Package ‘gamlss.dist’

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Type Package

Title Distributions to be used for GAMLSS modelling.

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Depends R (>= 2.15.0), MASS

Description This package contains the distributions for GAMLSS modelling.

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URL http://www.gamlss.org/

Repository CRAN

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R topics documented:

`gamlss.dist-package` *The GAMLSS distributions*

Description

This package contains all distributions to be used for GAMLSS models. Each distributions has its probability function, `d`, its commutative probability function, `p`, the inverse of the commutative probability function, `q`, its random generation function, `r`, and also the `gamlss.family` generating function

Details

Package:	gamlss.dist
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This package is design to be used with the package **gamlss** but the `d`, `p`, `q` and `r` functions can be used separately.

Author(s)

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References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Stasinopoulos D. M., Rigby R.A. and Akantziliotou C. (2003) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.com/)

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

gamlss.family

Examples

```
plot(function(y) dSICHEL(y, mu=10, sigma = 0.1 , nu=1 ), from=0, to=30, n=30+1, type="h") # pdf
# cdf plot
PPP <- par(mfrow=c(2,1))
plot(function(y) pSICHEL(y, mu=10, sigma =0.1, nu=1 ), from=0, to=30, n=30+1, type="h") # cdf
cdf<-pSICHEL(0:30, mu=10, sigma=0.1, nu=1)
sfun1  <- stepfun(1:30, cdf, f = 0)
plot(sfun1, xlim=c(0,30), main="cdf(x)")
par(PPP)
```

BB *Beta Binomial Distribution For Fitting a GAMLSS Model*

Description

This function defines the beta binomial distribution, a two parameter distribution, for a `gamlss.family` object to be used in a GAMLSS fitting using the function gamlss()

Usage

```
BB(mu.link = "logit", sigma.link = "log")
dBB(x, mu = 0.5, sigma = 1, bd = 10, log = FALSE)
pBB(q, mu = 0.5, sigma = 1, bd = 10, lower.tail = TRUE,
      log.p = FALSE)
qBB(p, mu = 0.5, sigma = 1, bd = 10, lower.tail = TRUE,
       log.p = FALSE, fast = FALSE)
rBB(n, mu = 0.5, sigma = 1, bd = 10, fast = FALSE)
```

Arguments

`mu.link`	Defines the `mu.link`, with "logit" link as the default for the mu parameter. Other links are "probit" and "cloglog"'(complementary log-log)
`sigma.link`	Defines the `sigma.link`, with "log" link as the default for the sigma parameter. Other links are "inverse", "identity" and "sqrt"
`mu`	vector of positive probabilities
`sigma`	the dispersion parameter
`bd`	vector of binomial denominators
`p`	vector of probabilities
`x,q`	vector of quantiles
`n`	number of random values to return
`log, log.p`	logical; if TRUE, probabilities p are given as log(p)
`lower.tail`	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
`fast`	a logical variable if `fast=TRUE` the `dBB` function is used in the calculation of the inverse c.d.f function. This is faster to the default `fast=FALSE`, where the `pBB{}` is used, but not always consistent with the results obtained from `pBB()`, for example if p <- pBB(c(0,1,2,3,4,5), mu=.5 , sigma=1, bd=5) do not ensure that qBB(p, mu=.5 , sigma=1, bd=5) will be c(0,1,2,3,4,5)

Details

Definition file for beta binomial distribution.

$$f(y|\mu,\sigma) = \frac{\Gamma(n+1)}{\Gamma(y+1)\Gamma(n-y+1)} \frac{\Gamma(\frac{1}{\sigma})\Gamma(y+\frac{\mu}{\sigma})\Gamma[n+\frac{(1-\mu)}{\sigma}-y]}{\Gamma(n+\frac{1}{\sigma})\Gamma(\frac{\mu}{\sigma})\Gamma(\frac{1-\mu}{\sigma})}$$

for $y = 0, 1, 2, \ldots, n$, $0 < \mu < 1$ and $\sigma > 0$. For $\mu = 0.5$ and $\sigma = 0.5$ the distribution is uniform.

Value

Returns a `gamlss.family` object which can be used to fit a Beta Binomial distribution in the `gamlss()` function.

Warning

The functions `pBB` and `qBB` are calculated using a laborious procedure so they are relatively slow.

Note

The response variable should be a matrix containing two columns, the first with the count of successes and the second with the count of failures. The parameter `mu` represents a probability parameter with limits $0 < \mu < 1$. $n\mu$ is the mean of the distribution where n is the binomial denominator. $\{n\mu(1-\mu)[1+(n-1)\sigma/(\sigma+1)]\}^{0.5}$ is the standard deviation of the Beta Binomial distribution. Hence σ is a dispersion type parameter

Author(s)

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References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Stasinopoulos D. M., Rigby R.A. and Akantziliotou C. (2006) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.com/).

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

gamlss.family, BI,

Examples

```
# BB()# gives information about the default links for the Beta Binomial distribution
#plot the pdf
plot(function(y) dBB(y, mu = .5, sigma = 1, bd =40), from=0, to=40, n=40+1, type="h")
#calculate the cdf and plotting it
ppBB <- pBB(seq(from=0, to=40), mu=.2 , sigma=3, bd=40)
plot(0:40,ppBB, type="h")
#calculating quantiles and plotting them
qqBB <- qBB(ppBB, mu=.2 , sigma=3, bd=40)
plot(qqBB~ ppBB)
# when the argument fast is useful
p <- pBB(c(0,1,2,3,4,5), mu=.01 , sigma=1, bd=5)
qBB(p, mu=.01 , sigma=1, bd=5, fast=TRUE)
#  0 1 1 2 3 5
qBB(p, mu=.01 , sigma=1, bd=5, fast=FALSE)
#  0 1 2 3 4 5
# generate random sample
tN <- table(Ni <- rBB(1000, mu=.2, sigma=1, bd=20))
r <- barplot(tN, col='lightblue')
# fitting a model
# library(gamlss)
#data(aep)
# fits a Beta-Binomial model
#h<-gamlss(y~ward+loglos+year, sigma.formula=~year+ward, family=BB, data=aep)
```

BCCG *Box-Cox Cole and Green distribution (or Box-Cox normal) for fitting a GAMLSS*

Description

The function BCCG defines the Box-Cox Cole and Green distribution (Box-Cox normal), a three parameter distribution, for a gamlss.family object to be used in GAMLSS fitting using the function gamlss(). The functions dBCCG, pBCCG, qBCCG and rBCCG define the density, distribution function, quantile function and random generation for the specific parameterization of the Box-Cox Cole and Green distribution. [The function BCCGuntr() is the original version of the function suitable only for the untruncated Box-Cox Cole and Green distribution See Cole and Green (1992) and Rigby and Stasinopoulos (2003a,2003b) for details. The function BCCGo is identical to BCCG but with log link for mu.

Usage

```
BCCG(mu.link = "identity", sigma.link = "log", nu.link = "identity")
BCCGo(mu.link = "log", sigma.link = "log", nu.link = "identity")
BCCGuntr(mu.link = "identity", sigma.link = "log", nu.link = "identity")
dBCCG(x, mu = 1, sigma = 0.1, nu = 1, log = FALSE)
pBCCG(q, mu = 1, sigma = 0.1, nu = 1, lower.tail = TRUE, log.p = FALSE)
qBCCG(p, mu = 1, sigma = 0.1, nu = 1, lower.tail = TRUE, log.p = FALSE)
rBCCG(n, mu = 1, sigma = 0.1, nu = 1)
```

Arguments

mu.link	Defines the mu.link, with "identity" link as the default for the mu parameter, other links are "inverse", "log" and "own"
sigma.link	Defines the sigma.link, with "log" link as the default for the sigma parameter, other links are "inverse", "identity" and "own"
nu.link	Defines the nu.link, with "identity" link as the default for the nu parameter, other links are "inverse", "log" and "own"
x,q	vector of quantiles
mu	vector of location parameter values
sigma	vector of scale parameter values
nu	vector of skewness parameter values
log, log.p	logical; if TRUE, probabilities p are given as log(p).
lower.tail	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
p	vector of probabilities.
n	number of observations. If length(n) > 1, the length is taken to be the number required

Details

The probability distribution function of the untrucated Box-Cox Cole and Green distribution, `BCCGuntr`, is defined as

$$f(y|\mu,\sigma,\nu) = \frac{1}{\sqrt{2\pi}\sigma}\frac{y^{\nu-1}}{\mu^{\nu}}\exp(-\frac{z^2}{2})$$

where if $\nu \neq 0$ then $z = [(y/\mu)^{\nu} - 1]/(\nu\sigma)$ else $z = \log(y/\mu)/\sigma$, for $y > 0$, $\mu > 0$, $\sigma > 0$ and $\nu = (-\infty, +\infty)$.

The Box-Cox Cole anf Green distribution, `BCCG`, adjusts the above density $f(y|\mu,\sigma,\nu)$ for the truncation resulting from the condition $y > 0$. See Rigby and Stasinopoulos (2003a,2003b) for details.

Value

`BCCG()` returns a `gamlss.family` object which can be used to fit a Cole and Green distribution in the `gamlss()` function. `dBCCG()` gives the density, `pBCCG()` gives the distribution function, `qBCCG()` gives the quantile function, and `rBCCG()` generates random deviates.

Warning

The `BCCGuntr` distribution may be unsuitable for some combinations of the parameters (mainly for large σ) where the integrating constant is less than 0.99. A warning will be given if this is the case. The BCCG distribution is suitable for all combinations of the distributional parameters within their range [i.e. $\mu > 0$, $\sigma > 0$, $\nu = (-\infty, +\infty)$]

Note

μ is the median of the distribution σ is approximately the coefficient of variation (for small values of σ), and ν controls the skewness.

The `BCCG` distribution is suitable for all combinations of the parameters within their ranges [i.e. $\mu > 0, \sigma > 0, \mathrm{and} \nu = (-\infty, \infty)$]

Author(s)

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References

Cole, T. J. and Green, P. J. (1992) Smoothing reference centile curves: the LMS method and penalized likelihood, *Statist. Med.* **11**, 1305–1319

Rigby, R. A. and Stasinopoulos, D. M. (2004). Smooth centile curves for skew and kurtotic data modelled using the Box-Cox Power Exponential distribution. *Statistics in Medicine*, **23**: 3053-3076.

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Rigby, R.A. Stasinopoulos, D.M. (2006). Using the Box-Cox *t* distribution in GAMLSS to mode skewnees and and kurtosis. to appear in *Statistical Modelling*.

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Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

gamlss.family, BCPE, BCT

Examples

```
BCCG()   # gives information about the default links for the Cole and Green distribution
# library(gamlss)
#data(abdom)
#h<-gamlss(y~cs(x,df=3), sigma.formula=~cs(x,1), family=BCCG, data=abdom)
#plot(h)
plot(function(x) dBCCG(x, mu=5,sigma=.5,nu=-1), 0.0, 20,
 main = "The BCCG  density mu=5,sigma=.5,nu=-1")
plot(function(x) pBCCG(x, mu=5,sigma=.5,nu=-1), 0.0, 20,
 main = "The BCCG  cdf mu=5, sigma=.5, nu=-1")
```

BCPE *Box-Cox Power Exponential distribution for fitting a GAMLSS*

Description

This function defines the Box-Cox Power Exponential distribution, a four parameter distribution, for a `gamlss.family` object to be used for a GAMLSS fitting using the function `gamlss()`. The functions `dBCPE`, `pBCPE`, `qBCPE` and `rBCPE` define the density, distribution function, quantile function and random generation for the Box-Cox Power Exponential distribution. The function `checkBCPE` can be used, typically when a BCPE model is fitted, to check whether there exit a turning point of the distribution close to zero. It give the number of values of the response below their minimum turning point and also the maximum probability of the lower tail below minimum turning point. [The function `Biventer()` is the original version of the function suitable only for the untruncated BCPE distribution.] See Rigby and Stasinopoulos (2003) for details. The function `BCPEo` is identical to `BCPE` but with log link for mu.

Usage

```
BCPE(mu.link = "identity", sigma.link = "log", nu.link = "identity",
           tau.link = "log")
BCPEo(mu.link = "log", sigma.link = "log", nu.link = "identity",
           tau.link = "log")
BCPEuntr(mu.link = "identity", sigma.link = "log", nu.link = "identity",
           tau.link = "log")
dBCPE(x, mu = 5, sigma = 0.1, nu = 1, tau = 2, log = FALSE)
```

```
pBCPE(q, mu = 5, sigma = 0.1, nu = 1, tau = 2, lower.tail = TRUE, log.p = FALSE)
qBCPE(p, mu = 5, sigma = 0.1, nu = 1, tau = 2, lower.tail = TRUE, log.p = FALSE)
rBCPE(n, mu = 5, sigma = 0.1, nu = 1, tau = 2)
checkBCPE(obj = NULL, mu = 10, sigma = 0.1, nu = 0.5, tau = 2,...)
```

Arguments

`mu.link`	Defines the `mu.link`, with "identity" link as the default for the `mu` parameter. Other links are "inverse", "log" and "own"
`sigma.link`	Defines the `sigma.link`, with "log" link as the default for the `sigma` parameter. Other links are "inverse", "identity" and "own"
`nu.link`	Defines the `nu.link`, with "identity" link as the default for the `nu` parameter. Other links are "inverse", "log" and "own"
`tau.link`	Defines the `tau.link`, with "log" link as the default for the `tau` parameter. Other links are "logshifted", "identity" and "own"
`x,q`	vector of quantiles
`mu`	vector of location parameter values
`sigma`	vector of scale parameter values
`nu`	vector of `nu` parameter values
`tau`	vector of `tau` parameter values
`log, log.p`	logical; if TRUE, probabilities p are given as log(p).
`lower.tail`	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
`p`	vector of probabilities.
`n`	number of observations. If `length(n) > 1`, the length is taken to be the number required
`obj`	a gamlss BCPE family object
`...`	for extra arguments

Details

The probability density function of the untrucated Box Cox Power Exponential distribution, (`BCPE.untr`), is defined as

$$f(y|\mu,\sigma,\nu,\tau) = \frac{y^{\nu-1}\tau\exp[-\frac{1}{2}|\frac{z}{c}|^{\tau}]}{\mu^{\nu}\sigma c 2^{(1+1/\tau)}\Gamma(\frac{1}{\tau})}$$

where $c = [2^{(-2/\tau)}\Gamma(1/\tau)/\Gamma(3/\tau)]^{0.5}$, where if $\nu \neq 0$ then $z = [(y/\mu)^{\nu} - 1]/(\nu\sigma)$ else $z = \log(y/\mu)/\sigma$, for $y > 0$, $\mu > 0$, $\sigma > 0$, $\nu = (-\infty, +\infty)$ and $\tau > 0$.

The Box-Cox Power Exponential, `BCPE`, adjusts the above density $f(y|\mu,\sigma,\nu,\tau)$ for the truncation resulting from the condition $y > 0$. See Rigby and Stasinopoulos (2003) for details.

Value

`BCPE()` returns a `gamlss.family` object which can be used to fit a Box Cox Power Exponential distribution in the `gamlss()` function. `dBCPE()` gives the density, `pBCPE()` gives the distribution function, `qBCPE()` gives the quantile function, and `rBCPE()` generates random deviates.

Warning

The BCPE.untr distribution may be unsuitable for some combinations of the parameters (mainly for large σ) where the integrating constant is less than 0.99. A warning will be given if this is the case.

The BCPE distribution is suitable for all combinations of the parameters within their ranges [i.e. $\mu > 0, \sigma > 0, \nu = (-\infty, \infty) \text{and} \tau > 0$]

Note

μ, is the median of the distribution, σ is approximately the coefficient of variation (for small σ and moderate nu>0), ν controls the skewness and τ the kurtosis of the distribution

Author(s)

Mikis Stasinopoulos, Bob Rigby and Calliope Akantziliotou

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

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Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

gamlss.family, BCT

Examples

```
# BCPE()   #
# library(gamlss)
# data(abdom)
#h<-gamlss(y~cs(x,df=3), sigma.formula=~cs(x,1), family=BCPE, data=abdom)
#plot(h)
plot(function(x)dBCPE(x, mu=5,sigma=.5,nu=1, tau=3), 0.0, 15,
 main = "The BCPE  density mu=5,sigma=.5,nu=1, tau=3")
plot(function(x) pBCPE(x, mu=5,sigma=.5,nu=1, tau=3), 0.0, 15,
 main = "The BCPE  cdf mu=5, sigma=.5, nu=1, tau=3")
```

BCT *Box-Cox t distribution for fitting a GAMLSS*

Description

The function BCT() defines the Box-Cox t distribution, a four parameter distribution, for a gamlss.family object to be used in GAMLSS fitting using the function gamlss(). The functions dBCT, pBCT, qBCT and rBCT define the density, distribution function, quantile function and random generation for the Box-Cox t distribution. [The function BCTuntr() is the original version of the function suitable only for the untruncated BCT distribution]. See Rigby and Stasinopoulos (2003) for details. The function BCT is identical to BCT but with log link for mu.

Usage

```
BCT(mu.link = "identity", sigma.link = "log", nu.link = "identity",
          tau.link = "log")
BCTo(mu.link = "log", sigma.link = "log", nu.link = "identity",
          tau.link = "log")
BCTuntr(mu.link = "identity", sigma.link = "log", nu.link = "identity",
          tau.link = "log")
dBCT(x, mu = 5, sigma = 0.1, nu = 1, tau = 2, log = FALSE)
pBCT(q, mu = 5, sigma = 0.1, nu = 1, tau = 2, lower.tail = TRUE, log.p = FALSE)
qBCT(p, mu = 5, sigma = 0.1, nu = 1, tau = 2, lower.tail = TRUE, log.p = FALSE)
rBCT(n, mu = 5, sigma = 0.1, nu = 1, tau = 2)
```

Arguments

mu.link	Defines the mu.link, with "identity" link as the default for the mu parameter. Other links are "inverse", "log" and "own"
sigma.link	Defines the sigma.link, with "log" link as the default for the sigma parameter. Other links are "inverse","identity", "own"
nu.link	Defines the nu.link, with "identity" link as the default for the nu parameter. Other links are "inverse", "log", "own"
tau.link	Defines the tau.link, with "log" link as the default for the tau parameter. Other links are "inverse", "identity" and "own"
x,q	vector of quantiles
mu	vector of location parameter values
sigma	vector of scale parameter values
nu	vector of nu parameter values
tau	vector of tau parameter values
log, log.p	logical; if TRUE, probabilities p are given as log(p).
lower.tail	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
p	vector of probabilities.
n	number of observations. If length(n) > 1, the length is taken to be the number required

Details

The probability density function of the untruncated Box-Cox t distribution, `BCTuntr`, is given by

$$f(y|\mu,\sigma,\nu,\tau) = \frac{y^{\nu-1}}{\mu^{\nu}\sigma}\frac{\Gamma[(\tau+1)/2]}{\Gamma(1/2)\Gamma(\tau/2)\tau^{0.5}}[1+(1/\tau)z^2]^{-(\tau+1)/2}$$

where if $\nu \neq 0$ then $z = [(y/\mu)^{\nu} - 1]/(\nu\sigma)$ else $z = \log(y/\mu)/\sigma$, for $y > 0$, $\mu > 0$, $\sigma > 0$, $\nu = (-\infty, +\infty)$ and $\tau > 0$.

The Box-Cox *t* distribution, `BCT`, adjusts the above density $f(y|\mu,\sigma,\nu,\tau)$ for the truncation resulting from the condition $y > 0$. See Rigby and Stasinopoulos (2003) for details.

Value

`BCT()` returns a `gamlss.family` object which can be used to fit a Box Cox-t distribution in the `gamlss()` function. `dBCT()` gives the density, `pBCT()` gives the distribution function, `qBCT()` gives the quantile function, and `rBCT()` generates random deviates.

Warning

The use `BCTuntr` distribution may be unsuitable for some combinations of the parameters (mainly for large σ) where the integrating constant is less than 0.99. A warning will be given if this is the case.

