Package ‘sld’

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Title Estimation and Use of the Quantile-Based Skew Logistic Distribution

Depends stats, lmom

Suggests graphics

Description The skew logistic distribution is a quantile-defined generalisation of the logistic distribution (van Staden and King 2015). Provides random numbers, quantiles, probabilities, densities and density quantiles for the distribution. It provides Quantile-Quantile plots and method of L-Moments estimation (including asymptotic standard errors) for the distribution.

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URL https://github.com/newystats/SLD/

NeedsCompilation yes

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Contents

`fit.sld.lmom` *Fit the skew logistic distribution using L-Moments*

Description

Fits the quantile-based Skew Logistic Distribution using L-Moments. `fit.sld.lmom` calculates the sample L Moments of a dataset and uses the method of L Moments to estimate the parameters of the skew logistic distribution. `fit.sld.lmom.given` fits the skew logistic using user-supplied values of the first three L Moments.

Usage

```
fit.sld.lmom.given(lmoms,n=NULL)
fit.sld.lmom(data)
```

Arguments

`lmoms`	A vector of length 3, containing the first and second (sample) L Moments and the 3rd (sample) L Moment ratio (τ_3)
`n`	The sample size
`data`	A vector containing a dataset

Details

The method of L-Moments estimates of the parameters of the quantile-based skew logistic distribution are:

$$\hat{\alpha} = L_1 - 6L_3$$

$$\hat{\beta} = 2L_2$$

$$\hat{\delta} = \frac{1}{2}(1 + 3\tau_3)$$

Note that L_3 in the $\hat{\alpha}$ estimate is the 3rd L-Moment, not the 3rd L-Moment ratio ($\tau_3 = L_3/L_2$).

`fit.sld.lmom` uses the `samlmu` function (from the `lmom` package) to calculate the sample L moments, then `fit.sld.lmom.given` to calculate the estimates.

Value

If the sample size is unknown (via using `fit.sld.lmom.given` and not specifying the sample size), a vector of length 3, with the estimated parameters, $\hat{\alpha}$, $\hat{\beta}$ and $\hat{\delta}$.

If the sample size is known, a 3 by 2 matrix. The first column contains the estimated parameters, $\hat{\alpha}$, $\hat{\beta}$ and $\hat{\delta}$, and the second column provides asymptotic standard errors for these.

Note that if $|\tau_3| > \frac{1}{3}$, $\hat{\delta}$ is beyond its allowed value of [0,1] and the function returns an error. Values of $|\tau_3|$, beyond $\frac{1}{3}$ correspond to distributions with greater skew than the exponential / reflected exponential, which form the limiting cases of the skew logistic distribution.

Author(s)

Robert King, <robert.king.newcastle@gmail.com>, https://github.com/newystats and Paul van Staden

References

van Staden, P.J. and King, Robert A.R. (2015) *The quantile-based skew logistic distribution*, Statistics and Probability Letters **96** 109–116. doi: 10.1016/j.spl.2014.09.001

van Staden, Paul J. 2013 *Modeling of generalized families of probability distribution in the quantile statistical universe*. PhD thesis, University of Pretoria. http://hdl.handle.net/2263/40265

See Also

sld

Examples

```
generated.data <- rsl(300,c(0,1,.4))
estimate1 <- fit.sld.lmom(generated.data)
estimate2 <- fit.sld.lmom.given(c(0,1,.3),n=300)
data(PCB1)
hist(PCB1,prob=TRUE,main="PCB in Pelican Egg Yolk with SLD fit")
fit.pcb <- fit.sld.lmom(PCB1)
print(fit.pcb)
plotsld(fit.pcb[,1],add=TRUE,col="blue")
```

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lmom.sample — *Calculate sample L-Moments*

Description

Calculate sample L-Moments of a dataset

Usage

```
lmom.sample(data,max.mom=3)
```

Arguments

data	A vector containing a dataset
max.mom	The maximum order of L-Moment to estimate

Details

This function is a wrapper around the samlmu function from Hosking's lmom package, to give different argument defaults. It calculates sample L Moments.

