

Package ‘gbs’

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Description

A collection of utilities for analyzing censored and uncensored data from generalized Birnbaum-Saunders distributions

License GPL

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gbs-package

Package for Generalized Birnbaum-Saunders Distributions

Description

A collection of utilities for analyzing censored and uncensored data from generalized Birnbaum-Saunders distributions.

Details

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Author(s)

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References

Diaz-Garcia, J.A., Leiva, V. (2005) A new family of life distributions based on elliptically contoured distributions. *J. Stat. Plan. Infer.* 128:445-457 (Erratum: *J. Stat. Plan. Infer.* 137:1512-1513).

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Sanhueza, A., Leiva, V., Balakrishnan, N. (2008) The generalized Birnbaum-Saunders distribution and its theory, methodology and application. *Comm. Stat. Theory and Meth.* 37:645-670.

acigbs

Approximate confidence region for the parameters of the GBSD

Description

The function `acigbs()` produces a plot of an approximate confidence region and computes approximate confidence intervals (ACI) for the parameters α and β of the GBSD from a sample of observations.

Usage

```
acigbs(x, kernel = "normal", confLevel = 95,  
       chart = c(NULL, NULL, NULL, NULL),  
       colourRegion = 1,  
       colourEstimates = 2)
```

Arguments

x	Vector of observations.
kernel	Kernel of the pdf of the associated symmetrical distribution by means of which the GBSD is obtained. The kernels: laplace, logistic, normal and t are available.
confLevel	Confidence level of the region.
chart	Vector of limits of the graphs. It is a vector of the type: c(xmin, xmax, ymin, ymax).
colourRegion	Color of an approximate confidence region in the plot.
colourEstimates	Color of MLE estimators in the plot.

Details

In order to construct a confidence region for α and β of the GBSD, we use the asymptotic normality of the MLEs.

Value

acigbs() shows a plot of an approximate confidence region and computes approximate confidence intervals (ACI) for the parameters of the GBSD considering the established confidence level from a sample of observations giving results according to the following list:

alphaEstimate	Return the value of the MLE of alpha.
alphaAci	Return 95% ACI for alpha.
betaEstimate	Return the value of the MLE of beta.
betaAci	Return 95% ACI for beta.

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References

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Examples

```
## Generates a sample from the GBSD with normal kernel
x <- rgsb(300, alpha = 1.0, beta = 1.0, nu = 1.0, kernel = "normal")

## Estimates the parameters of the GBSD with normal kernel by means of a
## 95% approximate confidence region and produces a graphical confidence
## region
acigs(x, kernel = "normal", confLevel = 95, colourRegion = 1, colourEstimates = 1)
```

descriptiveSummary *Descriptive summary of the data*

Description

The function `descriptiveSummary()` gives a descriptive statistics of the data.

Usage

```
descriptiveSummary(x)
```

Arguments

x Vector of observations.

Details

The function `descriptiveSummary()` gives a descriptive statistics of the data containing: mean (\bar{x}), median, mode, standard deviation (s), coefficients of variation, skewness and kurtosis, range, minimum, maximum and the number de observations. This function uses the command `searchMode()` that allows to find the empirical mode of the data.

Sample coefficient of variation (CV):

$$CV = \frac{S}{\bar{X}} \times 100 \quad (\text{in } \%).$$

Sample coefficient of skewness (CS):

$$CS = \frac{1}{n} \frac{\sum_{i=1}^n (X_i - \bar{X})^3}{S^3}.$$

Sample coefficient of kurtosis (CK):

$$CK = \frac{1}{n} \frac{\sum_{i=1}^n (X_i - \bar{X})^4}{S^4} - 3.$$

Value

The function `descriptiveSummary()` carries out a descriptive summary of the data.

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Examples

```
## Generates a sample from the GBSD with normal kernel
x <- rgsb(300, alpha = 1.0, beta = 1.0, nu = 1.0, kernel = "normal")

## Produces a descriptive statistics of the data x
descriptiveSummary(x)
```

 dgbskotz

Pdf of the GBSD generated from the Kotz kernel

Description

This function computes the probability density function of the GBSD generated from a Kotz kernel with parameters q , r and s .

Usage

```
dgbskotz(x, alpha = 1.0, beta = 1.0, parameters = c(1.0, 1.0, 1.0),
         log = FALSE)
```

Arguments

<code>x</code>	Vector of observations.
<code>alpha</code>	Shape parameter.
<code>beta</code>	Scale parameter.
<code>parameters</code>	Parameters of the Kotz distribution denoted by q , r and s .
<code>log</code>	Logical; if TRUE, probabilities p are given as $\log(p)$.

Details

For details about the pdf of the GBSD with Kotz kernel see Sanhueza et al. (2008).

Value

dgbskotz() gives the pdf of an GBSD generated from the Kotz kernel.

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References

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Examples

```
# Produces a graphical plot for the GBSD from the Kotz kernel
# with parameters q = 1, r = 2 and s = 3
x <- seq(-3, 3, by = 0.01)
y <- dgbskotz(x, 1.0, 1.0, parameters = c(1, 2, 3))
plot(x, y, type = "l", xlab = "x", ylab = "f(x)")
```

dgbspvii

Density of the GBSD generated from the Pearson type VII kernel

Description

Probability density function of the GBSD generated from the the Pearson type VII kernel with parameters q and r .

Usage

```
dgbspvii(x, alpha = 1.0, beta = 1.0, parameters = c(1.0, 1.0), log = FALSE)
```

Arguments

<code>x</code>	Vector of observations.
<code>alpha</code>	Shape parameter.
<code>beta</code>	Scale parameter.
<code>parameters</code>	Parameters of the Kotz distribution denoted by q and r .
<code>log</code>	Logical; if TRUE, probabilities p are given as $\log(p)$.

Details

For details about the pdf of the GBSD with Pearson VII kernel see Sanhueza et al. (2008)

Value

`dgbspvii()` gives the pdf of the GBSD generated from the Pearson VII kernel.

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References

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Sanhueza, A., Leiva, V., Balakrishnan, N. (2008) The generalized Birnbaum-Saunders distribution and its theory, methodology and application. *Comm. Stat. Theory and Meth.* 37:645-670.

Examples

```
# Produces a graphical plot for the GBSD from the Pearson VII type kernel
# with parameters q = 1 y r = 2
x <- seq(-3, 3, by = 0.01)
y <- dgbspvii(x, 1.0, 1.0, parameters = c(1, 2))
plot(x, y, type = "l", xlab = "x", ylab = "f(x)")
```

diagnosticsgbs

Influence diagnostics plots for the GBSD

Description

The function `diagnosticsgbs()` produces an index plot of total local influence.

Usage

```
diagnosticsgbs(x, kernel = "normal", mainTitle = "", yRange = NULL)
```

Arguments

<code>x</code>	Vector of observations.
<code>kernel</code>	Kernel of the pdf of the associated symmetrical distribution by means of which the GBSD is obtained. The kernels: "laplace", "logistic", "normal" and "t" are available.
<code>mainTitle</code>	An overall title for the plot.
<code>yRange</code>	Limit for the <i>y</i> axis.

Details

The Cook's local influence diagnostics method (1986) is used to evaluate the local influence by means of likelihood displacement.

Value

diagnosticsgbs() gives an influence diagnostics through a graphical plot for the GBSD from a sample of observations.

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References

Cook, R.D. (1986) Assessment of local influence (with discussion). J. Royal Stat. Soc. B 48: 133-169.

Sanhueza, A., Leiva, V., Balakrishnan, N. (2008) The generalized Birnbaum-Saunders distribution and its theory, methodology and application. Comm. Stat. Theory and Meth. 37:645-670.