The `BCT` distribution is suitable for all combinations of the parameters within their ranges [i.e. $\mu > 0, \sigma > 0, \nu = (-\infty, \infty) \text{and} \tau > 0$]

Note

μ is the median of the distribution, $\sigma(\frac{\tau}{\tau-2})^{0.5}$ is approximate the coefficient of variation (for small σ and moderate `nu>0` and moderate or large τ), ν controls the skewness and τ the kurtosis of the distribution

Author(s)

Mikis Stasinopoulos, Bob Rigby and Calliope Akantziliotou

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

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Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

gamlss.family, BCPE, BCCG

Examples

```
BCT()   # gives information about the default links for the Box Cox t distribution
# library(gamlss)
#data(abdom)
#h<-gamlss(y~cs(x,df=3), sigma.formula=~cs(x,1), family=BCT, data=abdom) #
#plot(h)
plot(function(x)dBCT(x, mu=5,sigma=.5,nu=1, tau=2), 0.0, 20,
 main = "The BCT  density mu=5,sigma=.5,nu=1, tau=2")
plot(function(x) pBCT(x, mu=5,sigma=.5,nu=1, tau=2), 0.0, 20,
 main = "The BCT  cdf mu=5, sigma=.5, nu=1, tau=2")
```

BE *The beta distribution for fitting a GAMLSS*

Description

The functions `BE()` and `BEo()` define the beta distribution, a two parameter distribution, for a `gamlss.family` object to be used in GAMLSS fitting using the function `gamlss()`. `BE()` has mean equal to the parameter `mu` and `sigma` as scale parameter, see below. `BE()` is the original parameterizations of the beta distribution as in `dbeta()` with `shape1`=mu and `shape2`=sigma. The functions `dBE` and `dBEo`, `pBE` and `pBEo`, `qBE` and `qBEo` and finally `rBE` and `rBE` define the density, distribution function, quantile function and random generation for the `BE` and `BEo` parameterizations respectively of the beta distribution.

Usage

```
BE(mu.link = "logit", sigma.link = "logit")
dBE(x, mu = 0.5, sigma = 0.02, log = FALSE)
pBE(q, mu = 0.5, sigma = 0.02, lower.tail = TRUE, log.p = FALSE)
qBE(p, mu = 0.5, sigma = 0.02, lower.tail = TRUE, log.p = FALSE)
rBE(n, mu = 0.5, sigma = 0.02)
BEo(mu.link = "log", sigma.link = "log")
dBEo(x, mu = 0.5, sigma = 0.02, log = FALSE)
pBEo(q, mu = 0.5, sigma = 0.02, lower.tail = TRUE, log.p = FALSE)
qBEo(p, mu = 0.5, sigma = 0.02, lower.tail = TRUE, log.p = FALSE)
```

Arguments

mu.link	the mu link function with default logit
sigma.link	the sigma link function with default logit
x,q	vector of quantiles
mu	vector of location parameter values

sigma	vector of scale parameter values
log, log.p	logical; if TRUE, probabilities p are given as log(p).
lower.tail	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
p	vector of probabilities.
n	number of observations. If length(n) > 1, the length is taken to be the number required

Details

The original beta distributions distribution is given as

$$f(y|\alpha, \beta) = \frac{1}{B(\alpha, \beta)} y^{\alpha-1}(1-y)^{\beta-1}$$

for $y = (0, 1)$, $\alpha > 0$ and $\beta > 0$. In the gamlss implementation of BEo $\alpha = \mu$ and $\beta > \sigma$. The reparametrization in the function BE() is $\mu = \frac{\alpha}{\alpha+\beta}$ and $\sigma = \frac{1}{\alpha+\beta+1}$ for $\mu = (0, 1)$ and $\sigma = (0, 1)$. The expected value of y is μ and the variance is $\sigma^2 \mu * (1 - \mu)$.

Value

returns a gamlss.family object which can be used to fit a normal distribution in the gamlss() function.

Note

Note that for BE, mu is the mean and sigma a scale parameter contributing to the variance of y

Author(s)

Bob Rigby and Mikis Stasinopoulos

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

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See Also

gamlss.family, BEINF

Examples

```
BE()# gives information about the default links for the normal distribution
dat1<-rBE(100, mu=.3, sigma=.5)
hist(dat1)
#library(gamlss)
# mod1<-gamlss(dat1~1,family=BE) # fits a constant for mu and sigma
#fitted(mod1)[1]
#fitted(mod1,"sigma")[1]
plot(function(y) dBE(y, mu=.1 ,sigma=.5), 0.001, .999)
plot(function(y) pBE(y, mu=.1 ,sigma=.5), 0.001, 0.999)
plot(function(y) qBE(y, mu=.1 ,sigma=.5), 0.001, 0.999)
plot(function(y) qBE(y, mu=.1 ,sigma=.5, lower.tail=FALSE), 0.001, .999)
dat2<-rBEo(100, mu=1, sigma=2)
#mod2<-gamlss(dat2~1,family=BEo) # fits a constant for mu and sigma
#fitted(mod2)[1]
#fitted(mod2,"sigma")[1]
```

BEINF *The beta inflated distribution for fitting a GAMLSS*

Description

The function `BEINF()` defines the beta inflated distribution, a four parameter distribution, for a `gamlss.family` object to be used in GAMLSS fitting using the function `gamlss()`. The beta inflated is similar to the beta but allows zeros and ones as values for the response variable. The two extra parameters model the probabilities at zero and one.

The functions `BEINF0()` and `BEINF1()` are three parameter beta inflated distributions allowing zeros or ones only at the response respectively. `BEINF0()` and `BEINF1()` are re-parameterize versions of the distributions `BEZI` and `BEOI` contributed to gamlss by Raydonal Ospina (see Ospina and Ferrari (2010)).

The functions `dBEINF`, `pBEINF`, `qBEINF` and `rBEINF` define the density, distribution function, quantile function and random generation for the `BEINF` parametrization of the beta inflated distribution.

The functions `dBEINF0`, `pBEINF0`, `qBEINF0` and `rBEINF0` define the density, distribution function, quantile function and random generation for the `BEINF0` parametrization of the beta inflated at zero distribution.

The functions `dBEINF1`, `pBEINF1`, `qBEINF1` and `rBEINF1` define the density, distribution function, quantile function and random generation for the `BEINF1` parametrization of the beta inflated at one distribution.

`plotBEINF`, `plotBEINF0` and `plotBEINF1` can be used to plot the distributions. `meanBEINF`, `meanBEINF0` and `meanBEINF1` calculates the expected value of the response for a fitted model.

Usage

```
BEINF(mu.link = "logit", sigma.link = "logit", nu.link = "log",
      tau.link = "log")
BEINF0(mu.link = "logit", sigma.link = "logit", nu.link = "log")
```

```
BEINF1(mu.link = "logit", sigma.link = "logit", nu.link = "log")

dBEINF(x, mu = 0.5, sigma = 0.1, nu = 0.1, tau = 0.1,
       log = FALSE)
dBEINF0(x, mu = 0.5, sigma = 0.1, nu = 0.1, log = FALSE)
dBEINF1(x, mu = 0.5, sigma = 0.1, nu = 0.1, log = FALSE)

pBEINF(q, mu = 0.5, sigma = 0.1, nu = 0.1, tau = 0.1,
       lower.tail = TRUE, log.p = FALSE)
pBEINF0(q, mu = 0.5, sigma = 0.1, nu = 0.1,
       lower.tail = TRUE, log.p = FALSE)
pBEINF1(q, mu = 0.5, sigma = 0.1, nu = 0.1,
        lower.tail = TRUE, log.p = FALSE)

qBEINF(p, mu = 0.5, sigma = 0.1, nu = 0.1, tau = 0.1,
       lower.tail = TRUE, log.p = FALSE)
qBEINF0(p, mu = 0.5, sigma = 0.1, nu = 0.1, tau = 0.1,
        lower.tail = TRUE, log.p = FALSE)
qBEINF1(p, mu = 0.5, sigma = 0.1, nu = 0.1,
        lower.tail = TRUE, log.p = FALSE)

rBEINF(n, mu = 0.5, sigma = 0.1, nu = 0.1, tau = 0.1)
rBEINF0(n, mu = 0.5, sigma = 0.1, nu = 0.1)
rBEINF1(n, mu = 0.5, sigma = 0.1, nu = 0.1)

plotBEINF(mu = 0.5, sigma = 0.5, nu = 0.5, tau = 0.5,
          from = 0.001, to = 0.999, n = 101, ...)
plotBEINF0(mu = 0.5, sigma = 0.5, nu = 0.5,
          from = 1e-04, to = 0.9999, n = 101, ...)
plotBEINF1(mu = 0.5, sigma = 0.5, nu = 0.5,
          from = 1e-04, to = 0.9999, n = 101, ...)

meanBEINF(obj)
meanBEINF0(obj)
meanBEINF1(obj)
```

Arguments

`mu.link`	the `mu` link function with default `logit`
`sigma.link`	the `sigma` link function with default `logit`
`nu.link`	the `nu` link function with default `log`
`tau.link`	the `tau` link function with default `log`
`x,q`	vector of quantiles
`mu`	vector of location parameter values
`sigma`	vector of scale parameter values
`nu`	vector of parameter values modelling the probability at zero

tau	vector of parameter values modelling the probability at one
log, log.p	logical; if TRUE, probabilities p are given as log(p).
lower.tail	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
p	vector of probabilities.
n	number of observations. If `length(n) > 1`, the length is taken to be the number required
from	where to start plotting the distribution from
to	up to where to plot the distribution
obj	a fitted `BEINF` object
...	other graphical parameters for plotting

Details

The beta inflated distribution is given as

$$f(y) = p_0$$

if (y=0)

$$f(y) = p_1$$

if (y=1)

$$f(y|\alpha, \beta) = \frac{1}{B(\alpha, \beta)} y^{\alpha-1}(1-y)^{\beta-1}$$

otherwise

for $y = (0, 1)$, $\alpha > 0$ and $\beta > 0$. The parametrization in the function `BEINF()` is $\mu = \frac{\alpha}{\alpha+\beta}$ and $\sigma = \frac{1}{\alpha+\beta+1}$ for $\mu = (0, 1)$ and $\sigma = (0, 1)$ and $\nu = \frac{p_0}{p_2}$, $\tau = \frac{p_1}{p_2}$ where $p_2 = 1 - p_0 - p_1$.

Value

returns a `gamlss.family` object which can be used to fit a beta inflated distribution in the `gamlss()` function. ...

Author(s)

Bob Rigby and Mikis Stasinopoulos

References

Ospina R. and Ferrari S. L. P. (2010) Inflated beta distributions, *Statistical Papers*, **23**, 111-126.

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Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

gamlss.family, BE, BEo, BEZI, BEOI

Examples

```
BEINF()# gives information about the default links for the beta inflated distribution
BEINF0()
BEINF1()
# plotting the distributions
op<-par(mfrow=c(2,2))
plotBEINF( mu =.5 , sigma=.5, nu = 0.5, tau = 0.5, from = 0, to=1, n = 101)
plotBEINF0( mu =.5 , sigma=.5, nu = 0.5,  from = 0, to=1, n = 101)
plotBEINF1( mu =.5 , sigma=.5, nu = 0.5,  from = 0.001, to=1, n = 101)
curve(dBE(x, mu =.5, sigma=.5),  0.01, 0.999)
par(op)
# plotting the cdf
op<-par(mfrow=c(2,2))
plotBEINF( mu =.5 , sigma=.5, nu = 0.5, tau = 0.5, from = 0, to=1, n = 101, main="BEINF")
plotBEINF0( mu =.5 , sigma=.5, nu = 0.5,  from = 0, to=1, n = 101, main="BEINF0")
plotBEINF1( mu =.5 , sigma=.5, nu = 0.5,  from = 0.001, to=1, n = 101, main="BEINF1")
curve(dBE(x, mu =.5, sigma=.5),  0.01, 0.999, main="BE")
par(op)
#---------------------------------------------
op<-par(mfrow=c(2,2))
plotBEINF( mu =.5 , sigma=.5, nu = 0.5, tau = 0.5, from = 0, to=1, n = 101, main="BEINF")
plotBEINF0( mu =.5 , sigma=.5, nu = 0.5,  from = 0, to=1, n = 101, main="BEINF0")
plotBEINF1( mu =.5 , sigma=.5, nu = 0.5,  from = 0.001, to=1, n = 101, main="BEINF1")
curve(dBE(x, mu =.5, sigma=.5),  0.01, 0.999, main="BE")
par(op)
#---------------------------------------------
op<-par(mfrow=c(2,2))
curve( pBEINF(x, mu=.5 ,sigma=.5, nu = 0.5, tau = 0.5,), 0, 1, ylim=c(0,1), main="BEINF" )
curve(pBEINF0(x, mu=.5 ,sigma=.5, nu = 0.5), 0, 1, ylim=c(0,1), main="BEINF0")
curve(pBEINF1(x, mu=.5 ,sigma=.5, nu = 0.5), 0, 1, ylim=c(0,1), main="BEINF1")
curve(    pBE(x, mu=.5 ,sigma=.5), .001, .99, ylim=c(0,1), main="BE")
par(op)
#---------------------------------------------
op<-par(mfrow=c(2,2))
curve(qBEINF(x, mu=.5 ,sigma=.5, nu = 0.5, tau = 0.5), .01, .99, main="BEINF" )
curve(qBEINF0(x, mu=.5 ,sigma=.5, nu = 0.5), .01, .99, main="BEINF0" )
curve(qBEINF1(x, mu=.5 ,sigma=.5, nu = 0.5), .01, .99, main="BEINF1" )
curve(qBE(x, mu=.5 ,sigma=.5), .01, .99 , main="BE")
par(op)

#---------------------------------------------
op<-par(mfrow=c(2,2))
hist(rBEINF(200, mu=.5 ,sigma=.5, nu = 0.5, tau = 0.5))
hist(rBEINF0(200, mu=.5 ,sigma=.5, nu = 0.5))
hist(rBEINF1(200, mu=.5 ,sigma=.5, nu = 0.5))
hist(rBE(200, mu=.5 ,sigma=.5))
par(op)
# fit a model to the data
```

```
# library(gamlss)
#m1<-gamlss(dat~1,family=BEINF)
#meanBEINF(m1)[1]
```

BEOI *The one-inflated beta distribution for fitting a GAMLSS*

Description

The function BEOI() defines the one-inflated beta distribution, a three parameter distribution, for a gamlss.family object to be used in GAMLSS fitting using the function gamlss(). The one-inflated beta is similar to the beta distribution but allows ones as y values. This distribution is an extension of the beta distribution using a parameterization of the beta law that is indexed by mean and precision parameters (Ferrari and Cribari-Neto, 2004). The extra parameter models the probability at one. The functions dBEOI, pBEOI, qBEOI and rBEOI define the density, distribution function, quantile function and random generation for the BEOI parameterization of the one-inflated beta distribution. plotBEOI can be used to plot the distribution. meanBEOI calculates the expected value of the response for a fitted model.

Usage

```
BEOI(mu.link = "logit", sigma.link = "log", nu.link = "logit")

dBEOI(x, mu = 0.5, sigma = 1, nu = 0.1, log = FALSE)

pBEOI(q, mu = 0.5, sigma = 1, nu = 0.1, lower.tail = TRUE, log.p = FALSE)

qBEOI(p, mu = 0.5, sigma = 1, nu = 0.1, lower.tail = TRUE,
        log.p = FALSE)

rBEOI(n, mu = 0.5, sigma = 1, nu = 0.1)

plotBEOI(mu = .5, sigma = 1, nu = 0.1, from = 0.001, to = 1, n = 101,
    ...)

meanBEOI(obj)
```

Arguments

mu.link	the mu link function with default logit
sigma.link	the sigma link function with default log
nu.link	the nu link function with default logit
x,q	vector of quantiles
mu	vector of location parameter values
sigma	vector of precision parameter values
nu	vector of parameter values modelling the probability at one

`log, log.p`	logical; if TRUE, probabilities p are given as log(p).
`lower.tail`	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
`p`	vector of probabilities.
`n`	number of observations. If `length(n) > 1`, the length is taken to be the number required
`from`	where to start plotting the distribution from
`to`	up to where to plot the distribution
`obj`	a fitted `BEOI` object
`...`	other graphical parameters for plotting

Details

The one-inflated beta distribution is given as

$$f(y) = \nu$$

if $(y = 1)$

$$f(y|\mu, \sigma) = (1-\nu)\frac{\Gamma(\sigma)}{\Gamma(\mu\sigma)\Gamma((1-\mu)\sigma)} y^{\mu\sigma}(1-y)^{((1-\mu)\sigma)-1}$$

if $y = (0, 1)$. The parameters satisfy $0 < \mu < 0$, $\sigma > 0$ and $0 < \nu < 1$.

Here $E(y) = \nu + (1-\nu)\mu$ and $Var(y) = (1-\nu)\frac{\mu(1-\mu)}{\sigma+1} + \nu(1-\nu)(1-\mu)^2$.

Value

returns a `gamlss.family` object which can be used to fit a one-inflated beta distribution in the `gamlss()` function.

Note

This work is part of my PhD project at the University of Sao Paulo under the supervion of Professor Silvia Ferrari. My thesis is concerned with regression modelling of rates and proportions with excess of zeros and/or ones

Author(s)

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References

Ferrari, S.L.P., Cribari-Neto, F. (2004). Beta regression for modelling rates and proportions. *Journal of Applied Statistics*, **31** (1), 799-815.

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See Also

gamlss.family, BEOI

Examples

```
BEOI()# gives information about the default links for the BEOI distribution
# plotting the distribution
plotBEOI( mu =0.5 , sigma=5, nu = 0.1, from = 0.001, to=1, n = 101)
# plotting the cdf
plot(function(y) pBEOI(y, mu=.5 ,sigma=5, nu=0.1), 0.001, 0.999)
# plotting the inverse cdf
plot(function(y) qBEOI(y, mu=.5 ,sigma=5, nu=0.1), 0.001, 0.999)
# generate random numbers
dat<-rBEOI(100, mu=.5, sigma=5, nu=0.1)
# fit a model to the data.
# library(gamlss)
#mod1<-gamlss(dat~1,sigma.formula=~1, nu.formula=~1, family=BEOI)
#fitted(mod1)[1]
#summary(mod1)
#fitted(mod1,"mu")[1]        #fitted mu
#fitted(mod1,"sigma")[1]     #fitted sigma
#fitted(mod1,"nu")[1]        #fitted nu
#meanBEOI(mod1)[1] # expected value of the response
```

BEZI *The zero-inflated beta distribution for fitting a GAMLSS*

Description

The function `BEZI()` defines the zero-inflated beta distribution, a three parameter distribution, for a `gamlss.family` object to be used in GAMLSS fitting using the function `gamlss()`. The zero-inflated beta is similar to the beta distribution but allows zeros as y values. This distribution is an extension of the beta distribution using a parameterization of the beta law that is indexed by mean and precision parameters (Ferrari and Cribari-Neto, 2004). The extra parameter models the probability at zero. The functions `dBEZI`, `pBEZI`, `qBEZI` and `rBEZI` define the density, distribution function, quantile function and random generation for the `BEZI` parameterization of the zero-inflated beta distribution. `plotBEZI` can be used to plot the distribution. `meanBEZI` calculates the expected value of the response for a fitted model.

Usage

```
BEZI(mu.link = "logit", sigma.link = "log", nu.link = "logit")

dBEZI(x, mu = 0.5, sigma = 1, nu = 0.1, log = FALSE)

pBEZI(q, mu = 0.5, sigma = 1, nu = 0.1, lower.tail = TRUE, log.p = FALSE)

qBEZI(p, mu = 0.5, sigma = 1, nu = 0.1, lower.tail = TRUE,
        log.p = FALSE)

rBEZI(n, mu = 0.5, sigma = 1, nu = 0.1)

plotBEZI(mu = .5, sigma = 1, nu = 0.1, from = 0, to = 0.999, n = 101,
    ...)

meanBEZI(obj)
```

Arguments

`mu.link`	the `mu` link function with default `logit`
`sigma.link`	the `sigma` link function with default `log`
`nu.link`	the `nu` link function with default `logit`
`x,q`	vector of quantiles
`mu`	vector of location parameter values
`sigma`	vector of precision parameter values
`nu`	vector of parameter values modelling the probability at zero
`log, log.p`	logical; if TRUE, probabilities p are given as log(p).
`lower.tail`	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
`p`	vector of probabilities.
`n`	number of observations. If `length(n) > 1`, the length is taken to be the number required
`from`	where to start plotting the distribution from
`to`	up to where to plot the distribution
`obj`	a fitted `BEZI` object
`...`	other graphical parameters for plotting

Details

The zero-inflated beta distribution is given as

$$f(y) = \nu$$

if $(y = 0)$

$$f(y|\mu,\sigma) = (1-\nu)\frac{\Gamma(\sigma)}{\Gamma(\mu\sigma)\Gamma((1-\mu)\sigma)}y^{\mu\sigma}(1-y)^{((1-\mu)\sigma)-1}$$

if $y = (0, 1)$. The parameters satisfy $0 < \mu < 0$, $\sigma > 0$ and $0 < \nu < 1$.