Value

A vector of length max.mom. The first two elements are the first two L moments. If max.mom is greater than two, the following elements are the corresponding L moment ratios (the L Moment divided by the 2nd L Moment).

Author(s)

Robert King, <robert.king.newcastle@gmail.com>, https://github.com/newystats and Paul van Staden

References

Hosking, J. R. M. (1990). *L-moments: analysis and estimation of distributions using linear combinations of order statistics.* Journal of the Royal Statistical Society, Series B, **52**, 105–124.

Hosking, J. R. M., and Wallis, J. R. (1997). *Regional frequency analysis: an approach based on L-moments.* Cambridge University Press.

J. R. M. Hosking (2014). L-moments. R package, version 2.2. https://cran.r-project.org/package=lmom

See Also

sld

Examples

```
generated.data <- rsl(300,c(0,1,.4))
lmom.sample(data=generated.data,max.mom=3)

data(PCB1)
lmom.sample(PCB1,max.mom=3)
```

PCB *concentration of polychlorinated biphenyl (PCB) in the yolk lipids of pelican eggs in ppm*

Description

Concentration (parts per million) of polychlorinated biphenyl (PCB) in the yolk lipids of pelican (*Pelecanus occidentalis*) eggs, from Anacapa, California. Published by Risebrough (1972).

The data PCB are the data as published in Risebrough (1972).

These data are also used in Thas (2010), as table 1, with a difference in the 24th observation (265 in Risebrough and 256 in Thas). PCB1 is the version in table 1 of Thas (2010).

This is a subset of a wider collection of data on *Pelecanus occidentalis* eggs from Risebrough et al (undated).

Usage

```
data(PCB)
```

Format

The data are in one vector, named PCB.

Source

Risebrough (1972) *Effects of environmental pollutants upon animals other than man*, Proceedings of the 6th Berkeley Symposium on Mathematical Statistics and Probability, Volume 6: Effects of Pollution on Health, 443–463, University of California Press, Berkeley, California.

http://projecteuclid.org/euclid.bsmsp/1200514718

R.W. Risebrough, F. Gress, J.K. Baptista, D.W. Anderson and R.W Schreiber (undated) *Oceanic pollution: Effects on the reproduction of Brown Pelicans Pelecanus occidentalis*, unpublished manuscript

References

Thas (2010) *Comparing Distributions*, Springer. 978-0-387-92710-7

Examples

```
data(PCB)
```

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plotsl — *Plots of density and distribution function for the quantile based skew logistic distribution*

Description

Produces plots of density and distribution function for the quantile based skew logistic distribution. Although you could use `curve(dsl(x))` to do this, the fact that the density and quantiles of this distribution are defined in terms of the depth, u, means that a seperate function that uses the depths to produce the values to plot is more accurate and efficient.

Usage

```
plotsld(parameters, add=FALSE, granularity = 10000,
  xlab = "x", ylab="density", quant.probs = seq(0,1,.25), ...)
plotslc(parameters, add=FALSE, granularity = 10000,
  xlab = "quantile", ylab="depth", quant.probs = seq(0,1,.25), ...)
```

Arguments

- `parameters` — A vector of length 3, giving the parameters of the quantile-based skew logistic distribution. The 3 elements are α (location), β (scale) and δ (skewing). α can take on any real value, β can take on any positive value and δ must satisfy $0 \leq \delta \leq 1$. $\delta = 0.5$ gives the logistic distribution, $\delta = 0$ gives the reflected exponential distribution and $\delta = 1$ gives the exponential distribution.
- `add` — Should this add to an existing plot (using `lines`) or produce a new plot (using `plot`).
- `granularity` — Number of points at which quantiles and density will be calculated.— see *details*
- `xlab` — X axis label
- `ylab` — Y axis label
- `quant.probs` — Quantiles of distribution to return (see *value* below). Set to NULL to suppress this return entirely.
- `...` — arguments that get passed to `plot` if this is a new plot

Details

The quantile-based skew logistic distribution is defined by its quantile function. The density of the distribution is available explicitly as a function of depths, u, but not explicitly available as a function of x (except for the special cases at δ=0,0.5 and 1). This function calculates quantiles and density as a function of depths to produce a density plot `plotsld` or cumulative probability plot `plotslc`.

