Package 'AEP'

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Type Package

Title Statistical Modelling for Asymmetric Exponential Power Distribution

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Description Developed for Computing the probability density function, cumulative distribution function, random generation, estimating the parameters of asymmetric exponential power distribution, and robust regression analysis with error term that follows asymmetric exponential power distribution.

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R topics documented:

daep *Computing the probability density function (pdf) of asymmetric exponential power (AEP) distribution.*

Description

Computes the pdf of AEP distribution that is given by

$$f_X(x|\Theta) = \begin{cases} \frac{1}{2\sigma\Gamma\left(1+\frac{1}{\alpha}\right)} \exp\left\{-\left|\frac{\mu-x}{\sigma(1-\epsilon)}\right|^{\alpha}\right\}, & x \leq \mu, \\ \frac{1}{2\sigma\Gamma\left(1+\frac{1}{\alpha}\right)} \exp\left\{-\left|\frac{x-\mu}{\sigma(1+\epsilon)}\right|^{\alpha}\right\}, & x > \mu, \end{cases}$$

where $-\infty < x < +\infty$, $\Theta = (\alpha, \sigma, \mu, \epsilon)^T$ with $0 < \alpha \leq 2$, $\sigma > 0$, $-\infty < \mu < \infty$, $-1 < \epsilon < 1$, and

$$\Gamma(u) = \int_0^{+\infty} x^{u-1} \exp\{-x\} dx,$$

for $u > 0$.

Usage

```
daep(x, alpha, sigma, mu, epsilon, log = FALSE)
```

Arguments

x	Vector of observation of requested random realizations.
alpha	Tail thickness parameter.
sigma	Scale parameter.
mu	Location parameter.
epsilon	Skewness parameter.
log	If TRUE, then $\log\big(f_X(x\|\Theta)\big)$ is returned.

Details

Note that if $\epsilon = 0$, then the AEP distribution turns into a normal distribution with mean μ and standard deviation $\sqrt{2}\sigma$. When $\alpha = 2$, the AEP distribution is a slight variant of that of

Value

Computed pdf of AEP distribution at points of vector x.

Author(s)

Mahdi Teimouri

References

G. S. Mudholkar and A. D. Huston, 2001. The epsilon-skew–normal distribution for analyzing near-normal data.*Journal of Statistical Planning and Inference*, 83, 291-309.

Examples

```
daep(x = 2, alpha = 1.5, sigma = 1, mu = 0, epsilon = 0.5, log = FALSE)
```

`fitaep` *Estimating the parameters of AEP distribution through the expectation-maximization (EM) algorithm*

Description

Estimates the parameters of AEP distribution for which the pdf is given by

$$f_X(x|\Theta) = \begin{cases} \frac{1}{2\sigma\Gamma\left(1+\frac{1}{\alpha}\right)} \exp\left\{-\left|\frac{\mu-x}{\sigma(1-\epsilon)}\right|^{\alpha}\right\}, & x \leq \mu, \\ \frac{1}{2\sigma\Gamma\left(1+\frac{1}{\alpha}\right)} \exp\left\{-\left|\frac{x-\mu}{\sigma(1+\epsilon)}\right|^{\alpha}\right\}, & x > \mu, \end{cases}$$

where $-\infty < x < +\infty$, $\Theta = (\alpha, \sigma, \mu, \epsilon)^T$ with $0 < \alpha \leq 2$, $\sigma > 0$, $-\infty < \mu < \infty$, and $-1 < \epsilon < 1$.

Usage

```
fitaep(x, initial = FALSE, starts)
```

Arguments

`x`	Vector of observations.
`initial`	By default is `FALSE`. If the initial values are given by user, then set `initial=TRUE`.
`starts`	If initial values are not given by user, i.e., `initial=FALSE`, then vector `starts` must contain the initial values of the parameter vector, i.e., `starts=`$\left(\alpha^{(0)}, \sigma^{(0)}, \mu^{(0)}, \epsilon^{(0)}\right)$ for starting the EM algorithm.

