, D, and F. See figure in examples below.
angles A matrix with \( n - 1 \) rows containing line lengths for the angles \( \kappa, \gamma \) and \( \delta \). See Figure in examples below.
moment.by.moment This component provides a matrix with \( n - 1 \) rows. Included are the columns: End.time, Eta.Index, Delta, Habitat, and Brdr chng. The columns Habitat, and Brdr chng are excluded if habitat = NULL or near.angle = NULL.
P.summary Contains averages and standard errors for \( \eta \).
crossing.summary Crossing binomial summaries. Provided if habitat and near.angle are specified.
Author(s)
Ken Aho

References

McGarigal K., SA Cushman, M.C. Neel, and E. Ene (2002) FRAGSTATS: Spatial Pattern Analysis Program for Categorical Maps. Computer software program produced by the authors at the University of Massachusetts, Amherst.

See Also

* nearNbound, bound.angle

Examples

```r
## Not run:
## #Diagram describing prp output.
y<-rnorm(100,0,5)
plot(seq(1,100),sort(y),type="l",xaxt="n",yaxt="n",lwd=2,xlab="",ylab="")
op <- par(font=3)
segments(52,-12,46,sort(y)[46],lty=1,col=1,lwd=1)#A
segments(90,-8,85,sort(y)[85],lty=1,col=1,lwd=1)#B
segments(46,sort(y)[46],85,sort(y)[85],lty=1)#F
segments(90,-8,46,sort(y)[46],lty=2)#D
arrows(52,-12,90,-8,length=.1,lwd=3)#C
arrows(20,-12,20,8,lty=2,col="gray",length=.1)#North
arrows(20,sort(y)[46],95,sort(y)[46],length=.1,lty=2,col="gray")
arrows(20,-12,95,-12,length=.1,lty=2,col="gray")#East
text(20,9,"N",col="gray");text(97,-12,"E",col="gray");text(97,sort(y)[46],"E",col="gray")
text(49.5,-12.5,"A");text(92.5,-8.5,"b")
text(67.5,-2.5,"D",font=4,col=1)
text(44,sort(y)[46]+1,"c");text(67.5,-2.5,"D",font=4,col=1)
text(70,-9,"C",font=4,col=1);text(91.5,-1.75,"B",font=4,col=1)
text(44,sort(y)[46]+1,"c");text(67.5,-2.5,"D",font=4,col=1)
text(87,sort(y)[87]+1,"d");text(57,-10,expression(kappa),col=1)
text(81,sort(y)[87]-3,expression(gamma),col=1);text(57,1.3,expression(theta),col=1)
text(64,-11.5,expression(beta),col=1)
library(plotrix)
draw.arc(50,-12,6,1.35,col=1);draw.arc(50,-12,6,3,col=1);draw.arc(50,-12,6,.02,col=1)
draw.arc(46,sort(y)[46],7,.01,col=1);draw.arc(46,sort(y)[46],7,.5,col="white")
draw.arc(85,sort(y)[85],6,-2.7,col=1);draw.arc(85,sort(y)[85],6,-1.4,col="white",lwd=2)
legend("topleft",c(expression(paste(kappa, " = \text{acos}([","C^2"," + ",X^2"," - ",D^2",])
```

The function returns jackknife pseudo-values which can then be used to create statistical summaries, e.g. the jackknife parameter estimate, and the jackknife standard error. The function can be run on univariate data (matrix = FALSE) or multivariate data (matrix = TRUE). In the later case matrix rows are treated as multivariate observations.

Usage

pseudo.v(data, statistic, order = 1, matrix = FALSE)
Arguments

data A vector (matrix =FALSE) or matrix (matrix=TRUE) of quantitative data.
statistic A function whose output is a statistic (e.g. a sample mean). The function must have only one argument, a call to data.
order The order of jackknifing to be used.
matrix A logical statement. If matrix = TRUE then rows in the matrix are sampled as multivariate observations.

Details

In the first order jackknife procedure a statistic \( \hat{\theta} \) is calculated using all \( n \) samples, it is then calculated with the first observation removed \( \hat{\theta}_1 \), with only the second observation removed, \( \hat{\theta}_2 \), and so on. This process is repeated for all \( n \) samples. The resulting vector of size \( n \) contains pseudovalues for their respective observations.

Value

A vector of first-order jackknife pseudovalues is returned.

Author(s)

Ken Aho

References


See Also

dataHcliffNspI,

cshannon.

Examples

data(cliff.sp)
siteCD1<-data.frame(t(cliff.sp[1,]))

#Shannon-Weiner diversity
SW<-function(data){
d<-data[data!=0]
p<-d/sum(d)
-1*sum(p*log(p))
}

pv<-pseudo.v(siteCD1,SW)
qq.Plot

Normal quantile plots for single or multiple factor levels

Description

Provides quantile plots for one or more factor levels overlaid on a single graph. If plot.CI = TRUE, then code for bootstrapped confidence provided in the documentation for boot is applied to create confidence envelopes. If plot.CI = FALSE, qqnorm and qqline are used to create overlaid normal probability plots given multiple categories in x.

Usage

qq.Plot(y, x = NULL, col = NULL, pch = NULL, main = "", R = 5000, fit.lty = 1, env.lty = 2, conf = 0.95, type = "point", ylim = NULL, xlim = NULL, xlab = NULL, ylab = NULL, plot.CI = FALSE, standy = TRUE, ...)

Arguments

y The response variable
x A categorical variables to subset y
col A scalar or vector with length equivalent to the number of levels in x, describing colors of points and lines for levels in x.
pch A scalar or vector with length equivalent to the number of levels in x, describing symbols for levels in x.
main Main title.
R Number of bootstrap samples for calculating confidence envelopes
fit.lty Line type for fit line(s).
env.lty Line type for fit line(s).
conf Level of confidence in confidence envelopes.
type Type of bootstrapped confidence envelope. One of "point" or "overall".
xlim A two element vector defining the lower and upper x-axis limits.
ylim A two element vector defining the lower and upper y-axis limits.
xlab X-axis label.
ylab Y-axis label.
plot.CI Logical, specifying whether or not confidence ellipses should be plotted.
standy Logical, specifying if observations should be standardized.
... Other arguments from plot.

Author(s)

Ken Aho
See Also

qqnorm, qline, envelope, boot

Examples

```R
y <- rnorm(50)
x <- c(rep(1, 25), rep(2, 25))
qq.plot(y, x)
```

Description

Calculates biweight midvariance if one variable is given and biweight midvariances, midcovariance and midcorrelation if two variables are given. Biweight midcorrelation is a robust alternative to Pearson’s \( r \).

Usage

```R
r.bw(x, y=NULL)
```

Arguments

- `x` A numeric vector
- `y` An optional second numeric variable.

Details

Biweight statistics are robust to violations of normality. Like the sample median the sample midvariance has a breakdown point of approximately 0.5. The triefficiency of the biweight midvariance was the highest for any of the 150 measures of scale compared by Lax (1985).

Value

Returns the biweight variance if one variable is given, and the biweight midvariances, midcovariance and midcorrelation if two variables are given.

Author(s)

Ken Aho

References


See Also

cor, r.pb

Examples

```r
x<-rnorm(100)
y<-rnorm(100)
r.bw(x,y)
```

**r.dist**  
Visualize the sampling distribution of Pearson’s product moment correlation

**Description**

Stumbling points for many methods of inference for the true correlation $\rho$ and for independence are: 1) asymmetry, 2) explicit bounds on $\rho$, and 3) dependence on sample size, of the sampling distribution of $r$.

The functions here allow visualization of these characteristics. The algorithm used for the sampling distribution of $r$ is based on the first two steps in an asymptotic series (see Kenney and Keeping 1951).

**Usage**

```r
r.dist(rho, r, n)
see.r.dist.tck()
```

**Arguments**

- `rho`  
  Population correlation
- `r`  
  A numeric vector containing possible estimates of `rho`.
- `n`  
  Sample size, an integer.

**Details**

All distributions are standardized to have an area of one.