Value

A number of quantiles from the distribution, the default being the minimum, maximum and quartiles.

Author(s)

Robert King, <robert.king.newcastle@gmail.com>, https://github.com/newystats/sld

References

van Staden, P.J. and King, Robert A.R. (2015) *The quantile-based skew logistic distribution*, Statistics and Probability Letters **96**, 109–116. doi: 10.1016/j.spl.2014.09.001

van Staden, Paul J. 2013 *Modeling of generalized families of probability distribution in the quantile statistical universe*. PhD thesis, University of Pretoria. http://hdl.handle.net/2263/40265

https://github.com/newystats/sld

See Also

`sld`

Examples

```
plotsld(c(0,1,1),main="Exponential Distribution")
plotsld(c(0,1,0.5),main="Logistic Distribution")
plotsld(c(0,1,0.7))
plotslc(c(0,1,0.7))
```

---

qqsl *Quantile-Quantile plot against the skew logistic distribution*

Description

qqgl produces a Quantile-Quantile plot of data against the quantile-based skew logistic distribution, or a Q-Q plot to compare two sets of parameter values for the quantile-based skew logistic distribution. This function does for the skew logistic distribution what qqnorm does for the normal.

Usage

```
qqsl(y=NULL,parameters1,parameters2=NULL,abline=TRUE,
     granularity.for.2.dists=4000,use.endpoints=FALSE,...)
```

Arguments

y	The data sample
parameters1	A vector of length 3, containg the parameters of the skew logistic distribution, α, β and δ.
parameters2	Second set of parameters of the skew logistic distribution. A vector of length 3, as described above for parameters1.
abline	A logical value, TRUE adds a line through the origian with a slope of 1 to the plot
granularity.for.2.dists	Number of quantiles to use in a Q-Q plot comparing two sets of parameter values
use.endpoints	logical. When comparing two sets of parameter values, should Q(0) and Q(1) be used? TRUE will give QQ plots including the theoretical minimum and maximum of the distribution, which is arguably not equivalent to what would be seen in QQ plots based on data. FALSE will give QQ plots based on ideal depths (type 8 quantiles, see quantile documentation), where n is the granularity.for.2.dists.
...	graphical parameters, passed to qqplot

Details

See sld for more details on the Skew Logistic Distribution. A Q-Q plot provides a way to visually assess the correspondence between a dataset and a particular distribution, or between two distributions.

Value

A list of the same form as that returned by qqline

- x — The x coordinates of the points that were/would be plotted, corresponding to a skew logistic distibution with parameters α, β and δ.
- y — The original y vector, i.e., the corresponding y coordinates, or a corresponding set of quantiles from a skew logistic distribution with the second set of parameters

Author(s)

Robert King, <robert.king.newcastle@gmail.com>, https://github.com/newystats/sld and Paul van Staden

References

van Staden, P.J. and King, R.A.R. (2015) *The quantile-based skew logistic distribution*, Statistics and Probability Letters **96** 109–116. doi: 10.1016/j.spl.2014.09.001

van Staden, Paul J. 2013 *Modeling of generalized families of probability distribution in the quantile statistical universe*. PhD thesis, University of Pretoria. http://hdl.handle.net/2263/40265

https://github.com/newystats/sld

See Also

sld

Examples

```
qqsl(y=rsl(100,c(0,1,0.7)),parameters1=c(0,1,0.7))
qqsl(parameters1=c(0,1,0.7),parameters2=c(0,0.9,0.5),col="blue")
```

SkewLogisticDistribution — *The quantile-based Skew Logistic Distribution*

Description

Density, density quantile, distribution and quantile functions and random generation for the quantile-based skew logistic distribution.

