Package 'MultiSkew'

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Type Package

Title Measures, Tests and Removes Multivariate Skewness

Version 1.1.1

Date 2017-06-13

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Description Computes the third multivariate cumulant of either the raw, centered or standardized data. Computes the main measures of multivariate skewness, together with their bootstrap distributions. Finally, computes the least skewed linear projections of the data.

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Depends MaxSkew

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MultiSkew-package *MultiSkew*

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References

Bartoletti, S. and Loperfido, N. (2010). Modelling Air Pollution Data by the Skew-Normal Distribution. Stochastic Environmental Research & Risk Assessment 24, 513-517.

Loperfido, N. (2013). Skewness and the Linear Discriminant Function. Statistics & Probability Letters 83, 93-99.

Loperfido, N. (2014). Linear Transformations to Symmetry. Journal of Multivariate Analysis 129, 186-192.

Malkovich, J.F. and Afifi, A.A. (1973). On Tests for Multivariate Normality. J. Amer. Statist. Ass. 68, 176-179.

Mardia, K.V. (1970). Measures of multivariate skewness and kurtosis with applications. Biometrika 57, 519-530.

Mori T.F., Rohatgi V.K. and Szekely G.J. (1993). On multivariate skewness and kurtosis. Theory Probab. Appl. 38, 547-551.

Examples

```
data(PM10_2006)
PM10_2006_matrix<-data.matrix(PM10_2006)

MinSkew(PM10_2006_matrix[,2:5],4)
PartialSkew(PM10_2006_matrix[,2:5])
SkewMardia(PM10_2006_matrix[,2:5])
Third(PM10_2006_matrix[,2:5], "raw")
```

```
#library(MaxSkew)

SkewBoot(PM10_2006_matrix[,2:5], 50, 50, "Directional")
SkewBoot(PM10_2006_matrix[,2:5], 50, 50, "Mardia")
SkewBoot(PM10_2006_matrix[,2:5], 50, 50, "Partial")
```

`FisherSkew` *Fisher's measure of skewness*

Description

Computes Fisher's measure of skewness, that is the third standardized moment of each variable in the dataset

Usage

```
FisherSkew(data)
```

Arguments

`data`	data matrix

Value

Dataframe containing Fisher's measure of skewness of each variable of the dataset

Author(s)

Cinzia Franceschini and Nicola Loperfido

Examples

```
data(PM10_2006)
PM10_2006_matrix<-data.matrix(PM10_2006)
FisherSkew(PM10_2006_matrix)
```

MinSkew *MinSkew*

Description

Reduces sample skewness by projecting the data onto appropriate linear subspaces

Usage

```
MinSkew(data, dimension)
```

Arguments

data	data matrix
dimension	number of required projections

Value

Linear	linear function of the variables
Projections	projected data

Author(s)

Cinzia Franceschini and Nicola Loperfido

References

Loperfido, N. (2014). Linear Transformations to Symmetry. Journal of Multivariate Analysis 129, 186-19

Examples

```
data(PM10_2006)
PM10_2006_matrix<-data.matrix(PM10_2006)
MinSkew(PM10_2006_matrix[,2:5],4)
```

PartialSkew *PartialSkew*

Description

Multivariate skewness, as defined in Mori, Rohatgi e Szekely (1993).

Usage

```
PartialSkew(data)
```

Arguments

data	data matrix

Value

Vector	The vector-valued skewness introduced by Mori et al (1993)
Scalar	The squared norm of Vector
pvalue	The probability of observing a value of Scalar greater than the observed one, when data are normally distributed

Author(s)

Cinzia Franceschini and Nicola Loperfido

References

Mori T.F., Rohatgi V.K. and Szekely G.J. (1993). On multivariate skewness and kurtosis. Theory Probab. Appl. 38, 547-551.

Examples

```
data(PM10_2006)
PM10_2006_matrix<-data.matrix(PM10_2006)
PartialSkew(PM10_2006_matrix[,2:5])
```

PM10_2006 *PM10_2006: dataset*

Description

The PM10 dataset provides an evaluation of PM10 (particulate matter with an aerodynamic equivalent diameter of up 10 m) concentrations recorded in Italy during year 2006. The variables, collected from 257 stations, are: average (MEAN) and 50th percentile (MEDIAN) for stations which have valid data with a time coverage of at least 50; 98th percentile (98TH) and maximum value (MAX). Stations are classified by region, province and zone (rural, urban, suburban).