Value

A list of objects in two parts as

1. The EM estimator for the parameters of AEP distribution.
2. A sequence of goodness-of-fit measures consist of Akaike Information Criterion (`AIC`), Consistent Akaike Information Criterion (`CAIC`), Bayesian Information Criterion (`BIC`), Hannan-Quinn information criterion (`HQIC`), Anderson-Darling (`AD`), Cram\'eer-von Misses (`CVM`), Kolmogorov-Smirnov (`KS`), and log-likelihood (`log-likelihood`) statistics.

Author(s)

Mahdi Teimouri

References

A. P. Dempster, N. M. Laird, and D. B. Rubin, 1977. Maximum likelihood from incomplete data via the EM algorithm, *Journal of the Royal Statistical Society Series B*, 39, 1-38.

Examples

```
x <- raep(n=50, alpha=.8, sigma=1, mu=0, epsilon=0.5)
fitaep(x, initial = FALSE, starts)
```

---

paep *Computing the cumulative distribution function (cdf) of asymmetric exponential power (AEP) distribution.*

Description

Computes the cdf of AEP distribution that is given by

$$F_X(x|\Theta) = \begin{cases} \frac{1-\epsilon}{2} - \frac{1-\epsilon}{2\Gamma\left(1+\frac{1}{\alpha}\right)}\gamma\left(\left|\frac{\mu-x}{\sigma(1-\epsilon)}\right|^{\alpha}, \frac{1}{\alpha}\right), & x \leq \mu, \\ \frac{1-\epsilon}{2} + \frac{1+\epsilon}{2\Gamma\left(1+\frac{1}{\alpha}\right)}\gamma\left(\left|\frac{x-\mu}{\sigma(1+\epsilon)}\right|^{\alpha}, \frac{1}{\alpha}\right), & x > \mu, \end{cases}$$

where $-\infty < x < +\infty$, $\Theta = (\alpha, \sigma, \mu, \epsilon)^T$ with $0 < \alpha \leq 2, \sigma > 0$, $-\infty < \mu < \infty$, $-1 < \epsilon < 1$, and

$$\gamma(u, \nu) = \int_0^u t^{\nu-1} \exp\{-t\} dt.$$

for $\nu > 0$.

Usage

```
paep(x, alpha, sigma, mu, epsilon, log.p = FALSE, lower.tail = TRUE)
```

Arguments

x	Vector of observations.
alpha	Tail thickness parameter.
sigma	Scale parameter.
mu	Location parameter.
epsilon	Skewness parameter.
log.p	If TRUE, then $\log\big(F_X(x\|\Theta)\big)$ is returned.
lower.tail	If FALSE, then $1 - F_X(x\|\Theta)$ is returned.

Value

Computed cdf of AEP distribution at points of vector x.

Author(s)

Mahdi Teimouri

Examples

```
paep(x = 2, alpha = 1.5, sigma = 1, mu = 0, epsilon = 0.5, log.p = FALSE, lower.tail = TRUE)
```

---

qaep *Computing the quantile function of asymmetric exponential power (AEP) distribution.*

Description

Computes the quantile function of AEP distribution that is given by

$$F^{-1}(u|\Theta) = \begin{cases} \mu - \sigma(1-\epsilon)\left[\frac{\gamma\left(\frac{1-\epsilon-2u}{1-\epsilon}, \frac{1}{\alpha}\right)}{\Gamma\left(\frac{1}{\alpha}\right)}\right]^{\frac{1}{\alpha}}, & u \leq \frac{1-\epsilon}{2}, \\ \mu + \sigma(1+\epsilon)\left[\frac{\gamma\left(\frac{2u+\epsilon-1}{1+\epsilon}, \frac{1}{\alpha}\right)}{\Gamma\left(\frac{1}{\alpha}\right)}\right]^{\frac{1}{\alpha}}, & u > \frac{1-\epsilon}{2}. \end{cases}$$

where $0 < u < 1$, $\Theta = (\alpha, \sigma, \mu, \epsilon)^T$ with $0 < \alpha \leq 2$, $\sigma > 0$, $-\infty < \mu < \infty$, and $-1 < \epsilon < 1$.

Usage

```
qaep(u, alpha, sigma, mu, epsilon)
```

Arguments

u	Number of requested realizations
alpha	Tail thickness parameter
sigma	Scale parameter
mu	Location parameter
epsilon	Skewness parameter

Value

A vector of length n, consists of the random generated values from AEP distribution.

