Package ‘CorrBin’

March 6, 2019

Title  Nonparametrics with Clustered Binary and Multinomial Data
Version  1.6
Date  2019-3-4
Encoding  UTF-8
Depends  R (>= 2.10)
Imports  boot, combinat, geepack, dirmult, mvtnorm
Suggests  lattice
Description  Implements non-parametric analyses for clustered binary and multinomial data. The elements of the cluster are assumed exchangeable, and identical joint distribution (also known as marginal compatibility, or reproducibility) is assumed for clusters of different sizes. A trend test based on stochastic ordering is implemented.
License  GPL (>= 2)
LazyLoad  yes
RoxygenNote  6.1.1
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Repository  CRAN
Repository/R-Forge/Project  corrbin
Repository/R-Forge/Revision  109
Repository/R-Forge/DateTimeStamp  2019-03-05 18:24:43
Date/Publication  2019-03-06 22:54:16 UTC

R topics documented:

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**CorrBin-package**

**Nonparametrics for Correlated Binary and Multinomial Data**

**Description**

This package implements nonparametric methods for analysing exchangeable binary and multinomial data with variable cluster sizes with emphasis on trend testing. The input should specify the treatment group, cluster-size, and the number of responses (i.e. the number of cluster elements with the outcome of interest) for each cluster.

**Details**

- **Package:** CorrBin
- **Type:** Package
- **Version:** 1.5
- **Date:** 2014-12-18
- **License:** GPL 2
- **LazyLoad:** yes
• The CBData/CMDa and read.CBData/read.CMDa functions create a ‘CBData’ or ‘CMData’ object used by the analysis functions.
• ran.CBData and ran.CMDa can be used to generate random binary or multinomial data using a variety of distributions.
• mc.test.chisq tests the assumption of marginal compatibility underlying all the methods, while mc.est estimates the distribution of the number of responses under marginal compatibility.
• Finally, trend.test performs three different tests for trend along the treatment groups for binomial data.

Author(s)
Aniko Szabo
Maintainer: Aniko Szabo <aszabo@mcw.edu>

References

CBData

Create a ‘CBdata’ object from a data frame.

Description
The CBData function creates an object of class CBData that is used in further analyses. It identifies the variables that define treatment group, clustersize and the number of responses.

Usage
CBData(x, trt, clustersize, nresp, freq = NULL)

Arguments
x a data frame with one row representing a cluster or potentially a set of clusters of the same size and number of responses
trt the name of the variable that defines treatment group
clustersize the name of the variable that defines cluster size
nresp the name of the variable that defines the number of responses in the cluster
freq the name of the variable that defines the number of clusters represented by the data row. If NULL, then each row is assumed to correspond to one cluster.
**Value**

A data frame with each row representing all the clusters with the same trt/size/number of responses, and standardized variable names:

- **T**rt factor, the treatment group
- **C**luster**S**ize numeric, the cluster size
- **N**Resp numeric, the number of responses
- **F**req numeric, number of clusters with the same values

**Author(s)**

Aniko Szabo

**See Also**

`read.CBData` for creating a CBData object directly from a file.

**Examples**

```r
data(shelltox)
sh <- CBData(shelltox, trt="Ttrt", clustersize="Clustersize", nresp="NResp")
str(sh)
```

---

**CMData**

*Create a ‘CMdata’ object from a data frame.*

**Description**

The `CMData` function creates an object of class `CMData` that is used in further analyses. It identifies the variables that define treatment group, clustersize and the number of responses for each outcome type.

**Usage**

```r
CMDData(x, trt, nresp, clustersize = NULL, freq = NULL)
```

**Arguments**

- **x** a data frame with one row representing a cluster or potentially a set of clusters of the same size and number of responses for each outcome
- **trt** the name of the variable that defines treatment group
either a character vector with the names or a numeric vector with indices of the variables that define the number of responses in the cluster for each outcome type. If clustersize is NULL, then it will be calculated assuming that the nresp vector contains all the possible outcomes. If clustersize is given, then an additional category is created for the excess cluster members.

The name or index of the variable that defines cluster size, or NULL. If NULL, its value will be calculated by adding the counts from the nresp variables. If defined, an additional response type will be created for the excess cluster members.

the name or index of the variable that defines the number of responses in the cluster for each outcome type. If clustersize is NULL, then it will be calculated assuming that the nresp vector contains all the possible outcomes. If clustersize is given, then an additional category is created for the excess cluster members.

Value

A data frame with each row representing all the clusters with the same trt/size/number of responses, and standardized variable names:

- Trt factor, the treatment group
- ClusterSize numeric, the cluster size
- NResp.1--NResp.K+1 numeric, the number of responses for each of the K+1 outcome types
- Freq numeric, number of clusters with the same values

Author(s)

Aniko Szabo

See Also

read.CMData for creating a CMData object directly from a file.