Here $E(y) = (1 - \nu)\mu$ and $Var(y) = (1 - \nu)\frac{\mu(1-\mu)}{\sigma+1} + \nu(1 - \nu)\mu^2$.

Value

returns a `gamlss.family` object which can be used to fit a zero-inflated beta distribution in the `gamlss()` function.

Note

This work is part of my PhD project at the University of Sao Paulo under the supervion of Professor Silvia Ferrari. My thesis is concerned with regression modelling of rates and proportions with excess of zeros and/or ones

Author(s)

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References

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Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

`gamlss.family`, `BEZI`

Examples

```
 BEZI()# gives information about the default links for the BEZI distribution
# plotting the distribution
plotBEZI( mu =0.5 , sigma=5, nu = 0.1, from = 0, to=0.99, n = 101)
# plotting the cdf
plot(function(y) pBEZI(y, mu=.5 ,sigma=5, nu=0.1), 0, 0.999)
# plotting the inverse cdf
plot(function(y) qBEZI(y, mu=.5 ,sigma=5, nu=0.1), 0, 0.999)
# generate random numbers
dat<-rBEZI(100, mu=.5, sigma=5, nu=0.1)
```

```
# fit a model to the data. Tits a constant for mu, sigma and nu
# library(gamlss)
#mod1<-gamlss(dat~1,sigma.formula=~1, nu.formula=~1, family=BEZI)
#fitted(mod1)[1]
#summary(mod1)
#fitted(mod1,"mu")[1]        #fitted mu
#fitted(mod1,"sigma")[1]     #fitted sigma
#fitted(mod1,"nu")[1]        #fitted nu
#meanBEZI(mod1)[1] # expected value of the response
```

BI *Binomial distribution for fitting a GAMLSS*

Description

The BI() function defines the binomial distribution, a one parameter family distribution, for a gamlss.family object to be used in GAMLSS fitting using the function gamlss(). The functions dBI, pBI, qBI and rBI define the density, distribution function, quantile function and random generation for the binomial, BI(), distribution.

Usage

```
BI(mu.link = "logit")
dBI(x, bd = 1, mu = 0.5, log = FALSE)
pBI(q, bd = 1, mu = 0.5, lower.tail = TRUE, log.p = FALSE)
qBI(p, bd = 1, mu = 0.5, lower.tail = TRUE, log.p = FALSE)
rBI(n, bd = 1, mu = 0.5)
```

Arguments

mu.link	Defines the mu.link, with "logit" link as the default for the mu parameter. Other links are "probit" and "cloglog"'(complementary log-log)
x	vector of (non-negative integer) quantiles
mu	vector of positive probabilities
bd	vector of binomial denominators
p	vector of probabilities
q	vector of quantiles
n	number of random values to return
log, log.p	logical; if TRUE, probabilities p are given as log(p)
lower.tail	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]

Details

Definition file for binomial distribution.

$$f(y|\mu) = \frac{\Gamma(n+1)}{\Gamma(y+1)\Gamma(n-y+1)}\mu^y(1-\mu)^{(n-y)}$$

for $y = 0, 1, 2, ..., n$ and $0 < \mu < 1$.

Value

returns a `gamlss.family` object which can be used to fit a binomial distribution in the `gamlss()` function.

Note

The response variable should be a matrix containing two columns, the first with the count of successes and the second with the count of failures. The parameter `mu` represents a probability parameter with limits $0 < \mu < 1$. $n\mu$ is the mean of the distribution where n is the binomial denominator.

Author(s)

Mikis Stasinopoulos, Bob Rigby and Calliope Akantziliotou

References

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See Also

`gamlss.family`, `ZABI`, `ZIBI`

Examples

```
 BI()# gives information about the default links for the Binomial distribution
# data(aep)
# library(gamlss)
# h<-gamlss(y~ward+loglos+year, family=BI, data=aep)
# plot of the binomial distribution
curve(dBI(x, mu = .5, bd=10), from=0, to=10, n=10+1, type="h")
tN <- table(Ni <- rBI(1000, mu=.2, bd=10))
r <- barplot(tN, col='lightblue')
```

checklink	*Set the Right Link Function for Specified Parameter and Distribution*

Description

This function is used within the distribution family specification of a GAMLSS model to define the right link for each of the parameters of the distribution. This function should not be called by the user unless he/she specify a new distribution family or wishes to change existing link functions in the parameters.

Usage

```
checklink(which.link = NULL, which.dist = NULL, link = NULL, link.List = NULL)
```

Arguments

`which.link`	which parameter link e.g. `which.link="mu.link"`
`which.dist`	which distribution family e.g. `which.dist="Cole.Green"`
`link`	a repetition of `which.link` e.g. `link=substitute(mu.link)`
`link.List`	what link function are required e.g. `link.List=c("inverse", "log", "identity")`

Value

Defines the right link for each parameter

Author(s)

Calliope Akantziliotou

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

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See Also

`gamlss.family`

DEL *The Delaporte distribution for fitting a GAMLSS model*

Description

The DEL() function defines the Delaporte distribution, a three parameter discrete distribution, for a gamlss.family object to be used in GAMLSS fitting using the function gamlss(). The functions dDEL, pDEL, qDEL and rDEL define the density, distribution function, quantile function and random generation for the Delaporte DEL(), distribution.

Usage

```
DEL(mu.link = "log", sigma.link = "log", nu.link = "logit")
dDEL(x, mu=1, sigma=1, nu=0.5, log=FALSE)
pDEL(q, mu=1, sigma=1, nu=0.5, lower.tail = TRUE,
        log.p = FALSE)
qDEL(p, mu=1, sigma=1, nu=0.5,  lower.tail = TRUE,
     log.p = FALSE,  max.value = 10000)
rDEL(n, mu=1, sigma=1, nu=0.5, max.value = 10000)
```

Arguments

mu.link	Defines the mu.link, with "log" link as the default for the mu parameter
sigma.link	Defines the sigma.link, with "log" link as the default for the sigma parameter
nu.link	Defines the nu.link, with "logit" link as the default for the nu parameter
x	vector of (non-negative integer) quantiles
mu	vector of positive mu
sigma	vector of positive dispersion parameter
nu	vector of nu
p	vector of probabilities
q	vector of quantiles
n	number of random values to return
log, log.p	logical; if TRUE, probabilities p are given as log(p)
lower.tail	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
max.value	a constant, set to the default value of 10000 for how far the algorithm should look for q

Details

The probability function of the Delaporte distribution is given by

$$f(y|\mu,\sigma,\nu) = \frac{e^{-\mu\nu}}{\Gamma(1/\sigma)} \left[1+\mu\sigma(1-\nu)\right]^{-1/\sigma} S$$

where

$$S = \sum_{j=0}^{y} \binom{y}{j} \frac{\mu^y \nu^{y-j}}{y!} \left[\mu + \frac{1}{\sigma(1-\nu)}\right]^{-j} \Gamma\left(\frac{1}{\sigma} + j\right)$$

for $y = 0, 1, 2, ..., \infty$ where $\mu > 0$, $\sigma > 0$ and $0 < \nu < 1$. This distribution is a parametrization of the distribution given by Wimmer and Altmann (1999) p 515-516 where $\alpha = \mu\nu$, $k = 1/\sigma$ and $\rho = [1 + \mu\sigma(1-\nu)]^{-1}$

Value

Returns a `gamlss.family` object which can be used to fit a Delaporte distribution in the `gamlss()` function.

Note

The mean of Y is given by $E(Y) = \mu$ and the variance by $V(Y) = \mu + \mu^2\sigma\left(1-\nu\right)^2$.

Author(s)

Rigby, R. A. and Stasinopoulos D. M.

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

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See Also

`gamlss.family`, `SI` , `SICHEL`

Examples

```
 DEL()# gives information about the default links for the  Delaporte distribution
#plot the pdf using plot
plot(function(y) dDEL(y, mu=10, sigma=1, nu=.5), from=0, to=100, n=100+1, type="h") # pdf
# plot the cdf
plot(seq(from=0,to=100),pDEL(seq(from=0,to=100), mu=10, sigma=1, nu=0.5), type="h")   # cdf
# generate random sample
tN <- table(Ni <- rDEL(100, mu=10, sigma=1, nu=0.5))
```

```
r <- barplot(tN, col='lightblue')
# fit a model to the data
# libary(gamlss)
# gamlss(Ni~1,family=DEL, control=gamlss.control(n.cyc=50))
```

EGB2 *The exponential generalized Beta type 2 distribution for fitting a GAMLSS*

Description

This function defines the generalized t distribution, a four parameter distribution. The response variable is in the range from minus infinity to plus infinity. The functions dEGB2, pEGB2, qEGB2 and rEGB2 define the density, distribution function, quantile function and random generation for the generalized beta type 2 distribution.

Usage

```
EGB2(mu.link = "identity", sigma.link = "identity", nu.link = "log",
      tau.link = "log")
dEGB2(x, mu = 0, sigma = 1, nu = 1, tau = 0.5, log = FALSE)
pEGB2(q, mu = 0, sigma = 1, nu = 1, tau = 0.5, lower.tail = TRUE,
      log.p = FALSE)
qEGB2(p, mu = 0, sigma = 1, nu = 1, tau = 0.5, lower.tail = TRUE,
      log.p = FALSE)
rEGB2(n, mu = 0, sigma = 1, nu = 1, tau = 0.5)
```

Arguments

mu.link	Defines the mu.link, with "identity" link as the default for the mu parameter.
sigma.link	Defines the sigma.link, with "log" link as the default for the sigma parameter.
nu.link	Defines the nu.link, with "log" link as the default for the nu parameter.
tau.link	Defines the tau.link, with "log" link as the default for the tau parameter.
x,q	vector of quantiles
mu	vector of location parameter values
sigma	vector of scale parameter values
nu	vector of skewness nu parameter values
tau	vector of kurtosis tau parameter values
log, log.p	logical; if TRUE, probabilities p are given as log(p).
lower.tail	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
p	vector of probabilities.
n	number of observations. If length(n) > 1, the length is taken to be the number required

Details

The probability density function of the Generalized Beta type 2, (GB2), is defined as

$$f(y|\mu, \sigma\, \nu, \tau) = e^{\nu z} \{|\sigma|\, B(\nu, \tau)\, [1 + e^{z}]^{\nu+\tau}\}^{-1}$$

for $-\infty < y < \infty$, where $z = (y - \mu)/\sigma$ and $-\infty < \mu < \infty$, $-\infty < \sigma < \infty$, $\nu > 0$ and $\tau > 0$, McDonald and Xu (1995).

Value

`EGB2()` returns a `gamlss.family` object which can be used to fit the EGB2 distribution in the `gamlss()` function. `dEGB2()` gives the density, `pEGB2()` gives the distribution function, `qEGB2()` gives the quantile function, and `rEGB2()` generates random deviates.

Author(s)

Bob Rigby <`r.rigby@londonmet.ac.uk`> and Mikis Stasinopoulos <`d.stasinopoulos@londonmet.ac.uk`>

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

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See Also

`gamlss.family`, `JSU`, `BCT`

Examples

```
EGB2()   #
y<- rEGB2(200, mu=5, sigma=2, nu=1, tau=4)
library(MASS)
truehist(y)
fx<-dEGB2(seq(min(y), 20, length=200), mu=5 ,sigma=2, nu=1, tau=4)
lines(seq(min(y),20,length=200),fx)
# something funny here
# library(gamlss)
# histDist(y, family=EGB2, n.cyc=60)
integrate(function(x) x*dEGB2(x=x, mu=5, sigma=2, nu=1, tau=4), -Inf, Inf)
curve(dEGB2(x, mu=5 ,sigma=2, nu=1, tau=4), -10, 10, main = "The EGB2  density mu=5, sigma=2, nu=1, tau=4")
```

exGAUS *The ex-Gaussian distribution*

Description

The ex-Gaussian distribution is often used by psychologists to model response time (RT). It is defined by adding two random variables, one from a normal distribution and the other from an exponential. The parameters mu and sigma are the mean and standard deviation from the normal distribution variable while the parameter nu is the mean of the exponential variable. The functions dexGAUS, pexGAUS, qexGAUS and rexGAUS define the density, distribution function, quantile function and random generation for the ex-Gaussian distribution.

Usage

```
exGAUS(mu.link = "identity", sigma.link = "log", nu.link = "log")
dexGAUS(x, mu = 5, sigma = 1, nu = 1, log = FALSE)
pexGAUS(q, mu = 5, sigma = 1, nu = 1, lower.tail = TRUE, log.p = FALSE)
qexGAUS(p, mu = 5, sigma = 1, nu = 1, lower.tail = TRUE, log.p = FALSE)
rexGAUS(n, mu = 5, sigma = 1, nu = 1, ...)
```

Arguments

mu.link	Defines the mu.link, with "identity" link as the default for the mu parameter.
sigma.link	Defines the sigma.link, with "log" link as the default for the sigma parameter.
nu.link	Defines the nu.link, with "log" link as the default for the nu parameter. Other links are "inverse", "identity", "logshifted" (shifted from one) and "own"
x,q	vector of quantiles
mu	vector of mu parameter values
sigma	vector of scale parameter values
nu	vector of nu parameter values
log, log.p	logical; if TRUE, probabilities p are given as log(p).
lower.tail	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
p	vector of probabilities.
n	number of observations. If length(n) > 1, the length is taken to be the number required
...	for extra arguments

Details

The probability density function of the ex-Gaussian distribution, (exGAUS), is defined as

$$f(y|\mu,\sigma,\nu) = \frac{1}{\nu} e^{\frac{\mu-y}{\nu}+\frac{\sigma^2}{2\nu^2}} \Phi(\frac{y-\mu}{\sigma} - \frac{\sigma}{\nu})$$

where Φ is the cdf of the standard normal distribution, for $-\infty < y < \infty$, $-\infty < \mu < \infty$, $\sigma > 0$ and $\nu > 0$.

Value

`exGAUS()` returns a `gamlss.family` object which can be used to fit ex-Gaussian distribution in the `gamlss()` function. `dexGAUS()` gives the density, `pexGAUS()` gives the distribution function, `qexGAUS()` gives the quantile function, and `rexGAUS()` generates random deviates.

Note

The mean of the ex-Gaussian is $\mu + \nu$ and the variance is $\sigma^2 + \nu^2$.

Author(s)

Mikis Stasinopoulos and Bob Rigby

References

Cousineau, D. Brown, S. and Heathecote A. (2004) Fitting distributions using maximum likelihood: Methods and packages, *Behavior Research Methods, Instruments and Computers*, **46**, 742-756.

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See Also

`gamlss.family`, `BCCG`, `GA`, `IG` `LNO`

Examples

```
exGAUS()   #
y<- rexGAUS(100, mu=300, nu=100, sigma=35)
hist(y)
# library(gamlss)
# m1<-gamlss(y~1, family=exGAUS)
# plot(m1)
curve(dexGAUS(x, mu=300 ,sigma=35,nu=100), 100, 600,
 main = "The ex-GAUS  density mu=300 ,sigma=35,nu=100")
plot(function(x) pexGAUS(x, mu=300,sigma=35,nu=100), 100, 600,
 main = "The ex-GAUS  cdf mu=300, sigma=35, nu=100")
```

EXP *Exponential distribution for fitting a GAMLSS*

Description

The function EXP defines the exponential distribution, a one parameter distribution for a `gamlss.family` object to be used in GAMLSS fitting using the function `gamlss()`. The `mu` parameter represents the mean of the distribution. The functions `dEXP`, `pEXP`, `qEXP` and `rEXP` define the density, distribution function, quantile function and random generation for the specific parameterization of the exponential distribution defined by function EXP.

Usage

```
EXP(mu.link ="log")
dEXP(x, mu = 1, log = FALSE)
pEXP(q, mu = 1, lower.tail = TRUE, log.p = FALSE)
qEXP(p, mu = 1, lower.tail = TRUE, log.p = FALSE)
rEXP(n, mu = 1)
```

Arguments

`mu.link`	Defines the mu.link, with "log" link as the default for the `mu` parameter, other links are "inverse" and "identity"
`x,q`	vector of quantiles
`mu`	vector of location parameter values
`log, log.p`	logical; if TRUE, probabilities p are given as log(p).
`lower.tail`	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
`p`	vector of probabilities
`n`	number of observations. If length(n) > 1, the length is taken to be the number required

Details

The specific parameterization of the exponential distribution used in EXP is

$$f(y|\mu) = \frac{1}{\mu} \exp\left\{-\frac{y}{\mu}\right\}$$

, for y>0, $\mu > 0$.

Value

EXP() returns a gamlss.family object which can be used to fit an exponential distribution in the gamlss() function. dEXP() gives the density, pEXP() gives the distribution function, qEXP() gives the quantile function, and rEXP() generates random deviates.

Author(s)

Mikis Stasinopoulos <d.stasinopoulos@londonmet.ac.uk>, Bob Rigby <r.rigby@londonmet.ac.uk> and Nicoleta Motpan

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

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See Also

gamlss.family

Examples

```
y<-rEXP(1000,mu=1) # generates 1000 random observations
hist(y)
# library(gamlss)
# histDist(y, family=EXP)
```

GA *Gamma distribution for fitting a GAMLSS*

Description

The function GA defines the gamma distribution, a two parameter distribution, for a gamlss.family object to be used in GAMLSS fitting using the function gamlss(). The parameterization used has the mean of the distribution equal to μ and the variance equal to $\sigma^2\mu^2$. The functions dGA, pGA, qGA and rGA define the density, distribution function, quantile function and random generation for the specific parameterization of the gamma distribution defined by function GA.

Usage

```
GA(mu.link = "log", sigma.link ="log")
dGA(x, mu = 1, sigma = 1, log = FALSE)
pGA(q, mu = 1, sigma = 1, lower.tail = TRUE, log.p = FALSE)
qGA(p, mu = 1, sigma = 1, lower.tail = TRUE, log.p = FALSE)
rGA(n, mu = 1, sigma = 1)
```

Arguments

`mu.link`	Defines the `mu.link`, with "log" link as the default for the mu parameter, other links are "inverse", "identity" ans "own"
`sigma.link`	Defines the `sigma.link`, with "log" link as the default for the sigma parameter, other link is the "inverse", "identity" and "own"
`x,q`	vector of quantiles
`mu`	vector of location parameter values
`sigma`	vector of scale parameter values
`log, log.p`	logical; if TRUE, probabilities p are given as log(p).
`lower.tail`	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
`p`	vector of probabilities.
`n`	number of observations. If `length(n) > 1`, the length is taken to be the number required

Details

The specific parameterization of the gamma distribution used in `GA` is

$$f(y|\mu,\sigma) = \frac{y^{(1/\sigma^2-1)} \exp[-y/(\sigma^2\mu)]}{(\sigma^2\mu)^{(1/\sigma^2)}\Gamma(1/\sigma^2)}$$

for $y > 0$, $\mu > 0$ and $\sigma > 0$.

Value

`GA()` returns a `gamlss.family` object which can be used to fit a gamma distribution in the `gamlss()` function. `dGA()` gives the density, `pGA()` gives the distribution function, `qGA()` gives the quantile function, and `rGA()` generates random deviates. The latest functions are based on the equivalent `R` functions for gamma distribution.

Note

μ is the mean of the distribution in `GA`. In the function `GA`, σ is the square root of the usual dispersion parameter for a GLM gamma model. Hence $\sigma\mu$ is the standard deviation of the distribution defined in `GA`.