Usage

```
data("PM10_2006")
```

Format

A data frame with 257 observations on the following 5 variables.

`zone` a factor with levels `R` `S` `U`

`mean` a numeric vector

`median` a numeric vector

`'98th'` a numeric vector

`max` a numeric vector

Source

APAT (2007) Environmental data yearbook http:www.apat.gov.it site it-IT APAT Pubblicazioni Annuario_dei_Dati_Ambientali

References

Bartoletti, S. and Loperfido, N. (2010). Modelling Air Pollution Data by the Skew-Normal Distribution. Stochastic Environmental Research & Risk Assessment 24, 513-517.

Christiansen, M. and Loperfido, N. (2014). Improved Approximation of the Sum of Random Vectors by the Skew-Normal Distribution. Journal of Applied Probability 51, 466-482.

Examples

```
data(PM10_2006)
## maybe str(PM10_2006) ; plot(PM10_2006) ...
```

SkewBoot *Bootstrap inference for multivariate skewness measures*

Description

Computes the bootstrap distribution, its histogram and the corresponding p-value of the chosen measure of multivariate skewness (Mardia, Partial or Directional), using a given number of bootstrap replicates.

Usage

```
SkewBoot(data, replicates, units, type)
```

Arguments

data	data matrix
replicates	number of bootstrap replicates
units	number of rows in the data matrices sampled from the original data matrix
type	"Directional", "Partial" or "Mardia". If type is set equal to "Directional" or "Mardia", units is an integer greater than the number of variables. If type set equal to "Partial", units is an integer greater than the number of variables + 1

Details

The function calls the package MaxSkew 1.1, which needs to be downloaded. The number of iterations required by the package MaxSkew is set equal to 5.

Value

histogram	plot of the above mentioned bootstrap distribution
Pvalue	p-value of the chosen skewness measure
Vector	vector containing the bootstrap replicates of the chosen skewness measure

Author(s)

Cinzia Franceschini and Nicola Loperfido

Examples

```
library(MaxSkew)
data(PM10_2006)
PM10_2006_matrix<-data.matrix(PM10_2006)
#source("SkewBoot.R")
#SkewBoot(PM10_2006_matrix[,2:5], 50, 50, "Partial")
#SkewBoot(PM10_2006_matrix[,2:5], 50, 50, "Mardia")
#SkewBoot(PM10_2006_matrix[,2:5], 50, 50, "Directional")
```

SkewMardia *Multivariate skewness as defined in Mardia (1970)*

Description

Sum of squared elements in the third standardized cumulant of the data matrix.

Usage

```
SkewMardia(data)
```

Arguments

data	data matrix

Value

MardiaSkewness	Squared norm of the third cumulant of the standardized data
pvalue	Probability of observing a value of MardiaSkewness greater than the observed one, when data are normally distributed.

Note

The measure has been introduced in Mardia, K.V. (1970)

Author(s)

Cinzia Franceschini and Nicola Loperfido

References

Mardia, K.V. (1970), Measures of multivariate skewness and kurtosis with applications.Biometrika 57, 519-530.

Examples

```
data(PM10_2006)
PM10_2006_matrix<-data.matrix(PM10_2006)
SkewMardia(PM10_2006_matrix[,2:5])
```

`Third` *Third multivariate moment of a data matrix*

Description

It contains all moments of order three which can be obtained from the variables.

Usage

```
Third(data, type)
```

Arguments

`data`	data matrix
`type`	type="raw" is the third raw moment type="central" is the third central moment type="standardized" is the third standardized moment

Details

Some general information about the third multivariate moment of both theoretical and emprical distributions are reviewed in Loperfido, N. (2015).

Value

Third moment: all moments of order three which can be obtained from the variables in "data".

Author(s)

Cinzia Franceschini and Nicola Loperfido

References

Loperfido, N. (2015). Singular Value Decomposition of the Third Multivariate Moment. Linear Algebra and its Applications 473, 202-216.

Examples

```
data(PM10_2006)
PM10_2006_matrix<-data.matrix(PM10_2006)
Third(PM10_2006_matrix[,2:5], "raw")
```

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