Package ‘logitnorm’

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Title  Functions for the Logitnormal Distribution
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Description  Density, distribution, quantile and random generation function for the logitnormal distribution. Estimation of the mode and the first two moments. Estimation of distribution parameters.
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Utilities for the logitnormal distribution in R

• Density, distribution, quantile and random generation function.
• Estimation of the mode and the first two moments.
• Estimation of distribution parameters from observations.

Details

The logitnormal distribution is useful as a prior density for variables that are bounded between 0 and 1, such as proportions. Fig. 1 displays its density for various combinations of parameters mu and sigma.

The package provides the main distribution functions:

• density dlogitnorm,
• distribution plogitnorm,
• quantile qlogitnorm, and
• random generation function rlogitnorm.

Transformation functions

• (0,1) -> (-Inf,Inf): logit
• (-Inf,Inf) -> (0,1): invlogit

Moments and mode

• Expected value and variance: momentsLogitnorm
• Mode: modeLogitnorm

Estimating parameters

• from mode and upper quantile: twCoefLogitnormMLE
• from mode and constraint to be unimodal and maximally flat: twCoefLogitnormMLEFlat
• from median and upper quantile: twCoefLogitnormN
• from expected value, i.e. mean and upper quantile: \texttt{twCoefLogitnorm}\texttt{E}
• from a confidence interval which is symmetric at normal scale: \texttt{twCoefLogitnorm}\texttt{CI}
• from prescribed quantiles: \texttt{twCoefLogitnorm}\texttt{N}

\textbf{Author(s)}
Thomas Wutzler

\textbf{References}

\begin{verbatim}
dlogitnorm dlogitnorm

\textbf{Description}
Density function of logitnormal distribution

\textbf{Usage}
dlogitnorm(q, mu = 0, sigma = 1, log = FALSE, ...)

\textbf{Arguments}
\begin{itemize}
  \item q quantiles
  \item mu distribution parameters
  \item sigma
  \item log if TRUE, the log-density is returned
  \item ... further arguments passed to \texttt{dnorm}: mean, and \texttt{sd} for \texttt{mu} and \texttt{sigma} respectively.
\end{itemize}

\textbf{Details}

\textbf{Logitnorm distribution} \hspace{1cm} \textbullet{} density function: \texttt{dlogitnorm}
\hspace{1cm} \textbullet{} distribution function: \texttt{plogitnorm}
\hspace{1cm} \textbullet{} quantile function: \texttt{qlogitnorm}
\hspace{1cm} \textbullet{} random generation function: \texttt{rlogitnorm}

\textbf{Author(s)}
Thomas Wutzler

\textbf{See Also}
\texttt{logitnorm}
Description
Transforming (-Inf,Inf) to original scale (0,1)

Usage
invlogit(q, ...)

Arguments
q
...

Details
function \( f(z) = \frac{e^z}{e^z + 1} = \frac{1}{1 + e^{-z}} \)

Author(s)
Thomas Wutzler

See Also
logit
logitnorm

Description
Transforming (0,1) to normal scale (-Inf Inf)

Usage
logit(p, ...)

Arguments
p
...

logit
Details

function \( \text{logit}(p) = \log \left( \frac{p}{1-p} \right) = \log(p) - \log(1-p) \)

Author(s)

Thomas Wutzler

See Also

invlogit
logitnorm

description

Mode of the logitnormal distribution by numerical optimization

Usage

modelogitnorm(mu, sigma, tol = invlogit(mu)/1000)

Arguments

mu parameter mu
sigma parameter sigma
tol precisions of the estimate

Author(s)

Thomas Wutzler

See Also

logitnorm
momentsLogitnorm

Description
First two moments of the logitnormal distribution by numerical integration

Usage
momentsLogitnorm(mu, sigma, abs.tol = 0, ...)

Arguments
- mu: parameter mu
- sigma: parameter sigma
- abs.tol: changing default to integrate
- ...: further parameters to the integrate function

Value
named numeric vector with components
- mean: expected value, i.e. first moment
- var: variance, i.e. second moment

Author(s)
Thomas Wutzler

Examples
(res <- momentsLogitnorm(4,1))
(res <- momentsLogitnorm(5,0.1))
plogitnorm

Description
Distribution function for logitnormal distribution

Usage
plogitnorm(q, mu = 0, sigma = 1, ...)