**Author(s)**

Ken Aho

**References**


See Also

cor

Examples

dev.new(height=3.5)
op <- par(mfrow=c(1,2),mar=c(0,0,1.5,3), oma=c(5, 4.2, 0, 0))
vals <- r.dist(0.9, seq(-1, 1, .001), 5)
plot(seq(-1, 1, .001), vals, type = "l", ylab = "", xlab = "")
vals <- r.dist(0.5, seq(-1, 1, .001), 5)
lines(seq(-1, 1, .001), vals, lty = 2)
vals <- r.dist(0.0, seq(-1, 1, .001), 5)
lines(seq(-1, 1, .001), vals, lty = 3)
legend("topleft", lty = c(1, 2, 3), title = expression(paste(italic(n), " = 5")),
legend = c(expression(paste(rho, " = 0.9")),expression(paste(rho, " = 0.5")),
expression(paste(rho, " = 0"))), bty = "n")
vals <- r.dist(0.9, seq(-1, 1, .001), 30)
plot(seq(-1, 1, .001), vals, type = "l", xlab = "", ylab = "")
vals <- r.dist(0.5, seq(-1, 1, .001), 30)
lines(seq(-1, 1, .001), vals, lty = 2)
vals <- r.dist(0.0, seq(-1, 1, .001), 30)
lines(seq(-1, 1, .001), vals, lty = 3)
legend("topleft", lty = c(1, 2, 3), title = expression(paste(italic(n), " = 30")),
legend = c(expression(paste(rho, " = 0.9")),expression(paste(rho, " = 0.5")),
expression(paste(rho, " = 0"))), bty = "n")
mtext(side = 2, expression(paste(italic(f), "(" , italic(r), ")")), outer = TRUE, line = 3)
mtext(side = 1, expression(italic(r)), outer = TRUE, line = 3, at = .45)
par(op)

R.hat

R hat MCMC convergence statistic

Description

The degree of convergence of a random Markov Chain can be estimated using the Gelman-Rubin
convergence statistic, \( \hat{R} \), based on the stability of outcomes between and within \( m \) chains of
the same length, \( n \). Values close to one indicate convergence to the underlying distribution. Values
greater than 1.1 indicate inadequate convergence.

Usage

R.hat(M, burn.in = 0.5)

Arguments

\( M \) An \( n \times m \) numeric matrix of Markov Chains.

\( \text{burn.in} \) The proportion of each chains to be used as a burn in period. The default value,
0.5, means that only the latter half of the chains will be used in computing \( \hat{R} \).
Details

Gelman et al. (2003, pg. 296) provides insufficient details to reproduce this function. To get the real function see Gelman and Rubin (1992). The authors list one other change in their Statlab version of this function at http://lib.stat.cmu.edu/S/itsim. They recommend multiplying $\sqrt{\text{var}(\hat{\theta})}$ by $\sqrt{\frac{\text{var}(\hat{\theta})}{\text{df}}}$. The original code and this function can produce estimates below 1.

Author(s)

Ken Aho and unknown StatLib author

References


\begin{verbatim}
r.pb

Percentage bend correlation
\end{verbatim}

Description

The percentage bend correlation is a robust alternative to Pearson’s product moment correlation.

Usage

\begin{verbatim}
r.pb(X, Y, beta = 0.2)
\end{verbatim}

Arguments

\begin{verbatim}
X A quantitative vector
Y A second quantitative vector
beta Bend criterion
\end{verbatim}

Details

The percentage bend correlation belongs to class of correlation measures which protect against marginal distribution (X and Y) outliers. In this way it is similar to Kendall’s $\tau$, Spearman’s $\rho$, and biweight midcovariance. A second class of robust correlation measures which take in to consideration the overall structure of the data ($O$ estimators) are discussed by Wilcox (2005, pg. 389). A value for the bend criterion beta is required in the r.pb function; beta = 0.2 is recommended by Wilcox (2005).

Value

A dataframe with the correlation, test statistic and $P$-value for the null hypothesis of independence are returned.
Rabino et al. (2013) provided: CSIRO $\delta^{13}\text{C}$ and CO$_2$ measures covering 1000 years.

**Usage**

data("Rabino_CO2")

**Format**

- **Sample.type**  A factor with levels firn and ice.
- **depth**  Depth of core (in meters).
- **effective.age**  Age of CO$_2$ (in years AD).
- **d13C.CO2**  $\delta^{13}\text{C}$ (per mille).
- **CO2**  CO$_2$ level (in ppm).
- **uncertainty**  Uncertainty in measures (in ppm (CO$_2$) or per mille ($\delta^{13}\text{C}$)).

**Source**

Examples

data(Rabino_CO2)
data(Rabino_del13C)

op <- par(mar=c(5,4.5,1,4.5))
with(Rabino_del13C, plot(effective.age, d13C.CO2, xlab = "Year", type='p',
col = 1, pch = 21, bg = 'red', ylab = ''))
axis(2, col = 'red', col.axis = 'red')
mtext(side = 2, expression(paste(delta,' ',
'^13','C (per mille)'))), col = 'red',
line = 3, cex = 1.2)
par(new = TRUE)

with(Rabino_CO2, plot(effective.age, CO2, type='p', col=1,pch = 21,
bg = 'blue', axes = FALSE, xlab = '', ylab = ''))
axis(4, col = 'blue', col.axis = 'blue')
mtext(side=4,expression(paste('Atmospheric ',
CO[2], ' (ppm)')),
line = 3, col = 'blue', cex = 1.2)
par(op)

rat

Rat glycogen data from Sokal and Rohlf (2012)

Description

This dataset from Sokal and Rohlf (2012) can be used to demonstrate pseudoreplication. Six rats
were randomly given one of three treatments: "control", "compound 217", and "compound 217 +
sugar". After a short period of time the rats were euthanized and the glycogen content of their livers
was measured. Two glycogen measurements were made for three different preparations of each
liver. Clearly the liver preparations and measurements on those preparations are nested in each rat,
and are not independent.

Usage

data(rat)

Format

A data frame with 36 observations on the following 4 variables.

glycogen  A numeric vector describing glycogen levels. Units are arbitrary.
diet  Nutritional compound: 1 = "control", 2 = "compound 217", 3 = "compound 217 + sugar".
rat  Rat animal number.
liver  Liver preparation.
measure  Measurement number.
Source


<table>
<thead>
<tr>
<th>refinery</th>
<th>Refinery CO dataset</th>
</tr>
</thead>
</table>

Description

In the early 1990s an oil refinery northeast of San Francisco agreed with local air quality regulators [the Bay Area Air Quality Management District (BAAQMD)] to reduce carbon monoxide emissions. Baselines for reductions were to be based on measurements of CO made by refinery personnel, and by independent measurements from BAAQMD scientists for the roughly the same time period.

Usage

data(refinery)

Format

The dataframe contains three columns:

- **CO** Carbon monoxide. Measured in ppm.
- **Source** The source of measurements; either refinery or BAAQMD.
- **Date** Month/Day/Year

<table>
<thead>
<tr>
<th>rinvchisq</th>
<th>Random draws from a scaled inverse chi-square distribution</th>
</tr>
</thead>
</table>

Description

The distribution is an important component of Bayesian normal hierarchical models with uniform priors.

Usage

rinvchisq(n, df, scale = 1/df)

Arguments

- **n** The number of random draws.
- **df** Degrees of freedom parameter.
- **scale** Scale non-centrality parameter.
Details

Code based on a function with same name in package goeR.

See Also

The function is a wrapper for rchisq.

---

**rmvm**  
*A multivariate normal dataset for data mining*

---

Description

Contains a $Y$ variable constrained to be a random function of fifteen $X$ variables, which, in turn, are generated from a multivariate normal distribution with no correlation between dimensions.

Usage

data("rmvm")

Format

A data frame with 500 observations on the following 16 variables.

- **Y** A response vector defined to be: $Y = X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7 + X_8 + X_9 + X_{10} + X_{11} + X_{12} + X_{13} + X_{14} + X_{15} + \epsilon$ where $\epsilon \sim N(0,1)$.
- X1 A random predictor
- X2 A random predictor
- X3 A random predictor
- X4 A random predictor
- X5 A random predictor
- X6 A random predictor
- X7 A random predictor
- X8 A random predictor
- X9 A random predictor
- X10 A random predictor
- X11 A random predictor
- X12 A random predictor
- X13 A random predictor
- X14 A random predictor
- X15 A random predictor
Details

Data used by Derryberry et al. (in review) to consider high dimensional model selection applications.

References


Examples

```r
## Code used to create data
## Not run:
sigma <- matrix(nrow = 15, ncol = 15, 0)
diag(sigma) = 1
mvn <- rmvnorm(n=500, mean=rnorm(15), sigma=sigma)
rmvm <- data.frame(cbind(Y, mvn))
names(rmvm) <- c("Y", paste("X", 1:15, sep = ""))

## End(Not run)
```

samp.dist

Animated and/or snapshot representations of a statistic’s sampling distribution

Description

This help page describes a series of asbio functions for depicting sampling distributions. The function samp.dist samples from a parent distribution without replacement with sample size = s.size, R times. At each iteration a statistic requested in stat is calculated. Thus a distribution of R statistic estimates is created. The function samp.dist shows this distribution as an animated anim = TRUE or non-animated anim = FALSE density histogram. Sampling distributions for up to four different statistics utilizing two different parent distributions are possible using samp.dist. Sampling distributions can be combined in various ways by specifying a function in func (see below). The function samp.dist.n was designed to show (with animation) how sampling distributions vary with sample size, and is still under development. The function samp.dist.snap creates snapshots, i.e. simultaneous views of a sampling distribution at particular sample sizes. The function dirty.dist can be used to create contaminated parent distributions.

