Package: MNormTest (via r-universe)

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Title Multivariate Normal Hypothesis Testing

Version 1.1.1

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URL <https://github.com/Astringency/MNormTest>,

<https://astringency.github.io/MNormTest/>,

<https://CRAN.R-project.org/package=MNormTest>

BugReports <https://github.com/Astringency/MNormTest/issues>

Description Hypothesis testing of the parameters of multivariate
normal distributions, including the testing of a single mean
vector, two mean vectors, multiple mean vectors, a single
covariance matrix, multiple covariance matrices, a mean and a
covariance matrix simultaneously, and the testing of
independence of multivariate normal random vectors. Huixuan,
Gao (2005, ISBN:9787301078587), ``Applied Multivariate
Statistical Analysis".

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RoxygenNote 7.3.2

Depends R (>= 4.0.0), Rmpfr (>= 0.9-5)

Suggests rmarkdown, knitr, yaml, testthat (>= 3.0.0), devtools,
roxygen2, pkgbuild, covr, usethis, DT

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NeedsCompilation no

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Repository CRAN

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covTest.multi	*Multiple Covariance Matrix Hypothesis Testing*

Description

Test whether the covariance matrices of multiple multivariate normal populations are all equal. Suppose we have k populations, the null hypothesis is "H0: Sigma1 = Sigma2 = ... = Sigmak".

Usage

```
covTest.multi(X, label, alpha = 0.05, verbose = TRUE)
```

Arguments

X	The data matrix which is a matrix or data frame.
label	A vector of group labels.
alpha	The significance level. Default is 0.05.
verbose	A boolean value. Default is TRUE. If TRUE, the null hypothesis will be displayed. If FALSE, the test will be carried out silently.

Value

An object of class "testResult", which is a list with the following elements:

Conclusion	The conclusion of the test.
Stat	A data frame containing the statistics, p value and critical value.
SampMeanT	The sample mean.
SampMeanWithin	The sample mean of each group.
SdWithin	The sample deviation of each group.
SdWithinT	The sample deviation within group.
Df	The degree of freedom.
sampleSize	The sample size of each group.
d	The Modified factor of the statistic.

Author(s)

Xifeng Zhang

References

Huixuan, Gao. Applied Multivariate Statistical Analysis. Peking University Press, 2005: pp.88-89.

Examples

```
data(iris)
chart <- iris[, 1:4]
species <- iris[, 5]
# carry out the test
test1 <- covTest.multi(chart, species)
test2 <- covTest.multi(chart, species, verbose = FALSE)
# get the elements
test1$Stat
test1$SampMeanT
test1$sampleSize
```

---

covTest.single	*Single Covariance Matrix Hypothesis Testing*

Description

Test whether the covariance matrix is equal to a certain value. The null hypothesis is "H0: Sigma = Sigma0" or "H0: Sigma = sigma^2 * Sigma0".

Usage

```
covTest.single(data, Sigma0, ball = FALSE, alpha = 0.05, verbose = TRUE)
```

Arguments

data	The data matrix which is a matrix or data frame.
Sigma0	The covariance matrix when the null hypothesis is true.
ball	A boolean value. Default is FALSE. If FALSE, test whether the covariance matrix is Sigma0 (known), which means the null hypothesis is "H0: Sigma = Sigma0". If TRUE and the Sigma0 is a unit matrix, the Mauchly's ball test will be performed. If TRUE but Sigma0 (known) is not a unit matrix, the covariance matrix will be tested to see if it is sigma^2*Sigma0 (sigma^2 is unknown), which means the null hypothesis is "H0: Sigma = sigma^2 * Sigma0".
alpha	The significance level. Default is 0.05.
verbose	A boolean value. Default is TRUE. If TRUE, the null hypothesis will be displayed. If FALSE, the test will be carried out silently.

Value

An object of class "testResult", which is a list with the following elements: Return when ball is FALSE.

Conclusion	The conclusion of the test.
Stat	A data frame containing the statistics, p value and critical value.
SampMean	The sample mean.
SampA	The sample deviation.
Df	The degree of freedom.

Return when ball is TRUE

Conclusion	The conclusion of the test.
Stat	A data frame containing the statistics, p value and critical value.
SampMean	The sample mean.
SampA	The sample deviation.
sigma.hat	The estimation of sigma^2.
Df	The degree of freedom.

Author(s)

Xifeng Zhang

References

Huixuan, Gao. Applied Multivariate Statistical Analysis. Peking University Press, 2005: pp.83-88.

Examples

```
data(iris)
X <- iris[, 1:4]
# carry out the test
test1 <- covTest.single(X, diag(1, 4))
test2 <- covTest.single(X, diag(1, 4), ball = TRUE)
test3 <- covTest.single(X, diag(2, 4), ball = TRUE)
test4 <- covTest.single(X, diag(1, 4), verbose = FALSE)
# get the elements
test1$Stat
test2$Df
test3$sigma.hat
```

***

indTest.multi *Multivariate Normal Independence Test*

***

Description

Test whether a set of multivariate normal random vectors are independent. The null hypothesis is "H0: The random vectors are independent of each other".

