

Package ‘twoexp’

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Type Package

Title The Two Parameter Exponential Distribution

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Description Density, distribution function, quantile function,
and random generation function, maximum likelihood estimation (MLE),
penalized maximum likelihood estimation (PMLE), the quartiles method estimation (QM),
and median rank estimation (MEDRANK) for the two-parameter exponential distribution.
MLE and PMLE are based on Mengjie Zheng (2013)<https://scse.d.umn.edu/sites/scse.d.umn.edu/files/mengjie-thesis_masters-1.pdf>.
QM is based on Entisar Elgmati and Nadia Gregni (2016)<[doi:10.5539/ijsp.v5n5p12](https://doi.org/10.5539/ijsp.v5n5p12)>.
MEDRANK is based on Matthew Reid (2022)<[doi:10.5281/ZENODO.3938000](https://doi.org/10.5281/ZENODO.3938000)>.
In addition, the functions for computing the Kolmogorov-Smirnov (D) statistic,
the Cramér-von Mises statistic, and the Anderson–Darling statistic are provided.

License GPL-3

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ADstat	<i>The Anderson–Darling (AD) statistic for the two-parameter exponential distribution.</i>
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Description

The Anderson–Darling statistic, called the AD statistic, measures the weighted distance between an empirical cumulative distribution function (ECDF) and a theoretical cumulative distribution function (CDF).

Usage

ADstat(x, theta, beta)

Arguments

- x a data vector (e.g., failure time, waiting time, etc.)
- theta location parameter, where $\theta > 0$.
- beta scale parameter, where $\beta > 0$ and $rate = 1/\beta$.

Value

A value of the AD statistic.

References

D’Agostino, R. B., & Stephens, M. A. (Eds.). (1986). Goodness-of-fit techniques. Marcel Dekker. (ISBN 0-8247-8705-6).

Examples

```
# Proschan (1963, Table I) has given some samples of data,
# consisting of intervals between failures of air conditioning equipment in aircraft
data <- c(12,21,26,27,29,29,48,57,59,70,74,153,326,386,502)
theta_hat <- min(data)           #estimate theta
beta_hat <- mean(data)-min(data) #estimate beta
ADstat(data, theta_hat, beta_hat)
```

cdfplot	<i>Distribution function plot of the two-parameter exponential distribution</i>
---------	---

Description

Distribution function plot of the two-parameter exponential distribution with theta and beta

Usage

```
cdfplot(x, theta, beta)
```

Arguments

x	vector of quantile.
theta	location parameter, where $\theta > 0$.
beta	scale parameter, where $\beta > 0$.

Value

a distribution function plot of the two-parameter exponential distribution

Examples

```
x <- seq(0,20,by=0.01)
theta <- 6
beta <- 2
cdfplot(x, theta, beta)
```

CMstat	<i>The Cramér-von Mises statistic for the two-parameter exponential distribution.</i>
--------	---

Description

The Cramér-von Mises statistic measures the total squared distance between an empirical distribution function (ECDF) and a reference cumulative distribution function (CDF).

Usage

```
CMstat(x, theta, beta)
```

Arguments

x	a data vector (e.g., failure time, waiting time, etc.)
theta	location parameter, where $\theta > 0$.
beta	scale parameter, where $\beta > 0$ and $rate = 1/\beta$.

Value

A value of the Cramér-von Mises statistic.

References

D'Agostino, R. B., & Stephens, M. A. (Eds.). (1986). Goodness-of-fit techniques. Marcel Dekker. (ISBN 0-8247-8705-6).

Examples

```
# Proschan (1963, Table I) has given some samples of data,
# consisting of intervals between failures of air conditioning equipment in aircraft
data <- c(12,21,26,27,29,29,48,57,59,70,74,153,326,386,502)
theta_hat <- min(data) #estimate theta
beta_hat <- mean(data)-min(data) #estimate beta
CMstat(data, theta_hat, beta_hat)
```

Dstat	<i>The Kolmogorov-Smirnov statistic (D statistic) for the two-parameter exponential distribution.</i>
-------	---

Description

The Kolmogorov-Smirnov statistic, also called the D statistic, measures the maximum vertical distance between the empirical distribution function (ECDF) of a sample of data and the CDF of a reference distribution. In this case, a reference distribution is the two-parameter exponential distribution.