Usage

```r
samp.dist(parent = NULL, parent2 = NULL, biv.parent = NULL, s.size = 1, s.size2 =
R = 1000, nbreaks = 50, stat = mean, stat2 = NULL, stat3 = NULL, stat4 =
R, xlab = expression(bar(x)), func = NULL, show.n = TRUE, show.SE = FALSE,
anim = TRUE, interval = 0.01, col.anim = "rainbow", digits = 3, ...)
```
samp.dist

```r
samp.dist.snap(parent = NULL, parent2 = NULL, biv.parent = NULL, stat = mean, stat2 = NULL, stat3 = NULL, stat4 = NULL, s.size = c(1, 3, 6, 10, 20, 50), s.size2 = NULL, R = 1000, func = NULL, xlab = expression(bar(x)), show.SE = TRUE, fits = NULL, show.fits = TRUE, xlim = NULL, ylim = NULL, ...)  
samp.dist.method.tck()

samp.dist.tck(statc = "mean")

dsamp.dist.snap.tck1(statc = "mean")

dsamp.dist.snap.tck2(statc = "mean")

dirty.dist(s.size, parent = expression(rnorm(1)), cont = expression(rnorm(1, mean = 10)), prop.cont = 0.1)

samp.dist.n(parent, R = 500, n.seq = seq(1, 30), stat = mean, xlab = expression(bar(x)), nbreaks = 50, func = NULL, show.n = TRUE, show.SE = FALSE, est.density = TRUE, col.density = 4, lwd.density = 2, est ylim = TRUE, ylim = NULL, anim = TRUE, interval = 0.5, col.anim = NULL, digits = 3, ...)
```

Arguments

- `parent` A vector or vector generating function, describing the parental distribution. Any collection of values can be used. When using random value generators for parental distributions, for CPU efficiency (and accuracy) one should use `parent = expression(rpdf(s.size, ...))`. Datasets exceeding 100000 observations are not recommended.

- `parent2` An optional second parental distribution (see `parent` above), useful for the construction of sampling distributions of test statistics. When using random value generators use `parent2 = expression(rpdf(s.size2, ...))`.

- `biv.parent` A bivariate (two column) distribution.

- `s.size` An integer defining sample size (or a vector of integers in the case of `samp.dist.snap`) to be taken at each of `R` iterations from the parental distribution.

- `s.size2` An optional integer defining a second sample size if a second statistic is to be calculated. Again, this will be a vector of integers in the of `samp.dist.snap`.

- `R` The number of samples to be taken from parent distribution(s).

- `nbbreaks` Number of breaks in the histogram.

- `stat` The statistic whose sampling distribution is to be represented. Will work for any summary statistic that only requires a call to data; e.g. `mean`, `var`, `median`, etc.


- `stat3` An optional third statistic. The sampling distribution is created from the same sample data used for `stat`. 

stat4  An optional fourth statistic. The sampling distribution is created from the same sample data used for stat2.

xlab  X-axis label.

func  An optional function used to manipulate a sampling distribution or to combine the sampling distributions of two or more statistics. The function must contain the following arguments (although they needn't all be used in the function): s.dist, s.dist2, s.size, and s.size2. When sampling from a single parent distribution use s.dist3 in the place of s.dist2. For an estimator involving two parent distributions and four statistics, six arguments will be required: s.dist, s.dist2, s.dist3, s.dist4, s.size, and s.size2, s.dist3, and as non-fixed arguments (see example below).

show.n  A logical command, TRUE indicates that sample size for parent will be displayed.

show.SE  A logical command, TRUE indicates that bootstrap standard error for the statistic will be displayed.

anim  A logical command indicating whether or not animation should be used.

interval  Animation speed. Decreasing interval increases speed.

col.anim  Color to be used in animation. Three changing color palettes: rainbow, gray, heat.colors, or "fixed" color types can be used.

digits  The number of digits to be displayed in the bootstrap standard error.

fits  Fitted distributions for samp.dist.snap A function with two argument: s.size and s.size2

show.fits  Logical indicating whether or not fits should be shown (fits will not be shown if no fitting function is specified regardless of whether this is TRUE or FALSE

xlim  A two element numeric vector defining the upper and lower limits of the X-axis.

ylim  A two element numeric vector defining the upper and lower limits of the Y-axis.

statc  Presets for certain statistics. Currently one of "custom", "mean", "median", "trimmed mean", "Winsorized mean", "Huber estimator", "H-L estimator", "sd", "var", "IQR", "MAD", "(n-1)S^2/sigma^2", "F*", "t* (1 sample)", "t* (2 sample)", "Pearson correlation" or "covariance".

cont  A distribution representing a source of contamination in the parent population. Used by function dirty.dist.

prop.cont  The proportion of the parent distribution that is contaminated by code.

n.seq  A range of sample sizes for samp.dist.n

est.density  A logical command for samp.dist.n. if TRUE then a density line is plotted over the histogram. Only used if fix.n = true.

col.density  The color of the density line for samp.dist.n. See est.density above.

lwd.density  The width of the density line for samp.dist.n. See est.density above.

est ylim  Logical. If TRUE Y-axis limits are estimated logically for the animation in samp.dist.n. Consistent Y-axis limits make animations easier to visualize. Only used if fix.n = TRUE.

...  Additional arguments from plot.histogram.
Details

Sampling distributions of individual statistics can be created with samp.dist, or the function can be used in more sophisticated ways, e.g. to create sampling distributions of ratios of statistics, i.e. \( t^*, F^* \) etc. (see examples below). To provide pedagogical clarity animation for figures is provided. To calculate bivariate statistics, specify the parent distribution with biv.parent and the statistic with func (see below).

Two general uses of the function samp.dist are possible. 1) One can demonstrate the accumulation of statistics for a single sample size using animation. This is useful because as more and more statistics are acquired the frequentist paradigm associated with sampling distributions becomes better represented (i.e the number of estimates is closer to infinity). This is elucidated by allowing the default fix.n = TRUE. Animation will be provided with the default anim = TRUE. Up two parent distributions, up to two sample sizes, and up to four distinct statistics (i.e. four distinct sampling distributions, representing four distinct estimators) can be used. The arguments stat and stat3 will be drawn from parent, while stat3 and stat4 will be drawn from parent2. These distributions can be manipulated and combined in an infinite number of ways with an auxiliary function called in the argument func (see examples below). This allows depiction of sampling distributions made up of multiple estimators, e.g. test statistics. 2) One can provide simultaneous snapshots of a sampling distribution at a particular sample size with the function samp.dist.snap.

Loading the package tcltk allows use of the functions samp.dist.tck, samp.dist.method.tck, samp.dist.snap.tck1 and samp.dist.snap.tck2, which provide interactive GUIs that run samp.dist.

Value

Returns a representation of a statistic’s sampling distribution in the form of a histogram.

Author(s)

Ken Aho

Examples

```r
## Not run:
##Central limit theorem
#Snapshots of four sample sizes.
samp.dist.snap(parent=expression(rexp(s.size)), s.size = c(1,5,10,50), R = 1000)

##sample mean animation
samp.dist(parent=expression(rexp(s.size)), col.anim="heat.colors", interval=.3)

##Distribution of t-statistics from a pooled variance t-test under valid and invalid assumptions
#valid
t.star<-function(s.dist1, s.dist2, s.dist3, s.dist4, s.size = 6, s.size2 = s.size){
MSE<-(((s.size - 1) * s.dist3) + ((s.size2 - 1) * s.dist4))/(s.size + s.size2-2)
func.res <- (s.dist1 - s.dist2)/((sqrt(MSE) * sqrt(1/s.size) + (1/s.size2)))
func.res
}
samp.dist(parent = expression(rnorm(s.size)), parent2 =
expression(rnorm(s.size2)), s.size=6, s.size2 = 6, R=1000, stat = mean,
```
stat2 = mean, stat3 = var, stat4 = var, xlab = "t*", func = t.star)

curve(dt(x, 10), from = -6, to = 6, add = TRUE, lwd = 2)
legend("topleft", lwd = 2, col = 1, legend = "t(10)"

#invalid; same population means (null true) but different variances and other distributional
#characteristics.
samp.dist(parent = expression(runif(s.size, min = 0, max = 2)), parent2 =
expression(rexp(s.size2)), s.size=6, s.size2 = 6, R = 10000, stat = mean,
stat2 = mean, stat3 = var, stat4 = var, xlab = "t*", func = t.star)

curve(dt(x, 10), from = -6, to = 6, add = TRUE, lwd = 2)
legend("topleft", lwd = 2, col = 1, legend = "t(10)"

## Pearson's R
require(mvtnorm)
BVN <- function(s.size) rmvnorm(s.size, c(0, 0), sigma = matrix(ncol = 2,
nrow = 2, data = c(1, 0, 0, 1)))
samp.dist(biv.parent = expression(BVN(s.size)), s.size = 20, func = cor, xlab = "r")

#Interactive GUI, require package 'tcltk'
samp.dist.tck("S+2")
samp.dist.snap.tck1("Huber estimator")
samp.dist.snap.tck2("Fx")

## End(Not run)

samp.dist.mech Animated representation of sampling distribution basics

---

**Description**

Mountain goats are randomly sampled 10 at a time and weighed [goat weights are normal N(90.5, 225)], a mean weight is calculated from these measures and added to collection of mean weights in the form of a histogram.