Examples

data(dehp)
dehp <- CMData(dehp, trt="Trt", nresp=c("NResp.1","NResp.2","NResp.3"))
str(dehp)

---

Developmental toxicology study of DEHP in mice

Description

This data set is based on a National Toxicology Program study on diethylhexyl phthalate, DEHP. Pregnant CD-1 mice were randomly assigned to receive 0, 250, 500, 1000, or 1500 ppm of DEHP in their feed during gestational days 0-17. The uterine contents of the mice were examined for toxicity endpoints prior to normal delivery. The possible outcomes are 1) malformation, 2) death or resorption, 3) no adverse event.
Usage
dehp

Format
A 'CMData' object, that is a data frame with the following variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trt</td>
<td>factor giving treatment group</td>
</tr>
<tr>
<td>ClusterSize</td>
<td>the size of the litter</td>
</tr>
<tr>
<td>NResp.1</td>
<td>the number of fetuses with a type 1 outcome (malformation)</td>
</tr>
<tr>
<td>NResp.2</td>
<td>the number of fetuses with a type 2 outcome (death or resorption)</td>
</tr>
<tr>
<td>NResp.3</td>
<td>the number of fetuses with a type 3 outcome (normal)</td>
</tr>
<tr>
<td>Freq</td>
<td>the number of litters with the given ClusterSize/NResp.1-NResp.3 combination</td>
</tr>
</tbody>
</table>

Source
National Toxicology Program, NTP Study TER84064.

References

Examples
data(dehp)
library(lattice)
pl <- xyplot(NResp.1/ClusterSize + NResp.2/ClusterSize + NResp.3/ClusterSize ~ Trt, data=dehp, outer=TRUE, type=c("p","a"), jitter.x=TRUE)
pl$condlevels[[1]] <- c("Malformed", "Dead", "Normal")
print(pl)

egde EGDE data

Description
The data set is based on a developmental toxicity experiment on the effect of ethylene glycol diethyl ether (EGDE) on fetal development of New Zealand white rabbits. In the study, four groups of pregnant does were randomly assigned to dose levels $0$, $25$, $50$, and $100$ milligrams per kilogram body weight of EGDE. For each litter and at each dose level, the adverse response used is the combined number of fetal malformation and fetal death.

Usage
data(egde)
Format

A 'CBData' object, that is a data frame with the following variables:

- **Trt**: factor giving treatment group
- **ClusterSize**: the size of the litter
- **NResp**: the number of affected fetuses
- **Freq**: the number of litters with the given ClusterSize/NResp combination

Source


Examples

```r
data(egde)
stripchart(I(NResp/ClusterSize)-~Trt, cex=sqrt(egde$Freq), data=egde, pch=1,
    method="jitter", vertical=TRUE, ylab="Proportion affected")
```

Extract

*Extract from a CBData or CMData object*

Description

The extracting syntax works as for {.data.frame}, and in general the returned object is not a CBData or CMData object. However if the columns are not modified, then the result is still a CBData or CMData object with appropriate attributes preserved, and the unused levels of treatment groups dropped.

Usage

```r
## S3 method for class 'CBData'
x[i, j, drop]
## S3 method for class 'CMData'
x[i, j, drop]
```

Arguments

- **x**: CMData object.
- **i**: numeric, row index of extracted values
- **j**: numeric, column index of extracted values
- **drop**: logical. If TRUE the result is coerced to the lowest possible dimension. The default is the same as for {.data.frame}: to drop if only one column is left, but not to drop if only one row is left.
Value

a CBData or CMData object

Author(s)

Aniko Szabo

See Also

CBData, CMData

Examples

data(shelltox)
str(shelltox[1:5,])
str(shelltox[1:5, 2:4])
data(dehp)
str(dehp[1:5,])
str(dehp[1:5, 2:4])

gee.trend.test  GEE-based trend test

Description

gee.trend.test implements a GEE based test for linear increasing trend for correlated binary data.

Usage

gee.trend.test(cbdata, scale.method = c("fixed", "trend", "all"))

Arguments

cbdata  a CBData object

scale.method  character string specifying the assumption about the change in the overdispersion (scale) parameter across the treatment groups: "fixed" - constant scale parameter (default); "trend" - linear trend for the log of the scale parameter; "all" - separate scale parameter for each group.
Details

The actual work is performed by the `geese` function of the `geepack` library. This function only provides a convenient wrapper to obtain the results in the same format as `RS.trend.test` and `ST.trend.test`.

The implementation aims for testing for increasing trend, and a one-sided p-value is reported. The test statistic is asymptotically normally distributed, and a two-sided p-value can be easily computed if needed.

Value

A list with components

- `statistic` numeric, the value of the test statistic
- `p.val` numeric, asymptotic one-sided p-value of the test

Author(s)

Aniko Szabo, aszabo@mcw.edu

See Also

- `RS.trend.test`, `ST.trend.test` for alternative tests; `CBData` for constructing a CBData object.

