Package ‘Hotelling’

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Description A set of R functions which implements Hotelling’s $T^2$ test and some variants of it. Functions are also included for Aitchison’s additive log ratio and centred log ratio transformations.
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Hotelling-package

Hotelling A set of R functions and data sets which implements Hotelling’s $T^2$ test, and some variants of it. Functions are also included for Aitchison’s additive log ratio and centred log ratio transformations.

Description

Hotelling A set of R functions and data sets which implements Hotelling’s $T^2$ test, and some variants of it. Functions are also included for Aitchison’s additive log ratio and centred log ratio transformations.

Author(s)

James Curran Maintainer: James Curran <j.curran@auckland.ac.nz> ~~ The author and/or maintainer of the package ~~

alr

Additive log ratio transformation

Description

Aitchison’s additive log ratio tranformation for compositional data

Usage

alr(form, data, group = NULL)

Arguments

form a formula which specifies the denominator variable as the response
data a data frame in which the data is stored
group if not NULL then a character string specifying the name of the grouping variable

Details

This function will give a warning if zeros are present because the transformed data will have -$\infty$s.

Value

a data frame with the ALR transformation applied to data. Each row in the data frame is standardized with respect to a specific variable by dividing by that variable. The logarithms of the resulting ratios are returned. If a grouping variable is specified, then this is preserved.
**Author(s)**

James M. Curran

**References**


**See Also**

clr

**Examples**

data(bottle.df)

## transform with respect to manganese
alr(Mn-, bottle.df, "Number")

## transform the data with respect to barium, but removing the
## grouping in column 1
alr(Ba-, bottle.df[, -1])

---

**bottle.df**

<table>
<thead>
<tr>
<th>Bottle data</th>
</tr>
</thead>
</table>

**Description**

This data contains the elemental concentration of five different elements (Manganese, Barium, Strontium, Zirconium, and Titanium) in samples of glass taken from six different Heineken beer bottles. 20 measurements were taken from each bottle.

**References**

centered log ratio transformation

Description

Aitchison’s centered log ratio transformation for compositional data

Usage

clr(data, group = NULL)

Arguments

data: a data frame in which the data is stored

group: if not NULL then a character string specifying the name of the grouping variable

Details

This function will give a warning if zeros are present because the transformed data will have -Inf.

Value

A data frame with the CLR transformation applied to data. Each row in the data frame is standardized by dividing by the geometric mean of that row. The logarithms of the resulting ratios are returned. If a grouping variable is specified, then this is preserved.

Author(s)

James M. Curran

References


See Also

alr

data(bottle.df)

## transform preserving grouping
clr(bottle.df, "Number")

## transform the data but remove the
## grouping in column 1
container.df

clr(bottle.df[, -1])

---

**container.df**

*Container data*

**Description**

This data contains the elemental concentration of nine different elements (Titanium, Aluminium, Iron, Manganese, Magnesium, Calcium, Barium, Strontium, and Zirconium) in specimens of glass taken from two different containers. Ten measurements were taken from each container.

**References**


---

**hotelling.stat**

*Calculate Hotelling’s two sample T-squared test statistic*

**Description**

Calculate Hotelling’s T-squared test statistic for the difference in two multivariate means.

**Usage**

`hotelling.stat(x, y, shrinkage = FALSE)`

**Arguments**

- `x` : a nx by p matrix containing the data points from sample 1
- `y` : a ny by p matrix containing the data points from sample 2
- `shrinkage` : set to TRUE if the covariance matrices are to be estimated using Schaefer and Strimmer’s James-Stein shrinkage estimator

**Details**

Note, the sample size requirements are that nx + ny - 1 > p. The procedure will stop if this is not met and the shrinkage estimator is not being used. The shrinkage estimator has not been rigorously tested for this application (small p, smaller n).
Value

A list containing the following components:

- **statistic**: Hotelling’s (unscaled) T-squared statistic
- **m**: The scaling factor - this can be used by multiplying it with the test statistic, or dividing the critical F value
- **df**: A vector of length containing the numerator and denominator degrees of freedom
- **nx**: The sample size of sample 1
- **ny**: The sample size of sample 2
- **p**: The number of variables to be used in the comparison

Author(s)

James M. Curran

References


Examples

```r
data(container.df)
split.data = split(container.df[,-1], container.df$gp)
x = split.data[[1]]
y = split.data[[2]]
hotelling.stat(x, y)
hotelling.stat(x, y, TRUE)
```

---

**hotelling.test**  
*Two-sample Hotelling’s T-squared test*

Description

Performs a two-sample Hotelling’s T-squared test for the difference in two multivariate means
Usage

hotelling.test(x, ...)

