Package 'gofgamma'

July 22, 2025

Type Package

Title Goodness-of-Fit Tests for the Gamma Distribution

Version 1.0

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Description We implement various classical tests for the composite hypothesis of testing the fit to the family of gamma distributions as the Kolmogorov-Smirnov test, the Cramer-von Mises test, the Anderson Darling test and the Watson test. For each test a parametric bootstrap procedure is implemented, as considered in Henze, Meintanis & Ebner (2012) <doi:10.1080/03610926.2010.542851>. The recent procedures presented in Henze, Meintanis & Ebner (2012) <doi:10.1080/03610926.2010.542851> and Betsch & Ebner (2019) <doi:10.1007/s00184-019-00708-7> are implemented. Estimation of parameters of the gamma law are implemented using the method of Bhattacharya (2001) <doi:10.1080/00949650108812100>.

Encoding UTF-8

LazyData true

RoxygenNote 7.0.2

Depends R (>= 3.5.0)

NeedsCompilation no

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Repository CRAN

Date/Publication 2020-04-29 14:40:05 UTC

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`AD` *statistic of the Anderson-Darling goodness-of-fit test for the gamma family*

Description

This function computes the goodness-of-fit test statistic for the gamma family in the spirit of Anderson and Darling. Note that this tests the composite hypothesis of fit to the family of gamma distributions, i.e. a bootstrap procedure is implemented to perform the test, see `crit.values`.

Usage

```
AD(data, k_estimator)
```

Arguments

`data`	a vector of positive numbers. NOTE: `data` has to be the rescaled data, i.e. devided by the estimated `scale` parameter!
`k_estimator`	value of the estimated shape parameter.

Details

The Anderson-Darling test is computed as described in Henze et. al. (2012). Values of `k_estimator` are found by `gamma_est`.

Value

value of the test statistic

References

Henze, N., Meintanis, S.G., Ebner, B. (2012) "Goodness-of-fit tests for the Gamma distribution based on the empirical Laplace transform". Communications in Statistics - Theory and Methods, 41(9): 1543-1556. DOI

Examples

```
X=stats::rgamma(20,3,6)
AD(X,k_estimator=gamma_est(X)[1])
```

BE *statistic of the Betsch-Ebner test*

Description

This function computes the statistic of the goodness-of-fit test for the gamma family due to Betsch and Ebner (2019).

Usage

```
BE(data, k_estimator, a)
```

Arguments

`data`	a vector of positive numbers. NOTE: `data` has to be the rescaled data, i.e. devided by the estimated `scale` parameter!
`k_estimator`	value of the estimated shape parameter.
`a`	positive tuning parameter.

Details

The test is of weighted L^2 type and uses a characterization of the distribution function of the gamma distribution. Values of `k_estimator` are found by `gamma_est`.

Value

value of the test statistic

References

Betsch, S., Ebner, B. (2019) "A new characterization of the Gamma distribution and associated goodness of fit tests", Metrika, 82(7):779-806. DOI

Examples

```
X=stats::rgamma(20,3,6)
BE(X,k_estimator=gamma_est(X)[1],a=2)
```

CM *statistic of the Cramer-von Mises goodness-of-fit test for the gamma family*

Description

This function computes the goodness-of-fit test statistic for the gamma family in the spirit of Cramer and von Mises. Note that this tests the composite hypothesis of fit to the family of gamma distributions, i.e. a bootstrap procedure is implemented to perform the test, see `crit.values`.

Usage

```
CM(data, k_estimator)
```

Arguments

`data`	a vector of positive numbers. NOTE: `data` has to be the rescaled data, i.e. devided by the estimated `scale` parameter!
`k_estimator`	value of the estimated shape parameter.

Details

The Cramér-von Mises test is computed as described in Henze et. al. (2012). Values of `k_estimator` are found by `gamma_est`.