Examples

data(shelltox)
GEE.trend.test(shelltox, "trend")

Description

An exchangeable multinomial distribution with $K + 1$ categories $O_1, \ldots, O_{K+1}$, can be parameterized by the joint probabilities of events

$$
\tau_{r_1, \ldots, r_K | n} = P[X_1 = \cdots = X_{r_1} = O_1, \ldots, X_{\sum_{i=1}^{K-1} r_i + 1} = \cdots = X_{\sum_{i=1}^{K} r_i} = O_K]
$$

where $r_i \geq 0$ and $r_1 + \cdots + r_K \leq n$. The `jointprobs` function estimates these probabilities under various settings. Note that when some of the $r_i$'s equal zero, then no restriction on the number of outcomes of the corresponding type are imposed, so the resulting probabilities are marginal.

Usage

`jointprobs(cmdata, type = c("averaged", "cluster", "mc"))`
mc.est.CMData

Arguments

- `cmdata` a CMData object
- `type` character string describing the desired type of estimate:
  - "averaged" - averaged over the observed cluster-size distribution within each treatment
  - "cluster" - separately for each cluster size within each treatment
  - "mc" - assuming marginal compatibility, i.e., that $\tau$ does not depend on the cluster-size

Value

a list with an array of estimates for each treatment. For a multinomial distribution with $K + 1$ categories the arrays will have either $K + 1$ or $K$ dimensions, depending on whether cluster-size specific estimates (`type="cluster"`) or pooled estimates (`type="averaged"` or `type="mc"`) are requested. For the cluster-size specific estimates the first dimension is the cluster-size. Each additional dimension is a possible outcome.

See Also

- `mcNest` for estimating the distribution under marginal compatibility, `uniprobs` and `multiNcorr` for extracting the univariate marginal event probabilities, and the within-multinomial correlations from the joint probabilities.

Examples

```r
data(dehp)
# averaged over cluster-sizes
tau.ave <- jointprobs(dehp, type="ave")
# averaged P(X1=X2=01, X3=02) in the 1500 dose group
tau.ave["1500"][[2,"1"]]
# there are two type-1, and one type-2 outcome

#plot P(X1=01) - the marginal probability of a type-1 event over cluster-sizes
tau <- jointprobs(dehp, type="cluster")
est <- as.data.frame(lapply(tau, function(x){"1","0"}))
matplot(eest, type="b")
```

Description

The `mc.est` function estimates the distribution of the number of responses in a cluster under the assumption of marginal compatibility: information from all cluster sizes is pooled. The estimation is performed independently for each treatment group.
Usage

## S3 method for class 'CMData'
mc.est(object, eps = 1e-06, ...)

## S3 method for class 'CBData'
mc.est(object, ...)

mc.est(object, ...)

Arguments

object a CBData or CMData object
eps numeric; EM iterations proceed until the sum of squared changes fall below eps
... other potential arguments; not currently used

Details

The EM algorithm given by Stefanescu and Turnbull (2003) is used for the binary data.

Value

For CMData: A data frame giving the estimated pdf for each treatment and clustersize. The probabilities add up to 1 for each Trt/ClusterSize combination. It has the following columns:

Prob numeric, the probability of NResp responses in a cluster of size ClusterSize in group Trt
Trt factor, the treatment group
ClusterSize numeric, the cluster size
NResp.1 - NResp.K numeric, the number of responses of each type

For CBData: A data frame giving the estimated pdf for each treatment and clustersize. The probabilities add up to 1 for each Trt/ClusterSize combination. It has the following columns:

Prob numeric, the probability of NResp responses in a cluster of size ClusterSize in group Trt
Trt factor, the treatment group
ClusterSize numeric, the cluster size
NResp numeric, the number of responses

Note

For multinomial data, the implementation is currently written in R, so it is not very fast.

Author(s)

Aniko Szabo
mc.test.chisq.CMData

References


Examples

data(dehp)
dehp.mc <- mc.est(subset(dehp, Trt=="0"))
subset(dehp.mc, ClusterSize==2)

data(shelltox)
sh.mc <- mc.est(shelltox)

library(lattice)
xyplot(Prob~NResp|factor(ClusterSize), groups=Trt, data=sh.mc, subset=ClusterSize>0,
type="l", as.table=TRUE, auto.key=list(columns=4, lines=TRUE, points=FALSE),
xlab="Number of responses", ylab="Probability P(R=r|N=n)"

mc.test.chisq.CMData  Test the assumption of marginal compatibility

Description

mc.test.chisq tests whether the assumption of marginal compatibility is violated in the data.

Usage

## S3 method for class 'CMData'
mc.test.chisq(object, ...)

## S3 method for class 'CBDData'
mc.test.chisq(object, ...)

mc.test.chisq(object, ...)