Author(s)

Mikis Stasinopoulos <`d.stasinopoulos@londonmet.ac.uk`>, Bob Rigby <`r.rigby@londonmet.ac.uk`> and Calliope Akantziliotou

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

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See Also

gamlss.family

Examples

```
GA()# gives information about the default links for the gamma distribution
# dat<-rgamma(100, shape=1, scale=10) # generates 100 random observations
# fit a gamlss model
# gamlss(dat~1,family=GA)
# fits a constant for each parameter mu and sigma of the gamma distribution
newdata<-rGA(1000,mu=1,sigma=1) # generates 1000 random observations
hist(newdata)
rm(dat,newdata)
```

---

gamlss.family   *Family Objects for fitting a GAMLSS model*

Description

GAMLSS families are the current available distributions that can be fitted using the `gamlss()` function.

Usage

```
gamlss.family(object,...)
as.gamlss.family(object)
as.family(object)
## S3 method for class 'gamlss.family'
print(x,...)
```

Arguments

object	a gamlss family object e.g. BCT
x	a gamlss family object e.g. BCT
...	further arguments passed to or from other methods.

Details

There are several distributions available for the response variable in the gamlss function. The following table display their names and their abbreviations in R. Note that the different distributions can be fitted using their R abbreviations (and optionally excluding the brackets) i.e. family=BI(), family=BI are equivalent.

Distributions	**R names**	**No of parameters**
Beta	BE()	2
Beta Binomial	BB()	2
Beta one inflated	BEOI()	3
Beta zero inflated	BEZI()	3
Beta inflated	BEINF()	4
Binomial	BI()	1
Box-Cox Cole and Green	BCCG()	3
Box-Cox Power Exponential	BCPE()	4
Box-Cox-t	BCT()	4
Delaport	DEL()	3
Exponential	EXP()	1
Exponential Gaussian	exGAUS()	3
Exponential generalized Beta type 2	EGB2()	4
Gamma	GA()	2
Generalized Beta type 1	GB1()	4
Generalized Beta type 2	GB2()	4
Generalized Gamma	GG()	3
Generalized Inverse Gaussian	GIG()	3
Generalized t	GT()	4
Geometric	GEOM()	1
Gumbel	GU()	2
Inverse Gamma	IGAMMA()	2
Inverse Gaussian	IG()	2
Johnson's SU	JSU()	4
Logarithmic	LG()	1
Logistic	LO()	2
log-Normal	LOGNO()	2
log-Normal (Box-Cox)	LNO()	3 (1 fixed)
Negative Binomial type I	NBI()	2
Negative Binomial type II	NBII()	2
Normal Exponential t	NET()	4 (2 fixed)
Normal	NO()	2
Normal Family	NOF()	3 (1 fixed)
Pareto type 2	PARETO2()	2
Pareto type 2 original	PARETO2o()	2
Power Exponential	PE()	3
Power Exponential type 2	PE2()	3
Poison	PO()	1
Poisson inverse Gaussian	PIG()	2
Reverse generalized extreme	RGE()	3
Reverse Gumbel	RG()	2

Skew Power Exponential type 1	SEP1()	4
Skew Power Exponential type 2	SEP2()	4
Skew Power Exponential type 3	SEP3()	4
Skew Power Exponential type 4	SEP4()	4
Shash	SHASH()	4
Shash original	SHASHo()	4
Shash original 2	SHASH()	4
Sichel (original)	SI()	3
Sichel (mu as the maen)	SICHEL()	3
Skew t type 1	ST1()	3
Skew t type 2	ST2()	3
Skew t type 3	ST3()	3
Skew t type 4	ST4()	3
Skew t type 5	ST5()	3
t-distribution	TF()	3
Waring	WARING()	1
Weibull	WEI()	2
Weibull(PH parameterization)	WEI2()	2
Weibull (mu as mean)	WEI3()	2
Yule	YULE()	1
Zero adjusted binomial	ZABI()	2
Zero inflated binomial	ZIBI()	2
Zero adjusted logarithmic	ZALG()	2
Zero inflated poisson	ZIP()	2
Zero inf. poiss.(mu as mean)	ZIP2()	2
Zero adjusted poisson	ZAP()	2
Zero adjusted IG	ZAIG()	2

Note that some of the distributions are in the package `gamlss.dist`. The parameters of the distributions are in order, `mu` for location, `sigma` for scale (or dispersion), and `nu` and `tau` for shape. More specifically for the `BCCG` family `mu` is the median, `sigma` approximately the coefficient of variation, and `nu` the skewness parameter. The parameters for `BCPE` distribution have the same interpretation with the extra fourth parameter `tau` modelling the kurtosis of the distribution. The parameters for BCT have the same interpretation except that $\sigma[(\tau/(\tau-2))^{0.5}]$ is approximately the coefficient of variation.

All of the distribution in the above list are also provided with the corresponding `d`, `p`, `q` and `r` functions for density (pdf), distribution function (cdf), quantile function and random generation function respectively, (see individual distribution for details).

Value

The above GAMLSS families return an object which is of type `gamlss.family`. This object is used to define the family in the `gamlss()` fit.

Note

More distributions will be documented in later GAMLSS releases. Further user defined distributions can be incorporate relatively easy, see, for example, the help documentation accompanying the gamlss library.

Author(s)

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References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

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See Also

BE,BB,BEINF,BI,LNO,BCT, BCPE,BCCG, GA,GU,JSU,IG,LO, NBI,NBII,NO,PE,PO, RG,PIG,TF,WEI,WEI2, ZIP

Examples

```
normal<-NO(mu.link="log", sigma.link="log")
normal
```

GB1 *The generalized Beta type 1 distribution for fitting a GAMLSS*

Description

This function defines the generalized beta type 1 distribution, a four parameter distribution. The function GB1 creates a gamlss.family object which can be used to fit the distribution using the function gamlss(). Note the range of the response variable is from zero to one. The functions dGB1, GB1, qGB1 and rGB1 define the density, distribution function, quantile function and random generation for the generalized beta type 1 distribution.

Usage

```
GB1(mu.link = "logit", sigma.link = "logit", nu.link = "log",
      tau.link = "log")
dGB1(x, mu = 0.5, sigma = 0.4, nu = 1, tau = 1, log = FALSE)
pGB1(q, mu = 0.5, sigma = 0.4, nu = 1, tau = 1, lower.tail = TRUE,
       log.p = FALSE)
qGB1(p, mu = 0.5, sigma = 0.4, nu = 1, tau = 1, lower.tail = TRUE,
       log.p = FALSE)
rGB1(n, mu = 0.5, sigma = 0.4, nu = 1, tau = 1)
```

Arguments

mu.link	Defines the `mu.link`, with "identity" link as the default for the `mu` parameter.
sigma.link	Defines the `sigma.link`, with "log" link as the default for the `sigma` parameter.
nu.link	Defines the `nu.link`, with "log" link as the default for the `nu` parameter.
tau.link	Defines the `tau.link`, with "log" link as the default for the `tau` parameter.
x,q	vector of quantiles
mu	vector of location parameter values
sigma	vector of scale parameter values
nu	vector of skewness `nu` parameter values
tau	vector of kurtosis `tau` parameter values
log, log.p	logical; if TRUE, probabilities p are given as log(p).
lower.tail	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
p	vector of probabilities.
n	number of observations. If `length(n) > 1`, the length is taken to be the number required

Details

The probability density function of the Generalized Beta type 1, (`GB1`), is defined as

$$f(y|\mu, \sigma\, \nu, \tau) = \frac{\tau \nu^{\beta} y^{\tau\alpha-1}(1-y^{\tau})^{\beta-1}}{B(\alpha,\beta)[\nu+(1-\nu)y^{\tau}]^{\alpha+\beta}}$$

where $0 < y < 1$, $\alpha = \mu(1-\sigma^2)/\sigma^2$ and $\beta = (1-\mu)(1-\sigma^2)/\sigma^2$, and $\alpha > 0$, $\beta > 0$. Note the $\mu = \alpha/(\alpha+\beta)$, $\sigma = (\alpha+\beta+1)^{-1/2}$. .

Value

`GB1()` returns a `gamlss.family` object which can be used to fit the GB1 distribution in the `gamlss()` function. `dGB1()` gives the density, `pGB1()` gives the distribution function, `qGB1()` gives the quantile function, and `rGB1()` generates random deviates.

Warning

The qSHASH and rSHASH are slow since they are relying on golden section for finding the quantiles

Author(s)

Bob Rigby <r.rigby@londonmet.ac.uk> and Mikis Stasinopoulos <d.stasinopoulos@londonmet.ac.uk>

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

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Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

gamlss.family, JSU, BCT

Examples

```
GB1()   #
y<- rGB1(200, mu=.1, sigma=.6, nu=1, tau=4)
hist(y)
# library(gamlss)
# histDist(y, family=GB1, n.cyc=60)
curve(dGB1(x, mu=.1 ,sigma=.6, nu=1, tau=4), 0.01, 0.99, main = "The GB1  density mu=0.1, sigma=.6, nu=1, tau=
```

GB2 *The generalized Beta type 2 and generalized Pareto distributions for fitting a GAMLSS*

Description

This function defines the generalized beta type 2 distribution, a four parameter distribution. The function GB2 creates a gamlss.family object which can be used to fit the distribution using the function gamlss(). The response variable is in the range from zero to infinity. The functions dGB2, GB2, qGB2 and rGB2 define the density, distribution function, quantile function and random generation for the generalized beta type 2 distribution. The generalised Pareto GP distribution is defined by setting the parameters sigma and nu of the GB2 distribution to 1.

Usage

```
GB2(mu.link = "log", sigma.link = "identity", nu.link = "log",
     tau.link = "log")
dGB2(x, mu = 1, sigma = 1, nu = 1, tau = 0.5, log = FALSE)
pGB2(q, mu = 1, sigma = 1, nu = 1, tau = 0.5, lower.tail = TRUE,
     log.p = FALSE)
qGB2(p, mu = 1, sigma = 1, nu = 1, tau = 0.5, lower.tail = TRUE,
     log.p = FALSE)
rGB2(n, mu = 1, sigma = 1, nu = 1, tau = 0.5)
```

```
GP(mu.link = "log", sigma.link = "log")
dGP(x, mu = 1, sigma = 1, log = FALSE)
pGP(q, mu = 1, sigma = 1, lower.tail = TRUE, log.p = FALSE)
qGP(p, mu = 1, sigma = 1, lower.tail = TRUE, log.p = FALSE)
rGP(n, mu = 1, sigma = 1)
```

Arguments

`mu.link`	Defines the `mu.link`, with "identity" link as the default for the `mu` parameter.
`sigma.link`	Defines the `sigma.link`, with "log" link as the default for the `sigma` parameter.
`nu.link`	Defines the `nu.link`, with "log" link as the default for the `nu` parameter.
`tau.link`	Defines the `tau.link`, with "log" link as the default for the `tau` parameter.
`x,q`	vector of quantiles
`mu`	vector of location parameter values
`sigma`	vector of scale parameter values
`nu`	vector of skewness `nu` parameter values
`tau`	vector of kurtosis `tau` parameter values
`log, log.p`	logical; if TRUE, probabilities p are given as log(p).
`lower.tail`	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
`p`	vector of probabilities.
`n`	number of observations. If `length(n) > 1`, the length is taken to be the number required

Details

The probability density function of the Generalized Beta type 2, (`GB2`), is defined as

$$f(y|\mu, \sigma\, \nu, \tau) = |\sigma| y^{\sigma v-1} \{\mu^{\sigma\nu}\, B(\nu,\tau)\, [1 + (y/\mu)^{\sigma}]^{\nu+\tau}\}^{-1}$$

where $y > 0$, $\mu > 0$, $-\infty < \sigma < \infty$, $\nu > 0$ and $\tau > 0$. .

Value

`GB2()` returns a `gamlss.family` object which can be used to fit the GB2 distribution in the `gamlss()` function. `dGB2()` gives the density, `pGB2()` gives the distribution function, `qGB2()` gives the quantile function, and `rGB2()` generates random deviates.

Warning

The qSHASH and rSHASH are slow since they are relying on golden section for finding the quantiles

Author(s)

Bob Rigby <r.rigby@londonmet.ac.uk> and Mikis Stasinopoulos <d.stasinopoulos@londonmet.ac.uk>

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

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See Also

gamlss.family, JSU, BCT

Examples

```
GB2()   #
y<- rGB2(200, mu=5, sigma=2, nu=1, tau=1)
library(MASS)
truehist(y)
fx<-dGB2(seq(0.01, 20, length=200), mu=5 ,sigma=2, nu=1, tau=1)
lines(seq(0.01,20,length=200),fx)
integrate(function(x) x*dGB2(x=x, mu=5, sigma=2, nu=1, tau=1), 0, Inf)
mean(y)
curve(dGB2(x, mu=5 ,sigma=2, nu=1, tau=1), 0.01, 20, main = "The GB2  density mu=5, sigma=2, nu=1, tau=4")
```

GE *Geometric distribution for fitting a GAMLSS*

Description

The function GE() defines the Yule distribution, a one parameter distribution, for a gamlss.family object to be used in GAMLSS fitting using the function gamlss(), with mean equal to the parameter mu. The functions dGE, pGE, qGE and rGE define the density, distribution function, quantile function and random generation for the GE parameterization of the Geometric distribution.

Usage

```
GE(mu.link = "log")
dGE(x, mu = 2, log = FALSE)
pGE(q, mu = 2, lower.tail = TRUE, log.p = FALSE)
qGE(p, mu = 2, lower.tail = TRUE, log.p = FALSE, max.value=10000)
rGE(n, mu = 2)
```

Arguments

`mu.link`	Defines the `mu.link`, with "log" link as the default for the mu parameter
`x, q`	vector of quantiles
`mu`	vector of location parameter values
`log, log.p`	logical; if TRUE, probabilities p are given as log(p)
`lower.tail`	logical; if TRUE (default), probabilities are P[X <= x], otherwise P[X > x]
`p`	vector of probabilities
`n`	number of observations. If `length(n) > 1`, the length is taken to be the number required
`max.value`	constant; generates a sequence of values for the cdf function

Details

The parameterization of the Geometric distribution in the function `GE` is

$$f(y|mu) = (1-p)^y p$$

where $p = 1/(mu + 1)$ for $y >= 0$ and $mu > 0$.

Value

returns a gamlss.family object which can be used to fit a Geometric distribution in the `gamlss()` function.

Author(s)

Bob Rigby <`r.rigby@londonmet.ac.uk`>, Mikis Stasinopoulos <`d.stasinopoulos@londonmet.ac.uk`>, Fiona McElduff <`F.Mcelduff@londonmet.ac.uk`> and Kalliope Akantziliotou

References

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Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. 23, Issue 7, Dec 2007, `http://www.jstatsoft.org/v23/i07`.

See Also

`gamlss.family`

Examples

```
par(mfrow=c(2,2))
y<-seq(0,20,1)
plot(y, dGE(y), type="h")
q <- seq(0, 20, 1)
plot(q, pGE(q), type="h")
p<-seq(0.0001,0.999,0.05)
plot(p , qGE(p), type="s")
dat <- rGE(100)
hist(dat)
#summary(gamlss(dat~1, family="GE"))
```

`gen.Family` *Functions to generate log and logit distributions from existing continuous gamlss.family distributions*

Description

There are five functions here. Only the functions `Family` and `gen.Family` should be used (see details).

Usage

```
Family.d(family = "NO", type = c("log", "logit"), ...)
Family.p(family = "NO", type = c("log", "logit"), ...)
Family.q(family = "NO", type = c("log", "logit"), ...)
Family.r(family = "NO", type = c("log", "logit"), ...)
Family(family = "NO", type = c("log", "logit"), local = TRUE, ...)
gen.Family(family = "NO", type = c("log", "logit"), ...)
```

Arguments

`family`	a continuous `gamlss.family` distribution
`type`	the type of transformation only "log" and "logit" are allowed
`local`	It is TRUE if is called within `gamlss()` otherwise is FALSE
`...`	for passing extra arguments

Details

The function `gen.Family` creates the standard `d,p,q,r` functions for the distribution plus the fitting `gamlss.family`. For example `gen.Family("NO", "logit")` will generate the functions `dlogitNO()`, `plogitNO()` , `qlogitNO()` , `rlogitNO()` and `dlogitNO()`. The latest function can be used in `family` argument of `gamlss()` to fit a logic-Normal distribution i.e. `family=logitNO`. The same fitting can be achieved by using `family=Family("NO", "logit")`. Here the required `dlogitNO()`, `plogitNO()` and `logitNO()` functions are generated locally within the `gamlss()` environment.

Value

The function gen.Family returns the d, p, q r functions plus the fitting function.

Author(s)

Mikis Stasinopoulos <d.stasinopoulos@londonmet.ac.uk> and Bob Rigby <r.rigby@londonmet.ac.uk>

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

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Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

Examples

```
# generating a log t distribution
gen.Family("TF")
# plotting the d, p, q, and r functions
op<-par(mfrow=c(2,2))
curve(dlogTF(x, mu=0), 0, 10)
curve(plogTF(x, mu=0), 0, 10)
curve(qlogTF(x, mu=0), 0, 1)
Y<- rlogTF(200)
hist(Y)
par(op)


# different mu
curve(dlogTF(x, mu=-1, sigma=1, nu=10), 0, 5, ylim=c(0,1))
curve(dlogTF(x, mu=0, sigma=1, nu=10), 0,  5, add=TRUE, col="red", lty=2)
curve(dlogTF(x, mu=1, sigma=1, nu=10), 0, 5, add=TRUE, col="blue", lty=3)

# different sigma
curve(dlogTF(x, mu=0, sigma=.5, nu=10), 0, 5, ylim=c(0,1))
curve(dlogTF(x, mu=0, sigma=1, nu=10), 0, 5, add=TRUE, col="red", lty=2)
curve(dlogTF(x, mu=0, sigma=2, nu=10), 0, 5, add=TRUE, col="blue", lty=3)

# different degrees of freedom nu
curve(dlogTF(x,  mu=0, sigma=1, nu=1), 0, 5, ylim=c(0,.8), n = 1001)
curve(dlogTF(x,  mu=0, sigma=1, nu=2), 0, 5, add=TRUE, col="red", lty=2)
curve(dlogTF(x,  mu=0, sigma=1, nu=5), 0, 5, add=TRUE, col="blue", lty=3)


# generating a logit t distribution
gen.Family("TF", "logit")
```

```
# plotting the d, p, q, and r functions
op<-par(mfrow=c(2,2))
curve(dlogitTF(x, mu=0), 0, 1)
curve(plogitTF(x, mu=0), 0, 1)
curve(qlogitTF(x, mu=0), 0, 1)
abline(v=1)
Y<- rlogitTF(200)
hist(Y)
par(op)


# different mu
curve(dlogitTF(x, mu=-2, sigma=1, nu=10), 0, 1, ylim=c(0,5))
curve(dlogitTF(x, mu=0, sigma=1, nu=10), 0, 1, add=TRUE, col="red", lty=2)
curve(dlogitTF(x, mu=2, sigma=1, nu=10), 0, 1, add=TRUE, col="blue", lty=3)

# different sigma
curve(dlogitTF(x, mu=0, sigma=1, nu=10), 0, 1, ylim=c(0,2.5))
curve(dlogitTF(x, mu=0, sigma=2, nu=10), 0, 1, add=TRUE, col="red", lty=2)
curve(dlogitTF(x, mu=0, sigma=.7, nu=10), 0, 1, add=TRUE, col="blue", lty=3)

# different degrees of freedom nu
curve(dlogitTF(x,  mu=0, sigma=1, nu=1), 0, 1, ylim=c(0,1.6))
curve(dlogitTF(x,  mu=0, sigma=1, nu=2), 0, 1, add=TRUE, col="red", lty=2)
curve(dlogitTF(x,  mu=0, sigma=1, nu=5), 0, 1, add=TRUE, col="blue", lty=3)
```

GEOM *Geometric distribution for fitting a GAMLSS model*

Description

The function GEOM() defines the Geometric distribution, a one parameter distribution, for a gamlss.family object to be used in GAMLSS fitting using the function gamlss(), with mean equal to the parameter mu. The functions dGEOM, pGEOM, qGEOM and rGEOM define the density, distribution function, quantile function and random generation for the GEOM parameterization of the Geometric distribution.