Value

value of the test statistic

References

Henze, N., Meintanis, S.G., Ebner, B. (2012) "Goodness-of-fit tests for the Gamma distribution based on the empirical Laplace transform". Communications in Statistics - Theory and Methods, 41(9): 1543-1556. DOI

Examples

```
X=stats::rgamma(20,3,6)
CM(X,k_estimator=gamma_est(X)[1])
```

`crit.values` *bootstrap critical value of statistic*

Description

bootstrap critical value of statistic

Usage

```
crit.values(
  samplesize,
  statistic,
  tuning = NULL,
  k_estimator,
  boot.param = 500,
  alpha = 0.05
)
```

Arguments

`samplesize`	number of observations in the sample
`statistic`	test statistic to be used
`tuning`	tuning parameter used for the test statistic (`NULL` stands for no tuning parameter needed)
`k_estimator`	value of the estimated shape parameter
`boot.param`	number of bootstrap iterations
`alpha`	significance level of the test

Value

returns the critical value for the goodness-of-fit test using the `statistic`.

Examples

```
crit.values(samplesize=20,statistic=HME1,tuning=1,k_estimator=2,boot.param=100,alpha=0.05)
```

gamma_est *Maximum-likelihood estimation of parameters for the gamma distribution*

Description

The maximum-likelihood estimators for the shape and scale parameters of a gamma distribution are computed due to the method of Bhattacharya (2001).

Usage

```
gamma_est(data)
```

Arguments

data	vector of positive valued observations

Value

returns a bivariate vector containing (shape,scale) estimated parameter vector.

References

Bhattacharya, B. (2001) "Testing equality of scale parameters against restricted alternatives for $m \geq 3$ gamma distributions with unknown common shape parameter". Journal of Statistical Computation and Simulations, 69(4):353-368, DOI

Examples

```
gamma_est(stats::rgamma(100,shape=3,scale=6))
```

HME1 *statistic of the first Henze-Meintanis-Ebner goodness-of-fit test for the gamma family*

Description

This function computes the goodness-of-fit test statistic for the gamma family due to the first test in Henze, Meintanis and Ebner (2012).

Usage

```
HME1(data, k_estimator, a = 1)
```

Arguments

data	a vector of positive numbers. NOTE: data has to be the rescaled data, i.e. devided by the estimated scale parameter!
k_estimator	value of the estimated shape parameter.
a	positive tuning parameter.

Details

The test statistic is of weighted L^2 type and uses a characterization of the distribution function of the gamma distribution.

Value

value of the test statistic

References

Henze, N., Meintanis, S.G., Ebner, B. (2012) "Goodness-of-fit tests for the Gamma distribution based on the empirical Laplace transform". Communications in Statistics - Theory and Methods, 41(9): 1543-1556. DOI

Examples

```
X=stats::rgamma(20,3,6)
HME1(X,k_estimator=gamma_est(X)[1],a=1)
```

HME2 *statistic of the second Henze-Meintanis-Ebner goodness-of-fit test for the gamma family*

Description

This function computes the goodness-of-fit test statistic for the gamma family due to the second test in Henze, Meintanis and Ebner (2012).

Usage

```
HME2(data, k_estimator, a = 4)
```

Arguments

data	a vector of positive numbers. NOTE: data has to be the rescaled data, i.e. devided by the estimated scale parameter!
k_estimator	value of the estimated shape parameter.
a	positive tuning parameter.

Details

The test statistic is of weighted L^2 type and uses a characterization of the distribution function of the gamma distribution.

Value

value of the test statistic

References

Henze, N., Meintanis, S.G., Ebner, B. (2012) "Goodness-of-fit tests for the Gamma distribution based on the empirical Laplace transform". Communications in Statistics - Theory and Methods, 41(9): 1543-1556. DOI

Examples

```
X=stats::rgamma(20,3,6)
HME2(X,k_estimator=gamma_est(X)[1],a=1)
```

KS *statistic of the Kolmogorov-Smirnov goodness-of-fit test for the gamma family*

Description

This function computes the goodness-of-fit test statistic for the gamma family in the spirit of Kolmogorov and Smirnov. Note that this tests the composite hypothesis of fit to the family of gamma distributions, i.e. a bootstrap procedure is implemented to perform the test, see `crit.values`.

