Package 'libstable4u'

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Version 1.0.4

Title Stable Distribution Functions...For You

Description Tools for fast and accurate evaluation of skew stable distributions (CDF, PDF and quantile functions), random number generation, and parameter estimation. This is 'libstableR' as per Royuela del Val, Simmross-Wattenberg, and Alberola López (2017) <doi:10.18637/jss.v078.i01> under a new maintainer.

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License GPL-3

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Contents

`libstable4u-package` *libstable4u: Fast and accurate evaluation, random number generation and parameter estimation of skew stable distributions.*

Description

libstable4u provides functions to work with skew stable distributions in a fast and accurate way [1]. It performs:

Details

- Fast and accurate evaluation of the probability density function (PDF) and cumulative density function (CDF).
- Fast and accurate evaluation of the quantile function (inverse CDF).
- Random numbers generation [2].
- Skew stable parameter estimation with:
  - McCulloch's method of quantiles [3].
  - Koutrouvellis' method based on the characteristic function [4].
  - Maximum likelihood estimation.
  - Modified maximum likelihood estimation as described in [1]. *The evaluation of the PDF and CDF is based on the formulas provided by John P Nolan in [5].

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References

- [1] Royuela-del-Val J, Simmross-Wattenberg F, Alberola López C (2017). libstable: Fast, Parallel and High-Precision Computation of alpha-stable Distributions in R, C/C++ and MATLAB. Journal of Statistical Software, 78(1), 1-25. doi:10.18637/jss.v078.i01
- [2] Chambers JM, Mallows CL, Stuck BW (1976). A Method for Simulating Stable Random Variables. Journal of the American Statistical Association, 71(354), 340-344. doi:10.1080/01621459.1976.10480344
- [3] McCulloch JH (1986). Simple Consistent Estimators of Stable Distribution Parameters. Communications in Statistics - Simulation and Computation, 15(4), 1109-1136. doi:10.1080/03610918608812563
- [4] Koutrouvelis IA (1981). An Iterative Procedure for the Estimation of the Parameters of Stable Laws. Communications in Statistics - Simulation and Computation, 10(1), 17-28. doi:10.1080/03610918108812189
- [5] Nolan JP (1997). Numerical Calculation of Stable Densities and Distribution Functions. Stochastic Models, 13(4), 759-774. doi:10.1080/15326349708807450

Examples

```
# Set alpha, beta, sigma and mu stable parameters in a vector
pars <- c(1.5, 0.9, 1, 0)

# Generate an abscissas axis and probabilities vector
x <- seq(-5, 10, 0.05)
p <- seq(0.01, 0.99, 0.01)

# Calculate pdf, cdf and quantiles
pdf <- stable_pdf(x, pars)
cdf <- stable_cdf(x, pars)
xq  <- stable_q(p, pars)

# Generate random values
set.seed(1)
rnd <- stable_rnd(100, pars)
head(rnd)

# Estimate the parameters of the skew stable distribution given
# the generated sample:

# Using the McCulloch's estimator:
pars_init <- stable_fit_init(rnd)

# Using the Koutrouvelis' estimator, with McCulloch estimation
# as a starting point:
pars_est_K <- stable_fit_koutrouvelis(rnd, pars_init)

# Using maximum likelihood estimator:
pars_est_ML <- stable_fit_mle(rnd, pars_est_K)

# Using modified maximum likelihood estimator (see [1]):
pars_est_ML2 <- stable_fit_mle2d(rnd, pars_est_K)
```

`stable_fit` *Methods for parameter estimation of skew stable distributions.*

Description

A set of functions are provided that perform the parameter estimation of skew stable distributions with different methods.

Usage

```
stable_fit_init(rnd, parametrization = 0L)

stable_fit_koutrouvelis(rnd, pars_init = as.numeric(c()), parametrization = 0L)
```

Arguments

`rnd`	Random sample
`parametrization`	Parametrization used for the skew stable distribution, as defined by JP Nolan (1997). By default, parametrization = 0.
`pars_init`	Vector with an initial estimation of the parameters. `pars_init = c(alpha, beta, sigma, mu)`, where • alpha: shape / stability parameter, with 0 < alpha <= 2. • beta: skewness parameter, with -1 <= beta <= 1. • sigma: scale parameter, with 0 < sigma. • mu: location parameter, with mu real.

Details

- `stable_fit_init()` uses McCulloch's method of quantiles [3]. This is usually a good initialization for the rest of the methods.
- `stable_fit_koutrouvelis()` implements Koutrouvellis' method based on the characteristic function [4].
- `stable_fit_mle()` implements a Maximum likelihood estimation.
- `stable_fit_mle2()` implements a modified maximum likelihood estimation as described in [1].

Value

A numeric vector.

Author(s)

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References

- [1] Royuela-del-Val J, Simmross-Wattenberg F, Alberola López C (2017). libstable: Fast, Parallel and High-Precision Computation of alpha-stable Distributions in R, C/C++ and MATLAB. Journal of Statistical Software, 78(1), 1-25. doi:10.18637/jss.v078.i01
- [2] Chambers JM, Mallows CL, Stuck BW (1976). A Method for Simulating Stable Random Variables. Journal of the American Statistical Association, 71(354), 340-344. doi:10.1080/01621459.1976.10480344.
- [3] McCulloch JH (1986). Simple Consistent Estimators of Stable Distribution Parameters. Communications in Statistics - Simulation and Computation, 15(4), 1109-1136. doi:10.1080/03610918608812563.
- [4] Koutrouvelis IA (1981). An Iterative Procedure for the Estimation of the Parameters of Stable Laws. Communications in Statistics - Simulation and Computation, 10(1), 17-28. doi:10.1080/03610918108812189.
- [5] Nolan JP (1997). Numerical Calculation of Stable Densities and Distribution Functions. Stochastic Models, 13(4) 759-774. doi:10.1080/15326349708807450.