Usage

```
GEOM(mu.link = "log")
dGEOM(x, mu = 2, log = FALSE)
pGEOM(q, mu = 2, lower.tail = TRUE, log.p = FALSE)
qGEOM(p, mu = 2, lower.tail = TRUE, log.p = FALSE, max.value=10000)
rGEOM(n, mu = 2)
```

Arguments

mu.link	Defines the mu.link, with log link as the default for the mu parameter

`x, q`	vector of quantiles
`mu`	vector of location parameter values
`log, log.p`	logical; if TRUE, probabilities p are given as log(p)
`lower.tail`	logical; if TRUE (default), probabilities are P[X <= x], otherwise P[X > x]
`p`	vector of probabilities
`n`	number of observations. If `length(n) > 1`, the length is taken to be the number required
`max.value`	constant; generates a sequence of values for the cdf function.

Details

The parameterization of the Geometric distribution in the function `GEOM` is

$$f(y|\mu) = (1-p)^y \, p$$

where $p = 1/(mu + 1)$ for $y >= 0$ and $mu > 0$.

Value

returns a `gamlss.family` object which can be used to fit a Geometric distribution in the `gamlss()` function.

Author(s)

Fiona McElduff, Bob Rigby and Mikis Stasinopoulos.

References

Johnson, N. L., Kemp, A. W., and Kotz, S. (2005). *Univariate discrete distributions.* Wiley.

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, 54, part 3, pp 507-554.

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Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. 23, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

`gamlss.family`

Examples

```
par(mfrow=c(2,2))
y<-seq(0,20,1)
plot(y, dGEOM(y), type="h")
q <- seq(0, 20, 1)
plot(q, pGEOM(q), type="h")
p<-seq(0.0001,0.999,0.05)
plot(p , qGEOM(p), type="s")
dat <- rGEOM(100)
hist(dat)
#summary(gamlss(dat~1, family=GEOM))
```

GG *Generalized Gamma distribution for fitting a GAMLSS*

Description

The function GG defines the generalized gamma distribution, a three parameter distribution, for a gamlss.family object to be used in GAMLSS fitting using the function gamlss(). The parameterization used has the mean of the distribution equal to mu and the variance equal to $(\sigma^2)(\mu^2)$. The functions dGG, pGG, qGG and rGG define the density, distribution function, quantile function and random generation for the specific parameterization of the generalized gamma distribution defined by function GG.

Usage

```
GG(mu.link = "log", sigma.link = "log",
                       nu.link = "identity")
dGG(x, mu=1, sigma=0.5, nu=1,
                      log = FALSE)
pGG(q, mu=1, sigma=0.5, nu=1,  lower.tail = TRUE,
                     log.p = FALSE)
qGG(p, mu=1, sigma=0.5, nu=1,  lower.tail = TRUE,
                     log.p = FALSE )
rGG(n, mu=1, sigma=0.5, nu=1)
```

Arguments

mu.link	Defines the mu.link, with "log" link as the default for the mu parameter, other links are "inverse" and "identity"
sigma.link	Defines the sigma.link, with "log" link as the default for the sigma parameter, other links are "inverse" and "identity"
nu.link	Defines the nu.link, with "identity" link as the default for the sigma parameter, other links are $1/nu^2$ and "log"
x,q	vector of quantiles
mu	vector of location parameter values

`sigma`	vector of scale parameter values
`nu`	vector of shape parameter values
`log, log.p`	logical; if TRUE, probabilities p are given as log(p).
`lower.tail`	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
`p`	vector of probabilities
`n`	number of observations. If length(n) > 1, the length is taken to be the number required

Details

The specific parameterization of the generalized gamma distribution used in GG is

$$f(y|\mu,\sigma,\nu) = \frac{\theta^{\theta} z^{\theta} \nu e^{(} - \theta z)}{(\Gamma(\theta) y)}$$

where $z = (y/\mu)^{\nu}$, $\theta = 1/(\sigma^2 |\nu|^2)$ for y>0, $\mu > 0$, $\sigma > 0$ and $-\infty < \nu < +\infty$. Note that for $\nu = 0$ the distribution is log normal.

Value

GG() returns a gamlss.family object which can be used to fit a generalized gamma distribution in the gamlss() function. dGG() gives the density, pGG() gives the distribution function, qGG() gives the quantile function, and rGG() generates random deviates.

Author(s)

Mikis Stasinopoulos d.stasinopoulos@londonmet.ac.uk, Bob Rigby r.rigby@londonmet.ac.uk and Nicoleta Motpan

References

Lopatatzidis, A. and Green, P. J. (2000), Nonparametric quantile regression using the gamma distribution, unpublished.

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Stasinopoulos D. M., Rigby R.A. and Akantziliotou C. (2006) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.com/).

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

gamlss.family, GA

Examples

```
y<-rGG(100,mu=1,sigma=0.1, nu=-.5) # generates 100 random observations
hist(y)
# library(gamlss)
#histDist(y, family=GG)
#m1 <-gamlss(y~1,family=GG)
#prof.dev(m1, "nu", min=-2, max=2, step=0.2)
```

GIG *Generalized Inverse Gaussian distribution for fitting a GAMLSS*

Description

The function GIG defines the generalized inverse gaussian distribution, a three parameter distribution, for a `gamlss.family` object to be used in GAMLSS fitting using the function `gamlss()`. The functions `DIG`, `pGIG`, `GIG` and `rGIG` define the density, distribution function, quantile function and random generation for the specific parameterization of the generalized inverse gaussian distribution defined by function GIG.

Usage

```
GIG(mu.link = "log", sigma.link = "log",
                        nu.link = "identity")
dGIG(x, mu=1, sigma=1, nu=1,
                       log = FALSE)
pGIG(q, mu=1, sigma=1, nu=1,  lower.tail = TRUE,
                       log.p = FALSE)
qGIG(p, mu=1, sigma=1, nu=1,  lower.tail = TRUE,
                       log.p = FALSE)
rGIG(n, mu=1, sigma=1, nu=1, ...)
```

Arguments

`mu.link`	Defines the mu.link, with "log" link as the default for the `mu` parameter, other links are "inverse" and "identity"
`sigma.link`	Defines the sigma.link, with "log" link as the default for the `sigma` parameter, other links are "inverse" and "identity"
`nu.link`	Defines the nu.link, with "identity" link as the default for the `nu` parameter, other links are "inverse" and "log"
`x,q`	vector of quantiles
`mu`	vector of location parameter values
`sigma`	vector of scale parameter values
`nu`	vector of shape parameter values
`log, log.p`	logical; if TRUE, probabilities p are given as log(p).
`lower.tail`	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]

p	vector of probabilities
n	number of observations. If length(n) > 1, the length is taken to be the number required
...	for extra arguments

Details

The specific parameterization of the generalized inverse gaussian distribution used in GIG is $f(y|\mu,\sigma,\nu) = (\frac{c}{\mu})^{\nu}(\frac{y^(\nu-1)}{2K(\frac{1}{\sigma},\nu)})(\exp((\frac{-1}{2\sigma})(\frac{cy}{\mu}+\frac{\mu}{cy})))$ where $c = \frac{K(\frac{1}{\sigma},\nu+1)}{K(\frac{1}{\sigma},\nu)}$, for y>0, $\mu > 0$, $\sigma > 0$ and $-\infty < \nu < +\infty$.

Value

GIG() returns a gamlss.family object which can be used to fit a generalized inverse gaussian distribution in the gamlss() function. DIG() gives the density, pGIG() gives the distribution function, GIG() gives the quantile function, and rGIG() generates random deviates.

Author(s)

Mikis Stasinopoulos `<d.stasinopoulos@londonmet.ac.uk>`, Bob Rigby `<r.rigby@londonmet.ac.uk>` and Nicoleta Motpan

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Stasinopoulos D. M., Rigby R.A. and Akantziliotou C. (2006) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.com/).

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

Jorgensen B. (1982) Statistical properties of the generalized inverse Gaussian distribution, Series: Lecture notes in statistics; 9, New York : Springer-Verlag.

See Also

gamlss.family, IG

Examples

```
y<-rGIG(100,mu=1,sigma=1, nu=-0.5) # generates 1000 random observations
hist(y)
# library(gamlss)
# histDist(y, family=GIG)
```

GT *The generalized t distribution for fitting a GAMLSS*

Description

This function defines the generalized t distribution, a four parameter distribution, for a `gamlss.family` object to be used for a GAMLSS fitting using the function `gamlss()`. The functions `dGT`, `pGT`, `qGT` and `rGT` define the density, distribution function, quantile function and random generation for the generalized t distribution.

Usage

```
GT(mu.link = "identity", sigma.link = "log", nu.link = "log",
   tau.link = "log")
dGT(x, mu = 0, sigma = 1, nu = 3, tau = 1.5, log = FALSE)
pGT(q, mu = 0, sigma = 1, nu = 3, tau = 1.5, lower.tail = TRUE,
   log.p = FALSE)
qGT(p, mu = 0, sigma = 1, nu = 3, tau = 1.5, lower.tail = TRUE,
   log.p = FALSE)
rGT(n, mu = 0, sigma = 1, nu = 3, tau = 1.5)
```

Arguments

`mu.link`	Defines the `mu.link`, with "identity" link as the default for the `mu` parameter.
`sigma.link`	Defines the `sigma.link`, with "log" link as the default for the `sigma` parameter.
`nu.link`	Defines the `nu.link`, with "log" link as the default for the `nu` parameter.
`tau.link`	Defines the `tau.link`, with "log" link as the default for the `tau` parameter.
`x,q`	vector of quantiles
`mu`	vector of location parameter values
`sigma`	vector of scale parameter values
`nu`	vector of skewness `nu` parameter values
`tau`	vector of kurtosis `tau` parameter values
`log, log.p`	logical; if TRUE, probabilities p are given as log(p).
`lower.tail`	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
`p`	vector of probabilities.
`n`	number of observations. If `length(n) > 1`, the length is taken to be the number required

Details

The probability density function of the generalized t distribution, (`GT`), , is defined as

$$f(y|\mu,\sigma\,\nu,\tau) = \tau \left\{ 2\sigma\nu^{1/\tau} B\left(\frac{1}{\tau},\nu\right) [1+|z|^{\tau}/\nu]^{\nu+1/\tau} \right\}^{-1}$$

where $-\infty < y < \infty$, $z = (y-\mu)/\sigma$ $\mu = (-\infty, +\infty)$, $\sigma > 0$, $\nu > 0$ and $\tau > 0$.

Value

GT() returns a gamlss.family object which can be used to fit the GT distribution in the gamlss() function. dGT() gives the density, pGT() gives the distribution function, qGT() gives the quantile function, and rGT() generates random deviates.

Warning

The qSHASH and rSHASH are slow since they are relying on golden section for finding the quantiles

Author(s)

Bob Rigby <r.rigby@londonmet.ac.uk> and Mikis Stasinopoulos <d.stasinopoulos@londonmet.ac.uk>

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Stasinopoulos D. M. Rigby R. A. and Akantziliotou C. (2006) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.com/).

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

gamlss.family, JSU, BCT

Examples

```
GT()   #
y<- rGT(200, mu=5, sigma=1, nu=1, tau=4)
hist(y)
curve(dGT(x, mu=5 ,sigma=2,nu=1, tau=4), -2, 11, main = "The GT  density mu=5 ,sigma=1, nu=1, tau=4")
# library(gamlss)
# m1<-gamlss(y~1, family=GT)
```

GU *The Gumbel distribution for fitting a GAMLSS*

Description

The function GU defines the Gumbel distribution, a two parameter distribution, for a gamlss.family object to be used in GAMLSS fitting using the function gamlss(). The functions dGU, pGU, qGU and rGU define the density, distribution function, quantile function and random generation for the specific parameterization of the Gumbel distribution.

Usage

```
GU(mu.link = "identity", sigma.link = "log")
dGU(x, mu = 0, sigma = 1, log = FALSE)
pGU(q, mu = 0, sigma = 1, lower.tail = TRUE, log.p = FALSE)
qGU(p, mu = 0, sigma = 1, lower.tail = TRUE, log.p = FALSE)
rGU(n, mu = 0, sigma = 1)
```

Arguments

`mu.link`	Defines the `mu.link`, with "identity" link as the default for the mu parameter. other available link is "inverse", "log" and "own")
`sigma.link`	Defines the `sigma.link`, with "log" link as the default for the sigma parameter, other links are the "inverse", "identity" and "own"
`x,q`	vector of quantiles
`mu`	vector of location parameter values
`sigma`	vector of scale parameter values
`log, log.p`	logical; if TRUE, probabilities p are given as log(p).
`lower.tail`	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
`p`	vector of probabilities.
`n`	number of observations. If `length(n) > 1`, the length is taken to be the number required

Details

The specific parameterization of the Gumbel distribution used in `GU` is

$$f(y|\mu,\sigma) = \frac{1}{\sigma}\;\exp\left\{\left(\frac{y-\mu}{\sigma}\right) - \exp\left(\frac{y-\mu}{\sigma}\right)\right\}$$

for $y = (-\infty, \infty)$, $\mu = (-\infty, +\infty)$ and $\sigma > 0$.

Value

`GU()` returns a `gamlss.family` object which can be used to fit a Gumbel distribution in the `gamlss()` function. `dGU()` gives the density, `pGU()` gives the distribution function, `qGU()` gives the quantile function, and `rGU()` generates random deviates.

Note

The mean of the distribution is $\mu - 0.57722\sigma$ and the variance is $\pi^2\sigma^2/6$.

Author(s)

Mikis Stasinopoulos `<d.stasinopoulos@londonmet.ac.uk>`, Bob Rigby `<r.rigby@londonmet.ac.uk>` and Calliope Akantziliotou

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Stasinopoulos D. M., Rigby R.A. and Akantziliotou C. (2006) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.com/).

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

gamlss.family, RG

Examples

```
plot(function(x) dGU(x, mu=0,sigma=1), -6, 3,
 main = "{Gumbel  density mu=0,sigma=1}")
GU()# gives information about the default links for the Gumbel distribution
dat<-rGU(100, mu=10, sigma=2) # generates 100 random observations
hist(dat)
# library(gamlss)
# gamlss(dat~1,family=GU) # fits a constant for each parameter mu and sigma
```

---

hazardFun   *Hazard functions for gamlss.family distributions*

Description

The function `hazardFun()` takes as an argument a `gamlss.family` object and creates the hazard function for it. The function `gen.hazard()` generates a hazard function called `hNAME` where `NAME` is a `gamlss.family` i.e. `hGA()`.

Usage

```
hazardFun(family = "NO", ...)
gen.hazard(family = "NO", ...)
```

Arguments

`family`	a `gamlss.family` object
`...`	for passing extra arguments

Value

A hazard function.

Author(s)

Mikis Stasinopoulos <d.stasinopoulos@londonmet.ac.uk>, Bob Rigby <r.rigby@londonmet.ac.uk> and Vlasios Voudouris <v.voudouris@londonmet.ac.uk>

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Stasinopoulos D. M., Rigby R.A. and Akantziliotou C. (2006) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.org/).

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

gamlss.family

Examples

```
gen.hazard("WEI2")
y<-seq(0,10,by=0.01)
plot(hWEI2(y, mu=1, sigma=1)~y, type="l", col="black", ylab="h(y)", ylim=c(0,2.5))
lines(hWEI2(y, mu=1, sigma=1.2)~y, col="red",lt=2,lw=2)
lines(hWEI2(y, mu=1, sigma=.5)~y, col="blue",lt=3,lw=2)
```

IG *Inverse Gaussian distribution for fitting a GAMLSS*

Description

The function `IG()`, or equivalently `Inverse.Gaussian()`, defines the inverse Gaussian distribution, a two parameter distribution, for a `gamlss.family` object to be used in GAMLSS fitting using the function `gamlss()`. The functions `dIG`, `pIG`, `qIG` and `rIG` define the density, distribution function, quantile function and random generation for the specific parameterization of the Inverse Gaussian distribution defined by function `IG`.

Usage

```
IG(mu.link = "log", sigma.link = "log")
dIG(x, mu = 1, sigma = 1, log = FALSE)
pIG(q, mu = 1, sigma = 1, lower.tail = TRUE, log.p = FALSE)
qIG(p, mu = 1, sigma = 1, lower.tail = TRUE, log.p = FALSE)
rIG(n, mu = 1, sigma = 1, ...)
```

Arguments

`mu.link`	Defines the `mu.link`, with "log" link as the default for the mu parameter
`sigma.link`	Defines the `sigma.link`, with "log" link as the default for the sigma parameter
`x,q`	vector of quantiles
`mu`	vector of location parameter values
`sigma`	vector of scale parameter values
`log, log.p`	logical; if TRUE, probabilities p are given as log(p).
`lower.tail`	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
`p`	vector of probabilities.
`n`	number of observations. If `length(n) > 1`, the length is taken to be the number required
`...`	`...` can be used to pass the uppr.limit argument to `qIG`

Details

Definition file for inverse Gaussian distribution.

$$f(y|\mu,\sigma) = \frac{1}{\sqrt{2\pi\sigma^2 y^3}} \exp\left\{-\frac{1}{2\mu^2\sigma^2 y}(y-\mu)^2\right\}$$

for $y > 0$, $\mu > 0$ and $\sigma > 0$.

Value

returns a `gamlss.family` object which can be used to fit a inverse Gaussian distribution in the `gamlss()` function.

Note

μ is the mean and $\sigma^2\mu^3$ is the variance of the inverse Gaussian

Author(s)

Mikis Stasinopoulos, Bob Rigby and Calliope Akantziliotou

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Stasinopoulos D. M., Rigby R.A. and Akantziliotou C. (2006) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.com/)

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

gamlss.family , GA, GIG

Examples

```
IG()# gives information about the default links for the normal distribution
# library(gamlss)
# data(rent)
# gamlss(R~cs(Fl),family=IG, data=rent) #
plot(function(x)dIG(x, mu=1,sigma=.5), 0.01, 6,
 main = "{Inverse Gaussian  density mu=1,sigma=0.5}")
plot(function(x)pIG(x, mu=1,sigma=.5), 0.01, 6,
 main = "{Inverse Gaussian  cdf mu=1,sigma=0.5}")
```

IGAMMA — *Inverse Gamma distribution for fitting a GAMLSS*

Description

The function `IGAMMA()` defines the Inverse Gamma distribution, a two parameter distribution, for a `gamlss.family` object to be used in GAMLSS fitting using the function `gamlss()`, with parameters `mu` (the mode) and `sigma`. The functions `dIGAMMA`, `pIGAMMA`, `qIGAMMA` and `rIGAMMA` define the density, distribution function, quantile function and random generation for the `IGAMMA` parameterization of the Inverse Gamma distribution.

Usage

```
IGAMMA(mu.link = "log", sigma.link="log")
dIGAMMA(x, mu = 1, sigma = .5, log = FALSE)
pIGAMMA(q, mu = 1, sigma = .5, lower.tail = TRUE, log.p = FALSE)
qIGAMMA(p, mu = 1, sigma = .5, lower.tail = TRUE, log.p = FALSE)
rIGAMMA(n, mu = 1, sigma = .5)
```

Arguments

`mu.link`	Defines the `mu.link`, with `log` link as the default for the mu parameter
`sigma.link`	Defines the `sigma.link`, with `log` as the default for the sigma parameter
`x, q`	vector of quantiles
`mu`	vector of location parameter values
`sigma`	vector of scale parameter values
`log, log.p`	logical; if TRUE, probabilities p are given as log(p)
`lower.tail`	logical; if TRUE (default), probabilities are P[X <= x], otherwise P[X > x]
`p`	vector of probabilities
`n`	number of observations. If `length(n) > 1`, the length is taken to be the number required

Details

The parameterization of the Inverse Gamma distribution in the function `IGA` is

$$f(y|\mu,\sigma) = \frac{[\mu\,(\alpha+1)]^{\alpha}}{\Gamma(\alpha)}\, y^{-(\alpha+1)}\, \exp\left[-\frac{\mu\,(\alpha+1)}{y}\right]$$

where $alpha = 1/(sigma^2)$ for $y > 0$, $mu > 0$ and $sigma > 0$.