**Usage**

```r
samp.dist.mech(rep, int = 0.05)
```

**Arguments**

- `rep` Number of samples. Should not greatly exceed 100.
- `int` The time interval for animation (in seconds). Smaller intervals speed up animation.
Author(s)

Ken Aho

Note

Nice goat image from http://all-free-download.com

Description


Usage

data("savage")

Format

A data frame with 1006 observations on the following 9 variables.

Order  Mammal order.
Family  Mammal family.
Species  Mammal genus and species.
Mass  Biomass in grams.
BMR  Basal metabolic rate in watts.
AvgMass  Average mass, given multiple reports for a particular species.
AvgBMR  Average BMR, given multiple reports for a particular species.
References  Authorities from whom data were obtained.
Notes  Note concerning a repeated species name.

Source

References


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sc.twin

Matched pairs schizophrenia data

Description

Scientists have long been concerned with identifying physiological characteristics which result in a disposition for schizophrenia. Early studies suggested that the volume of particular brain regions of schizophrenic patients may differ from non-afflicted individuals. However these studies often contained confounding variables (e.g. socioeconomic status, genetics) which obscured brain volume/ schizophrenia relationships (Ramsey and Schafer 1997). To control for confounding variables Suddath et al. (1990) examined 15 pairs of monozygotic twins where one twin was schizophrenic and the other was not. Twins were located from an intensive search throughout the United States and Canada. The authors used magnetic resonance imaging to measure brain volume of particular regions in the twin’s brains.

Usage

data(sc.twin)

Format

The dataframe has 2 columns:

unaffected  Left hippocampus volumes for unaffected twins.
affected  Left hippocampus volumes for affected twins.
se.jack

Jackknife standard error from a set of pseudovalues

Description

Calculates the conventional jackknife standard error from a set of pseudovalues. The function `se.jack` provides Tukey’s jackknife estimator. The function `se.jack` provides a measure associated with first order jackknife estimates of species richness (Heltsche and Forrester 1983).

Usage

```r
se.jack(x)
se.jack1(x)
```

Arguments

- `x` A numeric vector of pseudovalue, for instance from function `pseudo.v`.

Author(s)

Ken Aho

References


See Also

`pseudo.v`

Examples

```r
p <- pseudo.v(trag, statistic = mean)
se.jack(p[,2])
```
sedum.ts  CO2 exchange time series data

Description

Gurevitch et al. (1986) demonstrated time series analysis with data describing change in CO2 concentration of airstreams passing over a Sedum wrightii test plant.

Usage

data(sedum.ts)

Format

A data frame with 24 observations on the following 3 variables.

exchange  CO2 exchange, measured as: [change in CO2 concentration (g/mg)]/ plant fresh mass (g). Thus units are 1/mg. Positive values indicate net CO2 uptake while negative values indicate net CO2 output.

time  A numeric vector indicating two hour intervals

treatment  Dry = water withheld for several week, Wet = plant well watered.

Source


see.accPrec.tck  Interactive depiction of precision and accuracy

Description

Slider GUI for examining the interaction of precision and accuracy.

Usage

see.accPrec.tck()

Author(s)

Ken Aho
**See.ancova.tck**

*Visualize ANCOVA mechanics*

**Description**

An interactive GUI to view ANCOVA mechanics. Exp. power tries to simulate explanatory power in the concomitant variable. It simply results in $(1 - \text{Exp. power}) \times \text{Residual SE}$. 

**Usage**

```r
see.ancova.tck()
```

**Author(s)**

Ken Aho

---

**See.anova.tck**

*Interactive depiction of the ANOVA mechanism*

**Description**

Slider control of the means and (constant) variability of three factor level populations. An ANOVA is run based on a random sample of these populations.

**Usage**

```r
see.anova.tck()
```

**Author(s)**

Ken Aho
Depict the effect of range on correlation

Description

Function interactively depicts the effect of the data range on association measures.

Usage

see.cor.range.tck(sd = 0.5)

Arguments

sd

Amount of noise added to linear association. Residuals around line pulled from a normal distribution centered at zero with this standard deviation.

Author(s)

Ken Aho

References

Based on a figure from http://en.wikipedia.org/wiki/Correlation_and_dependence

Visualize exponential power functions

Description

Visualize exponential power functions, including a Gaussian distribution.

Usage

see.exppower.tck()

Details

The normal distribution and Gaussian distribution are based on an exponential power function:

\[ f(x) = e^{\exp(-|x|^m)} \]

Letting \( m = 2 \) results in a Gaussian distribution. Standardizing this so that the area under the curve = 1 results in the standard normal distribution.
see.HW

Author(s)
Ken Aho

See Also
book.menu

_____see.HW

Visualize the Hardy Weinberg equilibrium

Description
Allows interactive depiction of the Hardy Weinberg equilibrium.

Usage
see.HW(parg)
see.HW.tck()

Arguments
parg Proportion of the allele $p$ in the population, i.e. a number between 0 and 1.

Details
Solves and depicts the Hardy Weinberg equilibrium, i.e:

$$pp + 2pq + qq = 1$$

Author(s)
Ken Aho

_____see.lma.tck

ANOVA linear models

Description
Derives ANOVA linear model using matrix algebra

Usage
see.lma.tck()

Author(s)
Ken Aho
Regression linear model derivation from linear algebra

Description

Given Y and X matrices a regression linear model is demonstrated using matrix algebra.

Usage

see.lmr.tck()
plm(Y, X, sz=1, showXY = TRUE)

Arguments

Y  Response variable
X  Explanatory variables
sz  Text expansion factor
showXY  Logical, indicating whether or not X and Y matrices should be shown.

Details

X requires a Y intercept variable $X_0$ and at least one other variable.

Author(s)

Ken Aho

See Also

lm

Unbalanced and balanced linear models

Description

The default design is balanced, as a result Type I = Type II = Type III SS. A student can then delete one or more Y responses, and corresponding X responses to see create an unbalanced design. Now the types of SS will no longer be equal. Furthermore, the order that X1 and X2 are specified will now matter in the case of Type I SS, although it will not matter for type II and III SS.

Usage

see.lmu.tck()

pm(Y, X1, X2, X1X2, change.order = FALSE, delete = 0)
Arguments

- **Y**: Response variable.
- **X1**: First column in design matrix with effect coding.
- **X2**: Second column in design matrix.
- **X1X2**: An interaction column. The product of design matrix columns one and two.
- **change.order**: A logical command specifying whether or not the order of **X1** and **X2** should changed in the model specification.
- **delete**: when delete != 0 an observation number to be deleted.

Author(s)

Ken Aho

See Also

- **lm**

Description

It is vital that scientists understand what logical and fallacious arguments are. This worksheet provides a pedagogical tool for considering logic.

Usage

```
see.logic()
```

Author(s)

Ken Aho

References

- Salmon, W (1963) *Logic*. Prentice-Hall

See Also

- **book.menu**

Examples

```
## Not run:
see.logic()

## End(Not run)
```
Description

The function provides interactive visualization of robust M estimation of location.

Usage

see.M()

Details

The value $c = 1.28$ gives 95 percent efficiency of the mean given normality. The sample median and mean can be considered special cases of M-estimators. The value $c = 0$ provides the sample median, while the value, $c = \infty$ gives the sample mean.

Author(s)

Ken Aho

References


See Also

huber.mu, huber.NR

Description

The levels for a fixed factor are shown in rows, while the columns are levels for a random factor. Thus, the table depicts a mixed model. Assume that the values in the table are population means. For instance, the true mean of random level R1 for the fixed level F1 is 1. Using information from all random factor levels, the null hypothesis for the fixed factor is true. That is, $\mu_{F1} = \mu_{F2} = \mu_{F3}$. However when we select a subset of random levels, this is obscured. In fact, for any subset of random factor levels it appears as if there is evidence against $H_0$, i.e. there appears to be variability among the fixed factor level means. Thus, to avoid inflation of type I error (rejection of a true null hypothesis) we must consider the interaction of the random and fixed factors when considering inference for the fixed factor level populations.
Usage

see.mixedII()

Author(s)

Ken Aho, thanks to Ernest Keeley

References


see.mnom.tck

Interactive depiction of the multinomial distribution

Description

tcltk GUI representation of the multinomial in a simple (binomial) context.

Usage

see.mnom.tck()

Author(s)

Ken Aho

see.move

Interactive visualization of least squares regression.

Description

Scatterplot points can be moved with see.move, while points can be added and deleted with see.adddel. The function see.move is an appropriation from tcltk demos, with a few bells and whistles added.

Usage

see.move()
see.adddel()

Author(s)

the R Development Core Team for see.move, Ken Aho for see.adddel.
**see.nlm** Visualize important non-linear functions

**Description**

A number of important equation forms require that their parameters be estimated using the non-linear least squares. Here are six.

**Usage**

```r
see.nlm()
```

**Author(s)**

Ken Aho

**References**


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**see.norm.tck** Visualize pdfs

**Description**

Interactive GUIs for visualizing how distributions change with changing values of pdf parameters, e.g. \( \mu \) and \( \sigma \). The basic ideas here are lifted largely from a clever function from Greg Snow’s package *TeachingDemos*. The functions `see.pdfdriver.tck` and `see.pdfdriver` are `tcltk` utility functions.