Arguments
q
mu distribution parameters
sigma
...

Author(s)
Thomas Wutzler

See Also
logitnorm

qlogitnorm

Description
Quantiles of logitnormal distribution.

Usage
qlogitnorm(p, mu = 0, sigma = 1, ...)

Arguments
p
mu distribution parameters
sigma
...
Author(s)
Thomas Wutzler

See Also
logitnorm

rlogitnorm

Description
Random number generation for logitnormal distribution

Usage
rlogitnorm(mu = 0, sigma = 1, ...)

Arguments
mu          distribution parameters
sigma
...

arguments to rnorm

Author(s)
Thomas Wutzler

See Also
logitnorm

Description
Estimating coefficients of logitnormal distribution from median and upper quantile
Usage

twCoefLogitnorm(median, quant, perc = 0.975, method = "BFGS",

    theta0 = c(mu = 0, sigma = 1), returnDetails = FALSE,

    ...)

Arguments

median       numeric vector: the median of the density function
quant        numeric vector: the upper quantile value
perc         numeric vector: the probability for which the quantile was specified
method       method of optimization (see optim)
theta0        starting parameters
returnDetails if TRUE, the full output of optim is attached as attributes resOptim

Value

numeric matrix with columns c("mu","sigma")
rows correspond to rows in median, quant, and perc

Author(s)

Thomas Wutzler

See Also

logitnorm

Examples

# estimate the parameters, with median at 0.7 and upper quantile at 0.9

(theta <- twCoefLogitnorm(0.7,0.9))

x <- seq(0,1,length.out=41)[-c(1,41)] # plotting grid
px <- plogitnorm(x,mu=theta[1],sigma=theta[2]) #percentiles function
plot(px~x); abline(v=c(0.7,0.9),col="gray"); abline(h=c(0.5,0.975),col="gray")

dx <- dlogitnorm(x,mu=theta[1],sigma=theta[2]) #density function
plot(dx~x); abline(v=c(0.7,0.9),col="gray")

# vectorized

(theta <- twCoefLogitnorm(seq(0.4,0.8,by=0.1),0.9))

Description
Calculates mu and sigma of the logitnormal distribution from lower and upper quantile, i.e. confidence interval.

Usage
twCoefLogitnormCi(lower, upper, perc = 0.975, sigmaFac = qnorm(perc),

   isTransScale = FALSE)

Arguments

lower  value at the lower quantile, i.e. practical minimum
upper  value at the upper quantile, i.e. practical maximum
perc   numeric vector: the probability for which the quantile was specified
sigmaFac sigmaFac=2 is 95% sigmaFac=2.6 is 99% interval
isTransScale if true lower and upper are already on logit scale
Value

named numeric vector: mu and sigma parameter of the logitnormal distribution.

Author(s)

Thomas Wutzler

See Also

logitnorm

Examples

mu=2

sd=c(1,0.8)

p=0.99

lower <- l <- qlogitnorm(1-p, mu, sd ) # p-confidence interval

upper <- u <- qlogitnorm(p, mu, sd ) # p-confidence interval

cf <- twCoefLogitnormCI(lower, upper)

all.equal( cf[,"mu"] , c(mu,mu) )

all.equal( cf[,"sigma"] , sd )

Description

Estimating coefficients of logitnormal distribution from expected value, i.e. mean, and upper quantile.
Usage

twCoefLogitnormE(mean, quant, perc = c(0.975), method = "BFGS",

theta0 = c(mu = 0, sigma = 1), returnDetails = FALSE,

...)

