

Package ‘ParetoPosStable’

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Title Computing, Fitting and Validating the PPS Distribution

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Description Statistical functions to describe a Pareto Positive Stable (PPS)
distribution and fit it to real data. Graphical and statistical tools to
validate the fits are included.

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Contents

coef.PPSfit	2
forbes400	3
GoF	3
logLik.PPSfit	4
pareto.fit	5
ParetoPosStable	6
plot.PPSfit	6
PPS	7
PPS.fit	9

print.PPSfit	11
se	11
turkey	12
Index	14

coef.PPSfit	<i>Parameter estimates in a PPSfit Object</i>
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Description

coef returns the parameter estimates in a PPSfit Object

Usage

```
## S3 method for class 'PPSfit'
coef(object, ...)
```

Arguments

object	A PPSfit object, typically from PPS.fit().
...	Other arguments.

Value

A list with the parameter estimates.

See Also

[PPS.fit.](#)

Examples

```
x <- rPPS(50, 1.2, 100, 2.3)
fit <- PPS.fit(x)
coef(fit)
```

forbes400

Forbes 400 list. The Richest People in America in 2012

Description

The Forbes 400 or 400 Richest Americans is a list published by Forbes magazine of the wealthiest 400 Americans, ranked by net worth. The dataset presents results about 2012.

Format

A data frame with 400 observations on the following 2 variables.

- Namemembers of the list names.
- NetWorthnet worth in 2012 in \$ billion.

GoF

Goodness of fit tests for the Pareto Positive Stable (PPS) distribution

Description

Kolmogorov-Smirnov, Anderson-Darling and PPS goodness of fit tests to validate a PPS fit (typically from `PPS.fit()`).

Usage

```
GoF(PPSfit, k = 2000, parallel = TRUE, ncores = 2, ...)
```

Arguments

PPSfit	A PPSfit Object.
k	The number of iterations in the bootstrap procedure to approximate the p-values.
parallel	A logical argument specifying if parallelization is allowed in the bootstrap iteration procedure.
ncores	is the number of cores that we use if parallel is TRUE.
...	Other arguments.

Details

It returns the Kolmogorov-Smirnov, the Anderson-Darling tests and a specific test for PPS distributions. p-values are approximated by a bootstrap procedure. The specific goodness of fit test for PPS distributions is based on the linearity of the survival function vs. the scaled observations in a double log-log scale (see Sarabia and Prieto, 2009).

Value

A list with the values of the tests statistics and the approximated p-values.

References

Sarabia, J.M and Prieto, F. (2009). The Pareto-positive stable distribution: A new descriptive model for city size data, *Physica A: Statistical Mechanics and its Applications*, **388**(19), 4179-4191.

See Also

[PPS.fit](#), [plot.PPSfit](#)

Examples

```
x <- rPPS(50, 1.2, 100, 2.3)
fit <- PPS.fit(x)
GoF(fit, k = 50)
```

logLik.PPSfit	<i>Log-likelihood value of a PPSfit Object</i>
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Description

It returns the log-likelihood value of a PPSfit Object

Usage

```
## S3 method for class 'PPSfit'
logLik(object, ...)
```

Arguments

object	A PPSfit Object.
...	Other arguments.

Value

The log-likelihood.

References

Sarabia, J.M and Prieto, F. (2009). The Pareto-positive stable distribution: A new descriptive model for city size data, *Physica A: Statistical Mechanics and its Applications*, **388**(19), 4179-4191.

See Also

[PPS.fit](#)

Examples

```
x <- rPPS(50, 1.2, 100, 2.3)
fit <- PPS.fit(x)
logLik(fit)
```

pareto.fit	<i>Fitting a Pareto distribution</i>
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Description

It is an auxiliary function for fitting a Pareto distribution as a particular case of a Pareto Positive Stable distribution, allowing the scale parameter to be held fixed if desired.

Usage

```
pareto.fit(x, estim.method = "MLE", sigma = NULL, start, ...)
```

Arguments

x	The vector of observations.
estim.method	The estimation method, "MLE" or "OLS"
sigma	The value of the scale parameter, if it is known; if the value is NULL, the parameter is estimated.
start	Unused argument from PPS.fit.
...	Other arguments.