Author(s)

Mahdi Teimouri

Examples

```
qaep(runif(1), alpha = 1.5, sigma = 1, mu = 0, epsilon = 0.5)
```

raep *Simulating realizations from the asymmetric exponential power (AEP) distribution*

Description

Simulates realizations from AEP distribution with quantile function given by

$$F^{-1}(u|\Theta) = \begin{cases} \mu - \sigma(1-\epsilon)\left[\frac{\gamma\left(\frac{1-\epsilon-2u}{1-\epsilon}, \frac{1}{\alpha}\right)}{\Gamma\left(\frac{1}{\alpha}\right)}\right]^{\frac{1}{\alpha}}, & u \leq \frac{1-\epsilon}{2}, \\ \mu + \sigma(1+\epsilon)\left[\frac{\gamma\left(\frac{2u+\epsilon-1}{1+\epsilon}, \frac{1}{\alpha}\right)}{\Gamma\left(\frac{1}{\alpha}\right)}\right]^{\frac{1}{\alpha}}, & u > \frac{1-\epsilon}{2}. \end{cases}$$

where $0 < u < 1$, $\Theta = (\alpha, \sigma, \mu, \epsilon)^T$ with $0 < \alpha \leq 2$, $\sigma > 0$, $-\infty < \mu < \infty$, and $-1 < \epsilon < 1$.

Usage

```
raep(n, alpha, sigma, mu, epsilon)
```

Arguments

n	Number of requested realizations
alpha	Tail thickness parameter
sigma	Scale parameter
mu	Location parameter
epsilon	Skewness parameter

Value

A vector of length n, consists of the random generated values from AEP distribution.

Author(s)

Mahdi Teimouri

Examples

```
raep(n = 100, alpha = 1.5, sigma = 1, mu = 0, epsilon = 0.5)
```

regaep *Robust linear regression analysis when error term follows AEP distribution*

Description

Estimates parameters of the multiple linear regression model through EM algorithm when error term follows AEP distribution. The regression model is given by

$$y_i = \beta_0 + \beta_1 x_{i1} + \cdots + \beta_k x_{ik} + \nu_i, \;\; i = 1, \cdots, n,$$

where $\beta_0, \beta_1, \cdots, \beta_k$ are the regression coefficients and ν is the error term follows a zero-location AEP distibution with pdf given by

$$f_X(x|\Theta) = \begin{cases} \frac{1}{2\sigma\Gamma\left(1+\frac{1}{\alpha}\right)} \exp\left\{-\left|\frac{-x}{\sigma(1-\epsilon)}\right|^{\alpha}\right\}, & x \leq 0, \\ \frac{1}{2\sigma\Gamma\left(1+\frac{1}{\alpha}\right)} \exp\left\{-\left|\frac{x}{\sigma(1+\epsilon)}\right|^{\alpha}\right\}, & x > 0, \end{cases}$$

where $-\infty < x < +\infty$, $\Theta = (\alpha, \sigma, \epsilon)^T$ with $0 < \alpha \leq 2$, $\sigma > 0$, $-1 < \epsilon < 1$, and

$$\Gamma(u) = \int_0^{+\infty} x^{u-1} \exp\{-x\} dx,$$

for $u > 0$.

Usage

```
regaep(y, x)
```

Arguments

y	Vector of response observations of length n.
x	A $n \times k$ array of covariate(s).

Value

A list of estimated regression coefficients, estimated parameters of error term, F statistic, R-square, and adjusted R-square.

Author(s)

Mahdi Teimouri

References

A. P. Dempster, N. M. Laird, and D. B. Rubin, 1977. Maximum likelihood from incomplete data via the EM algorithm, *Journal of the Royal Statistical Society Series B*, 39, 1-38.

Examples

```
x <- seq(-5, 5, 0.1)
y <- 2 + 2*x + raep( length(x), alpha = 1, sigma = 0.5, mu = 0, epsilon = 0.5)
regaep(y, x)
```

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welcome *Starting message when loading AEP*

Description

It contains a welcome message for users of AEP.

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