Examples

```
## Generates a sample from the GBSD with normal kernel
x <- rgbs(300, alpha = 1.0, beta = 1.0, nu = 1.0, kernel = "normal")

## Produces influence diagnostics for the GBSD with normal kernel
diagnosticsgbs(x, kernel = "normal")
```

dlaplace

Density of the Laplace distribution

Description

Probability density function of the Laplace distribution.

Usage

```
dlaplace(x)
```

Arguments

x Vector of observations.

Details

The Laplace distribution has pdf given by

$$f_X(x) = (1/2) \exp(-|x|), \quad -\infty < x < +\infty$$

Value

`dlaplace()` gives the pdf of an Laplace distribution.

Author(s)

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References

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- Leiva, V., Barros, M., Paula, G.A., Sanhueza, A. (2008) Generalized Birnbaum-Saunders distributions applied to air pollutant concentration. *Environmetrics* 19:235-249.
- Mineo, A. (2003). A new package for the general error distribution. *R News* 3:13-16.
- Sanhueza, A., Leiva, V., Balakrishnan, N. (2008) The generalized Birnbaum-Saunders distribution and its theory, methodology and application. *Comm. Stat. Theory and Meth.* 37:645-670.

Examples

```
# Produces a graphical plot for the Laplace distribution
x <- seq(-3, 3, by = 0.01)
y <- dlaplace(x)
plot(x, y, type = "l", xlab = "x", ylab = "f(x)")
```

fracture

Data set

Description

Data set related to the GBSD which is available in the **gbs** package. This data set has been taken from the literature of this topic.

Usage

```
data(fracture)
```

Format

A vector containing 19 observations.

Details

psi21, psi26 and psi31 were taken from Birnbaum and Saunders (1969), who reported fatigue life data correspond to the cycles ($\times 10^{-3}$) of aluminum specimens of type 6061-T6. These specimens were cut in a parallel angle to the direction of rotation and oscillating at 18 cycles per seconds. They were exposed to a pressure with maximum stress of 21,000, 26,000 and 31,000 psi (pounds per square inch), for $n = 101, 102,$ and 101 specimens, respectively.

Other data set names are: repairtimes, sheliflife, fracture, precipitations and runoff, which correspond to maintenance data on active repair times (in hours) for an airborne communications transceiver, sheliflife (in days) of a food product, fracture toughnesses of welds, precipitation (in inches) and runoff amounts at Jug Bridge, Maryland, respectively.

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Source

Chhikara, R. S. and Folks, J. L. (1989). The Inverse Gaussian Distribution. Marcel Dekker, New York.

 frgbs

Failure rate of the GBSD

Description

Failure rate (fr) of the GBSD with shape parameter α , scale parameter β and associated kernel g .

Usage

```
frgbs(x, alpha = 1.0, beta = 1.0, nu = 1.0, kernel = "normal")
```

Arguments

x	Vector of observations.
alpha	Shape parameter.
beta	Scale parameter.
nu	Shape parameter corresponding to the degrees of freedom of the t distribution. In the case of the Laplace, logistic, normal kernels, nu can be fixed at the value 1.0 since this parameter is not involved in these kernels.
kernel	Kernel of the pdf of the associated symmetrical distribution by means of which the GBSD is obtained. The kernels: "laplace", "logistic", "normal" and "t" are available.

Details

The GBSD has hf given by

$$h_T(t) = \frac{f_T(t)}{1 - F_T(t)}$$

Value

frgbs() gives the fr of the GBSD.

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References

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Examples

```
## Computes the rf of the GBSD with normal kernel for a vector x with alpha = 1.0,
## beta = 1.0
x <- seq(0.01, 4, by = 0.01)
frx <- frgbs(x, alpha = 1.0, beta = 1.0, nu = 1.0, kernel = "normal")
print(frx)

## At the end there is the graph of this pdf
plot(x, frx, main = "fr of the GBSD (classical case)", ylab = "h(x)")
```

gbs

The generalized Birnbaum-Saunders distribution (GBSD)

Description

Density, distribution function, quantile function and random generation for the generalized Birnbaum-Saunders distribution with mean parameter α , scale parameter β and associated kernel.

Usage

```
dgbs(x, alpha = 1.0, beta = 1.0, nu = 1.0, kernel = "normal",
     log = FALSE)
```

```
pgbs(q, alpha = 1.0, beta = 1.0, nu = 1.0, kernel = "normal",
     lower.tail = TRUE, log.p = FALSE)
```

```
qgbs(p, alpha = 1.0, beta = 1.0, nu = 1.0, kernel = "normal",
     lower.tail = TRUE, log.p = FALSE)
```

```
rgbs(n, alpha = 1.0, beta = 1.0, nu = 1.0, kernel = "normal")
```

Arguments

x, q	Vector of observations or quantiles.
p	Vector of probabilities.
alpha	Shape parameter.
beta	Scale parameter.
nu	Shape parameter corresponding to the degrees of freedom of the t distribution. In the case of the Laplace, logistic, normal kernels, nu can be fixed at the value 1.0 since this parameter is not involved in these kernels.
n	Number of observations.
kernel	Kernel of the pdf of the associated symmetrical distribution by means of which the GBSD is obtained. The kernels: laplace, logistic, normal and t are available.
log, log.p	Logical; if TRUE, probabilities p are given as $\log(p)$.
lower.tail	Logical; if TRUE (default), probabilities are $P(X \leq x)$, otherwise, $P(X > x)$.

Details

Probability density function for the GBSD with shape parameter α , scale parameter β and associated kernel g . The GBSD is a generalization of the BSD; for details see Sanhueza et al. (2008). The argument g corresponds to the kernel of the pdf of the associated symmetrical distribution. In the **gbs** package, the GBSD can be obtained from the following kernels: Laplace, logistic, normal (classical case) and Student- t . All these kernels are implemented in the R software. The Laplace or double exponential distribution can be obtained from the **normalp** package developed by Mineo (2005).

If α , β or g are not specified, then they assume the default values 1.0, 1.0 and "normal", respectively.

The GBSD has pdf given by

$$f_T(t) = f_Z(a_t) A_t, \quad t > 0, \alpha > 0, \beta > 0,$$

where $f_Z(\cdot) = cg(\cdot)$ is the pdf of the associated symmetrical about zero distribution, $a_t = a_t(\alpha, \beta) = [1/\alpha][\sqrt{t/\beta} - \sqrt{\beta/t}]$ and A_t is the derivative of a_t .

It is not possible to find the quantile function of the GBSD in a closed analytical form, so these values must be obtained by numerical methods.

Statistical inference tools may not exist in closed form for the GBSD, which is not the case for the classical GBSD. Hence, simulation and numerical studies are needed, which require a random number (r.n) generator. The gbs package has implemented an r.n. generator according to Sanhueza et al. (2008).

Value

dgbs() gives the density, pgbs() gives the distribution function, qgbs() gives the quantile function and rgbs() generates random numbers from the GBSD.

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References

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Mineo, A. (2003). A new package for the general error distribution. *R News* 3:13-16.

Sanhueza, A., Leiva, V., Balakrishnan, N. (2008) The generalized Birnbaum-Saunders distribution and its theory, methodology and application. *Comm. Stat. Theory and Meth.* 37:645-670.