Usage

```
Dstat(x, theta, beta)
```

Arguments

x	a data vector (e.g., failure time, waiting time, etc.)
theta	location parameter, where $\theta > 0$.
beta	scale parameter, where $\beta > 0$ and $rate = 1/\beta$.

Value

A value of the D statistic.

References

D'Agostino, R. B., & Stephens, M. A. (Eds.). (1986). Goodness-of-fit techniques. Marcel Dekker. (ISBN 0-8247-8705-6).

Examples

```
# Proschan (1963, Table I) has given some samples of data,
# consisting of intervals between failures of air conditioning equipment in aircraft
data <- c(12,21,26,27,29,29,48,57,59,70,74,153,326,386,502)
theta_hat <- min(data) #estimate theta
beta_hat <- mean(data)-min(data) #estimate beta
Dstat(data, theta_hat, beta_hat)
```

medrank	<i>Median rank method to estimate parameters of the two-parameter exponential dist.</i>
---------	---

Description

Median rank method to estimate parameters of the two-parameter exponential dist.

Usage

```
medrank(x, methods = c("B"))
```

Arguments

x	vector of quantile (or a data set).
methods	there are some of median rank methods as follows; "B" stand for Benard median rank method (default), "BL" stand for Blom method, "MKM" stand for Hazen (Modified Kaplan Meier) method, "OT" stand for The one-third method, and "C" stand for Cunane method

Value

the estimate three values for the two-parameter exponential dist. as follows: `theta.hat` gives the estimate location parameter, `beta.hat` gives the estimate scale parameter, and `lamda.hat` gives the estimate the rate.

Source

Reid, M. (2022). Reliability – a Python library for reliability engineering (Version 0.8.2) [Computer software]. Zenodo. doi:[10.5281/ZENODO.3938000](https://doi.org/10.5281/ZENODO.3938000).

Examples

```
x1 <- c(25,43,53,65,76,86,95,115,132,150) # test a data set
medrank(x1,"B") # Benard method (default) or medrank(x1)
```

mle_tpexp	<i>Maximum likelihood estimation for the two-parameter exponential dist.</i>
-----------	--

Description

To estimate the location (or shift) and scale parameters for the two-parameter exponential distribution based on maximum likelihood method. See detail in source

Usage

```
mle_tpexp(x, theta = 0, beta = 1)
```

Arguments

x	vector of quantile (or a data set).
theta	location parameter, where $\theta > 0$.
beta	scale parameter, where $\beta > 0$ and $rate = 1/\beta$.

Value

the estimate three values for the two-parameter exponential dist. as follows: theta.hat gives the estimate location parameter, beta.hat gives the estimate scale parameter, and lamda.hat gives the estimate the rate.

Source

Zheng, M. (2013). *Penalized Maximum Likelihood Estimation of Two-Parameter Exponential Distributions [Master's thesis]*. https://scse.d.umn.edu/sites/scse.d.umn.edu/files/mengjie-thesis_masters-1.pdf

Examples

```
x1 <- c(25,43,53,65,76,86,95,115,132,150) # test a data set
mle_tpexp(x1)
x2 <- c(20,15,10,25,35,30,40,70,50,60,90,100,80,5) # test a data set
mle_tpexp(x2)
```

pdfplot

*Density plot of the two-parameter exponential distribution***Description**

Density plot of the two-parameter exponential distribution with theta and beta

Usage

```
pdfplot(x, theta, beta)
```

Arguments

x	vector of quantile.
theta	location parameter, where $\theta > 0$.
beta	scale parameter, where $\beta > 0$.

Value

a density plot of the two-parameter exponential distribution

Examples

```
x <- seq(0,20,by=0.01)
theta <- 6
beta <- 2
pdfplot(x,theta,beta)
```

pmle_tpexp	<i>Penalized maximum likelihood estimation for the two-parameter exponential dist.</i>
------------	--

Description

To estimate the location (or shift) and scale parameters for the two-parameter exponential distribution based on penalized maximum likelihood method. See detail in source

Usage

```
pmle_tpexp(x, theta = 0, beta = 1)
```

Arguments

x	vector of quantile (or a data set).
theta	location parameter, where $\theta > 0$.
beta	scale parameter, where $\beta > 0$ and $rate = 1/\beta$.

Value

the estimate three values for the two-parameter exponential dist. as follows: ptheta.hat gives the estimate location parameter, pbeta.hat gives the estimate scale parameter, and plambda.hat gives the estimate the rate.