**Usage**

```r
see.norm.tck()
see.normcdf.tck()
see.beta.tck()
see.betacdf.tck()
see.bin.tck()
see.bincdf.tck()
see.chi.tck()
see.chicdf.tck()
see.exp.tck()
see.expcdf.tck()
see.F.tck()
see.Fcdf.tck()
see.gam.tck()
see.gamcdf.tck()
```
Arguments

pdf Name of probability density function
show.cdf Logical, indicating whether or not the cumulative distribution function should be shown.

Author(s)

Ken Aho

Examples

## Not run:
see.norm.tck()

## End(Not run)

see.power Interactive depiction of type I and type II error and power

Description

Provides an interactive pedagogical display of power.
Usage

```
see.power(alpha = NULL, sigma = NULL, n = NULL, effect = NULL,
test = "lower", xlim = c(-3, 3), strict = FALSE)
```

Arguments

- **alpha**: Type I error.
- **sigma**: Standard deviation of underlying population.
- **n**: Sample size
- **effect**: Effect size
- **test**: Type of test, one of `c("lower", "upper", "two")`.
- **xlim**: X-axis limits
- **strict**: Causes the function to use a strict interpretation of power in a two-sided test. If `strict = TRUE` then power for a two-sided test will include the probability of rejection in the opposite tail of the true effect. If `strict = FALSE` (the default) power will be half the value of $\alpha$ if the true effect size is zero.

Details

The function `see.power` provides an interactive display of power. The function `see.power.tck` provides a `tcltk` GUI to manipulate `see.power`.

Author(s)

Ken Aho

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Description

An experiment to ascertain the effect of two randomly selected brands of soil fertilizer on wheat yield. In the upper figure two brands of fertilizer (1 and 2) are randomly chosen from a population of potential choices. The mean yields produced by the population of fertilizers $E(Y|A_i)$ are normally distributed. That is, it is possible to select a factor level that will result in very small average yields, or one that will result in large average yields, but it is more likely that a chosen factor level will produce some intermediate average effect. We proceed with the experiment by assigning two experimental units (two wheat fields) to each fertilizer. We assume that the yield of fields is normally distributed for each fertilizer, and furthermore that the factor levels are homoscedastic. We weigh our evidence against the $H_0$ of a non-zero population variance by estimating the variability among factor levels. The more that yield varies with respect to nutrient treatments the more evidence we will have against $H_0$. 

Usage

see.rEffect.tck()

Author(s)

Ken Aho

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**see.regression.tck**  *Demonstration of regression mechanics*

**Description**

Population and sample regression lines are interactively depicted. The same random observations generated by the true error distribution is used for both models.

Usage

see.regression.tck()

Author(s)

Ken Aho

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**see.roc.tck**  *Interactive depiction of ROC curves*

**Description**

Sliders allow users to change distinctness of dichotomous classes (success and failure). This will affect the ROC curve. One can also change the criteria defining what constitutes a success. While this will not change the ROC curve (which compares true positive and false negative rates at all possible success cutoff), it will change empirical rates of true positives, true negatives, false positives, and false negatives given the defined cutoff.

Usage

see.roc.tck()

Author(s)

**see.smooth.tck**

*Interactive smoother demonstrations*

**Description**

LOWESS, kernel, and spline smoothers are depicted, using `tcltk` widgets.

**Usage**

```r
see.smooth.tck()
```

**Author(s)**

Ken Aho, appropriated ideas from demo in library `tcltk`.

**See Also**

`loess`, `ksmooth`, `smooth`, `spline`

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**see.ttest.tck**

*Visualize t-tests*

**Description**

Interactive GUI for demonstrating t-tests

**Usage**

```r
see.ttest.tck()
```

**Author(s)**

Ken Aho
see.typeI_II

Interactive depiction of type I and II error

Description
The function provides a tcltk driver illustrating type I, type II error, and power.

Usage
see.typeI_II()

Author(s)
Ken Aho

See Also
see.power.power.z.test

selftest.se.tck1
Interactive self-testing statistical questions

Description
These functions provide interactive multiple-choice questions.

Usage
selftest.se.tck1()
selftest.se.tck2()
selftest.conf.tck1()
selftest.conf.tck2()
selftest.pdfs.tck1()
selftest.pdfs.tck2()
selftest.pdfs.tck3()
selftest.prob.tck1()
selftest.prob.tck2()
selftest.prob.tck3()
selftest.sampd.tck1()
selftest.sampd.tck2()
selftest.stats.tck1()
selftest.stats.tck2()

Author(s)
Ken Aho
**Semiconductor**

*Split plot computer chip data from Littell et al. (2006)*

**Description**

Littell et al. (2006) use the data here to introduce analysis of split plot designs using mixed models. Twelve silicon wafers were randomly selected from a lot, and were randomly assigned to four different processing modes. Resistance on the chips was measured in four different positions (four different chips) on each wafer. Mode of processing and position of chips were fixed factors, while wafer was a random effect. The experimental units with respect to process are the wafers. The experimental units with respect to position are individual chips. Thus the wafer is the whole plot, whereas the positions (chips) are split plot units.

**Usage**

```r
data(Semiconductor)
```

**Format**

The dataframe contains four columns:

- **Process**: The explanatory variable of interest. The type of process used to create the computer chips. A factor with 4 levels.
- **Wafer**: The whole plot containing four chips. There were four wafers tested, i.e., four levels, 1, 2, 3, 4.
- **Chip**: Position on the wafer. These are split plots within the whole plots. Four levels: 1, 2, 3, 4.

**Source**


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**SexDeterm**

*Fern environmental sex determination data*

**Description**

Sex determination (male and female) data at ecologically relevant glucose, N, and P concentrations and stoichiometries, at both ambient and elevated levels of CO_2_. The term "ameristic" denotes gametophytes with only male gametangia, while the term "meristic" refers to gametophytes with female or female and male gametangia.

**Usage**

```r
data("SexDeterm")
```
A data frame with 156 observations on the following 11 variables.

- **CO2.Level**: a factor with levels Ambient Elevated CO2 levels
- **Block**: a numeric vector, the elevated CO2 experiment was completed in 2 blocks
- **Glucose.Level**: the number of C atoms relative to the number of P atoms, with 5 indicating the presence of 6 micromolar glucose and 0 indicating the absence of glucose in the growth media
- **N.Level**: the number of N atoms relative to the number of P atoms
- **P.Level**: the number of P atoms relative to the number of N atoms
- **Total.Gametophyte.No.**: the total number of gametophytes in each population
- **No.of.Ameristic.Gametophytes**: the number of ameristic (male) gametophytes in each gametophyte population
- **No.of.Meristic.Gametophytes**: the number of meristic (female and hermaphrodite) gametophytes in each gametophyte population
- **Ameristic.Meristic.Ratio**: the ratio of ameristic gametophytes to meristic gametophytes (sex ratio)
- **Pct.Ameristic.Gametophytes**: the percentage of ameristic gametophytes per total gametophyte population

References


Examples

data(SexDeterm)

```
shad
```

American gizzard shad data

Description

Hollander and Wolfe (1999) describe young of year lengths at four sites for American gizzard shad, *Dorosoma cepedianum*, a fish of the herring family.

Usage

data(shad)
Format

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

length  Fish length in cm
site    a factor with levels I II III IV

Source


shade.norm  Shading functions for interpretation of pdf probabilities.

Description

Creates plots with lower, upper, two-tailed, and middle of the distribution shading for popular pdfs.

Usage

shade.norm(x = NULL, from = NULL, to = NULL, sigma = 1, mu = 0,  
tail = "lower", show.p = TRUE, show.d = FALSE, show.dist = TRUE, digits = 5,  
legend.cex = .9, shade.col="gray", ...)

shade.t(x = NULL, from = NULL, to = NULL, nu = 3, tail = "lower",  
show.p = TRUE, show.d = FALSE, show.dist = TRUE, digits = 5, legend.cex = .9,  
shade.col="gray", ...)

shade.F(x = NULL, from = NULL, to = NULL, nu1 = 1, nu2 = 5,  
tail = "lower", show.p = TRUE, show.d = FALSE, show.dist = TRUE,  
prob.to.each.tail = 0.025, digits = 5, legend.cex = .9, shade.col="gray", ...)

shade.chi(x = NULL, from = NULL, to = NULL, nu = 1, tail = "lower",  
show.p = TRUE, show.d = FALSE, show.dist = TRUE, prob.to.each.tail = 0.025,  
digits = 5, legend.cex = .9, shade.col="gray", ...)

shade.bin(x=NULL,from=NULL,to=NULL,n=1,p=0.5,tail="X=x",show.p=TRUE,  
show.dist=TRUE, show.d=FALSE,legend.cex = .9,digits=5, ...)

shade.poi(x=NULL,from=NULL,to=NULL,lambda=5,tail="X=x",show.p=TRUE,  
show.dist=TRUE, show.d=FALSE,legend.cex = .9,digits=5, ...)

shade.wei(x = NULL, from = NULL, to = NULL, theta = 1, beta = 1, tail = "lower",  
show.p = TRUE, show.d = FALSE, show.dist = TRUE, prob.to.each.tail = 0.025,  
digits = 5, legend.cex = 0.9, shade.col = "gray", ...)
Arguments

- **x**: A quantile, i.e. \( X = x \), or if `tail = "two.custom"` ins `shade.norm`, a two element vector specifying the upper bound of the lower tail and the lower bound of the upper tail.