Examples

```
## Computes the pdf of the GBSD with g = "normal" for a vector x with alpha = 1.0,
## beta = 1.0
x <- seq(0.01, 4, by = 0.01)
fx <- dgbs(x, alpha = 1.0, beta = 1.0, nu = 1.0, kernel = "normal")
print(fx)

## At the end there is a graph of this pdf
plot(x, fx, main = "pdf of the GBSD (classical case)", ylab = "f(x)")

## Computes the cdf of the GBSD with g = "normal" for a vector x with alpha = 1.0,
## beta = 1.0
Fx <- pgbs(x, alpha = 1.0, beta = 1.0, nu = 1.0, kernel = "normal")
print(Fx)

## At the end there is a graph of this cdf
plot(x, Fx, main = "cdf of the GBSD (classical case)", ylab = "F(x)")

## Compute the 50 percentile (median) for a vector of probabilities x
## of the gbs with alpha = 1.0, beta = 1.0 and kernel = "normal"
q <- qgbs(0.5, alpha = 1.0, beta = 1.0, nu = 1.0, kernel = "normal")
q
```

```
## Generates a sample x from the GBSD with normal kernel.
## At the end we have the histogram of x
x <- rgbs(1000, alpha = 1.0, beta = 1.0, nu = 1.0, kernel = "normal")
hist(x, main = "Histogram of a sample from GBSD")
```

histgbs

Histogram, box-plot and estimated pdf of the GBSD

Description

The function `histgbs()` produces a histogram and a box-plot of the data. Also, the estimated pdf may be sketched on the histogram.

Usage

```
histgbs(x, kernel = "normal", boxPlot = "TRUE", densityLine = "FALSE",
        mainTitle = "Histogram and boxplot", xLabel = "Data",
        yLabel = "Frequency", yRange = NULL, colourHistogram = "blue",
        colourDensity = "black", colourBoxPlot = "blue")
```

Arguments

<code>x</code>	Vector of observations.
<code>kernel</code>	Kernel of the pdf of the associated symmetrical distribution by means of which the GBSD is obtained. The kernels: <code>laplace</code> , <code>logistic</code> , <code>normal</code> and <code>t</code> are available.
<code>boxPlot</code>	Logical; if <code>TRUE</code> (default), the boxplot is plotted, otherwise not.
<code>densityLine</code>	Logical; if <code>TRUE</code> , the pdf is sketched on the histogram, otherwise not.
<code>mainTitle</code>	Main title of the graph.
<code>xLabel</code>	A title for the x axis.
<code>yLabel</code>	A title for the y axis.
<code>yRange</code>	Limit for the y axis.
<code>colourHistogram</code>	Color inside the histogram.
<code>colourDensity</code>	Color of the estimated pdf curve.
<code>colourBoxPlot</code>	Color inside the boxplot.

Details

The function `histgbs()` simultaneously produces a box-plot and a histogram for the data. The box-plot may be suppressed by the instruction `boxPlot = FALSE`. Also, the estimated pdf may be sketched on the histogram adding the instruction `densityLine = TRUE`.

Value

The function `histgbs()` carries out an exploratory graphical analysis and can be also useful as a simple goodness-of-fit tool.

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References

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Sanhueza, A., Leiva, V., Balakrishnan, N. (2008) The generalized Birnbaum-Saunders distribution and its theory, methodology and application. *Comm. Stat. Theory and Meth.* 37:645-670.

Examples

```
## Generates a sample from the GBSD with normal kernel
x <- rgbs(300, alpha = 1.0, beta = 1.0, nu = 1.0, kernel = "normal")

## Produces a histogram for the GBSD with normal kernel from the data x
histgbs(x,
  mainTitle = "",
  xLabel = "Data",
  kernel = "normal",
  colourHistogram = 4,
  colourBoxPlot = 4)
```

kappaii

Transformation of the GBSD distribution

Description

This function gives the value of a tranformation of the GBS distribution.

Usage

```
kappaii(x, theta = c(1.0, 1.0))
```

Arguments

x Vector of observations.
 theta Vector of parameters of alpha and beta.

Value

kappaii() computes the value of a tranformation of the GBSD.

Author(s)

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References

Sanhueza, A., Leiva, V., Balakrishnan, N. (2008) The generalized Birnbaum-Saunders distribution and its theory, methodology and application. *Comm. Stat. Theory and Meth.* 37:645-670.

 ksgbs

Test of Kolmogorov-Smirnov for the GBSD

Description

The function `ksgbs` gives the values for the Kolmogorov-Smirnov (KS) test assuming a GBSD with parameters α , β and an specific kernel. In addition, optionally, this function allows one to obtain a comparative graph between the empirical and theoretical cdfs for a given data set.

Usage

```
ksgbs(x, kernel = "normal", graph = FALSE,
      mainTitle = "Cumulative distribution function", xLabel = "data",
      yLabel = "cdf")
```

Arguments

<code>x</code>	Vector of observations.
<code>kernel</code>	Kernel of the pdf of the associated symmetrical distribution by means of which the GBSD is obtained. The kernels: "laplace", "logistic", "normal" and "t" are available.
<code>graph</code>	Logical; if TRUE (default), the cdf plot is provided.
<code>mainTitle</code>	Main title of the graph.
<code>xLabel</code>	A title for the x axis.
<code>yLabel</code>	A title for the y axis.

Details

The Kolmogorov-Smirnov test is a goodness-of-fit technique based on the maximum distance between the empirical and theoretical cdfs.

Value

The function `ksgbs()` carries out de Kolmogorov-Smirnov test for the GBSD.

Author(s)

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 Paula, Gilberto A. <giapaula@ime.usp.br>

References

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Leiva, V., Barros, M., Paula, G.A., Sanhueza, A. (2008) Generalized Birnbaum-Saunders distributions applied to air pollutant concentration. *Environmetrics* 19:235-249.

Sanhueza, A., Leiva, V., Balakrishnan, N. (2008) The generalized Birnbaum-Saunders distribution and its theory, methodology and application. *Comm. Stat. Theory and Meth.* 37:645-670.

Examples

```
## Generates a sample from the GBSB with normal kernel
x <- rgbs(300, alpha = 1.0, beta = 1.0, nu = 1.0, kernel = "normal")

## Produces a KS test and produces a graph for the GBSB with normal kernel
ksgbs(x, kernel = "normal", graph = TRUE, xLabel = "Data",
      yLabel = "Cumulative distribution function")
```

ksgbsc

Test of Kolmogorov-Smirnov for the GBSB

Description

The function `ksgbsc` gives the values for the Kolmogorov-Smirnov (KS) test assuming a GBSB with parameters α , β , an specific kernel and considering type II censored data. In addition, optionally, this function allows one to obtain a comparative graph between the empirical and theoretical cdfs for a given data set.

Usage

```
ksgbsc(x, status, kernel = "normal", graph = FALSE,
       mainTitle = "Cumulative distribution function", xLabel = "data",
       yLabel = "cdf")
```

Arguments

<code>x</code>	Vector of observations.
<code>status</code>	Vector indicating if the observation is uncensored taking a value equal to one (1) or censored taking a value equal to zero (0).
<code>kernel</code>	Kernel of the pdf of the associated symmetrical distribution by means of which the GBSB is obtained. The kernels: "laplace", "logistic", "normal" and "t" are available.

graph	Logical; if TRUE (default), the cdf plot is provided.
mainTitle	Main title of the graph.
xLabel	A title for the x axis.
yLabel	A title for the y axis.

Details

The Kolmogorov-Smirnov test is a goodness-of-fit technique based on the maximum distance between the empirical and theoretical cdfs.

Value

The function `ksgbsc()` carries out de Kolmogorov-Smirnov test for the GBSD.

Author(s)

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 Paula, Gilberto A. <giapaula@ime.usp.br>

References

- Diaz-Garcia, J.A., Leiva, V. (2005) A new family of life distributions based on elliptically contoured distributions. *J. Stat. Plan. Infer.* 128:445-457 (Erratum: *J. Stat. Plan. Infer.* 137:1512-1513).
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- Sanhueza, A., Leiva, V., Balakrishnan, N. (2008) The generalized Birnbaum-Saunders distribution and its theory, methodology and application. *Comm. Stat. Theory and Meth.* 37:645-670.