Arguments

object a CBDData or CMData object

... other potential arguments; not currently used

Details

The assumption of marginal compatibility (AKA reproducibility or interpretability) implies that the marginal probability of response does not depend on clustersize. Stefanescu and Turnbull (2003), and Pang and Kuk (2007) developed a Cochran-Armitage type test for trend in the marginal probability of success as a function of the clustersize. mc.test.chisq implements a generalization of that test extending it to multiple treatment groups.
Value

A list with the following components:

- `overall.chi` the test statistic; sum of the statistics for each group
- `overall.p` p-value of the test
- `individual` a list of the results of the test applied to each group separately:
  - `chi.sq` the test statistic for the group
  - `p` p-value for the group

Author(s)

Aniko Szabo

References


See Also

`mc.est` for estimating the distribution under marginal compatibility.

Examples

```r
data(dehp)
mc.test.chisq(dehp)

data(shelltox)
mc.test.chisq(shelltox)
```

---

**multi.corr** | Extract correlation coefficients from joint probability arrays

**Description**

Calculates the within- and between-outcome correlation coefficients for exchangeable correlated multinomial data based on joint probability estimates calculated by the `jointprobs` function. These determine the variance inflation due the cluster structure.

**Usage**

```r
multi.corr(jp, type = attr(jp, "type"))
```
Arguments

jp the output of jointprobs - a list of joint probability arrays by treatment

Details

If \( R_i \) and \( R_j \) is the number of events of type \( i \) and \( j \), respectively, in a cluster of size \( n \), then

\[
\text{Var}(R_i) = np_i(1 - p_i)(1 + (n - 1)\phi_{ii})
\]

\[
\text{Cov}(R_i, R_j) = -np_ip_j(1 + (n - 1)\phi_{ij})
\]

where \( p_i \) and \( p_j \) are the marginal event probabilities and \( \phi_{ij} \) are the correlation coefficients computed by multi.corr.

Value

a list of estimated correlation matrices by treatment group. If cluster-size specific estimates were requested ((type="cluster")), then each list elements are a list of these matrices for each cluster size.

See Also

jointprobs for calculating the joint probability arrays

Examples

data(dehp)
tau <- jointprobs(dehp, type="averaged")
multi.corr(tau)
Finding the NOSTASOT dose

Description

The NOSTASOT dose is the No-Statistical-Significance-Of-Trend dose – the largest dose at which no trend in the rate of response has been observed. It is often used to determine a safe dosage level for a potentially toxic compound.

Usage

NOSTASOT(cbdata, test = c("RS", "GEE", "GEEtrend", "GEEall", "SO"),
          exact = test == "SO", R = 100, sig.level = 0.05,
          control = soControl())

Arguments

cbdata a CBData object
test character string defining the desired test statistic. See trend.test for details.
exact logical, should an exact permutation test be performed. See trend.test for details.
R integer, number of permutations for the exact test
sig.level numeric between 0 and 1, significance level of the test
control an optional list of control settings for the stochastic order ("SO") test, usually a call to soControl. See there for the names of the settable control values and their effect.
Details

A series of hypotheses about the presence of an increasing trend overall, with all but the last group, all but the last two groups, etc. are tested. Since this set of hypotheses forms a closed family, one can test these hypotheses in a step-down manner with the same \texttt{sig.level} type I error rate at each step and still control the family-wise error rate.

The NOSTASOT dose is the largest dose at which the trend is not statistically significant. If the trend test is not significant with all the groups included, the largest dose is the NOSTASOT dose. If the testing sequence goes down all the way to two groups, and a significant trend is still detected, the lowest dose is the NOSTASOT dose. This assumes that the lowest dose is a control group, and this convention might not be meaningful otherwise.

Value

a list with two components

- \texttt{NOSTASOT} character string identifying the NOSTASOT dose.
- \texttt{p} numeric vector of the p-values of the tests actually performed.

The last element corresponds to all doses included, and will not be missing. p-values for tests that were not actually performed due to the procedure stopping are set to NA.

Author(s)

Aniko Szabo, aszabo@mcw.edu

References


See Also

trend.test for details about the available trend tests.

Examples

data(shelltox)
NOSTASOT(shelltox, test="RS")
**Description**

`qpowerNpdf` and `betabinNpdf` calculate the probability distribution function for the number of responses in a cluster of the q-power and beta-binomial distributions, respectively.

**Usage**

```r
betabinNpdf(p, rho, n)
qpowerNpdf(p, rho, n)
```

**Arguments**

- `p`: numeric, the probability of success.
- `rho`: numeric between 0 and 1 inclusive, the within-cluster correlation.
- `n`: integer, cluster size.

