Package 'bssn'

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Title Birnbaum-Saunders Model
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Description It provides the density, distribution function, quantile function, random number generator, reliability function, failure rate, likelihood function, moments and EM algorithm for Maximum Likelihood estimators, also empirical quantile and generated envelope for a given sample, all this for the three parameter Birnbaum-Saunders model based on Skew-Normal Distribution. Also, it provides the random number generator for the mixture of Birnbaum-Saunders model based on Skew-Normal distribution. Additionally, we incorporate the EM algorithm based on the assumption that the error term follows a finite mixture of Sinh-normal distributions.
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bssn-package

Description

It provides the density, distribution function, quantile function, random number generator, reliability function, failure rate, likelihood function, moments and EM algorithm for Maximum Likelihood estimators, also empirical quantile and generated envelope for a given sample, all this for the three parameter Birnbaum-Saunders model based on Skew-Normal Distribution. Also, it provides the random number generator for the mixture of Birnbaum-Saunders model based on Skew-Normal distribution. Additionally, we incorporate the EM algorithm based on the assumption that the error term follows a finite mixture of Sinh-normal distributions.

Details

Package: bssn
Type: Package
Version: 1.5
Date: 2020-02-12
License: GPL (>=2)

Author(s)

Rocio Maehara <rmaeharaa@gmail.com> and Luis Benites <lbenitesanchez@gmail.com>

References


See Also

bssn, EMbssn, momentsbssn, ozone, reliabilitybssn, FMshnReg

Examples

#See examples for the bssnEM function linked above.
Description

It provides the density, distribution function, quantile function, random number generator, likelihood function, moments and EM algorithm for Maximum Likelihood estimators for a given sample, all this for the three parameter Birnbaum-Saunders model based on Skew-Normal Distribution. Also, we have the random number generator for the mixture of Birbaum-Saunders model based on Skew-Normal distribution. Finally, the function mmmeth() is used to find the initial values for the parameters alpha and beta using modified-moment method.

Usage

dbssn(ti, alpha=0.5, beta=1, lambda=1.5)
pbssn(q, alpha=0.5, beta=1, lambda=1.5)
qbssn(p, alpha=0.5, beta=1, lambda=1.5)
rbssn(n, alpha=0.5, beta=1, lambda=1.5)
rmixbssn(n, alpha, beta, lambda, pii)
mmmeth(ti)

Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ti</td>
<td>vector of observations.</td>
</tr>
<tr>
<td>q</td>
<td>vector of quantiles.</td>
</tr>
<tr>
<td>p</td>
<td>vector of probabilities.</td>
</tr>
<tr>
<td>n</td>
<td>number of observations.</td>
</tr>
<tr>
<td>alpha</td>
<td>shape parameter.</td>
</tr>
<tr>
<td>beta</td>
<td>scale parameter.</td>
</tr>
<tr>
<td>lambda</td>
<td>skewness parameter.</td>
</tr>
<tr>
<td>pii</td>
<td>Are weights adding to 1. Each one of them (alpha, beta and lambda) must be a vector of length g if you want to generate a random numbers from a mixture distribution BSSN.</td>
</tr>
</tbody>
</table>

Details

If alpha, sigma or lambda are not specified they assume the default values of 0.5, 1 and 1.5, respectively, belonging to the Birnbaum-Saunders model based on Skew-Normal distribution denoted by BSSN(0.5, 1, 1.5).

As discussed in Filidor et. al (2011) we say that a random variable T is distributed as an BSSN with shape parameter $\alpha > 0$, scale parameter $\beta > 0$ and skewness parameter $\lambda$ in $R$, if its probability density function (pdf) is given by

$$f(t) = 2\phi(a(t; \alpha, \beta))\Phi(\lambda a(t; \alpha, \beta))A(t; \alpha, \beta), t > 0$$

where $\phi(.)$ and $\Phi(.)$ are the standard normal density and cumulative distribution function respectively. Also $a(t; \alpha, \beta) = (1/\alpha)(\sqrt{t/\beta} - \sqrt{\beta/t})$ and $A(t; \alpha, \beta) = t^{-3/2}(t + \beta)/(2\alpha\beta^{1/2})$. 
Value
dbssn gives the density, pbssn gives the distribution function, qbssn gives the quantile function, rbssn generates a random sample and rmixbssn generates a mixture random sample.
The length of the result is determined by n for rbssn, and is the maximum of the lengths of the numerical arguments for the other functions dbssn, pbssn and qbssn.