Examples

```
## Generates a sample from the GBSD with normal kernel
x <- rgsb(300, alpha = 1.0, beta = 1.0, nu = 1.0, kernel = "normal")

## Produces a KS test abd produces a graph for the GBSD with normal kernel

pc <- 20
status <- c(rep(1, floor((length(x) - pc) * (length(x)) / 100)),
            rep(0, (floor(pc * (length(x)) / 100))))
nuFixed = 1
ksgbsc(x, status, kernel = "normal", graph = TRUE, xLabel = "Data",
        yLabel = "Cumulative distribution function")
```

la

*Analytical first derivative with respect to alpha of the GBSD***Description**

This function computes the first analytical derivative of the loglikelihood with respect to α of the GBSD.

Usage

```
la(theta, x, nu = 1.0, kernel = "normal")
```

Arguments

theta	Vector of parameters alpha and beta.
x	Vector of observations.
nu	Shape parameter corresponding to the degrees of freedom of the t distribution. In the case of the Laplace, logistic, normal kernels, nu can be fixed at the value 1.0 since this parameter is not involved in these kernels.
kernel	Kernel of the pdf of the associated symmetrical distribution by means of which the GBSD is obtained. The kernels: laplace, logistic, normal and t are available.

Value

la() return the first analytical derivative of the loglikelihood with respect to α of the GBSD.

Author(s)

Barros, Michelli <michelli.karinne@gmail.com>
 Leiva, Victor <victor.leiva@uv.cl, victor.leiva@yahoo.com>
 Paula, Gilberto A. <giapaula@ime.usp.br>

References

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laa *Analytical second derivative with respect to alpha of the GBSD*

Description

This function computes the second analytical derivative of the loglikelihood with respect to α of the GBSD.

Usage

```
laa(theta, x, nu = 1.0, kernel = "normal")
```

Arguments

theta	Vector of parameters alpha and beta.
x	Vector of observations.
nu	Shape parameter corresponding to the degrees of freedom of the t distribution. In the case of the Laplace, logistic, normal kernels, nu can be fixed at the value 1.0 since this parameter is not involved in these kernels.
kernel	Kernel of the pdf of the associated symmetrical distribution by means of which the GBSD is obtained. The kernels: laplace, logistic, normal and t are available.

Value

laa() return the second analytical derivative of the loglikelihood with respect to α of the GBSD.

Author(s)

Barros, Michelli <michelli.karinne@gmail.com>
Leiva, Victor <victor.leiva@uv.cl, victor.leiva@yahoo.com>
Paula, Gilberto A. <giapaula@ime.usp.br>

References

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Sanhueza, A., Leiva, V., Balakrishnan, N. (2008) The generalized Birnbaum-Saunders distribution and its theory, methodology and application. *Comm. Stat. Theory and Meth.* 37:645-670.

`lab`*Analytical second derivative for the GBSD*

Description

This function computes the second analytical derivative of the loglikelihood with respect to α and β of the GBSD.

Usage

```
lab(theta, x, nu = 1.0, kernel = "normal")
```

Arguments

<code>theta</code>	Vector of parameters alpha and beta.
<code>x</code>	Vector of observations.
<code>nu</code>	Shape parameter corresponding to the degrees of freedom of the t distribution. In the case of the Laplace, logistic, normal kernels, nu can be fixed at the value 1.0 since this parameter is not involved in these kernels.
<code>kernel</code>	Kernel of the pdf of the associated symmetrical distribution by means of which the GBSD is obtained. The kernels: laplace, logistic, normal and t are available.

Value

`lab()` return the second analytical derivative of the loglikelihood with respect to α and β of the GBSD.

Author(s)

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Paula, Gilberto A. <giapaula@ime.usp.br>

References

Diaz-Garcia, J.A., Leiva, V. (2005) A new family of life distributions based on elliptically contoured distributions. *J. Stat. Plan. Infer.* 128:445-457 (Erratum: *J. Stat. Plan. Infer.* 137:1512-1513).

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lb *Analytical first derivative with respect to beta of the GBSD*

Description

This function computes the first analytical derivative of the loglikelihood with respect to β of the GBSD.

Usage

```
lb(theta, x, nu = 1.0, kernel = "normal")
```

Arguments

theta	Vector of parameters alpha and beta.
x	Vector of observations.
nu	Shape parameter corresponding to the degrees of freedom of the t distribution. In the case of the Laplace, logistic, normal kernels, nu can be fixed at the value 1.0 since this parameter is not involved in these kernels.
kernel	Kernel of the pdf of the associated symmetrical distribution by means of which the IGTD is obtained. The kernels: laplace, logistic, normal and t are available.

Value

lb() return the first analytical derivative of the loglikelihood with respect to β of the GBSD.

Author(s)

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References

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Sanhueza, A., Leiva, V., Balakrishnan, N. (2008) The generalized Birnbaum-Saunders distribution and its theory, methodology and application. *Comm. Stat. Theory and Meth.* 37:645-670.

lbb

*Analytical second derivative with respect to beta of the GBSD***Description**

This function computes the second analytical derivative of the loglikelihood with respect to β of the GBSD.

Usage

```
lbb(theta, x, nu = 1.0, kernel = "normal")
```

Arguments

theta	Vector of parameters alpha and beta.
x	Vector of observations.
nu	Shape parameter corresponding to the degrees of freedom of the t distribution. In the case of the Laplace, logistic, normal kernels, nu can be fixed at the value 1.0 since this parameter is not involved in these kernels.
kernel	Kernel of the pdf of the associated symmetrical distribution by means of which the GBSD is obtained. The kernels: Laplace, logistic, normal and t are available.

Value

lbb() return the second analytical derivative of the loglikelihood with respect to β of the GBSD.

Author(s)

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 Paula, Gilberto A. <giapaula@ime.usp.br>

References

Diaz-Garcia, J.A., Leiva, V. (2005) A new family of life distributions based on elliptically contoured distributions. *J. Stat. Plan. Infer.* 128:445-457 (Erratum: *J. Stat. Plan. Infer.* 137:1512-1513).

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Sanhueza, A., Leiva, V., Balakrishnan, N. (2008) The generalized Birnbaum-Saunders distribution and its theory, methodology and application. *Comm. Stat. Theory and Meth.* 37:645-670.

loglikgbs

*Loglikelihood function associated with the GBSD***Description**

This function computes the numerical value of the loglikelihood function associated with the GBSD.

Usage

```
loglikgbs(x, nu = 1.0, kernel = "normal")
```

Arguments

x	Vector of observations.
nu	Shape parameter corresponding to the degrees of freedom of the t distribution. In the case of the Laplace, logistic, normal kernels, nu can be fixed at the value 1.0 since this parameter is not involved in these kernels.
kernel	Kernel of the pdf of the associated symmetrical distribution by means of which the GBSD is obtained. The kernels: laplace, logistic, normal and t are available.

Value

Compute the loglikelihood function associated to the GBS distribution.

Author(s)

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References

Diaz-Garcia, J.A., Leiva, V. (2005) A new family of life distributions based on elliptically contoured distributions. *J. Stat. Plan. Infer.* 128:445-457 (Erratum: *J. Stat. Plan. Infer.* 137:1512-1513).

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Sanhueza, A., Leiva, V., Balakrishnan, N. (2008) The generalized Birnbaum-Saunders distribution and its theory, methodology and application. *Comm. Stat. Theory and Meth.* 37:645-670.