- **from**: To be used with `tail = "middle"`; the value \( a \) in \( P(a < X < b) \).

- **to**: To be used with `tail = "middle"`; the value \( b \) in \( P(a < X < b) \).

- **sigma**: Standard deviation for the normal distribution.

- **mu**: Mean of the normal distribution.

- **tail**: One of four possibilities: "lower" provides lower tail shading, "upper" provides upper tail shading, "two" provides two tail shading, and "middle" provides shading in the middle of the pdf, between "from" and "to". The additional option "two.custom" is allowed for `shade.norm`. This allows calculation of asymmetric two tailed probabilities. It requires that the argument `x` is a two element vector with elements denoting the upper bound of the lower tail and the lower bound of the upper tail. For discrete pdfs (binomial and Poisson) the possibility "x=x" is also allowed, and will be equivalent to the density. Two tailed probability is not implemented for `shade.poi`.

- **show.p**: Logical; indicating whether probabilities are to be shown.

- **show.d**: Logical; indicating whether densities are to be shown.

- **show.dist**: Logical; indicating whether parameters for the distribution are to be shown.

- **nu**: Degrees of freedom.

- **nu1**: Numerator degrees of freedom for the \( F \)-distribution.

- **nu2**: Denominator degrees of freedom for the \( F \)-distribution.

- **prob.to.each.tail**: Probability to be apportioned to each tail in the \( F \) and Chi-square distributions if `tail = "two"`.

- **digits**: Number of digits to be reported in probabilities and densities.

- **n**: The number of trials for the binomial pdf.

- **p**: The binomial probability of success.

- **lambda**: The Poisson parameter (i.e. rate).

- **legend.cex**: Character expansion for legends in plots.

- **shade.col**: Color of probability shading.

- **theta**: Pdf parameter.

- **beta**: Pdf parameter.

- **...**: Additional arguments to `plot`.

Value

Returns a plot with the requested pdf and probability shading.

Note

Lower-tailed chi-squared probabilities are not plotted correctly for \( df < 3 \).
Author(s)

Ken Aho

Examples

## Not run:

```r
#normal
shade.norm(x=1.2,sigma=1,mu=0,tail="lower")
shade.norm(x=1.2,sigma=1,mu=0,tail="upper")
shade.norm(x=1.2,sigma=1,mu=0,tail="two")
shade.norm(from=-.4,to=0,sigma=1,mu=0,tail="middle")
shade.norm(from=0,to=0,sigma=1,mu=0,tail="middle")
shade.norm(x=c(-.2, 2),sigma=1,mu=0,tail="two.custom")
```

```r
##
shade.t(x=-1,nu=5,tail="lower")
shade.t(x=-1,nu=5,tail="upper")
shade.t(x=-1,nu=5,tail="two")
shade.t(from=.5, to=.7, nu=5, tail="middle")
```

```r
##F
shade.F(x=2,nu1=15,nu2=8,tail="lower")
shade.F(x=2,nu1=15,nu2=8,tail="upper")
shade.F(nu1=15,nu2=8,tail="two",prob.to.each.tail=0.025)
shade.F(from=.5, to=.7, nu1=15,nu2=10, tail="middle")
```

```r
##Chi sq
shade.chi(x=2,nu=5,tail="lower")
shade.chi(x=2,nu=5,tail="upper")
shade.chi(nu=7,tail="two",prob.to.each.tail=0.025)
shade.chi(from=.5, to=.7, nu=5, tail="middle")
```

```r
##binomial
shade.bin(x=5,n=20,tail="X=x",show.d=TRUE)
shade.bin(x=5,n=20,tail="lower")
shade.bin(x=5,n=20,tail="two")
shade.bin(from=8, to=12, n=20, tail="middle")
```

```r
##Poisson
shade.poi(x=5,lambda=6,tail="X=x",show.d=TRUE)
shade.poi(x=5,lambda=7,tail="lower")
shade.poi(x=5,lambda=8,tail="upper")
shade.poi(from=8, to=12, lambda=7, tail="middle")
```

## End(Not run)
Description

Provides tcltk GUIs to manage asbio shade functions.

Usage

shade.bin.tck()
shade.chi.tck()
shade.F.tck()
shade.norm.tck()
shade.poi.tck()
shade.t.tck()

Author(s)

Ken Aho

See Also

shade

---

**simberloff**  
*Compilations of genus and species counts from Simberloff (1970)*

Description

A compilation of taxonomic (species and genus) counts for a wide array of organism groups for island and associated mainland locations. Taken from Simberloff (1970).

Usage

data("simberloff")

Format

A data frame with 204 observations on the following 12 variables.

Location  Island and mainland location.
Designation  A factor with levels Island Mainland.
Hypothesized.source  Hypothesized mainland location for particular island location.
No.spp.  The number of species
Obs. S.G  Observed species/genus (S/G) ratio
E.S.G.  Expected S/G ratio, based on random sampling from mainland pool of species.
prop.obs.cogeners  The proportion of observed cogeners, only reported for bird species.
prop.exp.cogeners  The proportion of expected cogeners based on random sampling from the associated mainland pool of species, only reported for bird species.

Authority  Source of information for compilation.
Life.form  A factor with levels Ants Land birds Passerine birds Vascular plants.
Notes.1  Notes from Simberloff (1970)
Notes.2  Additional notes from Simberloff (1970)

Source

---

**skew**

*Sample skewness and kurtosis*

**Description**

Functions for skewness and kurtosis.

**Usage**

```r
skew(x, method="unbiased")
kurt(x, method="unbiased")
```

**Arguments**

- `x` A vector of quantitative data.
- `method` The type of method used for computation of skew and kurtosis. Two choices are possible for skewness: "moments" and "unbiased", and three choices are possible for kurtosis: "unbiased", "moments", and "excess".

**Details**

Aside from centrality and variability we can describe distributions with respect to their shape. Two important shape descriptors are skewness and kurtosis. Skewness describes the relative density in the tails of a distribution while kurtosis describes the peakedness of a distribution. When quantified for a population skewness and kurtosis are denoted as $\gamma_1$ and $\gamma_2$ respectively. For a symmetric distribution skewness will equal zero; i.e. $\gamma_1 = 0$. A distribution with more density in its right-hand tail will have $\gamma_1 > 0$, while one with more density in its left-hand tail will have $\gamma_1 < 0$. These distributions are often referred to as positively-skewed and negatively-skewed respectively. If a distribution is normally peaked (mesokurtic) then $\gamma_2 = 3$. As a result the number three is generally
subtracted from kurtosis estimates so that a normal distribution will have $\gamma_2 = 0$. Thus strongly peaked (leptokurtic) distributions will have $\gamma_2 > 0$, while flat-looking (platykurtic) distributions will have a kurtosis $\gamma_2 < 0$.

Several types of skewness and kurtosis estimation are possible. For method of moments estimation let:

$$m_j = \frac{1}{n} \sum_i (X_i - \bar{X})^j,$$

then the method of moments skewness is: $m_3/m_2^{3/2}$, the method of moments kurtosis is: $m_4/m_2^2$, and the excess method of moments kurtosis is $m_4/m_2^2 - 3$.

These estimators are biased low, particularly given small sample sizes. A more complex estimator is required to account for this bias. This is provided by method = "unbiased" in skew and kurt.

Value

Output will be the sample skewness or kurtosis.

Author(s)

Ken Aho

Examples

```r
exp<-rexp(10000)
skew(exp)
kurt(exp)
```

SM.temp.moist Alpine soil temperature and moisture time series

Description

Soil temperature and water availability from Mt. Washburn in Yellowstone National Park. Data were taken at soil depth of 5cm from a late snowmelt site at UTM 4960736.977 544792.225 zone 12T NAD 83, elevation 3070m.

Usage

data(SM.temp.moist)

Format

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

- **year**: A numeric vector describing year.
- **day**: The "day of year", whereby Jan 1 = day 1 and Dec 32 = day 365 (366 for leap years).
- **Temp_C**: Temperature in degrees Celsius.
- **Moisture**: Soil water availability sensor reading. A reading of 35 is approximately equal to -1.5 MPa.
Source


---

**snore**  
*Snoring and heart disease contingency data*

**Description**

Norton and Dunn (1985) compiled data from four family practice clinics in Toronto to quantify the association between snoring and heart disease for 2484 subjects.

**Usage**

data(snore)

**Format**

A data frame with 2484 observations on the following 3 variables.