Author(s)
Rocio Maehara <rmaeharaa@gmail.com> and Luis Benites <lbenitesanchez@gmail.com>

References

See Also
EMbssn, momentsbssn, ozone, reliabilitybssn

Examples
## Not run:
## Let's plot an Birnbaum-Saunders model based on Skew-Normal distribution!

## Density
sseq <- seq(0,3,0.01)
dens <- dbssn(sseq,alpha=0.2,beta=1,lambda=1.5)
plot(sseq, dens,type="l", lwd=2,col="red", xlab="x", ylab="f(x)", main="BSSN Density function")

# Differing densities on a graph
# positive values of lambda
y <- seq(0,3,0.01)
f1 <- dbssn(y,0.2,1,1)
f2 <- dbssn(y,0.2,1,2)
f3 <- dbssn(y,0.2,1,3)
f4 <- dbssn(y,0.2,1,4)
den <- cbind(f1,f2,f3,f4)
matplot(y,den,type="l", col=c("deepskyblue4", "firebrick1", "darkmagenta", "aquamarine4"), ylab ="Density function",xlab="y",lwd=2,sub="(a)")

legend(1.5,2.8,c("BSSN(0.2,1,1)", "BSSN(0.2,1,2)", "BSSN(0.2,1,3)","BSSN(0.2,1,4)"),
col = c("deepskyblue4", "firebrick1", "darkmagenta", "aquamarine4"), lty=1:4,lwd=2,
seg.len=2,cex=0.8,box.lty=0,bg=NULL)

#negative values of lambda
```r
y <- seq(0.3, 0.01)
f1 <- dbssn(y, 0.2, 1, -1)
f2 <- dbssn(y, 0.2, 1, -2)
f3 <- dbssn(y, 0.2, 1, -3)
f4 <- dbssn(y, 0.2, 1, -4)
den <- cbind(f1, f2, f3, f4)
matplot(y, den, type="l", col=c("deepskyblue4", "firebrick1", "darkmagenta", "aquamarine4"),
ylab = "Density function", xlab = "y", lwd = 2, sub = "(a)"
legend(1.5, 2.8, c("BSSN(0.2,1,-1)", "BSSN(0.2,1,-2)","BSSN(0.2,1,-3)", "BSSN(0.2,1,-4)"),
col = c("deepskyblue4", "firebrick1", "darkmagenta", "aquamarine4"), lty = 1:4, lwd = 2, seg.len = 2,
cex = 1, box.lty = 0, bg = NULL)
## Distribution Function
sseq <- seq(0.1, 6, 0.05)
df <- pbssn(q = sseq, alpha = 0.75, beta = 1, lambda = 3)
plot(sseq, df, type = "l", lwd = 2, col = "blue", xlab = "x", ylab = "F(x)",
main = "BSSN Distribution function")
abline(h = 1, lty = 2)
# Inverse Distribution Function
prob <- seq(0, 1, length.out = 1000)
idf <- qbssn(p = prob, alpha = 0.75, beta = 1, lambda = 3)
plot(prob, idf, type = "l", lwd = 2, col = "gray80", xlab = "x", ylab = expression(F^{-1}(x)),
mgp = c(2.3, 1, .8))
title(main = "BSSN Inverse Distribution function")
abline(v = c(0, 1), lty = 2)
# Random Sample Histogram
sample <- rbssn(n = 10000, alpha = 0.75, beta = 1, lambda = 3)
hist(sample, breaks = 70, freq = FALSE, main = "")
title(main = "Histogram and True density")
sseq <- seq(0.8, 0.01)
dens <- dbssn(sseq, alpha = 0.75, beta = 1, lambda = 3)
lines(sseq, dens, col = "red", lwd = 2)
## Random Sample Histogram for Mixture of BSSN
alpha = c(0.55, 0.25); beta = c(1.1, 1.1); lambda = c(3, 2); pii = c(0.3, 0.7)
sample <- rmixbssn(n = 1000, alpha, beta, lambda, pii)
hist(sample$y, breaks = 70, freq = FALSE, main = "")
title(main = "Histogram and True density")
temp <- seq(min(sample$y), max(sample$y), length.out = 1000)
lines(temp, (pii[1] * dbssn(temp, alpha[1], beta[1], lambda[1])) + (pii[2] * dbssn(temp, alpha[2], beta[2], lambda[2])),
col = "red", lty = 3, lwd = 3) # the theoretical density
lines(temp, pii[1] * dbssn(temp, alpha[1], beta[1], lambda[1]), col = "blue", lty = 2, lwd = 3)
# the first component
lines(temp, pii[2] * dbssn(temp, alpha[2], beta[2], lambda[2]), col = "green", lty = 2, lwd = 3)
# the second component
```

