Package ‘symmetry’

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Title  Testing for Symmetry of Data and Model Residuals

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Author  Blagoje Ivanović [aut, cre]
       Bojana Milošević [aut]
       Marko Obradović [aut]

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Maintainer  Blagoje Ivanović <blagoje_ivanovic@matf.bg.ac.rs>

Description  Implementations of a large number of tests for symmetry and their
             bootstrap variants, which can be used for testing the symmetry of random
             samples around a known or unknown mean. Functions are also there for testing
             the symmetry of model residuals around zero. Currently, the supported models
             are linear models and generalized autoregressive conditional
             heteroskedasticity (GARCH) models (fitted with the 'fGarch' package). All
             tests are implemented using the 'Rcpp' package which ensures great
             performance of the code.

Depends  R (>= 3.1.0)

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LazyData  true

Imports  Rcpp, Rdpack

RdMacros  Rdpack

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rmixnorm Mixture of 2 normal distributions

Description
Generates random numbers from a mixture of 2 normal distributions

Usage
rmixnorm(n, mean1 = 0, sd1 = 1, mean2 = 0, sd2 = 1, p = 0.5)

Arguments
n number of observations
mean1 mean of the first normal
sd1 standard deviation of the first normal
mean2 mean of the second normal
sd2 standard deviation of the second normal
p probability of the first normal

Value
Vector of random numbers from the specified mixture of normals.

rsl Azzalini skew logistic distribution

Description
Generates random numbers from the skew logistic distribution

Usage
rsl(n = 1, xi = 0, omega = 1, alpha = 0, dp = NULL)
Arguments

- `n`: sample size.
- `xi`: vector of location parameters.
- `omega`: vector of (positive) scale parameters.
- `alpha`: vector of slant parameters.
- `dp`: a vector of length 3 whose elements represent the parameters described above. If `dp` is specified, the individual parameters cannot be set.

Value

Vector of random numbers from Azzalini skew logistic distribution.

Description

The package contains a large number of tests for symmetry (and their bootstrap variants), which can be used to test the symmetry of random samples or of model residuals. Currently, the supported models are linear models and generalized autoregressive conditional heteroskedasticity (GARCH) models (fitted with the `fGarch` package). The tests are implemented using the `Rcpp` package which ensures great performance.

Details

To see the available tests, see `TestStatistics`

For documentation on how to perform the tests, see `symmetry_test`

Description

This is a generic function used to perform symmetry tests on numeric vectors or objects of class `lm` (linear models) and objects of class `fGARCH` (GARCH models fitted with the `fGarch` package).
Usage

```r
symmetry_test(x, ...) # Default S3 method:
symmetry_test(x, stat, mu = NULL, bootstrap = TRUE,
    B = 1000, boot_method = c("sign", "reflect"), trim = 0, k = 0, ...
)

# S3 method for class 'lm'
symmetry_test(x, stat, B = 1000, boot_method = c("sign", "reflect"), k = 0, ...)

# S3 method for class 'fGARCH'
symmetry_test(x, stat, B = 1000, burn = 0,
    boot_method = c("sign", "reflect"), k = 0, approximate = FALSE, ...)
```

Arguments

- `x` an object of class numeric, lm or fGARCH
- `...` not used
- `stat` a character vector indicating the test statistic to be used (see Available Test Statistics)
- `mu` the centre parameter around which to test symmetry
- `bootstrap` a logical indicating whether to use bootstrap
- `B` the number of bootstrap replications
- `boot_method` the method of bootstrap sample generation (see Details)
- `trim` the trim value used for estimating the centre (as used in "mean")
- `k` the k parameter of the statistic, ignored if the test statistic doesn’t depend on a parameter (see Test Statistics)
- `burn` the number of elements to remove from the beginning of the time series for testing
- `approximate` a logical indicating whether to use the faster approximate bootstrap method (see Details)

Details

The tests are performed using bootstrap procedures or using asymptotic results, where applicable. Currently, two methods of generating a bootstrap sample from the null distribution are available. The "sign" method generates the bootstrap sample by multiplying the existing sample by -1 or 1 at random (with equal probabilities), essentially randomizing the sign of the data, giving a symmetric distribution. The "reflect" method reflects the sample around zero and samples length(x) elements with replacement. In practice, it has been shown that the "sign" method is almost always better, thus is the default.
For numeric data, the tests can be performed around a known (parameter "mu") or unknown centre. When the centre is known, the bootstrap method gives the same results as a Monte Carlo simulation of the p value, for tests which are distribution free. For unknown centre (when mu = NULL), bootstrap must be used and the estimate of the centre used is the trimmed mean, with trim parameter "trim". By default, the mean is taken (trim = 0).

For linear models, the tests are based on a bootstrap procedure as in (Allison and Pretorius 2017) and are used to test the symmetry of the residuals around zero.