Usage

```
indTest.multi(data, subdim = FALSE, alpha = 0.05, verbose = TRUE)
```

Arguments

data   The data matrix which is a matrix or data frame. Each column represents a
              random variable.

subdim   The dimensions of submatrices. The default is FALSE, which means the inde-
              pendence of all components of the random vector will be tested.

alpha   The significance level. Default is 0.05.

verbose   A boolean value. Default is TRUE. If TRUE, the null hypothesis will be dis-
              played. If FALSE, the test will be carried out silently.

Value

An object of class "testResult", which is a list with the following elements:

Conclusion   The conclusion of the test.

Stat   A data frame containing the statistics, p value and critical value.

SampMean   The sample mean.

SampA   The sample deviation.

SampAii   The sample deviation of submatrices.

Df   The degree of freedom.

b   The Modified factor of the statistic.

Author(s)

Xifeng Zhang

References

Huixuan, Gao. Applied Multivariate Statistical Analysis. Peking University Press, 2005: pp.92-94.

Examples

```
data(iris)
chart <- iris[, 1:4]
# carry out the test
test1 <- indTest.multi(chart)
test2 <- indTest.multi(chart, subdim = c(2, 1, 1))
test3 <- indTest.multi(chart, verbose = FALSE)
# get the elements
test1$Stat
test1$SampMean
test2$SampAii
```

---

meancov.Test   *Mean and Covariance Matrix Hypothesis Testing (Simultaneously)*

Description

Test whether the mean vectors and covariance matrices of multiple multivariate normal populations are all equal simultaneously. Suppose we have k populations, the null hypothesis is "H0: mu1 = mu2 = ... = muk and Sigma1 = Sigma2 = ... = Sigmak".

Usage

```
meancov.Test(X, label, alpha = 0.05, verbose = TRUE)
```

Arguments

X	The data matrix which is a matrix or data frame.
label	A vector of group labels.
alpha	The significance level. Default is 0.05.
verbose	A boolean value. Default is TRUE. If TRUE, the null hypothesis will be displayed. If FALSE, the test will be carried out silently.

Value

An object of class "testResult", which is a list with the following elements:

Conclusion	The conclusion of the test.
Stat	A data frame containing the statistics, p value and critical value.
SampMeanT	The sample mean.
SampMeanWithin	The sample mean of each group.
SdTotal	The total sample deviation.
SdWithin	The sample deviation of each group.
SdWithinT	The sample deviation within group.
Df	The degree of freedom.
sampleSize	The sample size of each group.
d	The Modified factor of the statistic.

Author(s)

Xifeng Zhang

References

Huixuan, Gao. Applied Multivariate Statistical Analysis. Peking University Press, 2005: pp.90-91.

Examples

```
data(iris)
chart <- iris[, 1:4]
species <- iris[, 5]
# carry out the test
test1 <- meancov.Test(chart, species)
test2 <- meancov.Test(chart, species, verbose = FALSE)
# get the elements
test1$Stat
test1$SampMeanT
```

---

meanTest.multi   *Multiple Mean Vectors Hypothesis Testing*

Description

Test whether the mean vectors of multiple multivariate normal populations are all equal when the covariance matrices are equal. Suppose we have k populations, the null hypothesis is that "H0: mu1 = mu2 = ... = muk". There are two approximations (Bartlett's chi2 and Rao's F) to compute the p-value and the critical value. The realized value of the Wilks Lambda statistic and its degrees of freedom are also provided. If you want to perform an exact test, consult the Wilks Lambda statistic quantile table yourself, depending on the realized value of the statistic and its degrees of freedom.

Usage

```
meanTest.multi(X, label, alpha = 0.05, verbose = TRUE)
```

Arguments

X	The data matrix which is a matrix or data frame.
label	A vector of group labels.
alpha	The significance level. Default is 0.05.
verbose	A boolean value. Default is TRUE. If TRUE, the null hypothesis will be displayed. If FALSE, the test will be carried out silently.

Value

An object of class "testResult", which is a list with the following elements:

Conclusion	The conclusion of the test.
Stat	A data frame containing the statistics, p value and critical value.
SampMeanT	The sample mean.
SampMeanWithin	The sample mean of each group.
SdTotal	The total sample deviation.
SdBetween	The sample deviation between group.
SdWithin	The sample deviation of each group.
SdWithinT	The sample deviation within group.
Df	The degree of freedom.
sampleSize	The sample size of each group.

Author(s)

Xifeng Zhang

References

Huixuan, Gao. Applied Multivariate Statistical Analysis. Peking University Press, 2005: pp.80-83.