Description
Performs the EM algorithm for Birnbaum-Saunders model based on Skew-Normal distribution.

Usage
EMbssn(ti, alpha, beta, delta, initial.values=FALSE, loglik=F, accuracy=1e-8, show.envelope="FALSE", iter.max=500)

Arguments
ti Vector of observations.
alpha, beta, delta Initial values.
initial.values Logical; if TRUE, get the initial values for the parameters.
loglik Logical; if TRUE, show value of the log-likelihood.
accuracy The convergence maximum error.
show.envelope Logical; if TRUE, show the simulated envelope for the fitted model.
iter.max The maximum number of iterations of the EM algorithm

Value
The function returns a list with 11 elements detailed as

iter Number of iterations.
alpha Returns the value of the MLE of the shape parameter.
beta Returns the value of the MLE of the scale parameter.
lambda Returns the value of the MLE of the skewness parameter.
SE Standard Errors of the ML estimates.
table Table containing the ML estimates with the corresponding standard errors.
loglik Log-likelihood.
AIC Akaike information criterion.
BIC Bayesian information criterion.
HQC Hannan-Quinn information criterion.
time processing time.
EMbssn

Author(s)

Rocio Maehara <rmaeharaa@gmail.com> and Luis Benites <lbenitesanchez@gmail.com>

References


See Also

bssn, EMbssn, momentsbssn, ozone, reliabilitybssn

Examples

```r
## Not run:
# Using the ozone data

data(ozone)
attach(ozone)

#################################
# The model
 ti <- dailyozonelevel

# Initial values for the parameters
 initial <- mmmeth(ti)
 alpha0 <- initial$alpha0ini
 beta0 <- initial$beta0init
 lambda0 <- 0
 delta0 <- lambda0/sqrt(1+lambda0^2)

# Estimated parameters of the model (by default)
est_param <- EMbssn(ti, alpha0, beta0, delta0, loglik=T, accuracy = 1e-8, show.envelope = "TRUE", iter.max=500)

# ML estimates
alpha <- est_param$res$alpha
beta <- est_param$res$beta
lambda <- est_param$res$lambda
```

Birnbaum-Saunders model based on Skew-Normal distribution

Birnbaum-Saunders model based on Skew-Normal distribution
Observations = 116
-----------
Estimates
-----------

|          | Estimate | Std. Error | z value | Pr(>|z|) |
|----------|----------|------------|---------|----------|
| alpha    | 1.26014  | 0.23673    | 5.32311 | 0.00000  |
| beta     | 14.65730 | 4.01984    | 3.64624 | 0.00027  |
| lambda   | 1.06277  | 0.54305    | 1.95706 | 0.05034  |

Model selection criteria
------------------------

<table>
<thead>
<tr>
<th></th>
<th>Loglik</th>
<th>AIC</th>
<th>BIC</th>
<th>HQC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>-542.768</td>
<td>4.705</td>
<td>4.741</td>
<td>4.719</td>
</tr>
</tbody>
</table>

Details
-------

Iterations = 415
Processing time = 0.4283214 secs
Convergence = TRUE

### End(Not run)

---

**enzyme**

*Enzymatic activity in the blood*

**Description**

These data correspond to representing the metabolism of carcinogenic substances among 245 unrelated individuals.