Usage

```
KS(data, k_estimator)
```

Arguments

`data`	a vector of positive numbers. NOTE: `data` has to be the rescaled data, i.e. devided by the estimated `scale` parameter!
`k_estimator`	value of the estimated `shape` parameter.

Details

The Kolmogorov-Smirnov test is computed as described in Henze et. al. (2012). Values of `k_estimator` are found by `gamma_est`.

Value

value of the test statistic

References

Henze, N., Meintanis, S.G., Ebner, B. (2012) "Goodness-of-fit tests for the Gamma distribution based on the empirical Laplace transform". Communications in Statistics - Theory and Methods, 41(9): 1543-1556. DOI

Examples

```
X=stats::rgamma(20,3,6)
KS(X,k_estimator=gamma_est(X)[1])
```

`print.gofgamma` *Print method for tests of Gamma distribution*

Description

Printing objects of class "gofgamma".

Usage

```
## S3 method for class 'gofgamma'
print(x, ...)
```

Arguments

`x`	object of class "gofgamma".
`...`	further arguments to be passed to or from methods.

Details

A `gofgamma` object is a named list of numbers and character string, supplemented with `test` (the name of the teststatistic). `test` is displayed as a title. The remaining elements are given in an aligned "name = value" format.

Value

the argument x, invisibly, as for all print methods.

Examples

```
print(test.BE(rgamma(20,1)))
```

test.AD *The Anderson-Darling goodness-of-fit test for the gamma family*

Description

This function computes the goodness-of-fit test for the gamma family in the spirit of Anderson and Darling. Note that this tests the composite hypothesis of fit to the family of gamma distributions, i.e. a bootstrap procedure is implemented to perform the test.

Usage

```
test.AD(data, boot = 500, alpha = 0.05)
```

Arguments

data	a vector of positive numbers.
boot	number of bootstrap iterations used to obtain critical value.
alpha	level of significance of the test.

Details

The Anderson-Darling test is computed as described in Henze et. al. (2012). Critical values are obtained by a parametric bootstrap procedure, see crit.values.

Value

a list containing the value of the test statistic, the approximated critical value and a test decision on the significance level alpha:

$T.value the value of the test statistic.

$cv the approximated critical value.

$par.est number of points used in approximation.

$Decision the comparison of the critical value and the value of the test statistic.

$sig.level level of significance chosen.

$boot.run number of bootstrap iterations.

References

Henze, N., Meintanis, S.G., Ebner, B. (2012) "Goodness-of-fit tests for the Gamma distribution based on the empirical Laplace transform". Communications in Statistics - Theory and Methods, 41(9): 1543-1556. DOI

Examples

```
test.AD(stats::rgamma(20,3,6),boot=100)
```

test.BE *The Betsch-Ebner goodness-of-fit test for the gamma family*

Description

This function computes the goodness-of-fit test for the gamma family due to Betsch and Ebner (2019).

Usage

```
test.BE(data, a = 1, boot = 500, alpha = 0.05)
```

Arguments

data	a vector of positive numbers.
a	positive tuning parameter.
boot	number of bootstrap iterations used to obtain critical value.
alpha	level of significance of the test.

Details

The test is of weighted L^2 type and uses a characterization of the distribution function of the gamma distribution. Critical values are obtained by a parametric bootstrap procedure, see crit.values.

Value

a list containing the value of the test statistic, the approximated critical value and a test decision on the significance level alpha:

$T.value the value of the test statistic.

$cv the approximated critical value.

$par.est number of points used in approximation.

$Decision the comparison of the critical value and the value of the test statistic.

$sig.level level of significance chosen.

$boot.run number of bootstrap iterations.