**Details**

The pdf of the q-power distribution is

\[
P(X = x) = \binom{n}{x} \sum_{k=0}^{x} (-1)^k \binom{x}{k} q^{(n-x+k)\gamma},
\]

\[x = 0, \ldots, n,\] where \( q = 1 - p, \) and the intra-cluster correlation

\[
\rho = \frac{q^{\gamma} - q^2}{q(1 - q)}.
\]

The pdf of the beta-binomial distribution is

\[
P(X = x) = \binom{n}{x} \frac{B(\alpha + x, n + \beta - x)}{B(\alpha, \beta)},
\]

\[x = 0, \ldots, n,\] where \( \alpha = p \frac{1-\rho}{\rho}, \) and \( \alpha = (1 - p) \frac{1-\rho}{\rho}. \)

**Value**

A numeric vector of length \( n + 1 \) giving the value of \( P(X = x) \) for \( x = 0, \ldots, n. \)

**Author(s)**

Aniko Szabo, aszabo@mcw.edu
References


See Also

ran.CBData for generating an entire dataset using these functions

Examples

```r
# the distributions have quite different shapes
# with q-power assigning more weight to the "all affected" event than other distributions
plot(0:10, betabin.pdf(0.3, 0.4, 10), type="o", ylim=c(0, 0.34),
     ylab="Density", xlab="Number of responses out of 10")
lines(0:10, qpower.pdf(0.3, 0.4, 10), type="o", col="red")
```

### ran.CBData

**Generate random correlated binary data**

#### Description

ran.mc.CBData generates a random CBData object from a given two-parameter distribution.

#### Usage

```r
ran.CBData(sample.sizes, p.gen.fun = function(g) 0.3,
            rho.gen.fun = function(g) 0.2, pdf.fun = qpower.pdf)
```

#### Arguments

- `sample.sizes`: a dataset with variables Trt, ClusterSize and Freq giving the number of clusters to be generated for each Trt/ClusterSize combination.
- `p.gen.fun`: a function of one parameter that generates the value of the first parameter of `pdf.fun` (`p`) given the group number.
- `rho.gen.fun`: a function of one parameter that generates the value of the second parameter of `pdf.fun` (`rho`) given the group number.
- `pdf.fun`: a function of three parameters (`p, rho, n`) giving the PDF of the number of responses in a cluster given the two parameters (`p, rho`), and the cluster size (`n`). Functions implementing two common distributions: the beta-binomial (`betabin.pdf`) and q-power (`qpower.pdf`) are provided in the package.
Details

`p.gen.fun` and `rho.gen.fun` are functions that generate the parameter values for each treatment group; `pdf.fun` is a function generating the pdf of the number of responses given the two parameters `p` and `rho`, and the cluster size `n`.

`p.gen.fun` and `rho.gen.fun` expect the parameter value of 1 to represent the first group, 2 - the second group, etc.

Value

A `CBData` object with randomly generated number of responses with sample sizes specified in the call.

Author(s)

Aniko Szabo, aszabo@mcw.edu

See Also

`betabin.pdf` and `qpower.pdf`

Examples

```r
set.seed(3486)
ss <- expand.grid(Trt=0:3, ClusterSize=5, Freq=4)
# Trt is converted to a factor
rd <- ran.CBData(ss, p.gen.fun=function(g)0.2+0.1*g)
rd
```

---

### Description

Generate a random `CMData` object

---

### Usage

```r
ran.CMData(n, ncat, clustersize.gen, distribution)
```
Arguments

- `n`: number of independent clusters to generate
- `ncat`: number of response categories
- `clustersize.gen`: either an integer vector specifying the sizes of the clusters, which will be recycled to achieve the target number of clusters `n`; or a function with one parameter that returns an integer vector of cluster sizes when the target number of clusters `n` is passed to it as a parameter
- `distribution`: a list with two components: "multinom.gen" and "param" that specifies the generation process for each cluster. The "multinom.gen" component should be a function of three parameters: number of clusters, vector of cluster sizes, and parameter list, that a matrix of response counts where each row is a cluster and each column is the number of responses of a given type. The "param" component should specify the list of parameters needed by the multinom.gen function.

Value

A `CMDData` object with randomly generated number of responses with sample sizes specified in the call

Author(s)

Aniko Szabo

See Also

`CMDData` for details about `CMDData` objects; `multinom.gen` for built-in generating functions

Examples

```r
# Resample from the dehp dataset
data(dehp)
ran.dehp <- ran.CMData(20, 3, 10, list(multinom.gen=mg.Resample, param=list(data=dehp)))

# Dirichlet-Multinomial distribution with two treatment groups and random cluster sizes
binom.cs <- function(n){rbinom(n, p=0.3, size=10)+1}
dm1 <- ran.CMData(15, 4, binom.cs, list(multinom.gen=mg.DirMult, param=list(shape=c(2,3,2,1))))
dm2 <- ran.CMData(15, 4, binom.cs, list(multinom.gen=mg.DirMult, param=list(shape=c(1,1,4,1))))
ran.dm <- rbind(dm1, dm2)

# Logit-Normal multinomial distribution
ran.ln <- ran.CMData(13, 3, 3, list(multinom.gen=mg.LogitNorm, param=list(mu=c(-1, 1), sigma=matrix(c(1,0.8,0.8,2), nr=2))))

# Mixture of two multinomial distributions
unif.cs <- function(n){sample(5:9, size=n, replace=TRUE)}
```
read.CBData

Description

A convenience function to read data from specially structured file directly into a CBData object.