Details

This function is called by PPS.fit() when Pareto argument is TRUE.

Value

A PPSfit Object.

References

Sarabia, J.M and Prieto, F. (2009). The Pareto-positive stable distribution: A new descriptive model for city size data, *Physica A: Statistical Mechanics and its Applications*, **388**(19), 4179-4191.

See Also

[PPS.fit](#), [coef.PPSfit](#), [print.PPSfit](#), [plot.PPSfit](#), [GoF](#)

ParetoPosStable

Computing, Fitting and Validating the PPS Distribution

Description

Statistical functions to describe a Pareto Positive Stable (PPS) distribution and fit it to real data. Graphical and statistical tools to validate the fits are included.

Details

The main function you're likely to need from **ParetoPosStable** is `PPS.fit`, in order to obtain a PPS fit from data. Validation can be obtain with `GoF` and `plot`.

References

Sarabia, J.M and Prieto, F. (2009). The Pareto-positive stable distribution: A new descriptive model for city size data, *Physica A: Statistical Mechanics and its Applications*, **388**(19), 4179-4191.

plot.PPSfit

Plots to validate a Pareto Positive Stable (PPS) fit

Description

Plots to validate a PPS fit (typically from `PPS.fit()`) with different comparisons between empirical and theoretical functions.

Usage

```
## S3 method for class 'PPSfit'
plot(x, which = 1:4, ask = prod(par("mfcol")) <
     length(which) && dev.interactive(), ylim, breaks, ...)
```

Arguments

x	a PPSfit Object.
which	values from 1 to 4 indicating the type of plot.
ask	an argument to control the plot window.
ylim	optional argument to control the y limits of the histogram. It is included to prevent non-desired scales on the y-axis.
breaks	optional argument to control the breakpoints of the histogram. See <code>hist</code> help for the details. It is included to prevent non-desired scales on the y-axis.
...	other arguments.

Details

The plots return:

1. The histogram of the observations and the fitted PPS density (which = 1). Optional `ylim` and `breaks` arguments are provided to prevent frequent imbalances between density and histogram scales in real data: they work as the analogue arguments of the default `hist` function.
2. The empirical distribution function of data and the cumulative distribution function of the fitted model (which = 2).
3. A rank-size plot in log-log scale to check the Pareto or power-law behaviour of data (which = 3). In the X-axis the log of the observations appears; in the Y-axis, the log of the empirical survival function. If the scatter-plot is around a straight line, then the observations exhibit a power law behaviour. The plot also includes the curve with the theoretical survival function of the model specified in the first argument class `PPSfit`: only when `nu` is 1, that curve is going to be a straight line.
4. A plot in a double log-log scale to check the adequacy of data to the PPS model (which = 4). On one hand, the X-axis shows the double log of the observations divided by the scale parameter, while the Y-axis shows the log of minus the log of the empirical survival function. On the other hand, the straight line determined by the linear relation between the survival function and the scaled data in a double log-log scale, in relation to the argument class `PPSfit` is added. The proximity of the points in the scatter-plot to that straight line is an evidence in favour of a PPS behaviour of data.

References

Sarabia, J.M and Prieto, F. (2009). The Pareto-positive stable distribution: A new descriptive model for city size data, *Physica A: Statistical Mechanics and its Applications*, **388**(19), 4179-4191.

See Also

[PPS.fit](#)

Examples

```
data(forbes400)
fit <- PPS.fit(forbes400$NetWorth)
par(mfrow=c(2,2))
plot(fit)
dev.off()
plot(fit, which = 1, breaks = seq(0, 60, length.out = 60))
```

Description

Density, distribution function, hazard function, quantile function and random generation for the Pareto Positive Stable (PPS) distribution with parameters λ , σ and ν .