Examples

```
data(iris)
chart <- iris[, 1:4]
species <- iris[, 5]
# carry out the test
test1 <- meanTest.multi(chart, species)
test2 <- meanTest.multi(chart, species, verbose = FALSE)
# get the elements
test1$Stat
test1$SampMeanT
test1$sampleSize
```

---

meanTest.single   *Single Mean Vector Hypothesis Testing*

Description

Test whether the mean vector of a single multivariate normal population is equal to a certain value when the population covariance matrix is known or unknown. The null hypothesis is that "H0: mu = mu0".

Usage

```
meanTest.single(data, mu0, Sigma0 = FALSE, alpha = 0.05, verbose = TRUE)
```

Arguments

data	The data matrix which is a matrix or data frame.
mu0	The mean vector when the null hypothesis is true.
Sigma0	The population covariance matrix. Default is FALSE which means the covariance matrix is unknown.
alpha	The significance level. Default is 0.05.
verbose	A boolean value. Default is TRUE. If TRUE, the null hypothesis will be displayed. If FALSE, the test will be carried out silently.

Value

An object of class "testResult", which is a list with the following elements:

Conclusion	The conclusion of the test.
Stat	A data frame containing the statistics, p value and critical value.
SampMean	The sample mean.
SampA	The sample deviation.
Df	The degree of freedom.

Author(s)

Xifeng Zhang

References

Huixuan, Gao. Applied Multivariate Statistical Analysis. Peking University Press, 2005: pp.66-68.

Examples

```
data(iris)
X <- iris[, 1:4]
mu0 <- c(5.8, 3.0, 4.3, 1.3)
# carry out the test
test1 <- meanTest.single(X, mu0)
test2 <- meanTest.single(X, mu0, Sigma0 = diag(1, 4))
test3 <- meanTest.single(X, mu0, verbose = FALSE)
# get the elements
test1$Stat
test1$SampMean
test1$SampA
test1$Df
```

---

meanTest.two	*Two Mean Vectors Hypothesis Testing*

Description

Test whether the mean vectors of two multivariate normal populations are equal when the covariance matrices are equal or unequal. The null hypothesis is that "H0: mu1 = mu2".

Usage

```
meanTest.two(
  data1,
  data2,
  alpha = 0.05,
  equal = TRUE,
  method = c("None", "Coupled", "Transformed"),
  verbose = TRUE
)
```

Arguments

data1	A matrix or data frame of group 1.
data2	A matrix or data frame of group 2.
alpha	The significance level. Default is 0.05.
equal	A boolean value. Default is TRUE. If TRUE, the covariance matrix is equal. If FALSE, the covariance matrix is not equal.
method	A string value. Default is "None". When equal is FALSE, you must choose a method in "Coupled" or "Transformed". Choose "Coupled" when the sample size of two groups is equal. Choose "Transformed" when the sample size of two groups is not equal.
verbose	A boolean value. Default is TRUE. If TRUE, the null hypothesis will be displayed. If FALSE, the test will be carried out silently.

Value

An object of class "testResult", which is a list with the following elements: Return when the param equal is TRUE.

Conclusion	The conclusion of the test.
Stat	A data frame containing the statistics, p value and critical value.
SampMean1	The sample mean of group 1.
SampMean2	The sample mean of group 2.
SampA1	The sample deviation of group 1.
SampA2	The sample deviation of group 2.

`MixSampA`	The mixed sample deviation.
`Df`	The degree of freedom.

Return when the param equal is FALSE and method is "Coupled".

`Conclusion`	The conclusion of the test.
`Stat`	A data frame containing the statistics, p value and critical value.
`SampMeanC`	The sample mean of coupled data.
`SampAC`	The sample deviation of coupled data.
`Df`	The degree of freedom.
`dataC`	The coupled data.

Return when the param equal is FALSE and method is "Transformed".

`Conclusion`	The conclusion of the test.
`Stat`	A data frame containing the statistics, p value and critical value.
`SampMeanT`	The sample mean of transformed data.
`SampAT`	The sample deviation of transformed data.
`Df`	The degree of freedom.
`dataT`	The transformed data. Return when the param equal is FALSE and method is "Transformed".

Author(s)

Xifeng Zhang

References

Huixuan, Gao. Applied Multivariate Statistical Analysis. Peking University Press, 2005: pp.76-80.

Examples

```
data(iris)
X <- iris[1:50, 1:4]
Y <- iris[51:100, 1:4]
# carry out the test
test1 <- meanTest.two(X, Y)
test2 <- meanTest.two(X, Y, verbose = TRUE)
test3 <- meanTest.two(X, Y, equal = FALSE, method = "Coupled")
test4 <- meanTest.two(X, Y, equal = FALSE, method = "Transformed")
# get the elements
test1$Stat
test1$SampMean1
test3$SampMeanC
test4$dataT
```

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