Usage

read.CBData(file, with.freq = TRUE, ...)

Arguments

file name of file with data. The first column should contain the treatment group, the second the size of the cluster, the third the number of responses in the cluster. Optionally, a fourth column could give the number of times the given combination occurs in the data.

with.freq logical indicator of whether a frequency variable is present in the file

... additional arguments passed to read.table

Value

a CBData object

Author(s)

Aniko Szabo

See Also

CBData

ran.mm <- ran.CBData(6, 3, unif.cs,
  list(multinom.gen=mg.MixMult,
    param=list(q=c(0.8,0.2), m=rbind(c(-1,0), c(0,2))))
Description

A convenience function to read data from specially structured file directly into a CMData object. There are two basic data format options: either the counts of responses of all categories are given (and the cluster size is the sum of these counts), or the total cluster size is given with the counts of all but one category. The first column should always give the treatment group, then either the counts for each category (first option, chosen by setting with.clustersize = FALSE), or the size of the cluster followed by the counts for all but one category (second option, chosen by setting with.clustersize = TRUE). Optionally, a last column could give the number of times the given combination occurs in the data.

Usage

read.CMData(file, with.clustersize = TRUE, with.freq = TRUE, ...)

Arguments

file name of file with data. The data in the file should be structured as described above.
with.clustersize logical indicator of whether a cluster size variable is present in the file
with.freq logical indicator of whether a frequency variable is present in the file
... additonal arguments passed to read.table

Value

a CMData object

Author(s)

Aniko Szabo

See Also

CMData
RS.trend.test

Rao-Scott trend test

Description

RS.trend.test implements the Rao-Scott adjusted Cochran-Armitage test for linear increasing trend with correlated data.

Usage

RS.trend.test(cbdata)

Arguments

cbdata a CBData object

Details

The test is based on calculating a design effect for each cluster by dividing the observed variability by the one expected under independence. The number of responses and the cluster size are then divided by the design effect, and a Cochran-Armitage type test statistic is computed based on these adjusted values.

The implementation aims for testing for increasing trend, and a one-sided p-value is reported. The test statistic is asymptotically normally distributed, and a two-sided p-value can be easily computed if needed.

Value

A list with components

statistic numeric, the value of the test statistic
p.val numeric, asymptotic one-sided p-value of the test

Author(s)

Aniko Szabo, aszabo@mcw.edu

References


See Also

S0.trend.test, GEE.trend.test for alternative tests; CBData for constructing a CBData object.
Examples

data(shelltox)
R5.trend.test(shelltox)

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**shelltox**

*Shell Toxicology data*

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**Description**

This is a classical developmental toxicology data set. Pregnant banded Dutch rabbits were treated with one of four levels of a chemical. The actual doses are not known, instead the groups are designated as Control, Low, Medium, and High. Before term the animals were sacrificed, and the total number of fetuses, as well as the number affected by the treatment was recorded.

**Usage**

data(shelltox)

**Format**

A 'CBData' object, that is a data frame with the following variables

- Trt: factor giving treatment group
- ClusterSize: the size of the litter
- NResp: the number of affected fetuses
- Freq: the number of litters with the given ClusterSize/NResp combination

**Source**


This data set has been analyzed (and listed) in numerous papers, including


**Examples**

data(shelltox)
SO.LRT computes the likelihood ratio test statistic for stochastic ordering against equality assuming marginal compatibility for both alternatives. Note that this statistic does not have a $\chi^2$ distribution, so the p-value computation is not straightforward. The `SO.trend.test` function implements a permutation-based evaluation of the p-value for the likelihood-ratio test.

**Usage**

```r
SO.LRT(cbdata, control = soControl())
```

**Arguments**

- `cbdata`: a CBData object
- `control`: an optional list of control settings, usually a call to `soControl`. See there for the names of the settable control values and their effect.

**Value**

The value of the likelihood ratio test statistic is returned with two attributes:

- `ll0`: the log-likelihood under $H_0$ (equality)
- `ll1`: the log-likelihood under $H_a$ (stochastic order)

**Author(s)**

Aniko Szabo

**See Also**

- `SO.trend.test`, `soControl`

**Examples**

```r
data(shelltox)
LRT <- SO.LRT(shelltox, control = soControl(max.iter = 100, max.directions = 50))
LRT
```
SO.mc.est

Order-restricted MLE assuming marginal compatibility

Description

SO.mc.est computes the nonparametric maximum likelihood estimate of the distribution of the number of responses in a cluster \( P(R = r|n) \) under a stochastic ordering constraint. Umbrella ordering can be specified using the `turn` parameter.