## Default S3 method:
hotelling.test(x, y, shrinkage = FALSE, perm = FALSE,
    B = 10000, progBar = (perm && TRUE), ...)

## S3 method for class 'formula'
hotelling.test(x, data = NULL, pair = c(1, 2), ...)

Arguments

x          a matrix containing the data points from sample 1 or a formula specifying the
          elements to be used as a response and the grouping variable as a predictor
...
          any additional arguments. This is useful to pass the optional arguments for the
          default call from the formula version
y          a matrix containing the data points from sample 2
shrinkage  if TRUE then Shaefer and Strimmer's James-Stein shrinkage estimator is used to
          calculate the sample covariance matrices
perm       if TRUE then permutation testing is used to estimate the non-parametric P-value
          for the hypothesis test
B          if perm is TRUE, then B is the number of permutations to perform
progBar    if TRUE and perm is TRUE then a progress bar will be displayed whilst the per-
          mutation procedure is carried out
data       a data frame needs to be specified if a formula is to be used to perform the test
pair       a vector of length two which can be used when the grouping factor has more
          than two levels to select different pairs of groups. For example for a 3-level
          factor, pairs could be set to c(1, 3) to perform Hotelling's test between groups
          1 and 3

Value

A list (which is also of class 'hotelling.test') with the following elements:

stats     a list containing all of the output from hotelling.stat
pval      the P-value from the test
results   if perm == TRUE, then all of the permutation test statistics are stored in results

Methods (by class)

- default: Two-sample Hotelling's T-squared test
- formula: Two-sample Hotelling's T-squared test

Author(s)

James M. Curran
References


See Also

hotelling.stat

Examples

data(container.df)
fit = hotelling.test(.~gp, data = container.df)
fit

subs.df = container.df[1:10,]
subs.df$gp = rep(1:2, c(5,5))
fitPerm = hotelling.test(Al+Fe~gp, data = subs.df, perm = TRUE)
fitPerm
plot(fitPerm)

data(bottle.df)
fit12 = hotelling.test(.~Number, data = bottle.df)
fit12

fit23 = hotelling.test(.~Number, data = bottle.df, pair = c(2,3))
fit23

plot.hotelling.test Plots the results from a permutation based version of Hotelling’s T-squared test for the difference in two multivariate sample means

Description

Plots a histogram of the distribution of the permuted test statistics for a permutation version of Hotelling’s T-squared

Usage

## S3 method for class 'hotelling.test'
plot(x, ...)

print.hotelling.test

Arguments

x an object of type hotelling.test

... any additional arguments to be passed to the hist command

Details

This function only works if you have performed a permutation test. It will return an error message if not. It could be programmed to draw the relevant F distribution in the standard case, but this seems rather pointless.

Author(s)

James M. Curran

Examples

data(bottle.df)
bottle.df = subset(bottle.df, Number == 1)
bottle.df$Number = rep(1:2,c(10,10))
fit = hotelling.test(~Number, bottle.df, perm = TRUE)
plot(fit)
plot(fit, col = "lightblue")

print.hotelling.test  Prints the results from a Hotelling's T-squared test for the difference in two multivariate sample means

Description

Prints the test statistic, degrees of freedom and P-value from Hotelling's T-squared test for the difference in two multivariate sample means

Usage

## S3 method for class 'hotelling.test'
print(x, ...)

Arguments

x an object of type hotelling.test

... any additional arguments to be passed to the hist command

Author(s)

James M. Curran
Examples

data(bottle.df)
bottle.df = subset(bottle.df, Number == 1)
bottle.df$Number = rep(1:2,c(10,10))
fit = hotelling.test(~Number, bottle.df, perm = TRUE)
fit
fit = hotelling.test(~Number, bottle.df)
fit

## an explict call
print(fit)
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