Package 'pearson7'

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Title Maximum Likelihood Inference for the Pearson VII Distribution with Shape Parameter 3/2

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Description Supports maximum likelihood inference for the Pearson VII distribution with shape parameter 3/2 and free location and scale parameters. This distribution is relevant when estimating the velocity of processive motor proteins with random detachment.

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R topics documented:

`dpearson7` *Evaluate the density for the Pearson VII distribution with shape parameter 3/2.*

Description

Evaluate the density for the Pearson VII distribution with shape parameter 3/2.

Usage

```
dpearson7(x, mu = 0, sigma = 1, log = FALSE)
```

Arguments

`x`	vector of quantiles.
`mu`	vector of means.
`sigma`	vector of scales.
`log`	logical; if `TRUE`, probabilities p are given as log(p).

Details

If `mu` is not specified, it assumes the default value of 0. If `sigma` is not specified, it assumes the default value of 1.

The Pearson VII distribution with location μ, scale σ, and shape 3/2 has density

$$f(x) = 1/(2\sigma)[1 + \{(x - \mu)/\sigma\}^2]^{-3/2}.$$

Value

the density.

References

Hughes, J., Shastry, S., Hancock, W. O., and Fricks, J. (2013) Estimating velocity for processive motor proteins with random detachment. *Journal of Agricultural, Biological, and Environmental Statistics*, in press.

Pearson, K. (1916) Mathematical contributions to the theory of evolution. xix. second supplement to a memoir on skew variation. *Philosophical Transactions of the Royal Society of London. Series A, Containing Papers of a Mathematical or Physical Character*, **216**, 429–457.

See Also

`ppearson7`, `qpearson7`, `rpearson7`

Examples

```
curve(dpearson7(x), -5, 5, lwd = 2, n = 500, ylab = "f(x)")
curve(dnorm(x), lwd = 2, lty = 2, n = 500, add = TRUE)
```

`pearson7.fit` *Find the MLE for a sample from the Pearson VII distribution with shape parameter 3/2.*

Description

Find the MLE for a sample from the Pearson VII distribution with shape parameter 3/2.

Usage

```
pearson7.fit(y, mu0 = median(y), sigma0 = sqrt(3) * median(abs(y -
  median(y))), tol = 1e-08)
```

Arguments

`y`	a vector of observations.
`mu0`	an initial value for μ.
`sigma0`	an initial value for σ.
`tol`	the convergence tolerance.

Details

This function uses a Newton-Raphson algorithm to find the MLE. The starting values for μ and σ are the sample median and $\sqrt{3}$ times the sample MAD, respectively. See the reference for details.

Value

`pearson7.fit` returns an object of class "`pearson7`", which is a list containing the following components.

`theta.hat`	the estimates of μ and σ.
`hessian`	the Hessian matrix evaluated at `theta.hat`.
`iterations`	the number of iterations required to attain convergence.
`value`	the value of the log likelihood at `theta.hat`.

References

Hughes, J., Shastry, S., Hancock, W. O., and Fricks, J. (2013) Estimating velocity for processive motor proteins with random detachment. *Journal of Agricultural, Biological, and Environmental Statistics*, in press.

See Also

pearson7.objective

Examples

```
y = rpearson7(100, 100, 10)
fit = pearson7.fit(y)
fit
summary(fit)
```

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pearson7.objective *Compute the negative log likelihood for a sample.*

Description

Compute the negative log likelihood for a sample.

Usage

```
pearson7.objective(params, y)
```

Arguments

params	a vector of parameter values.
y	a vector of observations.

Details

This function computes the negative log likelihood for (μ, σ) given a sample. This function can be optimized using optim, but it is better to use pearson7.fit.

Value

the negative log likelihood.

See Also

dpearson7, pearson7.fit

ppearson7 *Evaluate the distribution function for the Pearson VII distribution with shape parameter 3/2.*

Description

Evaluate the distribution function for the Pearson VII distribution with shape parameter 3/2.

Usage

```
ppearson7(q, mu = 0, sigma = 1, lower.tail = TRUE, log.p = FALSE)
```

Arguments

q	vector of quantiles.
mu	vector of means.
sigma	vector of scales.
lower.tail	logical; if TRUE (default), probabilities are $P(X \leq x)$, otherwise $P(X > x)$.
log.p	logical; if TRUE, probabilities p are given as log(p).