Examples

```
## Generates a sample from the GBSD with normal kernel
x <- rgbs(300, alpha = 1.0, beta = 1.0, nu = 1.0, kernel = "normal")

## Computes the value for the likelihood for a sample x from the GBSD
## with normal kernel
loglikgbs(x, nu = 1.0, kernel = "normal")
```

`mlebs`*Maximum likelihood estimation of the GBSD*

Description

The function `mlebs` gives the maximum likelihood estimate (MLE) of the parameters α and β of the BSD (classical case) from a sample of observations based on this distribution.

Usage`mlebs(x)`**Arguments**

`x` Vector of observations.

Details

The MLEs of the parameters α and β of the classical IG distribution are obtained using the analytical expressions of these estimators.

Value

`mlebs()` computes MLEs for the parameters of the classical BSD giving results according to the following list:

`alphaEstimate` Returns the value of the MLE of alpha.

`betaEstimate` Returns the value of the MLE of beta.

Author(s)

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References

Diaz-Garcia, J.A., Leiva, V. (2005) A new family of life distributions based on elliptically contoured distributions. *J. Stat. Plan. Infer.* 128:445-457 (Erratum: *J. Stat. Plan. Infer.* 137:1512-1513).

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Sanhueza, A., Leiva, V., Balakrishnan, N. (2008) The generalized Birnbaum-Saunders distribution and its theory, methodology and application. *Comm. Stat. Theory and Meth.* 37:645-670.

Examples

```
## Generates a sample from the GBSD with normal kernel
x <- rgsb(300, alpha = 1.0, beta = 1.0, nu = 1.0, kernel = "normal")

## Computes the likelihood for a sample x from the GBSD with normal kernel
mlebs(x)
```

mlebst	<i>MLE of the parameters of the GBSD generated from the t kernel</i>
--------	--

Description

The function `mlebst` gives the maximum likelihood estimates (MLE) of the parameters α and β of the GBSD generated from the `t` kernel based on a sample of observations based on this distribution.

Usage

```
mlebst(x)
```

Arguments

`x` Vector of observations.

Details

The MLEs of the parameters α and β of the GBSD generated from the `t` kernel must be obtained using numerical procedure already implemented in R. In this procedure, the parameter `nu` is obtained by using an optimal methodology based on the data.

Value

`mlebst()` computes MLEs for the parameters of the GBSD generated from the `t` kernel giving results according to the following list:

`alphaEstimate` Returns the value of the MLE of alpha.
`betaEstimate` Returns the value of the MLE of beta.
`nuOptimal` Returns the optimal value for nu.
`loglikelihood` Returns the value of the GBSD loglikelihood.

Author(s)

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References

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Sanhueza, A., Leiva, V., Balakrishnan, N. (2008) The generalized Birnbaum-Saunders distribution and its theory, methodology and application. *Comm. Stat. Theory and Meth.* 37:645-670.

Examples

```
## Generates a sample from the GBSD with t kernel
x <- rgbs(300, alpha = 1.0, beta = 1.0, nu = 5, kernel = "t")

## Computes the likelihood for a sample x from the GBSD with t kernel
mlebst(x)
```

mlebstNuFixed

MLE of the parameters of the BS-Student with fixed nu

Description

The function `mlebstNuFixed` gives the maximum likelihood estimates (MLE) of the parameters α and β of the GBSD generated from the t kernel based on a sample of observations based on this distribution.

Usage

```
mlebstNuFixed(x, nu = 1)
```

Arguments

`x` Vector of observations.
`nu` Shape parameter corresponding to the degrees of freedom of the t distribution.

Details

The MLEs of the parameters α and β of the classical BS distribution are obtained using numerical procedure already implemented in R. In this procedure, the parameter `nu` is previously fixed. This methodology can be useful for simulation studies or to determine the optimal value of `nu`.

Value

`mlebstNuFixed()` computes MLEs for the parameters of the GBSD generated from the t kernel giving results according to the following list:

`alphaEstimate` Returns the value of the MLE of alpha.
`betaEstimate` Returns the value of the MLE of beta.

nuFixed Returns the fixed value for nu.
 loglikelihood Returns the value of the GBSD loglikelihood.

Author(s)

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References

Diaz-Garcia, J.A., Leiva, V. (2005) A new family of life distributions based on elliptically contoured distributions. *J. Stat. Plan. Infer.* 128:445-457 (Erratum: *J. Stat. Plan. Infer.* 137:1512-1513).
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 Sanhueza, A., Leiva, V., Balakrishnan, N. (2008) The generalized Birnbaum-Saunders distribution and its theory, methodology and application. *Comm. Stat. Theory and Meth.* 37:645-670.

Examples

```
## Generates a sample from the GBSD with t kernel
x <- rgbs(300, alpha = 1.0, beta = 1.0, nu = 5, kernel = "t")

## Computes the likelihood for a sample x from the GBSD with t kernel
mlebstNuFixed(x, nu = 5)
```

mlegbs

MLE of the parameters of the GBSD

Description

The function `mlegbs` gives the maximum likelihood estimates (MLE) of the parameters α and β of the GBSD generated from the kernels: Laplace, logistic and normal (classical case) based on a sample of observations based on this distribution.

Usage

```
mlegbs(x, kernel = "normal")
```

Arguments

`x` Vector of observations.
`kernel` Kernel of the pdf of the associated symmetrical distribution by means of which the GBSD is obtained. The kernels: "laplace", "logistic" and "normal" are available.

Details

The MLEs of the parameters α and β of the GBS distribution generated from the kernels: Laplace, logistic and normal, must be obtained using numerical procedure already implemented in R.

Value

mlegbs() computes MLEs for the parameters of the GBSD generated from the kernels: Laplace, logistic and normal giving results according to the following list:

alphaEstimate Returns the value of the MLE of alpha.
 betaEstimate Returns the value of the MLE of beta.
 loglikelihood Returns the value of the GBSD loglikelihood.

Author(s)

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 Paula, Gilberto A. <giapaula@ime.usp.br>

References

Diaz-Garcia, J.A., Leiva, V. (2005) A new family of life distributions based on elliptically contoured distributions. J. Stat. Plan. Infer. 128:445-457 (Erratum: J. Stat. Plan. Infer. 137:1512-1513).
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 Sanhueza, A., Leiva, V., Balakrishnan, N. (2008) The generalized Birnbaum-Saunders distribution and its theory, methodology and application. Comm. Stat. Theory and Meth. 37:645-670.

Examples

```
## Generates a sample from the GBSD with t kernel
x <- rgsb(300, alpha = 1.0, beta = 1.0, nu = 5, kernel = "normal")

## Computes the likelihood for a sample x from the GBSD with normal kernel
mlegbs(x)
```

mlegbsc

MLE of the parameters of the GBSD with censored data

Description

The function mlegbsc gives the maximum likelihood estimates (MLE) of the parameters α and β of the GBSD generated from the kernels: Laplace, logistic and normal (classical case) based on a sample of type II censored observations based on this distribution.

Usage

```
mlegbsc(x, status)
```

Arguments

x	Vector of observations.
status	Vector indicating if the observation is uncensored taking a value equal to one (1) or censored taking a value equal to zero (0).

Details

The MLEs of the parameters α and β of the GBS distribution generated from the kernels: Laplace, logistic and normal with censored data, must be obtained using numerical procedure already implemented in R.

Value

mlegbsc() computes MLEs for the parameters of the GBSD generated from the kernels: Laplace, logistic and normal giving results according to the following list:

alphaEstimate	Returns the value of the MLE of alpha.
betaEstimate	Returns the value of the MLE of beta.
loglikelihood	Returns the value of the GBSD loglikelihood.

Author(s)

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 Paula, Gilberto A. <giapaula@ime.usp.br>

References

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Sanhueza, A., Leiva, V., Balakrishnan, N. (2008) The generalized Birnbaum-Saunders distribution and its theory, methodology and application. *Comm. Stat. Theory and Meth.* 37:645-670.