Examples

```
# Set alpha, beta, sigma and mu stable parameters in a vector
pars <- c(1.5, 0.9, 1, 0)

# Generate random values
set.seed(1)
rnd <- stable_rnd(100, pars)
head(rnd)

# Estimate the parameters of the skew stable distribution given
# the generated sample:

# Using the McCulloch's estimator:
pars_init <- stable_fit_init(rnd)

# Using the Koutrouvelis' estimator, with McCulloch estimation
# as a starting point:
pars_est_K <- stable_fit_koutrouvelis(rnd, pars_init)

# Using maximum likelihood estimator:
pars_est_ML <- stable_fit_mle(rnd, pars_est_K)

# Using modified maximum likelihood estimator (see [1]):
pars_est_ML2 <- stable_fit_mle2d(rnd, pars_est_K)
```

`stable_pdf_and_cdf` *PDF and CDF of a skew stable distribution.*

Description

Evaluate the PDF or the CDF of the skew stable distribution with parameters pars = c(alpha, beta, sigma, mu) at the points given in x.

parametrization argument specifies the parametrization used for the distribution as described by JP Nolan (1997). The default value is *parametrization* = 0.

tol sets the relative error tolerance (precision) to *tol*. The default value is tol = 1e-12.

Usage

```
stable_pdf(x, pars, parametrization = 0L, tol = 1e-12)
```

Arguments

`x`	Vector of points where the pdf will be evaluated.
`pars`	Vector with an initial estimation of the parameters. `pars_init = c(alpha, beta, sigma, mu)`, where • alpha: shape / stability parameter, with 0 < alpha <= 2.

- beta: skewness parameter, with -1 <= beta <= 1.
- sigma: scale parameter, with 0 < sigma.
- mu: location parameter, with mu real.

`parametrization`
: Parametrization used for the skew stable distribution, as defined by JP Nolan (1997). By default, parametrization = 0.

`tol`
: Relative error tolerance (precission) of the calculated values. By default, tol = 1e-12.

Value

A numeric vector.

Author(s)

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References

Nolan JP (1997). Numerical Calculation of Stable Densities and Distribution Functions. Stochastic Models, 13(4) 759-774.

Examples

```
pars <- c(1.5, 0.9, 1, 0)
x <- seq(-5, 10, 0.001)

pdf <- stable_pdf(x, pars)
cdf <- stable_cdf(x, pars)

plot(x, pdf, type = "l")
```

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stable_q *Quantile function of skew stable distributions*

Description

Evaluate the quantile function (CDF^-1) of the skew stable distribution with parameters pars = c(alpha, beta, sigma, mu) at the points given in p.

parametrization argument specifies the parametrization used for the distribution as described by JP Nolan (1997). The default value is *parametrization* = 0.

tol sets the relative error tolerance (precission) to *tol*. The default value is tol = 1e-12.

Usage

```
stable_q(p, pars, parametrization = 0L, tol = 1e-12)
```

Arguments

p	Vector of points where the quantile function will be evaluated, with 0 < p[i] < 1.0
pars	Vector with an initial estimation of the parameters. pars_init = c(alpha, beta, sigma, mu), where • alpha: shape / stability parameter, with 0 < alpha <= 2. • beta: skewness parameter, with -1 <= beta <= 1. • sigma: scale parameter, with 0 < sigma. • mu: location parameter, with mu real.
parametrization	Parametrization used for the skew stable distribution, as defined by JP Nolan (1997). By default, parametrization = 0.
tol	Relative error tolerance (precission) of the calculated values. By default, tol = 1e-12.

Value

A numeric vector.

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stable_rnd *Skew stable distribution random sample generation.*

Description

stable_rnd(N, pars) generates N random samples of a skew stable distribuiton with parameters pars = c(alpha, beta, sigma, mu) using the Chambers, Mallows, and Stuck (1976) method.

Usage

```
stable_rnd(N, pars, parametrization = 0L)
```

Arguments

N	Number of values to generate.
pars	Vector with an initial estimation of the parameters. pars_init = c(alpha, beta, sigma, mu), where • alpha: shape / stability parameter, with 0 < alpha <= 2. • beta: skewness parameter, with -1 <= beta <= 1. • sigma: scale parameter, with 0 < sigma. • mu: location parameter, with mu real.
parametrization	Parametrization used for the skew stable distribution, as defined by JP Nolan (1997). By default, parametrization = 0.

Value

A numeric vector.

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References

Chambers JM, Mallows CL, Stuck BW (1976). A Method for Simulating Stable Random Variables. Journal of the American Statistical Association, 71(354), 340-344. doi:10.1080/01621459.1976.10480344.

Examples

```
N <- 1000
pars <- c(1.25, 0.95, 1.0, 0.0)
rnd <- stable_rnd(N, pars)

hist(rnd)
```

Index