For GARCH models (must be fitted with the 'fGarch' package), the tests are also based on bootstrap and test for symmetry of the residuals around zero. An approximation of the bootstrap procedure is available where the residuals are treated as iid data, which is much faster and has been shown to give similar results to the default bootstrap procedure (described in (Klar et al. 2012)).

For a comparison of the performance of various tests of symmetry around an unknown centre, see (Miloslovic and Obrodovic 2019).

**Value**

An object of class "htest" containing the results of the testing.

**References**


**Examples**

```r
set.seed(1)

# IID samples
x <- rnorm(50)
symmetry_test(x, "MOI", bootstrap = FALSE, k = 3, mu = 0)
symmetry_test(x, "MOI", bootstrap = TRUE, k = 3, mu = 0)
symmetry_test(x, "MOI", bootstrap = TRUE, k = 3)

x <- rsl(50, alpha = 1.5)
symmetry_test(x, "MOI", bootstrap = FALSE, k = 3, mu = 0)
symmetry_test(x, "MOI", bootstrap = TRUE, k = 3, mu = 0)
symmetry_test(x, "MOI", bootstrap = TRUE, k = 3)

# Linear models
lin_model <- lm(dist ~ speed, cars)
symmetry_test(lin_model, "B1")

# Garch models
library(fGarch)
specskew19 = fGarch::garchSpec(model = list(omega = 0.1,

```


alpha = 0.3,
beta = 0.3,
skew = 1.9),
cond.dist = "snorm")
x <- fGarch::garchSim(specskew19, n = 500)
g <- fGarch::garchFit(~garch(1,1), x, cond.dist = "QMLE",
include.mean = FALSE, trace = FALSE)
symmetry_test(g, "CH", B=400, burn = 100) # slower
symmetry_test(g, "FM", B=400, burn = 100, approximate = TRUE)

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### TestStatistics

**Available test statistics for symmetry tests**

**Description**

The list of implemented test statistics and their functions

**Usage**

- B1(X)
- BH2(X)
- BHC1(X, k)
- BHC2(X, k)
- BHI(X)
- BHK(X)
- CM(X)
- FM(X)
- HM(X, k)
- K2U(X)
- K2(X)
- KS(X)
- SGN(X)
- WCX(X)
\textbf{TestStatistics}

\begin{verbatim}
MGG(X)
MI(X)
MOI(X, k)
MOK(X, k)
NAC1(X, k)
NAC2(X, k)
NAI(X, k)
NAK(X, k)
RW(X)
\end{verbatim}

\textbf{Arguments}

\begin{itemize}
  \item \texttt{X} \hspace{1cm} the numeric vector for which to calculate the test statistic
  \item \texttt{k} \hspace{1cm} the 'k' parameter in the formula (if applicable)
\end{itemize}

\textbf{Details}

Below is a list of the implemented test statistics in the package. Each statistic is listed by it's name, a code string (e.g. 'B1', 'CM','MOI') and the formula of the statistic which is evaluated. The code string is used as an argument to the \texttt{symmetry_test} function. Some statistics depend on a parameter 'k' which can be seen from the formulas and is also passed as an argument.

Each statistic is implemented as a function with the same name as the code string, so the name of the function is passed as the argument "stat" to the \texttt{symmetry_test} function.

\textbf{Value}

The value of the test statistic.

\textbf{Test statistics}

The list of available statistics in the format "code(s) : name (reference)"

\begin{itemize}
  \item MI : The Mira test statistic (see (Mira 1999))
  \item CM : The Cabilio–Masaro test statistic (see (Cabilio and Masaro 1996))
  \item MGG : The Miao, Gel and Gastwirth test statistic (see (Miao et al. 2006))
  \item B1 : The $\sqrt{b_1}$ test statistic (see (Milošević and Obradović 2019))
  \item KS : The Kolmogorov–Smirnov test statistic (see (Milošević and Obradović 2019))
  \item SGN : The Sign test statistic (see (Milošević and Obradović 2019))
\end{itemize}
TestStatistics

- KS : The Wilcoxon test statistic (see Milošević and Obradović 2019)
- FM : The characterization based test statistic (see Feuerverger et al. 1977)
- RW : The Rothman-Woodroofe test statistic (see Gaigall 2019)
- BHI : The Litvinova test statistic (see Litvinova 2001)
- BHK : The Baringhaus and Henze supremum-type test statistic (see Baringhaus and Henze 1992)
- BH2 : The Baringhaus-Henze test statistic (see Baringhaus and Henze 1992)
- MOI and MOK : The Milošević and Obradović test statistics (see Milošević and Obradović 2016)
- NAI and NAK : The Nikitin and Ahsanullah test statistics (see Nikitin and Ahsanullah 2015)
- K2 and K2U : The Božin, Milošević, Nikitin and Obradović Kolmogorov type statistics based on V- and U- statistics respectively (see Božin et al. 2018)
- NAC1, NAC2, BHC1 and BHC2 : The Allison and Pretorius test statistics (see Allison and Pretorius 2017)

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