Examples

```
## Generates a sample from the GBSD with t kernel
x <- rgsb(300, alpha = 1.0, beta = 1.0, nu = 5, kernel = "normal")

## Computes the likelihood for a sample x from the GBSD with normal kernel
## with type II censored data

pc <- 20
status <- c(rep(1, floor((length(x) - pc) * (length(x)) / 100)),
```

```
rep(0, (floor(pc * (length(x)) / 100)))
mlebstc(x, status)
```

mlebstc

MLE of the parameters of the GBSD generated from the t kernel

Description

The function mlebstc gives the maximum likelihood estimates (MLE) of the parameters α and β of the GBSD generated from the t kernel based on a type II censored sample.

Usage

```
mlebstc(x, nuFixed = 2.0, status)
```

Arguments

x	Vector of observations.
nuFixed	Shape parameter corresponding to the degrees of freedom of the t distribution, which must be fixed.
status	Vector indicating if the observation is uncensored taking a value equal to one (1) or censored taking a value equal to zero (0).

Details

The MLEs of the parameters α and β of the GBSD generated from the t kernel, must be obtained using numerical procedure already implemented in R. In this procedure, the parameter nu is obtained by using an optimal methodology based on the data.

Value

mlebstc() computes MLEs for the parameters of the GBSD generated from the t kernel with censored data giving results according to the following list:

alphaEstimate	Returns the value of the MLE of alpha.
betaEstimate	Returns the value of the MLE of beta.
nuOptimal	Returns the optimal value for nu.
loglikelihood	Returns the value of the GBSD loglikelihood.

Author(s)

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 Paula, Gilberto A. <giapaula@ime.usp.br>

References

Diaz-Garcia, J.A., Leiva, V. (2005) A new family of life distributions based on elliptically contoured distributions. *J. Stat. Plan. Infer.* 128:445-457 (Erratum: *J. Stat. Plan. Infer.* 137:1512-1513).

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Sanhueza, A., Leiva, V., Balakrishnan, N. (2008) The generalized Birnbaum-Saunders distribution and its theory, methodology and application. *Comm. Stat. Theory and Meth.* 37:645-670.

Examples

```
## Generates a sample from the GBSD with t kernel
x <- rpbs(300, alpha = 1.0, beta = 1.0, nu = 5, kernel = "t")

## Computes the likelihood for a sample x from the GBSD with t kernel
## with censored data
pc <- 20
status <- c(rep(1, floor((length(x) - pc) * (length(x)) / 100)),
            rep(0, (floor(pc * (length(x)) / 100))))
mlepbstc(x, 2, status)
```

ppgbs

probability versus probability plot for the the GBSD

Description

The function `ppgbs()` produces a probability-probability (pp) plot for the GBSD based on the MLE of their parameters. Also, a line going through the first and the third quartile can be sketched. In addition, the coefficient of determination of least squares for the fit line is given.

Usage

```
ppgbs(x, kernel = "normal", line = FALSE,
      xLabel = "Empirical distribution function",
      yLabel = "Theoretical distribution function")
```

Arguments

<code>x</code>	Vector of observations.
<code>kernel</code>	Kernel of the pdf of the associated symmetrical distribution by means of which the GBSD is obtained. The kernels: laplace, logistic, normal and t are available.
<code>line</code>	Logical; if TRUE (default), a line going by the first and third quartile is sketched.
<code>xLabel</code>	A title for the x axis.
<code>yLabel</code>	A title for the x axis.

Details

The function `ppgbs()` carries out a pp plot for the GBSD.

Value

The function `ppgbs()` carries out an graphical plot useful as goodness-of-fit tool.

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References

Diaz-Garcia, J.A., Leiva, V. (2005) A new family of life distributions based on elliptically contoured distributions. *J. Stat. Plan. Infer.* 128:445-457 (Erratum: *J. Stat. Plan. Infer.* 137:1512-1513).

Leiva, V., Barros, M., Paula, G.A., Sanhueza, A. (2008) Generalized Birnbaum-Saunders distributions applied to air pollutant concentration. *Environmetrics* 19:235-249.

Sanhueza, A., Leiva, V., Balakrishnan, N. (2008) The generalized Birnbaum-Saunders distribution and its theory, methodology and application. *Comm. Stat. Theory and Meth.* 37:645-670.

Examples

```
## Generates a sample from the GBSD with normal kernel
x <- rpbs(300, alpha = 1.0, beta = 1.0, nu = 1.0, kernel = "normal")

## Produces a pp plot for the GBSD with normal kernel
ppgbs(x, kernel = "normal", line = TRUE)
```

precipitations	<i>Data set</i>
----------------	-----------------

Description

Data set related to the GBSD which is available in the **gbs** package. This data set has been taken from the literature of this topic.

Usage

```
data(precipitations)
```

Format

A vector containing 25 observations.

Details

psi21, psi26 and psi31 were taken from Birnbaum and Saunders (1969), who reported fatigue life data correspond to the cycles ($\times 10^{-3}$) of aluminum specimens of type 6061-T6. These specimens were cut in a parallel angle to the direction of rotation and oscillating at 18 cycles per seconds. They were exposed to a pressure with maximum stress of 21,000, 26,000 and 31,000 psi (pounds per square inch), for $n = 101, 102$ and 101 specimens, respectively.

Other data set names are: repairtimes, shelloflife, fracture, precipitations and runoff, which correspond to maintenance data on active repair times (in hours) for an airborne communications transceiver, shelloflife (in days) of a food product, fracture toughnesses of welds, precipitation (in inches) and runoff amounts at Jug Bridge, Maryland, respectively.

Author(s)

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Source

Chhikara, R. S. and Folks, J. L. (1989). The Inverse Gaussian Distribution. Marcel Dekker, New York.

 psi21

Data set

Description

Data set related to the GBSGD which is available in the **gbs** package. This data set has been taken from the literature of this topic.

Usage

```
data(psi21)
```

Format

A vector containing 101 observations.

Details

psi21, psi26 and psi31 were taken from Birnbaum and Saunders (1969), who reported fatigue life data correspond to the cycles ($\times 10^{-3}$) of aluminum specimens of type 6061-T6. These specimens were cut in a parallel angle to the direction of rotation and oscillating at 18 cycles per seconds. They were exposed to a pressure with maximum stress of 21,000, 26,000 and 31,000 psi (pounds per square inch), for $n = 101, 102,$ and 101 specimens, respectively.

Other data set names are: repairtimes, shelloflife, fracture, precipitations and runoff, which correspond to maintenance data on active repair times (in hours) for an airborne communications

transceiver, shelflife (in days) of a food product, fracture toughnesses of welds, precipitation (in inches) and runoff amounts at Jug Bridge, Maryland, respectively.

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Source

Birnbaum Z. W. and Saunders S. C. (1969). Estimation for a family of life distributions. Journal of Applied Probability, 6, 319-327.

psi26

Data set

Description

Data set related to the GBSD which is available in the **gbs** package. This data set has been taken from the literature of this topic.

Usage

data(psi26)

Format

A vector containing 102 observations.

Details

psi21, psi26 and psi31 were taken from Birnbaum and Saunders (1969), who reported fatigue life data correspond to the cycles ($\times 10^{-3}$) of aluminum specimens of type 6061-T6. These specimens were cut in a parallel angle to the direction of rotation and oscillating at 18 cycles per seconds. They were exposed to a pressure with maximum stress of 21,000, 26,000 and 31,000 psi (pounds per square inch), for $n = 101, 102,$ and 101 specimens, respectively.

Other data set names are: repairtimes, shelflife, fracture, precipitations and runoff, which correspond to maintenance data on active repair times (in hours) for an airborne communications transceiver, shelflife (in days) of a food product, fracture toughnesses of welds, precipitation (in inches) and runoff amounts at Jug Bridge, Maryland, respectively.