References

Betsch, S., Ebner, B. (2019) "A new characterization of the Gamma distribution and associated goodness of fit tests", Metrika, 82(7):779-806. DOI

Examples

```
test.BE(stats::rgamma(20,3,6),boot=100)
```

`test.CM` *The Cramer-von Mises goodness-of-fit test for the gamma family*

Description

This function computes the goodness-of-fit test for the gamma family in the spirit of Cramer and von Mises. Note that this tests the composite hypothesis of fit to the family of gamma distributions, i.e. a bootstrap procedure is implemented to perform the test.

Usage

```
test.CM(data, boot = 500, alpha = 0.05)
```

Arguments

`data`	a vector of positive numbers.
`boot`	number of bootstrap iterations used to obtain critical value.
`alpha`	level of significance of the test.

Details

The Cramér-von Mises test is computed as described in Henze et. al. (2012). Critical values are obtained by a parametric bootstrap procedure, see `crit.values`.

Value

a list containing the value of the test statistic, the approximated critical value and a test decision on the significance level `alpha`:

`$T.value` the value of the test statistic.

`$cv` the approximated critical value.

`$par.est` number of points used in approximation.

`$Decision` the comparison of the critical value and the value of the test statistic.

`$sig.level` level of significance chosen.

`$boot.run` number of bootstrap iterations.

References

Henze, N., Meintanis, S.G., Ebner, B. (2012) "Goodness-of-fit tests for the Gamma distribution based on the empirical Laplace transform". Communications in Statistics - Theory and Methods, 41(9): 1543-1556. DOI

Examples

```
test.CM(stats::rgamma(20,3,6),boot=100)
```

`test.HME1` *The first Henze-Meintanis-Ebner goodness-of-fit test for the gamma family*

Description

This function computes the first goodness-of-fit test for the gamma family due to Henze, Meintanis and Ebner (2012).

Usage

```
test.HME1(data, a = 1, boot = 500, alpha = 0.05)
```

Arguments

`data`	a vector of positive numbers.
`a`	positive tuning parameter.
`boot`	number of bootstrap iterations used to obtain critical value.
`alpha`	level of significance of the test.

Details

The test is of weighted L^2 type and uses a characterization of the distribution function of the gamma distribution. Critical values are obtained by a parametric bootstrap procedure, see `crit.values`.

Value

a list containing the value of the test statistic, the approximated critical value and a test decision on the significance level `alpha`:

`$T.value` the value of the test statistic.

`$cv` the approximated critical value.

`$par.est` number of points used in approximation.

`$Decision` the comparison of the critical value and the value of the test statistic.

`$sig.level` level of significance chosen.

`$boot.run` number of bootstrap iterations.

References

Henze, N., Meintanis, S.G., Ebner, B. (2012) "Goodness-of-fit tests for the Gamma distribution based on the empirical Laplace transform". Communications in Statistics - Theory and Methods, 41(9): 1543-1556. DOI

Examples

```
test.HME1(stats::rgamma(20,3,6),boot=100)
```

`test.HME2` *The second Henze-Meintanis-Ebner goodness-of-fit test for the gamma family*

Description

This function computes the second goodness-of-fit test for the gamma family due to Henze, Meintanis and Ebner (2012).

Usage

```
test.HME2(data, a = 4, boot = 500, alpha = 0.05)
```

Arguments

`data`	a vector of positive numbers.
`a`	positive tuning parameter.
`boot`	number of bootstrap iterations used to obtain critical value.
`alpha`	level of significance of the test.

Details

The test is of weighted L^2 type and uses a characterization of the distribution function of the gamma distribution. Critical values are obtained by a parametric bootstrap procedure, see `crit.values`.

Value

a list containing the value of the test statistic, the approximated critical value and a test decision on the significance level `alpha`:

`$T.value` the value of the test statistic.

`$cv` the approximated critical value.

`$par.est` number of points used in approximation.

`$Decision` the comparison of the critical value and the value of the test statistic.

`$sig.level` level of significance chosen.

`$boot.run` number of bootstrap iterations.