Value

returns a gamlss.family object which can be used to fit an Inverse Gamma distribution in the `gamlss()` function.

Note

For the function `IGAMMA()`, *mu* is the mode of the Inverse Gamma distribution.

Author(s)

Fiona McElduff, Bob Rigby and Mikis Stasinopoulos.

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, 54, part 3, pp 507-554.

Stasinopoulos D. M., Rigby R.A. and Akantziliotou C. (2006) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.com/).

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. 23, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

`gamlss.family`, `GA`

Examples

```
par(mfrow=c(2,2))
y<-seq(0.2,20,0.2)
plot(y, dIGAMMA(y), type="l")
q <- seq(0.2, 20, 0.2)
plot(q, pIGAMMA(q), type="l")
p<-seq(0.0001,0.999,0.05)
plot(p , qIGAMMA(p), type="l")
dat <- rIGAMMA(50)
hist(dat)
#summary(gamlss(dat~1, family="IGAMMA"))
```

JSU *The Johnson's Su distribution for fitting a GAMLSS*

Description

This function defines the , a four parameter distribution, for a `gamlss.family` object to be used for a GAMLSS fitting using the function `gamlss()`. The functions `dJSU`, `pJSU`, `qJSU` and `rJSU` define the density, distribution function, quantile function and random generation for the the Johnson's Su distribution.

Usage

```
JSU(mu.link = "identity", sigma.link = "log", nu.link = "identity", tau.link = "log")
dJSU(x, mu = 0, sigma = 1, nu = 1, tau = 0.5, log = FALSE)
pJSU(q, mu = 0, sigma = 1, nu = 1, tau = 0.5, lower.tail = TRUE, log.p = FALSE)
qJSU(p, mu = 0, sigma = 1, nu = 0, tau = 0.5, lower.tail = TRUE, log.p = FALSE)
rJSU(n, mu = 0, sigma = 1, nu = 0, tau = 0.5)
```

Arguments

`mu.link`	Defines the `mu.link`, with "identity" link as the default for the `mu` parameter. Other links are "inverse" "log" ans "own"
`sigma.link`	Defines the `sigma.link`, with "log" link as the default for the `sigma` parameter. Other links are "inverse", "identity" ans "own"
`nu.link`	Defines the `nu.link`, with "identity" link as the default for the `nu` parameter. Other links are "onverse", "log" and "own"
`tau.link`	Defines the `tau.link`, with "log" link as the default for the `tau` parameter. Other links are "onverse", "identity" ans "own"
`x,q`	vector of quantiles
`mu`	vector of location parameter values
`sigma`	vector of scale parameter values
`nu`	vector of skewness `nu` parameter values
`tau`	vector of kurtosis `tau` parameter values
`log, log.p`	logical; if TRUE, probabilities p are given as log(p).
`lower.tail`	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
`p`	vector of probabilities.
`n`	number of observations. If `length(n) > 1`, the length is taken to be the number required

Details

The probability density function of the Jonhson's SU distribution, (JSU), is defined as

$$f(y|n, \mu, \sigma \, \nu, \tau) == \frac{1}{c\sigma} \frac{1}{\tau(z^2+1)^{\frac{1}{2}}} \frac{1}{\sqrt{2\pi}} \, \exp\left[-\frac{1}{2}r^2\right]$$

for $-\infty < y < \infty$, $\mu = (-\infty, +\infty)$, $\sigma > 0$, $\nu = (-\infty, +\infty)$ and $\tau > 0$. where $r = -\nu + \frac{1}{\tau}\sinh^{-1}(z)$, $z = \frac{y-(\mu+c\sigma w^{\frac{1}{2}}\sinh\Omega)}{c\sigma}$, $c = [\frac{1}{2}(w-1)(w\cosh 2\Omega + 1)]^{\frac{1}{2}}$, $w = e^{\tau^2}$ and $\Omega = -\nu\tau$. This is a reparameterization of the original Johnson Su distribution, Johnson (1954), so the parameters mu and sigma are the mean and the standard deviation of the distribution. The parameter nu determines the skewness of the distribution with nu>0 indicating positive skewness and nu<0 negative. The parameter tau determines the kurtosis of the distribution. tau should be positive and most likely in the region from zero to 1. As tau goes to 0 (and for nu=0) the distribution approaches the the Normal density function. The distribution is appropriate for leptokurtic data that is data with kurtosis larger that the Normal distribution one.

Value

JSU() returns a gamlss.family object which can be used to fit a Johnson's Su distribution in the gamlss() function. dJSU() gives the density, pJSU() gives the distribution function, qJSU() gives the quantile function, and rJSU() generates random deviates.

Warning

The function JSU uses first derivatives square in the fitting procedure so standard errors should be interpreted with caution

Author(s)

Bob Rigby and Mikis Stasinopoulos

References

Johnson, N. L. (1954). Systems of frequency curves derived from the first law of Laplace., *Trabajos de Estadistica*, **5**, 283-291.

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Stasinopoulos D. M. Rigby R. A. and Akantziliotou C. (2006) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.com/).

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

gamlss.family, JSUo, BCT

Examples

```
JSU()
plot(function(x)dJSU(x, mu=0,sigma=1,nu=-1, tau=.5), -4, 4,
 main = "The JSU  density mu=0,sigma=1,nu=-1, tau=.5")
plot(function(x) pJSU(x, mu=0,sigma=1,nu=-1, tau=.5), -4, 4,
 main = "The JSU  cdf mu=0, sigma=1, nu=-1, tau=.5")
# library(gamlss)
# data(abdom)
# h<-gamlss(y~cs(x,df=3), sigma.formula=~cs(x,1), family=JSU, data=abdom)
```

JSUo *The original Johnson's Su distribution for fitting a GAMLSS*

Description

This function defines the , a four parameter distribution, for a gamlss.family object to be used for a GAMLSS fitting using the function gamlss(). The functions dJSUo, pJSUo, qJSUo and rJSUo define the density, distribution function, quantile function and random generation for the the Johnson's Su distribution.

Usage

```
JSUo(mu.link = "identity", sigma.link = "log", nu.link = "identity", tau.link = "log")
dJSUo(x, mu = 0, sigma = 1, nu = 0, tau = 1, log = FALSE)
pJSUo(q, mu = 0, sigma = 1, nu = 0, tau = 1, lower.tail = TRUE, log.p = FALSE)
qJSUo(p, mu = 0, sigma = 1, nu = 0, tau = 1, lower.tail = TRUE, log.p = FALSE)
rJSUo(n, mu = 0, sigma = 1, nu = 0, tau = 1)
```

Arguments

mu.link	Defines the mu.link, with "identity" link as the default for the mu parameter. Other links are "inverse", "log" and "own"
sigma.link	Defines the sigma.link, with "log" link as the default for the sigma parameter. Other links are "inverse", "identity" and "own"
nu.link	Defines the nu.link, with "identity" link as the default for the nu parameter. Other links are "inverse", "log" ans "own"
tau.link	Defines the tau.link, with "log" link as the default for the tau parameter. Other links are "inverse", "identity" and "own"
x,q	vector of quantiles
mu	vector of location parameter values
sigma	vector of scale parameter values
nu	vector of skewness nu parameter values
tau	vector of kurtosis tau parameter values
log, log.p	logical; if TRUE, probabilities p are given as log(p).

lower.tail	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
p	vector of probabilities.
n	number of observations. If `length(n) > 1`, the length is taken to be the number required

Details

The probability density function of the orininal Jonhson's SU distribution, (`JSU`), is defined as

$$f(y|n, \mu, \sigma\, \nu, \tau) = \frac{\tau}{\sigma} \frac{1}{(z^2+1)^{\frac{1}{2}}} \frac{1}{\sqrt{2\pi}} \; \exp\left[-\frac{1}{2} r^2\right]$$

for $-\infty < y < \infty$, $\mu = (-\infty, +\infty)$, $\sigma > 0$, $\nu = (-\infty, +\infty)$ and $\tau > 0$. where $z = \frac{(y-\mu)}{\sigma}$, $r = \nu + \tau sinh^{-1}(z)$.

Value

`JSUo()` returns a `gamlss.family` object which can be used to fit a Johnson's Su distribution in the `gamlss()` function. `dJSUo()` gives the density, `pJSUo()` gives the distribution function, `qJSUo()` gives the quantile function, and `rJSUo()` generates random deviates.

Warning

The function `JSU` uses first derivatives square in the fitting procedure so standard errors should be interpreted with caution. It is recomented to be used only with `method=mixed(2,20)`

Author(s)

Mikis Stasinopoulos <d.stasinopoulos@londonmet.ac.uk> and Bob Rigby <r.rigby@londonmet.ac.uk>

References

Johnson, N. L. (1954). Systems of frequency curves derived from the first law of Laplace., *Trabajos de Estadistica*, **5**, 283-291.

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Stasinopoulos D. M. Rigby R. A. and Akantziliotou C. (2006) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.com/).

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

`gamlss.family`, `JSU`, `BCT`

Examples

```
JSU()
plot(function(x)dJSUo(x, mu=0,sigma=1,nu=-1, tau=.5), -4, 15,
 main = "The JSUo  density mu=0,sigma=1,nu=-1, tau=.5")
plot(function(x) pJSUo(x, mu=0,sigma=1,nu=-1, tau=.5), -4, 15,
 main = "The JSUo  cdf mu=0, sigma=1, nu=-1, tau=.5")
# library(gamlss)
# data(abdom)
# h<-gamlss(y~cs(x,df=3), sigma.formula=~cs(x,1), family=JSUo,
#          data=abdom, method=mixed(2,20))
# plot(h)
```

LG — *Logarithmic and zero adjusted logarithmic distributions for fitting a GAMLSS model*

Description

The function `LG` defines the logarithmic distribution, a one parameter distribution, for a `gamlss.family` object to be used in GAMLSS fitting using the function `gamlss()`. The functions `dLG`, `pLG`, `qLG` and `rLG` define the density, distribution function, quantile function and random generation for the logarithmic , `LG()`, distribution.

The function `ZALG` defines the zero adjusted logarithmic distribution, a two parameter distribution, for a `gamlss.family` object to be used in GAMLSS fitting using the function `gamlss()`. The functions `dZALG`, `pZALG`, `qZALG` and `rZALG` define the density, distribution function, quantile function and random generation for the inflated logarithmic , `ZALG()`, distribution.

Usage

```
LG(mu.link = "logit")
dLG(x, mu = 0.5, log = FALSE)
pLG(q, mu = 0.5, lower.tail = TRUE, log.p = FALSE)
qLG(p, mu = 0.5, lower.tail = TRUE, log.p = FALSE, max.value = 10000)
rLG(n, mu = 0.5)
ZALG(mu.link = "logit", sigma.link = "logit")
dZALG(x, mu = 0.5, sigma = 0.1, log = FALSE)
pZALG(q, mu = 0.5, sigma = 0.1, lower.tail = TRUE, log.p = FALSE)
qZALG(p, mu = 0.5, sigma = 0.1, lower.tail = TRUE, log.p = FALSE)
rZALG(n, mu = 0.5, sigma = 0.1)
```

Arguments

`mu.link`	defines the `mu.link`, with `logit` link as the default for the `mu` parameter
`sigma.link`	defines the `sigma.link`, with `logit` link as the default for the sigma parameter which in this case is the probability at zero.
`x`	vector of (non-negative integer)

mu	vector of positive means
sigma	vector of probabilities at zero
p	vector of probabilities
q	vector of quantiles
n	number of random values to return
log, log.p	logical; if TRUE, probabilities p are given as log(p)
lower.tail	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
max.value	valued needed for the numerical calculation of the q-function

Details

For the definition of the distributions see Rigby and Stasinopoulos (2010) below.

Value

The function LG and ZALG return a gamlss.family object which can be used to fit a logarithmic and a zero inflated logarithmic distributions respectively in the gamlss() function.

Author(s)

Mikis Stasinopoulos <d.stasinopoulos@londonmet.ac.uk>, Bob Rigby <r.rigby@londonmet.ac.uk>

References

Johnson, Norman Lloyd; Kemp, Adrienne W; Kotz, Samuel (2005). "Chapter 7: Logarithmic and Lagrangian distributions". Univariate discrete distributions (3 ed.). John Wiley & Sons. ISBN 9780471272465.

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Stasinopoulos D. M., Rigby R.A. and Akantziliotou C. (2006) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.com/).

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

Rigby, R. A. and Stasinopoulos D. M. (2010) The gamlss.family distributions, (distributed with this package or see http://www.gamlss.com/)

See Also

gamlss.family, PO, ZAP

Examples

```
LG()
ZAP()
# creating data and plotting them
 dat <- rLG(1000, mu=.3)
   r <- barplot(table(dat), col='lightblue')
dat1 <- rZALG(1000, mu=.3, sigma=.1)
  r1 <- barplot(table(dat1), col='lightblue')
```

LNO *Log Normal distribution for fitting in GAMLSS*

Description

The functions LOGNO and LOGNO2 define a gamlss.family distribution to fits the log-Normal distribution. The difference between them is that while LOGNO retains the original parametrization for mu, (identical to the normal distribution NO) and therefore $\mu = (-\infty, +\infty)$, the function LOGNO2 use mu as the median, so $\mu = (0, +\infty)$.

The function LNO is more general and can fit a Box-Cox transformation to data using the gamlss() function. In the LOGNO (and LOGNO2) there are two parameters involved mu sigma, while in the LNO there are three parameters mu sigma, and the transformation parameter nu. The transformation parameter nu in LNO is a 'fixed' parameter (not estimated) and it has its default value equal to zero allowing the fitting of the log-normal distribution as in LOGNO. See the example below on how to fix nu to be a particular value. In order to estimate (or model) the parameter nu, use the gamlss.family BCCG distribution which uses a reparameterized version of the the Box-Cox transformation. The functions dLOGNO, pLOGNO, qLOGNO and rLOGNO define the density, distribution function, quantile function and random generation for the specific parameterization of the log-normal distribution.

The functions dLOGNO2, pLOGNO2, qLOGNO2 and rLOGNO2 define the density, distribution function, quantile function and random generation when mu is the median of the log-normal distribution.

The functions dLNO, pLNO, qLNO and rLNO define the density, distribution function, quantile function and random generation for the specific parameterization of the log-normal distribution and more generally a Box-Cox transformation.

Usage

```
LNO(mu.link = "identity", sigma.link = "log")
LOGNO(mu.link = "identity", sigma.link = "log")
LOGNO2(mu.link = "log", sigma.link = "log")
dLNO(x, mu = 1, sigma = 0.1, nu = 0, log = FALSE)
dLOGNO(x, mu = 0, sigma = 1, log = FALSE)
dLOGNO2(x, mu = 1, sigma = 1, log = FALSE)
pLNO(q, mu = 1, sigma = 0.1, nu = 0, lower.tail = TRUE, log.p = FALSE)
pLOGNO(q, mu = 0, sigma = 1, lower.tail = TRUE, log.p = FALSE)
pLOGNO2(q, mu = 1, sigma = 1, lower.tail = TRUE, log.p = FALSE)
```

```
qLNO(p, mu = 1, sigma = 0.1, nu = 0, lower.tail = TRUE, log.p = FALSE)
qLOGNO(p, mu = 0, sigma = 1, lower.tail = TRUE, log.p = FALSE)
qLOGNO2(p, mu = 1, sigma = 1, lower.tail = TRUE, log.p = FALSE)
rLNO(n, mu = 1, sigma = 0.1, nu = 0)
rLOGNO(n, mu = 0, sigma = 1)
rLOGNO2(n, mu = 1, sigma = 1)
```

Arguments

`mu.link`	Defines the `mu.link`, with "identity" or "log" link depending on te parametrization
`sigma.link`	Defines the `sigma.link`, with "log" link as the default for the sigma parameter. Other links are "inverse", "identity" ans "own"
`x,q`	vector of quantiles
`mu`	vector of location parameter values
`sigma`	vector of scale parameter values
`nu`	vector of shape parameter values
`log, log.p`	logical; if TRUE, probabilities p are given as log(p).
`lower.tail`	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
`p`	vector of probabilities.
`n`	number of observations. If `length(n) > 1`, the length is taken to be the number required

Details

The probability density function in `LOGNO` is defined as

$$f(y|\mu,\sigma) = \frac{1}{y\sqrt{2\pi}\sigma} \exp[-\frac{1}{2\sigma^2}(log(y)-\mu)^2]$$

for $y > 0$, $\mu = (-\infty, +\infty)$ and $\sigma > 0$.

The probability density function in `LNO` is defined as

$$f(y|\mu,\sigma,\nu) = \frac{1}{\sqrt{2\pi}\sigma} y^{\nu-1} \exp[-\frac{1}{2\sigma^2}(z-\mu)^2]$$

where if $\nu \neq 0$ $z = (y^\nu - 1)/\nu$ else $z = \log(y)$ and $z \sim N(0, \sigma^2)$, for $y > 0$, $\mu > 0$, $\sigma > 0$ and $\nu = (-\infty, +\infty)$.

Value

`LNO()` returns a `gamlss.family` object which can be used to fit a log-normal distribution in the `gamlss()` function. `dLNO()` gives the density, `pLNO()` gives the distribution function, `qLNO()` gives the quantile function, and `rLNO()` generates random deviates.

Warning

This is a two parameter fit for μ and σ while ν is fixed. If you wish to model ν use the gamlss family BCCG.

Note

μ is the mean of z (and also the median of y), the Box-Cox transformed variable and σ is the standard deviation of z and approximate the coefficient of variation of y

Author(s)

Mikis Stasinopoulos, Bob Rigby and Calliope Akantziliotou

References

Box, G. E. P. and Cox, D. R. (1964) An analysis of transformations (with discussion), *J. R. Statist. Soc.* B., **26**, 211–252

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Stasinopoulos D. M., Rigby R.A. and Akantziliotou C. (2006) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.com/).

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

gamlss.family, BCCG

Examples

```
LOGNO()#  gives information about the default links for the log normal distribution
LOGNO2()
LNO()# gives information about the default links for the Box Cox distribution

# plotting the d, p, q, and r functions
op<-par(mfrow=c(2,2))
curve(dLOGNO(x, mu=0), 0, 10)
curve(pLOGNO(x, mu=0), 0, 10)
curve(qLOGNO(x, mu=0), 0, 1)
Y<- rLOGNO(200)
hist(Y)
par(op)

# plotting the d, p, q, and r functions
op<-par(mfrow=c(2,2))
curve(dLOGNO2(x, mu=1), 0, 10)
curve(pLOGNO2(x, mu=1), 0, 10)
curve(qLOGNO2(x, mu=1), 0, 1)
```

```
Y<- rLOGNO(200)
hist(Y)
par(op)

# library(gamlss)
# data(abdom)
# h1<-gamlss(y~cs(x), family=LOGNO, data=abdom)#fits the log-Normal distribution
# h2<-gamlss(y~cs(x), family=LNO, data=abdom)  #should be identical to the one above
# to change to square root transformation, i.e. fix nu=0.5
# h3<-gamlss(y~cs(x), family=LNO, data=abdom, nu.fix=TRUE, nu.start=0.5)
```

`LO` *Logistic distribution for fitting a GAMLSS*

Description

The function `LO()`, or equivalently `Logistic()`, defines the logistic distribution, a two parameter distribution, for a `gamlss.family` object to be used in GAMLSS fitting using the function gamlss()

Usage

```
LO(mu.link = "identity", sigma.link = "log")
dLO(x, mu = 0, sigma = 1, log = FALSE)
pLO(q, mu = 0, sigma = 1, lower.tail = TRUE, log.p = FALSE)
qLO(p, mu = 0, sigma = 1, lower.tail = TRUE, log.p = FALSE)
rLO(n, mu = 0, sigma = 1)
```

Arguments

`mu.link`	Defines the `mu.link`, with "identity" link as the default for the mu parameter
`sigma.link`	Defines the `sigma.link`, with "log" link as the default for the sigma parameter
`x,q`	vector of quantiles
`mu`	vector of location parameter values
`sigma`	vector of scale parameter values
`log, log.p`	logical; if TRUE, probabilities p are given as log(p).
`lower.tail`	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
`p`	vector of probabilities.
`n`	number of observations. If `length(n) > 1`, the length is taken to be the number required

Details

Definition file for Logistic distribution.

$$f(y|\mu,\sigma) = \frac{1}{\sigma} e^{-\frac{y-\mu}{\sigma}} [1 + e^{-\frac{y-\mu}{\sigma}}]^{-2}$$

for $y = (-\infty, \infty)$, $\mu = (-\infty, \infty)$ and $\sigma > 0$.