Arguments

mean the expected value of the density function
quant the quantile values
perc the probabilities for which the quantiles were specified
method method of optimization (see optim)
theta0 starting parameters
returnDetails if TRUE, the full output of optim is returned with attribute resOptim

Value

named numeric matrix with estimated parameters of the logitnormal distribution.
colnames: c("mu", "sigma")

Author(s)

Thomas Wutzler

See Also

logitnorm

Examples

# estimate the parameters

(thetaE <- twCoefLogitnormE(0.7, 0.9))

x <- seq(0, 1, length.out = 41)[-c(1, 41)] # plotting grid
px <- plogitnorm(x, mu=theta[1], sigma=theta[2])  # percentiles function

plot(px~x); abline(v=c(0.7,0.9), col="gray"); abline(h=c(0.5,0.975), col="gray")

dx <- dlogitnorm(x, mu=theta[1], sigma=theta[2])  # density function

plot(dx~x); abline(v=c(0.7,0.9), col="gray")

z <- rlogitnorm(1e5, mu=theta[1], sigma=theta[2])

mean(z)  # about 0.7

# vectorized

(theta <- twCoefLogitnormMLE(mean=seq(0.4, 0.8, by=0.1), quant=0.9))
twCoefLogitnormMLEFlat

description

Estimating coefficients of a maximally flat unimodal logitnormal distribution from mode

Usage

twCoefLogitnormMLEFlat(mle)

Arguments

mle numeric vector: the mode of the density function

Details

When increasing the sigma parameter, the distribution becomes eventually becomes bi-model, i.e. has two maxima. This function estimates parameters for given mode, so that the distribution assigns high density to a maximum range, i.e. is maximally flat, but still is unimodal.
**Description**

Estimating coefficients of logitnormal distribution from a vector of quantiles and percentiles (non-vectorized).

**Usage**

```r
twCoefLogitnormN(quant, perc = c(0.5, 0.975), method = "BFGS",

theta0 = c(mu = 0, sigma = 1), returnDetails = FALSE,

...)
```

**Arguments**

- `quant` the quantile values
- `perc` the probabilities for which the quantiles were specified
- `method` method of optimization (see `optim`)
- `theta0` starting parameters
- `returnDetails` if TRUE, the full output of `optim` is returned instead of only entry `par`
- `...` further parameters passed to `optim`, e.g. `control=list(maxit=1000)`

**Value**

named numeric vector with estimated parameters of the logitnormal distribution.

names: c("mu","sigma")

**Author(s)**

Thomas Wutzler

**See Also**

logitnorm
Examples

# experiment of re-estimation the parameters from generated observations

thetaTrue <- c(mu=0.8, sigma=0.7)

obsTrue <- rlogitnorm(thetaTrue["mu"], thetaTrue["sigma"], n=500)

obs <- obsTrue + rnorm(100, sd=0.05)  # some observation uncertainty

plot(density(obsTrue), col="blue"); lines(density(obs))

# re-estimate parameters based on the quantiles of the observations

(theta <- twCoefLogitnorm( median(obs), quantile(obs, probs=0.9), perc = 0.9))

# add line of estimated distribution

x <- seq(0,1,length.out=41)[-c(1,41)]  # plotting grid

dx <- dlogitnorm(x, mu=theta[1], sigma=theta[2])

lines(dx ~ x, col="orange")

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twSigmaLogitnorm  twSigmaLogitnorm

Description

Estimating coefficients of logitnormal distribution from mode and given mu
**twSigmaLogitnorm**

**Usage**

\[ \text{twSigmaLogitnorm}(mle, \mu = 0) \]

**Arguments**

- `mle` numeric vector: the mode of the density function
- `mu` for \( \mu = 0 \) the distribution will be the flattest case (maybe bimodal)

**Details**

For a mostly flat unimodal distribution use \text{twCoefLogitnormMLE}(mle, 0)

**Value**

numeric matrix with columns \((\mu', \sigma')\) rows correspond to rows in \(mle\) and \(mu\)

**Author(s)**

Thomas Wutzler

**See Also**

logitnorm

**Examples**

```r
mle <- 0.8
(\theta <- \text{twSigmaLogitnorm}(mle))
#
x <- \text{seq}(0,1, length.out=41)[-c(1,41)] # plotting grid
px <- \text{plogitnorm}(x, \mu=\theta[1], \sigma=\theta[2]) # percentiles function
plot(px~x); abline(v=c(mle), col="gray")
dx <- \text{dlogitnorm}(x, \mu=\theta[1], \sigma=\theta[2]) # density function
plot(dx~x); abline(v=c(mle), col="gray")
# vectorized
(\theta <- \text{twSigmaLogitnorm}(mle=\text{seq}(0.40, 0.8, by=0.1)))
```
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