**Usage**

`data(enzyme)`

**Format**

enzyme is a data frame with 245 cases (rows).

**Details**

For more information about dataset see Bechtel et al. (1993).

**Source**

Description

Performs the EM-type algorithm with conditional maximation to perform maximum likelihood inference of the parameters of the proposed model based on the assumption that the error term follows a finite mixture of Sinh-normal distributions.

Usage

`FMshnReg(y, x1, alpha = NULL, Abetas = NULL, medj=NULL, pii = NULL, g = NULL, get.init = TRUE, algorithm = "K-means", accuracy = 10^-6, show.envelope="FALSE", iter.max = 100)`

Arguments

- `y`: the response matrix (dimension nx1).
- `x1`: Matrix or vector of covariates.
- `alpha`: Value of the shape parameter for the EM algorithm. Each of them must be a vector of length g. (the algorithm considers the number of components to be adjusted based on the size of these vectors).
- `Abetas`: Parameters of vector regression dimension \((p + 1)\) include intercept.
- `medj`: a list of g arguments of vectors of values (dimension p) for the location parameters.
- `pii`: Value for the EM algorithm. Each of them must be a vector of length g. (the algorithm considers the number of components to be adjusted based on the size of these vectors).
- `g`: The number of cluster to be considered in fitting.
- `get.init`: if TRUE, the initial values are generated via k-means.
- `algorithm`: clustering procedure of a series of vectors according to a criterion. The clustering algorithms may classified in 4 main categories: exclusive, overlapping, hierarchical and probabilistic.
- `accuracy`: The convergence maximum error.
- `show.envelope`: Logical; if TRUE, show the simulated envelope for the fitted model.
- `iter.max`: The maximum number of iterations of the EM algorithm

Value

The function returns a list with 10 elements detailed as

- `iter`: Number of iterations.
- `criteria`: Attained criteria value.
convergence: Convergence reached or not.
SE: Standard Error estimates, if the output shows NA the function does not provide the standard error for this parameter.
table: Table containing the inference for the estimated parameters.
LK: log-likelihood.
AIC: Akaike information criterion.
BIC: Bayesian information criterion.
EDC: Efficient Determination criterion.
time: Processing time.

Author(s)
Rocio Maehara <rmaeharaa@gmail.com> and Luis Benites <lbenitesanchez@gmail.com>

References

Examples
## Not run:
#Using the AIS data

library(FMsmsnReg)
data(ais)

#The model
x1 <- cbind(1,ais$SSF,ais$Ht)
y <- ais$Bfat

library(ClusterR) #This library is useful for using the k-medoids algorithm.

FMshnReg(y, x1, get.init = TRUE, g=2, algorithm="k-medoids", accuracy = 10^-6, show.envelope="FALSE", iter.max = 1000)

#A simple output example

Finite Mixture of Sinh Normal Regression Model

Observations = 202
momentsbssn

Moments for the Birnbaum-Saunders model based on Skew-Normal distribution

Description

Mean, variance, skewness and kurtosis for the Birnbaum-Saunders model based on Skew-Normal distribution defined in Filidor et. al (2011).

Usage

```r
meanbssn(alpha=0.5, beta=1, lambda=1.5)
varbssn(alpha=0.5, beta=1, lambda=1.5)
skewbssn(alpha=0.5, beta=1, lambda=1.5)
kurtbssn(alpha=0.5, beta=1, lambda=1.5)
```
Arguments

- **alpha**: shape parameter $\alpha$.
- **beta**: scale parameter $\beta$.
- **lambda**: skewness parameter $\lambda$.

Value

- **meanbssn** gives the mean, **varbssn** gives the variance, **skewbssn** gives the skewness, **kurtbssn** gives the kurtosis.