Usage

```
dsl(x,parameters,inverse.eps=.Machine$double.eps,max.iterations=500)
dqsl(p,parameters)
psl(q,parameters,inverse.eps=.Machine$double.eps,max.iterations=500)
qsl(p,parameters)
rsl(n,parameters)
```

Arguments

`x, q`	vector of quantiles.
`p`	vector of probabilities.
`n`	number of observations.
`parameters`	A vector of length 3, giving the parameters of the quantile-based skew logistic distribution. The 3 elements are α (location), β (scale) and δ (skewing). α can take on any real value, β can take on any positive value and δ must satisfy $0 \leq \delta \leq 1$. $\delta = 0.5$ gives the logistic distribution, $\delta = 0$ gives the reflected exponential distribution and $\delta = 1$ gives the exponential distribution.
`inverse.eps`	Accuracy of calculation for the numerical determination of $F(x)$, defaults to `.Machine$double.eps`
`max.iterations`	Maximum number of iterations in the numerical determination of $F(x)$, defaults to 500

Details

The quantile-based skew logistic distribution is a generalisation of the logistic distribution, defined by its quantile funtion, Q(u), the inverse of the distribution function.

$$Q(u) = \alpha + \beta \left[(1-\delta)\log(u) - \delta(\log(1-u))\right])$$

for $\beta > 0$ and $0 \leq \delta \leq 1$.

The distribution was first used by Gilchrist (2000) in the book *Statistical Modelling with Quantile Functions*. Full details of the properties of the distributions, including moments, L-moments and estimation via L-Moments are given in van Staden and King (2015).

The distribution is defined by its quantile function and its distribution and density functions do not exist in closed form (except for some special cases). Accordingly, the results from `psl` and `dsl` are the result of numerical solutions to the quantile function, using the Newton-Raphson method. Since the density quantile function, $f(Q(u))$, does exist, an additional function, `dqsl`, computes this.

The distribution has closed form method of L-Moment estimates (see `fit.sld.lmom` for details). The 4th L-Moment ratio of the the distribution is constant $\tau_4 = \frac{1}{6}$ for all values of δ. The 3rd L-Moment ratio of the distribution is restricted to $\frac{-1}{3} \leq \tau_3 \leq \frac{1}{3}$, being the the 3rd L-moment ratio values of the reflected exponential and the exponential distributions respectively.

Value

`dsl` gives the density (based on the quantile density and a numerical solution to $Q(u) = x$),

`dqsl` gives the density quantile,

`psl` gives the distribution function (based on a numerical solution to Q(u)=x and `dqsl`

`qsl` gives the quantile function, and

`rsl` generates random deviates.

Author(s)

Robert King, `<robert.king.newcastle@gmail.com>`, https://github.com/newystats/

References

Gilchrist, W.G. (2000) *Statistical Modelling with Quantile Functions* Chapman & Hall, print 978-1-58488-174-2, e-book 978-1-4200-3591-9.

van Staden, P.J. and King, Robert A.R. (2015) *The quantile-based skew logistic distribution*, Statistics and Probability Letters **96** 109–116. doi: 10.1016/j.spl.2014.09.001

van Staden, Paul J. 2013 *Modeling of generalized families of probability distribution in the quantile statistical universe*. PhD thesis, University of Pretoria. http://hdl.handle.net/2263/40265

https://github.com/newystats/sld

Examples

```
qsl(seq(0,1,0.02),c(0,1,0.123))
psl(seq(-2,2,0.2),c(0,1,.1),inverse.eps=1e-10)
rsl(21,c(3,2,0.3))
```

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