Usage

```
dPPS(x, lam, sc, v, log = FALSE)

hPPS(x, lam, sc, v)

pPPS(x, lam, sc, v, lower.tail = TRUE, log.p = FALSE)

qPPS(p, lam, sc, v, lower.tail = TRUE, log.p = FALSE)

rPPS(n, lam, sc, v)
```

Arguments

<code>x</code>	vector of quantiles.
<code>lam</code>	vector of (non-negative) first shape parameters.
<code>sc</code>	vector of (non-negative) scale parameters.
<code>v</code>	vector of (non-negative) second shape parameters.
<code>log</code>	logical; if TRUE, probabilities/densities p are returned as $\log(p)$.
<code>lower.tail</code>	logical; if TRUE (default), probabilities are $P[X \leq x]$, otherwise, $P[X > x]$.
<code>log.p</code>	logical; if TRUE, probabilities/densities p are returned as $\log(p)$.
<code>p</code>	vector of probabilities.
<code>n</code>	number of random values to return.

Details

The PPS distribution has density

$$f(x) = \lambda\nu[\log(x/\sigma)]^{\nu-1} \exp(-\lambda[\log(x/\sigma)]^\nu)/x,$$

cumulative distribution function

$$F(x) = 1 - \exp(-\lambda[\log(x/\sigma)]^\nu),$$

quantile function

$$Q(p) = \sigma \exp([- (1/\lambda) \log(1-p)]^{1/\nu})$$

and hazard function

$$\lambda\nu(\log(x/\sigma))^{\nu-1} x^{-1}.$$

See Sarabia and Prieto (2009) for the details about the numbers random generation.

Value

dPPS gives the (log) density, pPPS gives the (log) distribution function, qPPS gives the quantile function, and rPPS generates random samples. Invalid parameters will result in return value NaN, with a warning. The length of the result is determined by `n` for rPPS, and is the common length of the numerical arguments for the other functions.

References

Sarabia, J.M and Prieto, F. (2009). The Pareto-positive stable distribution: A new descriptive model for city size data, *Physica A: Statistical Mechanics and its Applications*, **388**(19), 4179-4191.

Examples

```
print(x <- sort(rPPS(10, 1.2, 100, 2.3)))
dPPS(x, 1.2, 100, 2.3)
pPPS(x, 1.2, 100, 2.3)
qPPS(pPPS(x, 1.2, 100, 2.3), 1.2, 100, 2.3)
hPPS(x, 1.2, 100, 2.3)
```

 PPS.fit

Fitting the Pareto Positive Stable (PPS) distribution

Description

PPS.fit() returns the fit of a PPS distribution to real data, allowing the scale parameter to be held fixed if desired.

Usage

```
PPS.fit(x, estim.method = "MLE", sigma = NULL, start, Pareto = FALSE, ...)
```

Arguments

x	a vector of observations
estim.method	the method of parameter estimation. It may be "MLE", "iMLE", "OLS", or "LMOM".
sigma	the value of the scale parameter, if it is known; if the value is NULL, the parameter is estimated.
start	a list with the initial values of the parameters for some of the estimation methods.
Pareto	a logical argument to constrain the PPS fit to a Pareto fit when the value is TRUE.
...	other arguments.

Details

The maximum likelihood method implemented by the direct optimization of the log-likelihood is given by estim.method = "MLE". The numerical algorithm to search the optimum is the "Nelder-Mead" method implemented in the optim function, considering as initial values those given in the start argument or, if it is missing, those provided by the OLS method.

A different approximation of the maximum likelihood estimates is given by estim.method = "iMLE"; it is an iterative methodology where optimize() function provides the optimum scale parameter value, while the uniroot() function solve normal equations for that given scale parameter.

The regression estimates ("OLS") searches an optimum scale value (in a OLS criterion) by the `optimize()` function. Then the rest of the parameters are estimated also by OLS, as appears in Sarabia and Prieto (2009).

In the L-moments method ("LMOM") estimates are obtained searching parameters that equal the first three sample and theoretical L-moments by means of the "Nelder-Mead" algorithm implemented in `optim()`; the initial values are given in the `start` argument or, if it is missing, provided by the "iMLE".

Value

A `PPSfit` Object, a list with

- `estimateparameter` estimates.
- `loglik` the log-likelihood value.
- `n` the number of observations.
- `obs` the observations.
- `obsName` the name of the variable with the observations.
- `estim.method` the method of parameter estimation.