- **snoring** A factor with levels `every.night` `nearly.ever.night` `never` `occasional`
- **ord.snoring** Agresti (21012) transformed the explanatory levels to ordinal values in his analysis of this data.
- **disease** Presence/absence of heart disease

**Source**


---

**so2.us.cities**  
*SO2 data for 32 US cities with respect to 6 explanatory variables*

**Description**

Of concern for public health officials and biologists are models of air pollution as a function of environmental characteristics. Using a meta-analysis of government publications Sokal and Rolf (1995) compiled an interesting dataset which investigates air pollution (measured as annual mean SO$_2$ concentration per m$^3$) as a function of six environmental variables for 32 cities in the United States. Whenever the data were available they are based on averages of three years 1969, 1970, and 1971.

**Usage**

data(so2.us.cities)
The dataset contains 8 variables:

- **City**: US city.
- **Y**: Average annual SO$_2$ concentration per m$^3$.
- **X1**: Average annual temperature (degrees Celsius).
- **X2**: Number of industrial companies with more than 20 employees.
- **X3**: Population size (1970 census) in thousands.
- **X4**: Average Annual average wind speed.
- **X5**: Average Annual precipitation (cm).
- **X6**: Average number of days with precipitation.

**Source**


---

**Description**

Estimator for the variance for the sampling distribution of the sample mean, i.e. $S^2/n$, and the standard deviation of the sampling distribution, i.e. $S/\sqrt{n}$.

**Usage**

```r
stan.error(x)
stan.error.sq(x)
```

**Arguments**

- **x**: A vector of quantitative data.

**Author(s)**

Ken Aho

**See Also**

`sd`
starkey  

*DEM data from the Starkey experimental forest in NE Oregon*

**Description**

UTM northing and easting data along with 18 other environmental variables describing the Starkey experimental forest.

**Usage**

data(starkey)

**Source**


suess  

*del14C in the atmosphere from 1700-1950*

**Description**

Six reservoir model prediction of the $\delta^{14}C$ in the atmosphere from approximately 1700-1950 as provided by Bacastow and Keeling (1973).

**Usage**

data("suess")

**Format**

A data frame with 149 observations on the following 3 variables.

- **Year**  Year
- **del14C**  Levels of $\delta^{14}C$

**Source**


**Source**

Bacastow, R., Keeling, C. D., Woodwell, G. M., & Pecan, E. V. (1973). Atmospheric carbon dioxide and radiocarbon in the natural carbon cycle. II. Changes from AD 1700 to 2070 as deduced from a geochemical model (No. CONF-720510--). Univ. of California, San Diego, La Jolla; Brookhaven National Lab., Upton, NY (USA).
References

Secondary sources used by Bacastow et al. (1973):


Examples

data(suess)
with(suess, plot(Year, del14C, col = Source, pch = as.numeric(Source)))
with(suess, legend("topright", legend = levels(Source), col = 1:4, pch = 1:4))
lines(lowess(suess$Year, suess$del14C, f = .25), lwd = 2)

trag  
*Salsify height dataset*

Description

Heights of salsify *Tragopogon dubius* at the Barton Road long term experimental site in Pocatello Idaho.

Usage

data(trag)

Format

A data frame with 20 observations on the following variable.

height  *T. dubius* plant height in cm
transM

Transition matrix analysis

Description

Creates a plot showing expected numbers of individuals in specified age classes or life stages given survivorship probabilities from a transition matrix (cf. Caswell 2000). The function `anm.transM` provides an animated view of the population growth curves. The function `anm.TM.tck` provides a `tcltk` GUI to run `anm.TM.tck`.

Usage

```r
transM(A, init, inter = 100, stage.names = c("All grps",1:(ncol(A))),
leg.room = 1.5, ...)

anm.transM(A,init,inter=100,stage.names =c("All grps",1:(ncol(A))),
leg.room = 1.5, anim.interval=0.1,...)

anm.TM.tck()
```

Arguments

- `A` Transition matrix containing survivorship probabilities and fecundities see Caswell (2000).
- `init` A numeric vector containing initial numbers in each age class of interest.
- `inter` Number of time intervals for which population numbers are to be calculated.
- `stage.names` A character vector giving life stage names.
- `leg.room` A Y-axis multiplier intended to create room for a legend.
- `anim.interval` Speed of animation in frames per second.
- `...` Additional arguments for `plot`

Value

Returns a plot and proportions of the population in each age class for the number of time intervals in `inter`.

Author(s)

Ken Aho

References


Examples

```r
# Endangered cactus data data from Gurevitch et al. (2006)
A <- matrix(nrow = 3, ncol = 3, data = c(.672, .0, .561, .0.018, .0.849, .0.0, .0.0.138, .0.969),
byrow = TRUE)
init <- c(10, 2, 1)
transM(A, init, inter = 100, stage.names = c("All", "Sm. Juv.", "Lg. Juv.", "Adults"),
xlab = "Years from present", ylab = "n")
# animated version
## Not run:
anm.transM(A, init, inter = 100, stage.names = c("All", "Sm. Juv.", "Lg. Juv.", "Adults"),
xlab = "Years from present", ylab = "n")
## End(Not run)
```

trim.me

**Trim data**

Description

Trims observations above and below the central \((1 - 2\lambda)\) part of an ordered vector of data.

Usage

```r
trim.me(Y, trim = 0.2)
```

Arguments

- **Y**: A vector of quantitative data.
- **trim**: Proportion (0-1) to be trimmed from each tail of an ordered version of \(Y\).

Value

Returns a trimmed data vector.

Author(s)

Ken Aho

Examples

```r
x <- c(2, 1, 4, 5, 6, 2, 4, 7, 2, 2, .002, 15, 17, .001)
trim.me(x)
```
trim.ranef.test  Robust test for random factors using trimmed means.

Description
Provides a robust hypothesis test for the null: \( \text{Var}(X) = 0 \), for a population of random factor levels.

Usage
trim.ranef.test(Y, X, tr = 0.2)

Arguments
- \( Y \) Vector of response data. A quantitative vector.
- \( X \) Vector of factor levels
- \( tr \) Amount of trimming. A number from 0-0.5.

Details
Robust analyses for random effect designs are particularly important since standard random effects models provide poor control over type I error when assumptions of normality and homoscedasticity are violated. Specifically, Wilcox (1994) showed that even with equal sample sizes, and moderately large samples, actual probability of type I error can exceed 0.3 if normality and homoscedasticity are violated.

Value
Returns a list with three components dataframe describing numerator and denominator degrees of freedom, the \( F \) test statistic and the \( p \)-value.

Note
code based on Wilcox (2005)

Author(s)
Ken Aho

References

Examples
rye< c(50, 49.8, 52.3, 44.5, 62.3, 74.8, 72.5, 80.2, 47.6, 39.5, 47.7, 50.7)
nutrient< factor(c(rep(1,4), rep(2,4), rep(3,4)))
trim.ranef.test(rye, nutrient, tr=.2)
trim.test

Robust one way trimmed means test.

Description

A robust heteroscedastic procedure using trimmed means.

Usage

trim.test(y, x, tr = 0.2)

Arguments

y A vector of responses. A quantitative vector
x A vector of factor levels.
tr The degree of trimming. A value from 0-0.5.

Details

The method utilized here is based on the simple idea of replacing means with trimmed means and standard error estimates, based on all the data, with the standard error of the trimmed mean (Wilcox 2005). The method has the additional benefit of being resistant to heteroscedasticity due to the use of the Welch method for calculating degrees of freedom. With no trimming the degrees of freedom reduce to those of the one way Welch procedure in oneway.test.

Value

Returns a dataframe with numerator and denominator degrees of freedom, a test statistic, and a $p$-value based on the $F$-distribution.

Note

code based on Wilcox (2005)

Author(s)

Ken Aho

References


See Also

oneway.test
Examples

tyuey.add.test

```r
rye <- c(50, 49.8, 52.3, 64.5, 62.3, 74.8, 72.5, 80.2, 47.6, 39.5, 47.7, 50.7)
nutrient <- factor(c(rep(1, 4), rep(2, 4), rep(3, 4)))
trim.test(rye, nutrient, tr = .2)
```

Description

With an RBD we are testing the null hypothesis that there is no treatment effect in any block. As a result randomized block designs including RBDs, Latin Squares, and spherical repeated measures assume that there is no interaction effect between blocks and main factors (i.e. main effects and block are additive). We can test this assumption with the Tukey’s test for additivity. We address the following hypotheses:

\[ H_0: \text{Main effects and blocks are additive, versus } H_A: \text{Main effects and blocks are non-additive.} \]

Usage

```
tukey.add.test(y, A, B)
```

Arguments

- `y`: Response variable. Vector of quantitative data.
- `A`: Main effects. Generally a vector of categorical data.
- `B`: Blocking variable. A vector of categories (blocks).

Details

Tukey’s test for additivity is best for detecting simple block x treatment interactions; for instance, when lines in an interaction plot cross. As a result interaction plots should be used for diagnosis of other types of interactions. A high probability of type II error results from the inability Tukey’s additivity test to detect complex interactions (Kirk 1995). As a result a conservative value of should be used, i.e. 0.1 - 0.25.