Author(s)

Rocio Maehara <rmaeharaa@gmail.com> and Luis Benites <lbenitesanchez@gmail.com>

References


See Also

- bssn, EMbssn, momentsbssn, ozone, reliabilitybssn

Examples

```r
## Let's compute some moments for a Birnbaum-Saunders model based on Skew normal Distribution.
# The well known mean, variance, skewness and kurtosis
meanbssn(alpha=0.5,beta=1,lambda=1.5)
varbssn(alpha=0.5,beta=1,lambda=1.5)
skewbssn(alpha=0.5,beta=1,lambda=1.5)
kurtbssn(alpha=0.5,beta=1,lambda=1.5)
```

---

**ozone**

*Daily ozone level measurements*

Description

These data correspond to daily ozone level measurements (in *ppb = ppm x 1000*) in New York in May-September, 1973, from the New York State Department of Conservation.

Usage

data(ozone)
reliabilitybssn

Format

ozone is a data frame with 116 cases (rows).

Details

For a complete description of various distributions applied to data concentration of air pollutants see Gokhale and Khare (2004).

Source


reliabilitybssn

Reliability Function for the Birnbaum-Saunders model based on Skew-Normal distribution

Description

Two useful descriptors in reliability analysis are the reliability function (rf), and the failure rate (fr) function or hazard function. For a non-negative random variable t with pdf \( f(t) \) (and cdf \( F(t) \)), its distribution can be characterized equally in terms of the rf, or of the fr, which are respectively defined by \( R(t) = 1 - F(t) \), and \( h(t) = f(t)/R(t) \), for \( t > 0 \),and \( 0 < R(t) < 1 \).

Usage

\[ \text{Rebssn}(ti, \alpha=0.5, \beta=1, \lambda=1.5) \]
\[ \text{Fbssn}(ti, \alpha=0.5, \beta=1, \lambda=1.5) \]

Arguments

- \( ti \): dataset.
- \( \alpha \): shape parameter \( \alpha \).
- \( \beta \): scale parameter \( \beta \).
- \( \lambda \): skewness parameter \( \lambda \).

Value

\( \text{Rbssn} \) gives the reliability function, \( \text{Fbssn} \) gives the failure rate or hazard function.

Author(s)

Rocio Maehara <rmaeharaa@gmail.com> and Luis Benites <lbenitesanchez@gmail.com>
References


See Also

bssn, EMbssn, momentsbssn, ozone, Rebssn

Examples

## Let's compute some realiability functions for a Birnbaum-Saunders model based on
## Skew normal Distribution for different values of the shape parameter.

```r
ti <- seq(0,2,0.01)
f1 <- Rebssn(ti,0.75,1,1)
f2 <- Rebssn(ti,1,1,1)
f3 <- Rebssn(ti,1.5,1,1)
f4 <- Rebssn(ti,2,1,1)
den <- cbind(f1,f2,f3,f4)
matplot(ti,den,type="l", col=c("deepskyblue4","firebrick1","darkmagenta","aquamarine4"),
ylab="S(t)", xlab="t",lwd=2)
legend(1.5,1.5,c(expression(alpha==0.75), expression(alpha==1), expression(alpha==1.5),
expression(alpha==2)),col= c("deepskyblue4","firebrick1","darkmagenta","aquamarine4"),
lyt=1:4,lwd=2,seg.len=2,cex=0.9,box.lty=0,bg=NULL)
```

## Let's compute some hazard functions for a Birnbaum Saunders model based on
## Skew normal Distribution for different values of the skewness parameter.

```r
ti <- seq(0,2,0.01)
f1 <- Fbssn(ti,0.5,1,-1)
f2 <- Fbssn(ti,0.5,1,-2)
f3 <- Fbssn(ti,0.5,1,-3)
f4 <- Fbssn(ti,0.5,1,-4)
den <- cbind(f1,f2,f3,f4)
matplot(ti,den,type = "l", col = c("deepskyblue4","firebrick1","darkmagenta","aquamarine4"),
ylab = "h(t)", xlab="t",lwd=2)
legend(0.1,23, c(expression(lambda==-1), expression(lambda==-2), expression(lambda == -3),
expression(lambda == -4)), col = c("deepskyblue4","firebrick1","darkmagenta","aquamarine4"),
lyt=1:4,lwd=2,seg.len=2,cex=0.9,box.lty=1,bg=NULL)
```
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