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Source

Birnbaum Z. W. and Saunders S. C. (1969). Estimation for a family of life distributions. *Journal of Applied Probability*, 6, 319-327.

psi31

Data set

Description

Data set related to the GBSD which is available in the **gbs** package. This data set has been taken from the literature of this topic.

Usage

```
data(psi31)
```

Format

A vector containing 101 observations.

Details

psi21, psi26 and psi31 were taken from Birnbaum and Saunders (1969), who reported fatigue life data correspond to the cycles ($\times 10^{-3}$) of aluminum specimens of type 6061-T6. These specimens were cut in a parallel angle to the direction of rotation and oscillating at 18 cycles per seconds. They were exposed to a pressure with maximum stress of 21,000, 26,000 and 31,000 psi (pounds per square inch), for $n = 101, 102,$ and 101 specimens, respectively.

Other data set names are: repairtimes, shelflife, fracture, precipitations and runoff, which correspond to maintenance data on active repair times (in hours) for an airborne communications transceiver, shelflife (in days) of a food product, fracture toughnesses of welds, precipitation (in inches) and runoff amounts at Jug Bridge, Maryland, respectively.

Author(s)

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Source

Birnbaum Z. W. and Saunders S. C. (1969). Estimation for a family of life distributions. *Journal of Applied Probability*, 6, 319-327.

 qqgbs

Quantile versus quantile plot for the the GBSD

Description

The function `qqgbs()` produces a quantile-quantile (QQ) plot for the GBSD based on the MLE of their parameters. Also, a line going through the first and the third quartile can be sketched. In addition, the coefficient of determination of least squares for the fit line is given.

Usage

```
qqgbs(x, kernel = "normal", line = FALSE, xLabel = "Empirical quantiles",
      yLabel = "Theoretical quantiles")
```

Arguments

<code>x</code>	Vector of observations.
<code>kernel</code>	Kernel of the pdf of the associated symmetrical distribution by means of which the GBSD is obtained. The kernels: <code>laplace</code> , <code>logistic</code> , <code>normal</code> and <code>t</code> are available.
<code>line</code>	Logical; if TRUE (default), a line going by the first and third quartile is sketched.
<code>xLabel</code>	A title for the x axis.
<code>yLabel</code>	A title for the y axis.

Details

The function `qqgbs()` carries out a QQ plot for the GBSD.

Value

The function `qqgbs()` carries out an graphical plot useful as goodness-of-fit tool.

Author(s)

Barros, Michelli <michelli.karinne@gmail.com>
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References

Diaz-Garcia, J.A., Leiva, V. (2005) A new family of life distributions based on elliptically contoured distributions. *J. Stat. Plan. Infer.* 128:445-457 (Erratum: *J. Stat. Plan. Infer.* 137:1512-1513).

Leiva, V., Barros, M., Paula, G.A., Sanhueza, A. (2008) Generalized Birnbaum-Saunders distributions applied to air pollutant concentration. *Environmetrics* 19:235-249.

Sanhueza, A., Leiva, V., Balakrishnan, N. (2008) The generalized Birnbaum-Saunders distribution and its theory, methodology and application. *Comm. Stat. Theory and Meth.* 37:645-670.

Examples

```
## Generates a sample from the GBSD with normal kernel
x <- rgsb(300, alpha = 1.0, beta = 1.0, nu = 1.0, kernel = "normal")

## Produces a QQ plot for the GBSD with normal kernel
qqgs(x, kernel = "normal", line = TRUE)
```

rcgbs

*Relative change on the MLE of the GBSD***Description**

The function `rcgbs()` computes the relative change (RC) on the MLE when some observations are removed in order to evaluate the effect of their potential influence.

Usage

```
rcgbs(x, casesRemoved = NULL, kernel = "normal")
```

Arguments

<code>x</code>	Vector of observations.
<code>casesRemoved</code>	Index of the potentially influential case(s) that must be removed.
<code>kernel</code>	Kernel of the pdf of the associated symmetrical distribution by means of which the GBSD is obtained. The kernels: laplace, logistic, normal and t are available.

Details

This function computes the relative changes (RC), in percentage, of each estimated parameter, defined by $RC_{\theta_j} = |(\hat{\theta}_j - \hat{\theta}_{j(I)}) / \hat{\theta}_j| \times 100\%$, where $\hat{\theta}_{j(I)}$ denotes the MLE of θ_j after the set I of cases has been removed.

Value

`rcgbs()` gives the RCs on the MLEs of the parameters of the GBSD from a sample of observations without to consider some potentially influential case(s) related to the MLE of the complete sample.

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References

Diaz-Garcia, J.A., Leiva, V. (2005) A new family of life distributions based on elliptically contoured distributions. *J. Stat. Plan. Infer.* 128:445-457 (Erratum: *J. Stat. Plan. Infer.* 137:1512-1513).

Leiva, V., Barros, M., Paula, G.A., Sanhueza, A. (2008) Generalized Birnbaum-Saunders distributions applied to air pollutant concentration. *Environmetrics* 19:235-249.

Sanhueza, A., Leiva, V., Balakrishnan, N. (2008) The generalized Birnbaum-Saunders distribution and its theory, methodology and application. *Comm. Stat. Theory and Meth.* 37:645-670.

Examples

```
## Generates a sample from the GBSD with normal kernel
x <- rgbs(300, alpha = 1.0, beta = 1.0, nu = 1.0, kernel = "normal")

## Computes the RC the MLE of the parameters of the GBSD with g="normal" when the
## case 1 has been removed
rcgbs(x, casesRemoved = c(1), kernel = "normal")
```

repairtimes

Data set

Description

Data set related to the GBSD which is available in the **gbs** package. This data set has been taken from the literature of this topic.

Usage

```
data(repairtimes)
```

Format

A vector containing 46 observations.

Details

psi21, psi26 and psi31 were taken from Birnbaum and Saunders (1969), who reported fatigue life data correspond to the cycles ($\times 10^{-3}$) of aluminum specimens of type 6061-T6. These specimens were cut in a parallel angle to the direction of rotation and oscillating at 18 cycles per seconds. They were exposed to a pressure with maximum stress of 21,000, 26,000 and 31,000 psi (pounds per square inch), for $n = 101, 102,$ and 101 specimens, respectively.

Other data set names are: repairtimes, sheliflife, fracture, precipitations and runoff, which correspond to maintenance data on active repair times (in hours) for an airborne communications transceiver, sheliflife (in days) of a food product, fracture toughnesses of welds, precipitation (in inches) and runoff amounts at Jug Bridge, Maryland, respectively.

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Source

Chhikara, R. S. and Folks, J. L. (1989). The Inverse Gaussian Distribution. Marcel Dekker, New York.

 rfgbs

Reliability function of the GBSD

Description

Reliability function (rf) for the GBSD with shape parameter *alpha*, scale parameter *beta* and associated kernel *g*.

Usage

```
rfgbs(x, alpha = 1.0, beta = 1.0, nu = 1.0, kernel = "normal")
```

Arguments

x	Vector of observations.
alpha	Shape parameter.
beta	Scale parameter.
nu	Shape parameter corresponding to the degrees of freedom of the t distribution. In the case of the Laplace, logistic, normal kernels, nu can be fixed at the value 1.0 since this parameter is not involved in these kernels.
kernel	Kernel of the pdf of the associated symmetrical distribution by means of which the GBSD is obtained. The kernels: laplace, logistic, normal and t are available.

Details

The GBSD has rf given by

$$S_T(t) = 1 - F_T(t); t > 0.$$

Value

rfgbs() gives the rf of an GBSD.