References

Henze, N., Meintanis, S.G., Ebner, B. (2012) "Goodness-of-fit tests for the Gamma distribution based on the empirical Laplace transform". Communications in Statistics - Theory and Methods, 41(9): 1543-1556. DOI

Examples

```
test.HME2(stats::rgamma(20,3,6),boot=100)
```

`test.KS` *The Kolmogorov-Smirnov goodness-of-fit test for the gamma family*

Description

This function computes the goodness-of-fit test for the gamma family in the spirit of Kolmogorov and Smirnov. Note that this tests the composite hypothesis of fit to the family of gamma distributions, i.e. a bootstrap procedure is implemented to perform the test.

Usage

```
test.KS(data, boot = 500, alpha = 0.05)
```

Arguments

`data`	a vector of positive numbers.
`boot`	number of bootstrap iterations used to obtain critical value.
`alpha`	level of significance of the test.

Details

The Kolmogorov Smirnov test is computed as described in Henze et. al. (2012). Critical values are obtained by a parametric bootstrap procedure, see `crit.values`.

Value

a list containing the value of the test statistic, the approximated critical value and a test decision on the significance level `alpha`:

`$T.value` the value of the test statistic.

`$cv` the approximated critical value.

`$par.est` number of points used in approximation.

`$Decision` the comparison of the critical value and the value of the test statistic.

`$sig.level` level of significance chosen.

`$boot.run` number of bootstrap iterations.

References

Henze, N., Meintanis, S.G., Ebner, B. (2012) "Goodness-of-fit tests for the Gamma distribution based on the empirical Laplace transform". Communications in Statistics - Theory and Methods, 41(9): 1543-1556. DOI

Examples

```
test.KS(stats::rgamma(20,3,6),boot=100)
```

`test.WA` *The Watson goodness-of-fit test for the gamma family*

Description

This function computes the goodness-of-fit test for the gamma family in the spirit of Watson. Note that this tests the composite hypothesis of fit to the family of gamma distributions, i.e. a bootstrap procedure is implemented to perform the test.

Usage

```
test.WA(data, boot = 500, alpha = 0.05)
```

Arguments

`data`	a vector of positive numbers.
`boot`	number of bootstrap iterations used to obtain critical value.
`alpha`	level of significance of the test.

Details

The Watson test is computed as described in Henze et. al. (2012). Critical values are obtained by a parametric bootstrap procedure, see `crit.values`.

Value

a list containing the value of the test statistic, the approximated critical value and a test decision on the significance level `alpha`:

`$T.value` the value of the test statistic.

`$cv` the approximated critical value.

`$par.est` number of points used in approximation.

`$Decision` the comparison of the critical value and the value of the test statistic.

`$sig.level` level of significance chosen.

`$boot.run` number of bootstrap iterations.

References

Henze, N., Meintanis, S.G., Ebner, B. (2012) "Goodness-of-fit tests for the Gamma distribution based on the empirical Laplace transform". Communications in Statistics - Theory and Methods, 41(9): 1543-1556. DOI

Examples

```
test.WA(stats::rgamma(20,3,6),boot=100)
```

WA *statistic of the Watson goodness-of-fit test for the gamma family*

Description

This function computes the goodness-of-fit test statistic for the gamma family in the spirit of Watson. Note that this tests the composite hypothesis of fit to the family of gamma distributions, i.e. a bootstrap procedure is implemented to perform the test, see `crit.values`.

Usage

```
WA(data, k_estimator)
```

Arguments

`data`	a vector of positive numbers. NOTE: `data` has to be the rescaled data, i.e. devided by the estimated `scale` parameter!
`k_estimator`	value of the estimated `shape` parameter.

Details

The Watson test is computed as described in Henze et. al. (2012). Values of `k_estimator` are found by `gamma_est`.

Value

value of the test statistic

References

Henze, N., Meintanis, S.G., Ebner, B. (2012) "Goodness-of-fit tests for the Gamma distribution based on the empirical Laplace transform". Communications in Statistics - Theory and Methods, 41(9): 1543-1556. DOI

Examples

```
X=stats::rgamma(20,3,6)
WA(X,k_estimator=gamma_est(X)[1])
```

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