Usage

```
SO.mc.est(cbdata, turn = 1, control = soControl())
```

Arguments

- `cbdata`: an object of class `CBData`.
- `turn`: integer specifying the peak of the umbrella ordering (see Details). The default corresponds to a non-decreasing order.
- `control`: an optional list of control settings, usually a call to `soControl`. See there for the names of the settable control values and their effect.

Details

Two different algorithms: EM and ISDM are implemented. In general, ISDM (the default) should be faster, though its performance depends on the tuning parameter `max.directions`: values that are too low or too high slow the algorithm down.

SO.mc.est allows extension to an umbrella ordering: \( D_1 \geq^* \cdots \geq^* D_k \leq^* \cdots \leq^* D_n \) by specifying the value of \( k \) as the `turn` parameter. This is an experimental feature, and at this point none of the other functions can handle umbrella orderings.

Value

A list with components:

- `mlest`: data frame with the maximum likelihood estimates of \( P(R_i = r|n) \)
- `Q`: numeric matrix; estimated weights for the mixing distribution
- `D`: numeric matrix; directional derivative of the log-likelihood
- `loglik`: the achieved value of the log-likelihood
- `converge`: a 2-element vector with the achieved relative error and the performed number of iterations

Author(s)

Aniko Szabo, aszabo@mcw.edu
SO.trend.test

References
Szabo A, George EO. (2009) On the Use of Stochastic Ordering to Test for Trend with Clustered Binary Data. *Biometrika*

See Also
soControl

Examples

data(shelltox)
ml <- SO.mc.est(shelltox, control=soControl(eps=0.01, method="ISDM"))
attr(ml, "converge")

require(lattice)
panel.cumsum <- function(x,y,...){
  x.ord <- order(x)
  panel.xyplot(x[x.ord], cumsum(y[x.ord]), ...)
}

xyplot(Prob~NResp|factor(ClusterSize), groups=Trt, data=ml, type="s",
  panel=panel.superpose, panel.groups=panel.cumsum,
  as.table=TRUE, auto.key=list(columns=4, lines=TRUE, points=FALSE),
  xlab="Number of responses", ylab="Cumulative Probability R(R>r|N=n)",
  ylim=c(0,1.1), main="Stochastically ordered estimates
with marginal compatibility")

SO.trend.test  Likelihood ratio test of stochastic ordering

Description
Performs a likelihood ratio test of stochastic ordering versus equality using permutations to estimate the null-distribution and the p-value. If only the value of the test statistic is needed, use *SO.LRT* instead.

Usage

SO.trend.test(cbdata, R = 100, control = soControl())

Arguments

cbdata  a CBData object.
R       an integer – the number of random permutations for estimating the null distribution.
control an optional list of control settings, usually a call to soControl. See there for the names of the settable control values and their effect.
Details

The test is valid only under the assumption that the cluster-size distribution does not depend on group. During the estimation of the null-distribution the group assignments of the clusters are permuted keeping the group sizes constant; the within-group distribution of the cluster-sizes will vary randomly during the permutation test.

The default value of \( R \) is probably too low for the final data analysis, and should be increased.

Value

A list with the following components

- `LRT` the value of the likelihood ratio test statistic. It has two attributes: `llP` and `llQ` - the values of the log-likelihood under \( H_0 \) and \( H_a \) respectively.
- `p.val` the estimated one-sided p-value.
- `boot.res` an object of class "boot" with the detailed results of the permutations. See `boot` for details.

Author(s)

Aniko Szabo, aszabo@mcw.edu

References

Szabo A, George EO. (2009) On the Use of Stochastic Ordering to Test for Trend with Clustered Binary Data.

See Also

`SO.LRT` for calculating only the test statistic, `soControl`

Examples

data(shelltox)
set.seed(45742)
sh.test <- SO.trend.test(shelltox, R=5, control=soControl(eps=0.1, max.directions=25))
sh.test

# a plot of the resampled LRT values
# would look better with a reasonable value of R
null.vals <- sh.test$boot.res$ll[1]
hist(null.vals, breaks=10, freq=FALSE, xlab="Test statistic", ylab="Density",
     main="Simulated null-distribution", xlim=range(c(0,20,null.vals)))
points(sh.test$LRT, 0, pch="x",col="red", cex=3)
soControl

Control values for order-constrained fit

Description

The values supplied in the function call replace the defaults and a list with all possible arguments is returned. The returned list is used as the control argument to the mc.est, SO.LRT, and SO.trend.test functions.