Source

Zheng, M. (2013). *Penalized Maximum Likelihood Estimation of Two-Parameter Exponential Distributions [Master's thesis]*. https://scse.d.umn.edu/sites/scse.d.umn.edu/files/mengjie-thesis_masters-1.pdf

Examples

```
x1 <- c(25,43,53,65,76,86,95,115,132,150) # test a data set
pmle_tpexp(x1)
x2 <- c(20,15,10,25,35,30,40,70,50,60,90,100,80,5) # test a data set
pmle_tpexp(x2)
```

qm_tpexp	<i>Quartile method estimation of the two-parameter exponential distribution</i>
----------	---

Description

To estimate the location (or shift) and scale parameters for the two-parameter exponential distribution based on quartile method. See detail in source

Usage

```
qm_tpexp(x, methods = c("Q13"))
```

Arguments

x	vector of quantile (or a data set).
methods	there are two quartile methods as follows; "Q13" stand for the first and the third quartile method (default), and "Q12" stand for the first and the second quartile (median) method.

Value

the estimate three values for the two-parameter exponential dist. as follows: qmtheta.hat gives the estimate location parameter, qmbeta.hat gives the estimate scale parameter, and qmlamda.hat gives the estimate the rate.

Source

Elgmati, E., Gregni, N. (2016). Quartile Method Estimation of Two-Parameter Exponential Distribution Data with Outliers. *International Journal of Statistics and Probability*, 5(5), 12-15. doi:10.5539/ijsp.v5n5p12

Examples

```
x1 <- c(25,43,53,65,76,86,95,115,132,150) # test a data set
qm_tpexp(x1,"Q13") # or qm_tpexp(x1)
qm_tpexp(x1,"Q12")
```

surplot	<i>Survival function plot of the two-parameter exponential distribution</i>
---------	---

Description

Survival function plot of the two-parameter exponential distribution with theta and beta

Usage

```
surplot(x, theta, beta)
```

Arguments

x	vector of quantile.
theta	location parameter, where $\theta > 0$.
beta	scale parameter, where $\beta > 0$.

Value

a survival function plot of the two-parameter exponential distribution

Examples

```
x <- seq(0,20,by=0.01)
theta <- 8
beta <- 1
surplot(x, theta, beta)
```

tpexp	<i>The two-parameter exponential distribution(tpexp)</i>
-------	--

Description

Density, distribution function, quantile function, and random generation function for the two-parameter exponential distribution with theta and beta

Usage

```
dtexp(x, theta = 0, beta = 1, log = FALSE)

ptexp(q, theta = 0, beta = 1, lower.tail = TRUE, log.p = FALSE)

qtexp(p, theta = 0, beta = 1, lower.tail = TRUE, log.p = FALSE)

rtexp(n, theta = 0, beta = 1)
```

Arguments

<code>x, q</code>	vector of quantile.
<code>theta</code>	location parameter, where $\theta > 0$.
<code>beta</code>	scale parameter, where $\beta > 0$ and $rate = 1/\beta$.
<code>log, log.p</code>	logical; (default = FALSE), if TRUE, then probabilities are given as $\log(p)$.
<code>lower.tail</code>	logical; if TRUE (default), probabilities are $P[X \leq x]$, otherwise, $P[X > x]$.
<code>p</code>	vector of probabilities
<code>n</code>	number of observations. If $\text{length}(n) > 1$, the length is taken to be the number required.

Value

`dtexp` gives the density, `ptexp` gives the distribution function, `qtexp` gives the quantile function, and `rtexp` generates random samples.

Examples

```

NULL
x <- c(0.1,0.2,0.3,0.4,0.5,0.6,0.7,0.8,0.9,1.0)
dtexp(x,theta=0,beta=1)
dtexp(x,theta=0,beta=1,log=TRUE)

q <- c(0.1,0.2,0.3,0.4,0.5,0.6,0.7,0.8,0.9,1.0)
ptexp(q,theta = 0, beta = 1)
ptexp(q,theta=0, beta = 1, lower.tail = FALSE)

q <- c(0.1,0.2,0.3,0.4,0.5,0.6,0.7,0.8,0.9,1.0)
p<- ptexp(q,theta = 0, beta = 1); p
qtexp(p,theta=0, beta = 1)

rtexp(5, theta=0, beta=1)
rtexp(10, theta=1, beta=1.5)

```

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