Package ‘gbs’

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

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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

Package:	gbs
Type:	Package
Version:	1.0
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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).

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.

`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 observatons 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 <- rgbs(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
acigbs(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 ($\overline{x}$), 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):

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

Sample coefficient of skewness (CS):

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

Sample coefficient of kurtosis (CK):

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

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 <- rgbs(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 probabilility 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

`x`	Vector of observations.
`alpha`	Shape parameter.
`beta`	Scale parameter.
`parameters`	Parameters of the Kotz distribution denoted by q, r and s.
`log`	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

Probabilility 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

`x`	Vector of observations.
`alpha`	Shape parameter.
`beta`	Scale parameter.
`parameters`	Parameters of the Kotz distribution denoted by q and r.
`log`	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

`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.
`mainTitle`	An overall title for the plot.
`yRange`	Limit for the y 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

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

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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`, `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.

`frgbs` *Failure rate of the GBSD*

Description

Failure rate (fr) of the GBSD with shape parameter $alpha$, scale parameter $beta$ 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

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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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 $f_Z(\cdot) = c\,g(\cdot)$ 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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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

`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.
`boxPlot`	Logical; if TRUE (default), the boxplot is plotted, otherwise not.
`densityLine`	Logical; if TRUE, the pdf is sketched on the histogram, otherwise not.
`mainTitle`	Main title of the graph.
`xLabel`	A title for the x axis.
`yLabel`	A title for the x axis.
`yRange`	Limit for the y axis.
`colourHistogram`	Color inside the histogram.
`colourDensity`	Color of the estimated pdf curve.
`colourBoxPlot`	Color inside the boxplot.

Details

The function histgbs() simultaneously produces a box-plot and a histogram for the data. The box-plot may be supressed 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

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

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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")

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

`ksgbsc` *Test of Kolmogorov-Smirnov for the GBSD*

Description

The function ksgbsc gives the values for the Kolmogorov-Smirnov (KS) test assuming a GBSD 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

`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).
`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.
`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).

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")

## 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)

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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.

`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)

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Leiva, Victor <victor.leiva@uv.cl, victor.leiva@yahoo.com>
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.

`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

`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

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

Author(s)

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

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.

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 $\beta$of the GBSD.

Author(s)

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Leiva, Victor <victor.leiva@uv.cl, victor.leiva@yahoo.com>
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 <- rgbs(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 — *MLE of the parameters of the GBSD generated from the t kernel*

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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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 <- 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 previosly fixed. This methodoly 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

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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 <- rgbs(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)

Barros, Michelli <michelli.karinne@gmail.com>
Leiva, Victor <victor.leiva@uv.cl, victor.leiva@yahoo.com>
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 <- rgbs(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))))
mlegbsc(x, status)
```

---

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

Description

The function mlegbstc 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

```
mlegbstc(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 implmented in R. In this procedure, the parameter nu is obtained by using an optimal methodology based on the data.

Value

mlegbstc() 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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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 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
## with censored data
pc     <- 20
status <- c(rep(1, floor((length(x) - pc) * (length(x)) / 100)),
            rep(0, (floor(pc * (length(x)) / 100))))
mlegbstc(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 = "Theorical distribution function")
```

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.
`line`	Logical; if TRUE (default), a line going by the first and third quartile is sketched.
`xLabel`	A title for the `x` axis.
`yLabel`	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).

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

`precipitations` *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(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, 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.

`psi21` *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(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, 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.

`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.

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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

`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.
`line`	Logical; if TRUE (default), a line going by the first and third quartile is sketched.
`xLabel`	A title for the x axis.
`yLabel`	A title for the x 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

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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 QQ plot for the GBSD with normal kernel
qqgbs(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

`x`	Vector of observations.
`casesRemoved`	Index of the potentially influential case(s) that must be removed.
`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

This function computes the relative changes (RC), in percentage, of each estimated parameter, defined by $\mathrm{RC}_{\theta_j} = |(\hat{\theta}_j - \hat{\theta}_{j(\mathrm{I})})/\hat{\theta}_j| \times 100\%$, where $\hat{\theta}_{j(\mathrm{I})}$ 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

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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 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, 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.

`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

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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.

Author(s)

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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.

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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, $\beta$and a specific kernel.

Usage

```
sicgbs(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.

Details

The SIC is a selection model criterion based on information loss. According to this criterion, it is possible to choice 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 Spieglhaiter et al. (2002).

Value

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

Spieglhaiter, 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 <- rgbs(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
sicgbs(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.

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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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