Usage

soControl(method = c("ISDM", "EM"), eps = 0.005, max.iter = 5000, max.directions = 0, start = ifelse(method == "ISDM", "H0", "uniform"), verbose = FALSE)

Arguments

- method: a string specifying the maximization method
- eps: a numeric value giving the maximum absolute error in the log-likelihood
- max.iter: an integer specifying the maximal number of iterations
- max.directions: an integer giving the maximal number of directions considered at one step of the ISDM method. If zero or negative, it is set to the number of non-empty cells. A value of 1 corresponds to the VDM algorithm.
- start: a string specifying the starting setup of the mixing distribution; "H0" puts weight only on constant vectors (corresponding to the null hypothesis of no change), "uniform" puts equal weight on all elements. Only a "uniform" start can be used for the "EM" algorithm.
- verbose: a logical value; if TRUE details of the optimization are shown.

Value

a list with components for each of the possible arguments.

Author(s)

Aniko Szabo aszabo@mcw.edu

See Also

mc.est, SO.LRT, SO.trend.test

Examples

# decrease the maximum number iterations and
# request the "EM" algorithm
soControl(method="EM", max.iter=100)
trend.test

Test for increasing trend with correlated binary data

Description

The `trend.test` function provides a common interface to the trend tests implemented in this package: `SO.trend.test`, `RS.trend.test`, and `GEE.trend.test`. The details of each test can be found on their help page.

Usage

```r
trend.test(cbdata, test = c("RS", "GEE", "GEEtrend", "GEEall", "SO"),
    exact = test == "SO", R = 100, control = soControl())
```

Arguments

- `cbdata` a `CBData` object
- `test` character string defining the desired test statistic. "RS" performs the Rao-Scott test (`RS.trend.test`), "SO" performs the stochastic ordering test (`SO.trend.test`), "GEE", "GEEtrend", "GEEall" perform the GEE-based test (`GEE.trend.test`) with constant, linearly modeled, and freely varying scale parameters, respectively.
- `exact` logical, should an exact permutation test be performed. Only an exact test can be performed for "SO". The default is to use the asymptotic p-values except for "SO".
- `R` integer, number of permutations for the exact test
- `control` an optional list of control settings for the stochastic order ("SO") test, usually a call to `soControl`. See there for the names of the settable control values and their effect.

Value

A list with two components and an optional "boot" attribute that contains the detailed results of the permutation test as an object of class `boot` if an exact test was performed.

- `statistic` numeric, the value of the test statistic
- `p.val` numeric, asymptotic one-sided p-value of the test

Author(s)

Aniko Szabo, aszabo@mcw.edu

See Also

`SO.trend.test`, `RS.trend.test`, and `GEE.trend.test` for details about the available tests.
Examples

data(shelltox)
trend.test(shelltox, test="RS")
set.seed(5724)
# R=50 is too low to get a good estimate of the p-value
trend.test(shelltox, test="RS", R=50, exact=TRUE)

uniprobs

Extract univariate marginal probabilities from joint probability arrays

Description

Calculates the marginal probability of each event type for exchangeable correlated multinomial data based on joint probability estimates calculated by the jointprobs function.

Usage

uniprobs(jp, type = attr(jp, "type"))

Arguments

jp the output of jointprobs - a list of joint probability arrays by treatment
type one of c("averaged","cluster","mc") - the type of joint probability. By default, the type attribute of jp is used.

Value

a list of estimated probability of each outcome by treatment group. The elements are either matrices or vectors depending on whether cluster-size specific estimates were requested (type="cluster") or not.

See Also

jointprobs for calculating the joint probability arrays

Examples

data(dehp)
tau <- jointprobs(dehp, type="averaged")
uniprobs(tau)

# separately for each cluster size
tau2 <- jointprobs(dehp, type="cluster")
uniprobs(tau2)
unwrap.CBData

Unwrap a clustered object

Description

unwrap is a utility function that reformat a CBData or CMData object so that each row is one observation (instead of one or more clusters). A new ‘ID’ variable is added to indicate clusters. This form can be useful for setting up the data for a different package.

Usage

```r
## S3 method for class 'CBData'
unwrap(object, ...)

## S3 method for class 'CMData'
unwrap(object, ...)
```

Arguments

- `object`: a `CBData` object
- `...`: other potential arguments; not currently used

Value

For `unwrap.CMData`: a data frame with one row for each cluster element (having a multinomial outcome) with the following standardized column names

- `Trt`: factor, the treatment group
- `ClusterSize`: numeric, the cluster size
- `ID`: factor, each level representing a different cluster
- `Resp`: numeric with integer values giving the response type of the cluster element

For `unwrap.CBData`: a data frame with one row for each cluster element (having a binary outcome) with the following standardized column names

- `Trt`: factor, the treatment group
- `ClusterSize`: numeric, the cluster size
- `ID`: factor, each level representing a different cluster
- `Resp`: numeric with 0/1 values, giving the response of the cluster element

Author(s)

Aniko Szabo
Examples

```r
data(dehp)
dehp.long <- unwrap(dehp)
head(dehp.long)

data(shelltox)
ush <- unwrap(shelltox)
head(ush)
```
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