Author(s)

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References

Diaz-Garcia, J.A., Leiva, V. (2005) A new family of life distributions based on elliptically contoured distributions. *J. Stat. Plan. Infer.* 128:445-457 (Erratum: *J. Stat. Plan. Infer.* 137:1512-1513).

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Sanhueza, A., Leiva, V., Balakrishnan, N. (2008) The generalized Birnbaum-Saunders distribution and its theory, methodology and application. *Comm. Stat. Theory and Meth.* 37:645-670.

Examples

```
## Computes the rf of the GBSD with normal kernel for a vector x with alpha = 1,
## beta = 1
x <- seq(0.01, 4, by = 0.01)
rfx <- rfgbs(x, alpha = 1.0, beta = 1.0, nu = 1.0, kernel = "normal")
print(rfx)

## At the end there is the graph of this pdf
plot(x, rfx, main = "Rf of the GBSD (classical case)", ylab = "R(x)")
```

runoff

Data set

Description

Data set related to the GBSD which is available in the **gbs** package. This data set has been taken from the literature of this topic.

Usage

```
data(runoff)
```

Format

A vector containing 25 observations.

Details

psi21, psi26 and psi31 were taken from Birnbaum and Saunders (1969), who reported fatigue life data correspond to the cycles ($\times 10^{-3}$) of aluminum specimens of type 6061-T6. These specimens were cut in a parallel angle to the direction of rotation and oscillating at 18 cycles per seconds. They were exposed to a pressure with maximum stress of 21,000, 26,000 and 31,000 psi (pounds per square inch), for $n = 101, 102,$ and 101 specimens, respectively.

Other data set names are: repairtimes, shelflife, fracture, precipitations and runoff, which correspond to maintenance data on active repair times (in hours) for an airborne communications transceiver, shelflife (in days) of a food product, fracture toughnesses of welds, precipitation (in inches) and runoff amounts at Jug Bridge, Maryland, respectively.

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Source

Chhikara, R. S. and Folks, J. L. (1989). The Inverse Gaussian Distribution. Marcel Dekker, New York.

searchMode

Function for obtaining the empirical mode of the data

Description

This function computes the empirical mode of the data.

Usage

```
searchMode(x)
```

Arguments

x Vector of observations.

Value

codesearchMode() return the empirical mode (modal value) of the data.

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shelflife

Data set

Description

Data set related to the GBSD which is available in the **gbs** package. This data set has been taken from the literature of this topic.

Usage

```
data(shelflife)
```

Format

A vector containing 26 observations.

Details

psi21, psi26 and psi31 were taken from Birnbaum and Saunders (1969), who reported fatigue life data correspond to the cycles ($\times 10^{-3}$) of aluminum specimens of type 6061-T6. These specimens were cut in a parallel angle to the direction of rotation and oscillating at 18 cycles per seconds. They were exposed to a pressure with maximum stress of 21,000, 26,000 and 31,000 psi (pounds per square inch), for $n = 101, 102,$ and 101 specimens, respectively.

Other data set names are: repairtimes, shelflife, fracture, precipitations and runoff, which correspond to maintenance data on active repair times (in hours) for an airborne communications transceiver, shelflife (in days) of a food product, fracture toughnesses of welds, precipitation (in inches) and runoff amounts at Jug Bridge, Maryland, respectively.

Author(s)

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Source

Chhikara, R. S. and Folks, J. L. (1989). The Inverse Gaussian Distribution. Marcel Dekker, New York.

`sicgbs`*Schwartz information criterion for a sample from the GBSD*

Description

The function `sicgbs()` gives the Schwartz information criterion (SIC) value assuming a GBSD with parameters α , β and a specific kernel.

Usage

```
sicgbs(x, nu = 1.0, kernel = "normal")
```

Arguments

<code>x</code>	Vector of observations.
<code>nu</code>	Shape parameter corresponding to the degrees of freedom of the t distribution. In the case of the Laplace, logistic, normal kernels, <code>nu</code> can be fixed at the value 1.0 since this parameter is not involved in these kernels.
<code>kernel</code>	Kernel of the pdf of the associated symmetrical distribution by means of which the GBSD is obtained. The kernels: "laplace", "logistic", "normal" and "t" are available.

Details

The SIC is a selection model criterion based on information loss. According to this criterion, it is possible to choose a hypothetic model that better describe the data set considering the smaller SIC value. The SIC is defined as $SIC = -l(\theta)/n + p \log(n)/(2n)$, where $l(\theta)$ is the log-likelihood function associated with the model, n is the sample size and p is the number of involved parameters; for more details see Spiegelhaiter et al. (2002).

Value

`sicgbs()` gives the value for the SIC of the GBSD.

Author(s)

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References

Diaz-Garcia, J.A., Leiva, V. (2005) A new family of life distributions based on elliptically contoured distributions. *J. Stat. Plan. Infer.* 128:445-457 (Erratum: *J. Stat. Plan. Infer.* 137:1512-1513).
Leiva, V., Barros, M., Paula, G.A., Sanhueza, A. (2008) Generalized Birnbaum-Saunders distributions applied to air pollutant concentration. *Environmetrics* 19:235-249.

Sanhueza, A., Leiva, V., Balakrishnan, N. (2008) The generalized Birnbaum-Saunders distribution and its theory, methodology and application. *Comm. Stat. Theory and Meth.* 37:645-670.

Spiegelhalter, D. J., Best, N. G., Carlin, B. P., van der Linde, A. (2002). Bayesian measures of complexity and fit. *Journal of the Royal Statistical Society Series B* 64, 1-34.

Examples

```
## Generates a sample from the GBSD with normal kernel
x <- rpbs(300, alpha = 1.0, beta = 1.0, nu = 1.0, kernel = "normal")

## Computes the SIC value of the GBSD with normal kernel from the data x
sicpbs(x, nu = 1.0, kernel = "normal")
```

wg

Weights in the likelihood of the GBSD

Description

This function computes the weights in the likelihood function of the GBS distribution given by: $w = g'(u)/g(u)$, where g is the kernel of the pdf of the symmetrical distribution.

Usage

```
wg(u, nu = 1.0, kernel = "normal")
```

Arguments

u	Vector of values.
nu	Shape parameter corresponding to the degrees of freedom of the t distribution. In the case of the Laplace, logistic, normal kernels, nu can be fixed at the value 1.0 since this parameter is not involved in these kernels.
kernel	Kernel of the pdf of the associated symmetrical distribution by means of which the GBSD is obtained. The kernels: Laplace, logistic, normal and t are available.

Value

wg() return the weights in the likelihood function of the GBS distribution.

Author(s)

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References

Sanhueza, A., Leiva, V., Balakrishnan, N. (2008) The generalized Birnbaum-Saunders distribution and its theory, methodology and application. *Comm. Stat. Theory and Meth.* 37:645-670.

wgp

Derivatives of the weights in the likelihood of the GBSD

Description

This function computes the derivatives of the weights in the likelihood function of the GBS distribution.

Usage

```
wgp(u, nu = 1.0, kernel = "normal")
```

Arguments

u	Vector of values.
nu	Shape parameter corresponding to the degrees of freedom of the t distribution. In the case of the Laplace, logistic, normal kernels, nu can be fixed at the value 1.0 since this parameter is not involved in these kernels.
kernel	Kernel of the pdf of the associated symmetrical distribution by means of which the GBSD is obtained. The kernels: Laplace, logistic, normal and t are available.

Value

wgp() return the derivatives of the weights in the likelihood function of the GBS distribution.

Author(s)

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References

Sanhueza, A., Leiva, V., Balakrishnan, N. (2008) The generalized Birnbaum-Saunders distribution and its theory, methodology and application. *Comm. Stat. Theory and Meth.* 37:645-670.

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