Value

`LO()` returns a `gamlss.family` object which can be used to fit a logistic distribution in the `gamlss()` function. `dLO()` gives the density, `pLO()` gives the distribution function, `qLO()` gives the quantile function, and `rLO()` generates random deviates for the logistic distribution. The latest functions are based on the equivalent `R` functions for logistic distribution.

Note

μ is the mean and $\sigma\pi/\sqrt{3}$ is the standard deviation for the logistic distribution

Author(s)

Mikis Stasinopoulos `<d.stasinopoulos@londonmet.ac.uk>`, Bob Rigby `<r.rigby@londonmet.ac.uk>` and Calliope Akantziliotou

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Stasinopoulos D. M., Rigby R.A. and Akantziliotou C. (2006) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.com/).

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

`gamlss.family`, `NO`, `TF`

Examples

```
LO()# gives information about the default links for the Logistic distribution
plot(function(y) dLO(y, mu=10 ,sigma=2), 0, 20)
plot(function(y) pLO(y, mu=10 ,sigma=2), 0, 20)
plot(function(y) qLO(y, mu=10 ,sigma=2), 0, 1)
# library(gamlss)
# data(abdom)
# h<-gamlss(y~cs(x,df=3), sigma.formula=~cs(x,1), family=LO, data=abdom) # fits
# plot(h)
```

LOGITNO *Logit Normal distribution for fitting in GAMLSS*

Description

The functions dLOGITNO, pLOGITNO, qLOGITNO and rLOGITNO define the density, distribution function, quantile function and random generation for the logit-normal distribution. The function LOGITNO can be used for fitting the distribution in gamlss().

Usage

```
LOGITNO(mu.link = "logit", sigma.link = "log")
dLOGITNO(x, mu = 0.5, sigma = 1, log = FALSE)
pLOGITNO(q, mu = 0.5, sigma = 1, lower.tail = TRUE, log.p = FALSE)
qLOGITNO(p, mu = 0.5, sigma = 1, lower.tail = TRUE, log.p = FALSE)
rLOGITNO(n, mu = 0.5, sigma = 1)
```

Arguments

mu.link	the link function for mu
sigma.link	the link function for sigma
x,q	vector of quantiles
mu	vector of location parameter values
sigma	vector of scale parameter values
log, log.p	logical; if TRUE, probabilities p are given as log(p).
lower.tail	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
p	vector of probabilities.
n	number of observations. If length(n) > 1, the length is taken to be the number required

Details

The probability density function in LOGITNO is defined as

$$f(y|\mu,\sigma) = \frac{1}{y(1-y)\sqrt{2\pi}\sigma} \exp[-\frac{1}{2\sigma^2}(log(y/(1-y)) - log(\mu/(1-\mu))^2]$$

for $0 < y > 1$, $\mu = (0, 1$ and $\sigma > 0$.

Value

LOGITNO() returns a gamlss.family object which can be used to fit a logit-normal distribution in the gamlss() function.

Author(s)

Mikis Stasinopoulos, Bob Rigby

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Stasinopoulos D. M., Rigby R.A. and Akantziliotou C. (2006) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.com/).

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

gamlss.family, LOGNO

Examples

```
# plotting the d, p, q, and r functions
op<-par(mfrow=c(2,2))
curve(dLOGITNO(x), 0, 1)
curve(pLOGITNO(x), 0, 1)
curve(qLOGITNO(x), 0, 1)
Y<- rLOGITNO(200)
hist(Y)
par(op)

# plotting the d, p, q, and r functions
# sigma 3
op<-par(mfrow=c(2,2))
curve(dLOGITNO(x, sigma=3), 0, 1)
curve(pLOGITNO(x, sigma=3), 0, 1)
curve(qLOGITNO(x, sigma=3), 0, 1)
Y<- rLOGITNO(200, sigma=3)
hist(Y)
par(op)
```

---

make.link.gamlss *Create a Link for GAMLSS families*

Description

The function `make.link.gamlss()` is used with `gamlss.family` distributions in package **gamlss()**. Given a link, it returns a link function, an inverse link function, the derivative dpar/deta where 'par' is the appropriate distribution parameter and a function for checking the domain. It differs from the usual `make.link` of `glm()` by having extra links as the `logshifto1`, and the own. For the use of the own link see the example bellow. show.link provides a way in which the user can identify the link functions available for each gamlss distribution. If your required link function is not available for any of the gamlss distributions you can add it in.

Usage

```
make.link.gamlss(link)
show.link(family = "NO")
```

Arguments

link	character or numeric; one of "logit", "probit", "cloglog", "identity", "log", "sqrt", "1/mu^2", "inverse", "logshifted", "logitshifted", or number, say lambda resulting in power link μ^λ.
family	a gamlss distribution family

Details

The own link function is added to allow the user greater flexibility. In order to used the own link function for any of the parameters of the distribution the own link should appear in the available links for this parameter. You can check this using the function show.link. If the own do not appear in the list you can create a new function for the distribution in which own is added in the list. For example the first line of the code of the binomial distribution, BI, has change from

"mstats <- checklink("mu.link", "Binomial", substitute(mu.link), c("logit", "probit", "cloglog", "log")), in version 1.0-0 of gamlss, to

"mstats <- checklink("mu.link", "Binomial", substitute(mu.link), c("logit", "probit", "cloglog", "log", "own"))

in version 1.0-1. Given that the parameter has own as an option the user needs also to define the following four new functions in order to used an own link.

i) own.linkfun

ii) own.linkinv

iii) own.mu.eta and

iv) own.valideta.

An example is given below.

Only one parameter of the distribution at a time is allowed to have its own link, (unless the same four own functions above are suitable for more that one parameter of the distribution).

Note that from **gamlss** version 1.9-0 the user can introduce its own link function by define an appropriate function, (see the example below).

Value

For the make.link.gamlss a list with components

linkfun: Link function function(parameter)

linkinv: Inverse link function function(eta)

mu.eta: Derivative function(eta) dparameter/deta validetа: `function(eta)` TRUE if all of eta is in the domain of `linkinv`.

For the `show.link` a list with components the available links for the distribution parameters

Note

For the links involving parameters as in `logshifted` and `logitshifted` the parameters can be passed in the definition of the distribution by calling the `checklink` function, for example in the definition of the `tau` parameter in BCPE distribution the following call is made: `tstats <- checklink( "tau.link", "B`

Author(s)

Mikis Stasinopoulos and Bob Rigby

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Stasinopoulos D. M., Rigby R.A. and Akantziliotou C. (2006) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.com/).

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

gamlss.family

Examples

```
str(make.link.gamlss("logshiftto1"))
l2<-make.link.gamlss("logshiftto1")
l2$linkfun(2) # should close to zero (Note that 0.00001 is added)
l2$linkfun(1-0.00001) # should be -Inf but it is large negative
#---------------------------------------------------------
# now use the own link function
# first if the distribution allows you
show.link(BI)
# seems OK now define the four own functions
# First try the probit link using the own link function
# 1: the linkfun function
own.linkfun <- function(mu) { qNO(p=mu)}
# 2: the inverse link function
own.linkinv <- function(eta) {
              thresh <- -qNO(.Machine$double.eps)
               eta <- pmin(thresh, pmax(eta, -thresh))
              pNO(eta)}
# 3: the dmu/deta function
own.mu.eta <- function(eta) pmax(dNO(eta), .Machine$double.eps)
# 4: the valideta function
```

```
own.valideta <- function(eta) TRUE

## bring the data
# library(gamlss)
#data(aep)
# fitting the model using "own"
# h1<-gamlss(y~ward+loglos+year, family=BI(mu.link="own"), data=aep)
# model h1 should be identical to the probit
# h2<-gamlss(y~ward+loglos+year, family=BI(mu.link="probit"), data=aep)
# now using a function instead of "own"
probittest <- function()
{
linkfun <- function(mu) { qNO(p=mu)}
linkinv <- function(eta)
            {
              thresh <- -qNO(.Machine$double.eps)
               eta <- pmin(thresh, pmax(eta, -thresh))
              pNO(eta)
            }
mu.eta <- function(eta) pmax(dNO(eta), .Machine$double.eps)
valideta <- function(eta) TRUE
link <- "probitTest"
structure(list(linkfun = linkfun, linkinv = linkinv, mu.eta = mu.eta,
        valideta = valideta, name = link), class = "link-gamlss")
}
# h3<-gamlss(y~ward+loglos+year, family=BI(mu.link=probittest()), data=aep)
# Second try the complementary log-log
# using the Gumbel distribution
own.linkfun <- function(mu) { qGU(p=mu)}
own.linkinv <- function(eta) {
              thresh <- -qGU(.Machine$double.eps)
               eta <- pmin(thresh, pmax(eta, -thresh))
              pGU(eta)}
own.mu.eta <- function(eta) pmax(dGU(eta), .Machine$double.eps)
own.valideta <- function(eta) TRUE
# h1 and h2 should be identical to cloglog
# h1<-gamlss(y~ward+loglos+year, family=BI(mu.link="own"), data=aep)
# h2<-gamlss(y~ward+loglos+year, family=BI(mu.link="cloglog"), data=aep)
# note that the Gumbel distribution is negatively skew
# for a positively skew link function we can used the Reverse Gumbel
revloglog  <- function()
{
linkfun <- function(mu) { qRG(p=mu)}
linkinv <- function(eta) {
              thresh <- -qRG(.Machine$double.eps)
               eta <- pmin(thresh, pmax(eta, -thresh))
              pRG(eta)}
mu.eta <- function(eta) pmax(dRG(eta), .Machine$double.eps)
valideta <- function(eta) TRUE
link <- "revloglog"
structure(list(linkfun = linkfun, linkinv = linkinv, mu.eta = mu.eta,
        valideta = valideta, name = link), class = "link-gamlss")
}
```

```
# h1<-gamlss(y~ward+loglos+year, family=BI(mu.link=revloglog()), data=aep)
# a considerable improvement in the deviance
# try a shifted logit link function from -1, 1
own.linkfun <- function(mu)
             { shift = c(-1,1)
               log((mu-shift[1])/(shift[2]-mu))
             }
own.linkinv <- function(eta)
            {
            shift = c(-1,1)
            thresh <- -log(.Machine$double.eps)
               eta <- pmin(thresh, pmax(eta, -thresh))
                      shift[2]-(shift[2]-shift[1])/(1 + exp(eta))
            }
own.mu.eta <- function(eta)
            {
        shift = c(-1,1)
            thresh <- -log(.Machine$double.eps)
               res <- rep(.Machine$double.eps, length(eta))
            res[abs(eta) < thresh] <- ((shift[2]-shift[1])*exp(eta)/(1 + exp(eta))^2)[abs(eta) < thresh]
            res
            }
own.valideta <- function(eta) TRUE
#----------
str(make.link.gamlss("own"))
l2<-make.link.gamlss("own")
l2$linkfun(0) # should be zero
l2$linkfun(1) # should be Inf
l2$linkinv(-5:5)
```

MN3 *Multinomial distribution in GAMLSS*

Description

The set of function presented here is useful for fitting multinomial regression within gamlss.

Usage

```
MN3(mu.link = "log", sigma.link = "log")
MN4(mu.link = "log", sigma.link = "log", nu.link = "log")
MN5(mu.link = "log", sigma.link = "log", nu.link = "log", tau.link = "log")
MULTIN(type = "3")
fittedMN(model)

dMN3(x, mu = 1, sigma = 1, log = FALSE)
dMN4(x, mu = 1, sigma = 1, nu = 1, log = FALSE)
dMN5(x, mu = 1, sigma = 1, nu = 1, tau = 1, log = FALSE)
```

```
pMN3(q, mu = 1, sigma = 1, lower.tail = TRUE, log.p = FALSE)
pMN4(q, mu = 1, sigma = 1, nu = 1, lower.tail = TRUE, log.p = FALSE)
pMN5(q, mu = 1, sigma = 1, nu = 1, tau = 1, lower.tail = TRUE, log.p = FALSE)

qMN3(p, mu = 1, sigma = 1, lower.tail = TRUE, log.p = FALSE)
qMN4(p, mu = 1, sigma = 1, nu = 1, lower.tail = TRUE, log.p = FALSE)
qMN5(p, mu = 1, sigma = 1, nu = 1, tau = 1, lower.tail = TRUE, log.p = FALSE)

rMN3(n, mu = 1, sigma = 1)
rMN4(n, mu = 1, sigma = 1, nu = 1)
rMN5(n, mu = 1, sigma = 1, nu = 1, tau = 1)
```

Arguments

mu.link	the link function for mu
sigma.link	the link function for sigma
nu.link	the link function for nu
tau.link	the link function for tau
x	the x variable
q	vector of quantiles
p	vector of probabilities
lower.tail	logical; if TRUE (default), probabilities are P[X <= x] otherwise, P[X > x].
log.p	logical; if TRUE, probabilities p are given as log(p).
log	logical; if TRUE, probabilities p are given as log(p).
n	the number of observations
mu	the mu parameter
sigma	the sigma parameter
nu	the nu parameter
tau	the tau parameter
type	permitted values are 2 (Binomial), 3, 4, and 5
model	a gamlss multinomial fitted model

Details

GAMLSS is in general not suitable for multinomial regression. Nevertheless multinomial regression can be fitted within GAMLSS if the response variable y has less than five categories. The function here provide the facilities to do so. The functions `MN3()`, `MN4()` and `MN5()` fit multinomial responses with 3, 4 and 5 categories respectively. The function `MULTIN()` can be used instead of codeMN3(), `MN4()` and `MN5()` by specifying the number of levels of the response. Note that `MULTIN(2)` will produce a binomial fit.

Value

returns a `gamlss.family` object which can be used to fit a binomial distribution in the `gamlss()` function.

Author(s)

Mikis Stasinopoulos, Bob Rigby and Vlasios Voudouris

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Stasinopoulos D. M., Rigby R.A. and Akantziliotou C. (2006) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.com/).

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

gamlss.family, BI

Examples

```
dMN3(3)
pMN3(2)
qMN3(.6)
rMN3(10)
```

NBI *Negative Binomial type I distribution for fitting a GAMLSS*

Description

The NBI() function defines the Negative Binomial type I distribution, a two parameter distribution, for a gamlss.family object to be used in GAMLSS fitting using the function gamlss(). The functions dNBI, pNBI, qNBI and rNBI define the density, distribution function, quantile function and random generation for the Negative Binomial type I, NBI(), distribution.

Usage

```
NBI(mu.link = "log", sigma.link = "log")
dNBI(x, mu = 1, sigma = 1, log = FALSE)
pNBI(q, mu = 1, sigma = 1, lower.tail = TRUE, log.p = FALSE)
qNBI(p, mu = 1, sigma = 1, lower.tail = TRUE, log.p = FALSE)
rNBI(n, mu = 1, sigma = 1)
```

Arguments

`mu.link`	Defines the `mu.link`, with "log" link as the default for the mu parameter
`sigma.link`	Defines the `sigma.link`, with "log" link as the default for the sigma parameter
`x`	vector of (non-negative integer) quantiles
`mu`	vector of positive means
`sigma`	vector of positive despersion parameter
`p`	vector of probabilities
`q`	vector of quantiles
`n`	number of random values to return
`log, log.p`	logical; if TRUE, probabilities p are given as log(p)
`lower.tail`	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]

Details

Definition file for Negative Binomial type I distribution.

$$f(y|\mu,\sigma) = \frac{\Gamma(y+1/\sigma)}{\Gamma(y+1)\Gamma(1/\sigma)} \left[\frac{(\mu\sigma)^y}{(\mu\sigma+1)}\right]^{y+(1/\sigma)}$$

for $y = 0, 1, 2, \ldots, \infty$, $\mu > 0$ and $\sigma > 0$. This parameterization is equivalent to that used by Anscombe (1950) except he used $\alpha = 1/\sigma$ instead of σ.

Value

returns a `gamlss.family` object which can be used to fit a Negative Binomial type I distribution in the `gamlss()` function.

Warning

For values of $\sigma < 0.0001$ the d,p,q,r functions switch to the Poisson distribution

Note

μ is the mean and $(\mu+\sigma\mu^2)^{0.5}$ is the standard deviation of the Negative Binomial type I distribution (so σ is the dispersion parameter in the usual GLM for the negative binomial type I distribution)

Author(s)

Mikis Stasinopoulos `<d.stasinopoulos@londonmet.ac.uk>`, Bob Rigby `<r.rigby@londonmet.ac.uk>` and Calliope Akantziliotou

References

Anscombe, F. J. (1950) Sampling theory of the negative bimomial and logarithmic distributiona, *Biometrika*, **37**, 358-382.

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Stasinopoulos D. M., Rigby R.A. and Akantziliotou C. (2006) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.com/).

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

gamlss.family, NBII, PIG, SI

Examples

```
NBI()   # gives information about the default links for the Negative Binomial type I distribution
# plotting the distribution
plot(function(y) dNBI(y, mu = 10, sigma = 0.5 ), from=0, to=40, n=40+1, type="h")
# creating random variables and plot them
tN <- table(Ni <- rNBI(1000, mu=5, sigma=0.5))
r <- barplot(tN, col='lightblue')
# library(gamlss)
# data(aids)
# h<-gamlss(y~cs(x,df=7)+qrt, family=NBI, data=aids) # fits the model
# plot(h)
# pdf.plot(family=NBI, mu=10, sigma=0.5, min=0, max=40, step=1)
```

NBII *Negative Binomial type II distribution for fitting a GAMLSS*

Description

The NBII() function defines the Negative Binomial type II distribution, a two parameter distribution, for a gamlss.family object to be used in GAMLSS fitting using the function gamlss(). The functions dNBII, pNBII, qNBII and rNBII define the density, distribution function, quantile function and random generation for the Negative Binomial type II, NBII(), distribution.

Usage

```
NBII(mu.link = "log", sigma.link = "log")
dNBII(x, mu = 1, sigma = 1, log = FALSE)
pNBII(q, mu = 1, sigma = 1, lower.tail = TRUE, log.p = FALSE)
qNBII(p, mu = 1, sigma = 1, lower.tail = TRUE, log.p = FALSE)
rNBII(n, mu = 1, sigma = 1)
```

Arguments

mu.link	Defines the mu.link, with "log" link as the default for the mu parameter
sigma.link	Defines the sigma.link, with "log" link as the default for the sigma parameter
x	vector of (non-negative integer) quantiles
mu	vector of positive means
sigma	vector of positive despersion parameter
p	vector of probabilities
q	vector of quantiles
n	number of random values to return
log, log.p	logical; if TRUE, probabilities p are given as log(p)
lower.tail	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]

Details

Definition file for Negative Binomial type II distribution.

$$f(y|\mu,\sigma) = \frac{\Gamma(y+(\mu/\sigma))\sigma^y}{\Gamma(\mu/\sigma)\Gamma(y+1)(1+\sigma)^{y+(\mu/\sigma)}}$$

for $y = 0, 1, 2, ..., \infty$, $\mu > 0$ and $\sigma > 0$. This parameterization was used by Evans (1953) and also by Johnson *et al.* (1993) p 200.

Value

returns a gamlss.family object which can be used to fit a Negative Binomial type II distribution in the gamlss() function.

Note

μ is the mean and $[(1+\sigma)\mu]^{0.5}$ is the standard deviation of the Negative Binomial type II distribution, so σ is a dispersion parameter

Author(s)

Mikis Stasinopoulos <d.stasinopoulos@londonmet.ac.uk>, Bob Rigby <r.rigby@londonmet.ac.uk> and Calliope Akantziliotou

References

Evans, D. A. (1953). Experimental evidence concerning contagious distributions in ecology. *Biometrika*, **40**: 186-211.

Johnson, N. L., Kotz, S. and Kemp, A. W. (1993). *Univariate Discrete Distributions*, 2nd edn. Wiley, New York.

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Stasinopoulos D. M., Rigby R.A. and Akantziliotou C. (2006) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.com/).