Details

If mu is not specified, it assumes the default value of 0. If sigma is not specified, it assumes the default value of 1.

The Pearson VII distribution with location μ, scale σ, and shape 3/2 has cdf

$$F(x) = \{1 + (x - \mu)/\sqrt{\sigma^2 + (x - \mu)^2}\}/2.$$

Value

the probability.

References

Hughes, J., Shastry, S., Hancock, W. O., and Fricks, J. (2013) Estimating velocity for processive motor proteins with random detachment. *Journal of Agricultural, Biological, and Environmental Statistics*, in press.

See Also

dpearson7, qpearson7, rpearson7

Examples

```
curve(ppearson7(x), 0, 5, lwd = 2, ylim = c(0.8, 1), ylab = "F(x)")
curve(pnorm(x), lwd = 2, lty = 2, add = TRUE)
```

qpearson7 *Evaluate the quantile function for the Pearson VII distribution with shape parameter 3/2.*

Description

Evaluate the quantile function for the Pearson VII distribution with shape parameter 3/2.

Usage

```
qpearson7(p, mu = 0, sigma = 1, lower.tail = TRUE, log.p = FALSE)
```

Arguments

p	vector of probabilities.
mu	vector of means.
sigma	vector of scales.
lower.tail	logical; if TRUE (default), probabilities are $P(X \leq x)$, otherwise $P(X > x)$.
log.p	logical; if TRUE, probabilities p are given as log(p).

Details

If mu is not specified, it assumes the default value of 0. If sigma is not specified, it assumes the default value of 1.

The Pearson VII distribution with location μ, scale σ, and shape 3/2 has quantile function

$$F^{-1}(x) = \mu + (\sigma/2)(2x - 1)/\sqrt{x(1 - x)}.$$

Value

the quantile.

References

Hughes, J., Shastry, S., Hancock, W. O., and Fricks, J. (2013) Estimating velocity for processive motor proteins with random detachment. *Journal of Agricultural, Biological, and Environmental Statistics*, in press.

See Also

dpearson7, ppearson7, rpearson7

Examples

```
curve(qpearson7(x), 0, 1, lwd = 2, ylab = expression(F^{-1}*(x)))
curve(qnorm(x), lwd = 2, lty = 2, n = 500, add = TRUE)
```

`rpearson7` *Generate random deviates from a Pearson VII distribution with shape parameter 3/2.*

Description

Generate random deviates from a Pearson VII distribution with shape parameter 3/2.

Usage

```
rpearson7(n, mu = 0, sigma = 1)
```

Arguments

`n`	number of observations.
`mu`	vector of means.
`sigma`	vector of scales.

Details

If `mu` is not specified, it assumes the default value of 0. If `sigma` is not specified, it assumes the default value of 1.

Value

random deviates.

References

Hughes, J., Shastry, S., Hancock, W. O., and Fricks, J. (2013) Estimating velocity for processive motor proteins with random detachment. *Journal of Agricultural, Biological, and Environmental Statistics*, in press.

Devroye, L. (1986) *Non-Uniform Random Variate Generation*. New York: Springer-Verlag.

See Also

`dpearson7`, `ppearson7`, `qpearson7`

Examples

```
y = rpearson7(1000)
hist(y, prob = TRUE, breaks = 100, col = "gray")
curve(dpearson7(x), lwd = 2, col = "blue", add = TRUE)
```

summary.pearson7 *Print a summary of a Pearson VII fit.*

Description

Print a summary of a Pearson VII fit.

Usage

```
## S3 method for class 'pearson7'
summary(object, alpha = 0.05, digits = 4, ...)
```

Arguments

object	an object of class "pearson7", the result of a call to pearson7.fit.
alpha	the significance level used to compute the confidence intervals. The default is 0.05.
digits	the number of significant digits to display. The default is 4.
...	additional arguments.

Details

This function displays (1) a table of estimates, (2) the value of the log likelihood, and (3) the number of Newton-Raphson iterations. Each row of the table of estimates shows the parameter estimate and the approximate $(1 - \alpha)100\%$ confidence interval for the parameter.

See Also

pearson7.fit

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