When this last value is "LMOM" the function also returns details about the convergence of the numerical method involved (convergence value).

References

Sarabia, J.M and Prieto, F. (2009). The Pareto-positive stable distribution: A new descriptive model for city size data, *Physica A: Statistical Mechanics and its Applications*, **388**(19), 4179-4191. 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.

See Also

[coef.PPSfit](#), [print.PPSfit](#), [plot.PPSfit](#), [GoF](#)

Examples

```
data(turkey)
fit <- PPS.fit(turkey$Pop2000)
print(fit)
coef(fit)
se(fit, k = 100, parallel = FALSE)
logLik(fit)
par(mfrow=c(2,2))
plot(fit)
GoF(fit, k = 100, parallel = FALSE)
```

print.PPSfit	<i>Printing a PPSfit Object</i>
--------------	---------------------------------

Description

It prints its argument (typically from `PPS.fit()`), returning some of the most important aspects.

Usage

```
## S3 method for class 'PPSfit'
print(x, digits = max(3, getOption("digits") - 3), ...)
```

Arguments

x	a PPSfit object.
digits	the number of digits to be printed.
...	other arguments.

References

Sarabia, J.M and Prieto, F. (2009). The Pareto-positive stable distribution: A new descriptive model for city size data, *Physica A: Statistical Mechanics and its Applications*, **388**(19), 4179-4191.

See Also

[PPS.fit](#)

Examples

```
x <- rPPS(50, 1.2, 100, 2.3)
fit <- PPS.fit(x)
print(fit)
```

se	<i>Approximated standard errors of Pareto Positive Stable (PPS) parameter estimates</i>
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Description

It approximates the standard errors of PPS parameter estimates by bootstrapping.

Usage

```
se(PPSfit, k = 2000, parallel = TRUE, ncores = 2, ...)
```

Arguments

PPSfit	a PPSfit Object, typically from <code>PPS.fit()</code> .
k	the number of steps in the bootstrapping procedure.
parallel	A logical argument specifying if parallelization is allowed in the bootstrapping procedure.
ncores	is the number of cores that we use if parallel is TRUE
...	other arguments.

Details

The function simulates `k` samples from the model given in the `PPSfit` argument, fits them with the same method of estimation and uses the parameter estimates to approximate the standard errors.

Value

A list with the standard errors.

References

Sarabia, J.M and Prieto, F. (2009). The Pareto-positive stable distribution: A new descriptive model for city size data, *Physica A: Statistical Mechanics and its Applications*, **388**(19), 4179-4191.

See Also

[PPS.fit](#)

Examples

```
x <- rPPS(50, 1.2, 100, 2.3)
fit <- PPS.fit(x)
coef(fit)
se(fit, k = 50)
```

turkey

Population of Turkish cities and towns

Description

Census population of Turkish cities and towns of more than 20,000 inhabitants in 1990 and 2000.

Format

A data frame with 280 observations on the following 4 variables.

- Namecities and towns names.
- Adm. abbreviated province name of cities and towns.
- Pop1990the population in 1990.
- Pop2000the population in 2000. #'

turkey

13

Source

<http://www.citypopulation.de/Turkey-C20.html>

Index

`coef.PPSfit`, [2](#), [5](#), [10](#)
`dPPS (PPS)`, [7](#)
`forbes400`, [3](#)
`GoF`, [3](#), [5](#), [6](#), [10](#)
`hPPS (PPS)`, [7](#)
`logLik.PPSfit`, [4](#)
`pareto.fit`, [5](#)
`ParetoPosStable`, [6](#)
`ParetoPosStable-package`
 (`ParetoPosStable`), [6](#)
`plot`, [6](#)
`plot.PPSfit`, [4](#), [5](#), [6](#), [10](#)
`pPPS (PPS)`, [7](#)
`PPS`, [7](#)
`PPS.fit`, [2](#), [4–7](#), [9](#), [11](#), [12](#)
`print.PPSfit`, [5](#), [10](#), [11](#)
`print.se (se)`, [11](#)

`qPPS (PPS)`, [7](#)

`rPPS (PPS)`, [7](#)

`se`, [11](#)

`turkey`, [12](#)