Value

Returns a table with test results.

Author(s)

Original author unknown. Modified by K. Aho
veneer

References


Examples

treatment<-as.factor(c(36,54,72,108,144,36,54,72,108,144,36,54,72,108,144))
block<-as.factor(c(rep(1,5),rep(2,5),rep(3,5)))
strength<-c(7.62,8.14,7.76,7.17,7.46,8.15,7.73,7.57,7.68,7.93,7.87,7.74,7.8,7.21)
tukey.add.test(strength,treatment,block)

---

<table>
<thead>
<tr>
<th>Veneer data from Littell et al. (2002)</th>
</tr>
</thead>
</table>

Description

Four examples of each of five brands of a synthetic wool veneer material were subjected to a friction test and a measure of wear was determined for each experimental unit.

Usage

```r
data(veneer)
```

Format

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

- **wear**: a numeric vector
- **brand**: a factor with levels `ACME AJAX CHAMP TUFFY XTRA`

Source

Venn probability diagrams for an event with two outcomes

Description

The user specifies the probabilities of two outcomes, and if applicable, their intersection. A Venn diagram is returned. The universe, S, will generally not have unit area, but in many applications will be a good approximation. The area of the intersection will also be an approximation.

Usage

Venn(A, B, AandB = 0, labA = "A", labB = "B", cex.text = .95, ...)

Venn.tck()

Arguments

A Probability of event A
B Probability of event B
AandB Probability of the intersection of A and B
labA Label assigned to event A in the diagram
labB Label assigned to event B in the diagram
cex.text Character expansion for text.
... Additional arguments from plot

Value

A Venn diagram is returned.

Author(s)

K. Aho

References


Examples

Venn(A=.3,B=.2,AandB=.06)
### Scandinavian site by species community matrix

**Description**

Scandinavian, lichen, bryophyte, and vascular plant data from Vare et al. (1995).

**Usage**

data(vs)

**Format**

A data frame with 24 observations (sites) on 44 variables (species).

**Details**

Lifted from dataframe `{varespec}` in package `vegan`.

**Source**

The dataset `{varespec}` in package `vegan`

**References**


### Species richness and environmental variables from Mt Washburn

**Description**

Aho and Weaver (2010) examined the effect of environmental characteristics on alpine vascular plant species richness on Mount Washburn (3124m) a volcanic peak in north-central Yellowstone National Park.

**Usage**

data(wash.rich)
Format

A data frame with 40 observations on the following 7 variables.

- **site**: Site identifier.
- **y**: Species richness.
- **xQ**: Percent Kjeldahl (total) soil N.
- **xR**: Slope in degrees.
- **xS**: Aspect in degrees from true north.
- **xT**: Percent cover of surface rock.
- **xU**: Soil pH.

Source


---

**webs**

*Spider web length data*

Description

Gosline et al. (1984) applied heat to strands of spider web to determine whether the structure underlying webs was rubber-like. Data are estimated from a scatterplot in Gosline et al..

Usage

data(webs)

Format

The dataframe contains 4 columns

- **obs**: Observation number.
- **relative length**: Relative strand strand length after heat application.
- **temp.C**: Temp in degrees Celsius.
- **residuals**: Residuals from the linear model length~temp.C.

Source

Agricultural randomized block design

Description

Allard (1966) sought to quantify variation in the yield in wheat grasses. Five wheat crosses were selected from a breeding program and were grown at four randomly selected locations where the wheat would be grown commercially. At each location crosses (families) were randomly assigned to particular sections of fields, i.e. at each location a one way randomized block design was conducted.

Usage

data(wheat)

Format

The dataframe has four columns:

- **yield**: Refers to wheat yield.
- **loc**: Refers to randomly selected locations where wheat were grown commercially. A factor with four levels: 1, 2, 3, 4.
- **block**: Refers to the replicate block within location. A factor with four levels: 1, 2, 3, 4. Within each block five wheat crosses were randomly assigned and grown.
- **cross**: Refers to wheat crosses. A factor with five levels: 1, 2, 3, 4, 5.

Source


Whickham contingency table data for smokers and survivorship

Description

Appleton et al. (1996) summarized a study from the Whickham district of England to quantify the association of smoking, age, and death. 1,314 women were interviewed in the early 1970s with respect to their smoking habits. Twenty years later the women were relocated and classified with respect to survival at the time of the follow up (yes or no), whether they smoked at the time of the original interview (yes or no), and age at the time of the original study (1 = 18-24, 2 = 35-64, 3 = >65).

Usage

data(whickham)
Format

A data frame with 12 observations on the following 4 variables.

age  A factor with levels 1 2 3.
survival  A factor with levels N Y.
smoke  A factor with levels N Y.
count  Cross-classification count.

Source


Description

To test the "predation-sensitive food" hypothesis, which predicts that both food and predation limit prey populations, Sinclair and Arcese (1995) examined wildebeest (*Connochaetes taurinus*) carcasses in the Serengeti. The degree of malnutrition in animals was measured by marrow content since marrow will contain the last fat reserves in ungulates. Carcasses were cross-classified with respect to three categorical variables: sex (M, F), cause of death (predation, non-predation), and marrow type (SWF = Solid White Fatty, indicating healthy animals, OG = Opaque Gelatinous, indicating malnourishment, and TG = Translucent Gelatinous, the latter indicating severe malnourishment).

Usage

data(wildebeest)

Source

Description

Winsorizes the proportion of ordered data given by lambda from each tail.

Usage

\[
\text{win}(x, \text{lambda} = 0.2)
\]

Arguments

- **x**: A vector of data.
- **lambda**: A proportion from 0-1 giving the amount of data to be Winsorized in each tail of an ordered dataset.

Details

In Winsorization we replace responses that are not in the central \(1 - 2\lambda\) part of an ordered sample with the minimum and maximum responses of the central part of the sample.

Value

Returns Winsorized data.

Author(s)

Ken Aho

References


Examples

```r
x <- c(2, 1, 4, 5, 6, 2.4, 7, 2.2, .002, 15, 17, .001)
win(x)
```
Description

These data concern white variants of the Portuguese "Vinho Verde" wine. Quality is an ordinal variable based on the median assessment of at least 3 wine experts. Each expert graded wine quality between 0 (very bad) and 10 (excellent).

Usage

data("wine")

Format

A data frame with 4898 observations on the following 12 variables.

Y   Wine quality.
X1  Volatile acidity.
X2  Citric acid content.
X3  Residual Sugar content.
X4  Chloride content.
X5  Free sulfur dioxide content.
X6  Total sulfur dioxide content.
X7  Density.
X8  pH: $-\log_{10}[H^+]$.
X9  Sulphate content.
X10 Alcohol content.
X11 Fixed acidity.

Source

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References

Past Usage:
**Description**

The US department of energy has compiled data since 1980 detailing total carbon dioxide emissions from the consumption and flaring of fossil fuels (in millions of metric tons of carbon dioxide). Data can be broken down by country.

**Usage**

```r
data(world.co2)
```

**Format**

The dataframe contains 16 columns

- **Year**  The year of CO2 measure (1980-2006).
- **Afghanistan**  CO2 emissions in Afghanistan from 1980-2006 (1x10^6 metric tons).
- **Belgium**  CO2 emissions in Belgium...
- **Brazil**  CO2 emissions in Brazil...
- **Canada**  CO2 emissions in Canada...
- **China**  CO2 emissions in China...
- **Finland**  CO2 emissions in Finland...
- **Ghana**  CO2 emissions in Ghana...
- **Italy**  CO2 emissions in Italy...
- **Japan**  CO2 emissions in Japan...
- **Kenya**  CO2 emissions in Kenya...
- **Mexico**  CO2 emissions in Mexico...
- **Saudi Arabia**  CO2 emissions in Saudi Arabia...
- **United Arab Emirates**  CO2 emissions in the United Arab Emirates..
- **United States**  CO2 emissions in United States...
- **World Total**  CO2 emissions totals for the world...

**Source**

US Department of energy: [www.eia.doe.gov/emeu/iea/](http://www.eia.doe.gov/emeu/iea/)
Description

Population levels of 13 countries from 1980-2006. Population numbers are rounded to the nearest 100,000.

Usage

data(world.pop)

Format

The dataframe contains 14 columns

- **Year**  The year of population measurements (1980-2006)
- **Afghanistan**  Population in Afghanistan from 1980-2006, rounded to the nearest 100,000.
- **Brazil**  Population in Brazil...
- **Canada**  Population in Canada...
- **China**  Population in China...
- **Finland**  Population in Finland...
- **Italy**  Population in Italy...
- **Japan**  Population in Japan...
- **Kenya**  Population in Kenya...
- **Mexico**  Population in Mexico...
- **Saudi Arabia**  Population in Saudi Arabia...
- **United Arab Emirates**  Population in the United Arab Emirates...
- **United States**  Population in United States...
- **World.Total**  Population totals for the world...

Source

US census bureau: [www.census.gov/population/international/data/idb/informationGateway.php](http://www.census.gov/population/international/data/idb/informationGateway.php)
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