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

gamlss.family, NBI, PIG, SI

Examples

```
NBII()  # gives information about the default links for the Negative Binomial type II distribution
# plotting the distribution
plot(function(y) dNBII(y, mu = 10, sigma = 0.5 ), from=0, to=40, n=40+1, type="h")
# creating random variables and plot them
tN <- table(Ni <- rNBII(1000, mu=5, sigma=0.5))
r <- barplot(tN, col='lightblue')
# library(gamlss)
# data(aids)
# h<-gamlss(y~cs(x,df=7)+qrt, family=NBII, data=aids) # fits a model
# plot(h)
# pdf.plot(family=NBII, mu=10, sigma=0.5, min=0, max=40, step=1)
```

NET — *Normal Exponential t distribution (NET) for fitting a GAMLSS*

Description

This function defines the Power Exponential t distribution (NET), a four parameter distribution, for a gamlss.family object to be used for a GAMLSS fitting using the function gamlss(). The functions dNET, pNET define the density and distribution function the NET distribution.

Usage

```
NET(mu.link = "identity", sigma.link = "log")
pNET(q, mu = 5, sigma = 0.1, nu = 1, tau = 2)
dNET(x, mu = 0, sigma = 1, nu = 1.5, tau = 2, log = FALSE)
```

Arguments

mu.link	Defines the mu.link, with "identity" link as the default for the mu parameter. Other links are "inverse", "log" and "own"
sigma.link	Defines the sigma.link, with "log" link as the default for the sigma parameter. Other links are "inverse", "identity" and "own"
x,q	vector of quantiles

mu	vector of location parameter values
sigma	vector of scale parameter values
nu	vector of nu parameter values
tau	vector of tau parameter values
log	logical; if TRUE, probabilities p are given as log(p).

Details

The NET distribution was introduced by Rigby and Stasinopoulos (1994) as a robust distribution for a response variable with heavier tails than the normal. The NET distribution is the abbreviation of the Normal Exponential Student t distribution. The NET distribution is a four parameter continuous distribution, although in the GAMLSS implementation only the two parameters, `mu` and `sigma`, of the distribution are modelled with `nu` and `tau` fixed. The distribution takes its names because it is normal up to `nu`, Exponential from `nu` to `tau` (hence `abs(nu)<=abs(tau)`) and Student-t with `nu*tau-1` degrees of freedom after `tau`. Maximum likelihood estimator of the third and forth parameter can be obtained, using the GAMLSS functions, `find.hyper` or `prof.dev`.

Value

`NET()` returns a `gamlss.family` object which can be used to fit a Box Cox Power Exponential distribution in the `gamlss()` function. `dNET()` gives the density, `pNET()` gives the distribution function.

Author(s)

Mikis Stasinopoulos, Bob Rigby and Calliope Akantziliotou

References

Rigby, R. A. and Stasinopoulos, D. M. (1994), Robust fitting of an additive model for variance heterogeneity, *COMPSTAT : Proceedings in Computational Statistics*, editors:R. Dutter and W. Grossmann, pp 263-268, Physica, Heidelberg.

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Stasinopoulos D. M. Rigby R. A. and Akantziliotou C. (2006) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.com/).

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

gamlss.family, BCPE

Examples

```
NET()   #
data(abdom)
plot(function(x)dNET(x, mu=0,sigma=1,nu=2, tau=3), -5, 5)
plot(function(x)pNET(x, mu=0,sigma=1,nu=2, tau=3), -5, 5)
# fit NET with nu=1 and tau=3
# library(gamlss)
#h<-gamlss(y~cs(x,df=3), sigma.formula=~cs(x,1), family=NET,
#        data=abdom, nu.start=2, tau.start=3)
#plot(h)
```

NO *Normal distribution for fitting a GAMLSS*

Description

The function `NO()` defines the normal distribution, a two parameter distribution, for a `gamlss.family` object to be used in GAMLSS fitting using the function `gamlss()`, with mean equal to the parameter `mu` and `sigma` equal the standard deviation. The functions `dNO`, `pNO`, `qNO` and `rNO` define the density, distribution function, quantile function and random generation for the `NO` parameterization of the normal distribution. [A alternative parameterization with `sigma` equal to the variance is given in the function `NO2()`]

Usage

```
NO(mu.link = "identity", sigma.link = "log")
dNO(x, mu = 0, sigma = 1, log = FALSE)
pNO(q, mu = 0, sigma = 1, lower.tail = TRUE, log.p = FALSE)
qNO(p, mu = 0, sigma = 1, lower.tail = TRUE, log.p = FALSE)
rNO(n, mu = 0, sigma = 1)
```

Arguments

`mu.link`	Defines the `mu.link`, with "identity" link as the default for the mu parameter
`sigma.link`	Defines the `sigma.link`, with "log" link as the default for the sigma parameter
`x,q`	vector of quantiles
`mu`	vector of location parameter values
`sigma`	vector of scale parameter values
`log, log.p`	logical; if TRUE, probabilities p are given as log(p).
`lower.tail`	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
`p`	vector of probabilities.
`n`	number of observations. If `length(n) > 1`, the length is taken to be the number required

Details

The parametrization of the normal distribution given in the function `NO()` is

$$f(y|\mu,\sigma) = \frac{1}{\sqrt{2\pi}\sigma} \exp\left[-\frac{1}{2}(\frac{y-\mu}{\sigma})^2\right]$$

for $y = (-\infty, \infty)$, $\mu = (-\infty, +\infty)$ and $\sigma > 0$.

Value

returns a `gamlss.family` object which can be used to fit a normal distribution in the `gamlss()` function.

Note

For the function `NO()`, μ is the mean and σ is the standard deviation (not the variance) of the normal distribution.

Author(s)

Mikis Stasinopoulos, Bob Rigby and Calliope Akantziliotou

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Stasinopoulos D. M., Rigby R.A. and Akantziliotou C. (2006) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.com/).

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

`gamlss.family`, `NO2`

Examples

```
NO()# gives information about the default links for the normal distribution
plot(function(y) dNO(y, mu=10 ,sigma=2), 0, 20)
plot(function(y) pNO(y, mu=10 ,sigma=2), 0, 20)
plot(function(y) qNO(y, mu=10 ,sigma=2), 0, 1)
dat<-rNO(100)
hist(dat)
# library(gamlss)
# gamlss(dat~1,family=NO) # fits a constant for mu and sigma
```

NO2 *Normal distribution (with variance as sigma parameter) for fitting a GAMLSS*

Description

The function NO2() defines the normal distribution, a two parameter distribution, for a gamlss.family object to be used in GAMLSS fitting using the function gamlss() with mean equal to mu and variance equal to sigma. The functions dNO2, pNO2, qNO2 and rNO2 define the density, distribution function, quantile function and random generation for this specific parameterization of the normal distribution.

[A alternative parameterization with sigma as the standard deviation is given in the function NO()]

Usage

```
NO2(mu.link = "identity", sigma.link = "log")
dNO2(x, mu = 0, sigma = 1, log = FALSE)
pNO2(q, mu = 0, sigma = 1, lower.tail = TRUE, log.p = FALSE)
qNO2(p, mu = 0, sigma = 1, lower.tail = TRUE, log.p = FALSE)
rNO2(n, mu = 0, sigma = 1)
```

Arguments

mu.link	Defines the mu.link, with "identity" link as the default for the mu parameter
sigma.link	Defines the sigma.link, with "log" link as the default for the sigma parameter
x,q	vector of quantiles
mu	vector of location parameter values
sigma	vector of scale parameter values
log, log.p	logical; if TRUE, probabilities p are given as log(p).
lower.tail	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
p	vector of probabilities.
n	number of observations. If length(n) > 1, the length is taken to be the number required

Details

The parametrization of the normal distribution given in the function NO2() is

$$f(y|\mu,\sigma) = \frac{1}{\sqrt{2\pi\sigma}} \exp\left[-\frac{1}{2}\frac{(y-\mu)^2}{\sigma}\right]$$

for $y = (-\infty, \infty)$, $\mu = (-\infty, +\infty)$ and $\sigma > 0$.

Value

returns a `gamlss.family` object which can be used to fit a normal distribution in the `gamlss()` function.

Note

For the function `NO()`, μ is the mean and σ is the standard deviation (not the variance) of the normal distribution. [The function `NO2()` defines the normal distribution with σ as the variance.]

Author(s)

Mikis Stasinopoulos, Bob Rigby and Calliope Akantziliotou

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Stasinopoulos D. M., Rigby R.A. and Akantziliotou C. (2006) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.com/).

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

`gamlss.family`, `NO`

Examples

```
NO()# gives information about the default links for the normal distribution
dat<-rNO(100)
hist(dat)
plot(function(y) dNO(y, mu=10 ,sigma=2), 0, 20)
plot(function(y) pNO(y, mu=10 ,sigma=2), 0, 20)
plot(function(y) qNO(y, mu=10 ,sigma=2), 0, 1)
# library(gamlss)
# gamlss(dat~1,family=NO) # fits a constant for mu and sigma
```

`NOF` *Normal distribution family for fitting a GAMLSS*

Description

The function NOF() defines a normal distribution family, which has three parameters. The distribution can be used in a GAMLSS fitting using the function gamlss(). The mean of NOF is equal to mu. The variance is equal to sigma^2*mu^nu so the standard deviation is sigma*mu^(nu/2). The function is design for cases where the variance is proportional to a power of the mean. The functions dNOF, pNOF, qNOF and rNOF define the density, distribution function, quantile function and random generation for the NOF parametrization of the normal distribution family.

Usage

```
NOF(mu.link = "identity", sigma.link = "log", nu.link = "identity")
dNOF(x, mu = 0, sigma = 1, nu = 0, log = FALSE)
pNOF(q, mu = 0, sigma = 1, nu = 0, lower.tail = TRUE, log.p = FALSE)
qNOF(p, mu = 0, sigma = 1, nu = 0, lower.tail = TRUE, log.p = FALSE)
rNOF(n, mu = 0, sigma = 1, nu = 0)
```

Arguments

mu.link	Defines the mu.link, with "identity" link as the default for the mu parameter
sigma.link	Defines the sigma.link, with "log" link as the default for the sigma parameter
nu.link	Defines the nu.link with "identity" link as the default for the nu parameter
x,q	vector of quantiles
mu	vector of location parameter values
sigma	vector of scale parameter values
nu	vector of power parameter values
log, log.p	logical; if TRUE, probabilities p are given as log(p).
lower.tail	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
p	vector of probabilities.
n	number of observations. If length(n) > 1, the length is taken to be the number required

Details

The parametrization of the normal distribution given in the function NOF() is

$$f(y|\mu,\sigma,\nu) = \frac{1}{\sqrt{2\pi}\sigma\mu^{\nu/2}} \exp\left[-\frac{1}{2}\frac{(y-\mu)^2}{\sigma^2\mu^\nu}\right]$$

for $y = (-\infty, \infty)$, $\mu = (-\infty, \infty)$, $\sigma > 0$ and $\nu = (-\infty, +\infty)$.

Value

returns a gamlss.family object which can be used to fit a normal distribution family in the gamlss() function.

Note

For the function `NOF()`, μ is the mean and $\sigma\mu^{\nu/2}$ is the standard deviation of the normal distribution family. The NOF is design for fitting regression type models where the variance is proportional to a power ofthe mean. Models of this type are related to the "pseudo likelihood" models of Carroll and Rubert (1987) but here a proper likelihood is miximised.

Note that because the high correlation between the `sigma` and the `nu` parameter the `mixed()` method should be used in the fitting.

Author(s)

Mikis Stasinopoulos, Bob Rigby and Calliope Akantziliotou

References

Davidian, M. and Carroll, R. J. (1987), Variance Function Estimation, *Journal of the American Statistical Association*, Vol. **82**, pp. 1079-1091

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Stasinopoulos D. M., Rigby R.A. and Akantziliotou C. (2006) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.com/).

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

gamlss.family, NO, NO2

Examples

```
NOF()# gives information about the default links for the normal distribution family
# library(gamlss)
#data(abdom)
## the normal distribution fit with constant sigma
#m1<-gamlss(y~poly(x,2), sigma.fo=~1, family=NO, data=abdom)
## the normal family fit with variance proportional to mu
#m2<-gamlss(y~poly(x,2), sigma.fo=~1, family=NOF, data=abdom, method=mixed(1,20))
## a nornal distribution fit with variance as a function of x
#m3 <-gamlss(y~poly(x,2), sigma.fo=~x,   family=NO, data=abdom, method=mixed(1,20))
#GAIC(m1,m2,m3)
```

PARETO2 *Pareto Type 2 distribution for fitting a GAMLSS*

Description

The functions `PARETO2()` and `PARETO2o()` define the Pareto Type 2 distribution, a two parameter distribution, for a `gamlss.family` object to be used in GAMLSS fitting using the function `gamlss()`. The parameters are `mu` and `sigma` in both functions but the parameterasation different. The `mu` is identical for both `PARETO2()` and `PARETO2o()`. The `sigma` in `PARETO2o()` is the inverse of the `sigma` in codePARETO2() and coresponse to the usual parameter `alpha` of the Patreto distribution. The functions `dPARETO2`, `pPARETO2`, `qPARETO2` and `rPARETO2` define the density, distribution function, quantile function and random generation for the `PARETO2` parameterization of the Pareto type 2 distribution while the functions `dPARETO2o`, `pPARETO2o`, `qPARETO2o` and `rPARETO2o` define the density, distribution function, quantile function and random generation for the original `PARETO2o` parameterization of the Pareto type 2 distribution

Usage

```
PARETO2(mu.link = "log", sigma.link = "log")
dPARETO2(x, mu = 1, sigma = 0.5, log = FALSE)
pPARETO2(q, mu = 1, sigma = 0.5, lower.tail = TRUE, log.p = FALSE)
qPARETO2(p, mu = 1, sigma = 0.5, lower.tail = TRUE, log.p = FALSE)
rPARETO2(n, mu = 1, sigma = 0.5)
PARETO2o(mu.link = "log", sigma.link = "log")
dPARETO2o(x, mu = 1, sigma = 0.5, log = FALSE)
pPARETO2o(q, mu = 1, sigma = 0.5, lower.tail = TRUE, log.p = FALSE)
qPARETO2o(p, mu = 1, sigma = 0.5, lower.tail = TRUE, log.p = FALSE)
rPARETO2o(n, mu = 1, sigma = 0.5)
```

Arguments

`mu.link`	Defines the `mu.link`, with "‘"’ link sa the default for the mu parameter
`sigma.link`	Defines the `sigma.link`, with "‘log"’ as the default for the sigma parameter
`x, q`	vector of quantiles
`mu`	vector of location parameter values
`sigma`	vector of scale parameter values
`log, log.p`	logical; if TRUE, probabilities p are given as log(p)
`lower.tail`	logical; if TRUE (default), probabilities are P[X <= x], otherwise P[X > x]
`p`	vector of probabilities
`n`	number of observations. If `length(n) > 1`, the length is taken to be the number required

Details

The parameterization of the Pareto Type 2 distribution in the function PA2 is:

$$f(y|\mu,\sigma) = \frac{1}{\sigma}\mu^{\frac{1}{\sigma}}(y+mu)^{-\frac{1}{sigma+1}}$$

for $y >= 0$, $mu > 0$ and $sigma > 0$.

Value

returns a gamlss.family object which can be used to fit a Pareto type 2 distribution in the `gamlss()` function.

Author(s)

Fiona McElduff, Bob Rigby and Mikis Stasinopoulos

References

Johnson, N., Kotz, S., and Balakrishnan, N. (1997). *Discrete Multivariate Distributions.* Wiley-Interscience, NY, USA.

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See Also

gamlss.family

Examples

```
par(mfrow=c(2,2))
y<-seq(0.2,20,0.2)
plot(y, dPARETO2(y), type="l" , lwd=2)
q<-seq(0,20,0.2)
plot(q, pPARETO2(q), ylim=c(0,1), type="l", lwd=2)
p<-seq(0.0001,0.999,0.05)
plot(p, qPARETO2(p), type="l", lwd=2)
dat <- rPARETO2(100)
hist(rPARETO2(100), nclass=30)
#summary(gamlss(a~1, family="PARETO2"))
```

PE *Power Exponential distribution for fitting a GAMLSS*

Description

The functions define the Power Exponential distribution, a three parameter distribution, for a `gamlss.family` object to be used in GAMLSS fitting using the function `gamlss()`. The functions `dPE`, `pPE`, `qPE` and `rPE` define the density, distribution function, quantile function and random generation for the specific parameterization of the power exponential distribution showing below. The functions `dPE2`, `pPE2`, `qPE2` and `rPE2` define the density, distribution function, quantile function and random generation of a standard parameterization of the power exponential distribution.

Usage

```
PE(mu.link = "identity", sigma.link = "log", nu.link = "log")
dPE(x, mu = 0, sigma = 1, nu = 2, log = FALSE)
pPE(q, mu = 0, sigma = 1, nu = 2, lower.tail = TRUE, log.p = FALSE)
qPE(p, mu = 0, sigma = 1, nu = 2, lower.tail = TRUE, log.p = FALSE)
rPE(n, mu = 0, sigma = 1, nu = 2)
PE2(mu.link = "identity", sigma.link = "log", nu.link = "log")
dPE2(x, mu = 0, sigma = 1, nu = 2, log = FALSE)
pPE2(q, mu = 0, sigma = 1, nu = 2, lower.tail = TRUE, log.p = FALSE)
qPE2(p, mu = 0, sigma = 1, nu = 2, lower.tail = TRUE, log.p = FALSE)
rPE2(n, mu = 0, sigma = 1, nu = 2)
```

Arguments

`mu.link`	Defines the `mu.link`, with "identity" link as the default for the mu parameter
`sigma.link`	Defines the `sigma.link`, with "log" link as the default for the sigma parameter
`nu.link`	Defines the `nu.link`, with "log" link as the default for the nu parameter
`x,q`	vector of quantiles
`mu`	vector of location parameter values
`sigma`	vector of scale parameter values
`nu`	vector of kurtosis parameter
`log, log.p`	logical; if TRUE, probabilities p are given as log(p).
`lower.tail`	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
`p`	vector of probabilities.
`n`	number of observations. If `length(n) > 1`, the length is taken to be the number required

Details

Power Exponential distribution (PE) is defined as

$$f(y|\mu,\sigma,\nu) = \frac{\nu \exp[-(\frac{1}{2})|\frac{z}{c}|^{\nu}]}{\sigma c 2^{(1+1/\nu)}\Gamma(\frac{1}{\nu})}$$

where $c = [2^{-2/\nu}\Gamma(1/\nu)/\Gamma(3/\nu)]^{0.5}$, for $y = (-\infty, +\infty)$, $\mu = (-\infty, +\infty)$, $\sigma > 0$ and $\nu > 0$. This parametrization was used by Nelson (1991) and ensures μ is the mean and σ is the standard deviation of y (for all parameter values of μ, σ and ν within the rages above)

Thw Power Exponential distribution (PE2) is defined as

$$f(y|\mu,\sigma,\nu) = \frac{\nu \exp[-|z|^{\nu}]}{2\sigma\Gamma\left(\frac{1}{\nu}\right)}$$

Value

returns a `gamlss.family` object which can be used to fit a Power Exponential distribution in the `gamlss()` function.

Note

μ is the mean and σ is the standard deviation of the Power Exponential distribution

Author(s)

Mikis Stasinopoulos <d.stasinopoulos@londonmet.ac.uk>, Bob Rigby <r.rigby@londonmet.ac.uk>

References

Nelson, D.B. (1991) Conditional heteroskedasticity in asset returns: a new approach. *Econometrica*, **57**, 347-370.

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

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See Also

`gamlss.family`, `BCPE`

Examples

```
PE()# gives information about the default links for the Power Exponential distribution
# library(gamlss)
# data(abdom)
# h1<-gamlss(y~cs(x,df=3), sigma.formula=~cs(x,1), family=PE, data=abdom) # fit
# h2<-gamlss(y~cs(x,df=3), sigma.formula=~cs(x,1), family=PE2, data=abdom) # fit
# plot(h1)
# plot(h2)
# leptokurtotic
plot(function(x) dPE(x, mu=10,sigma=2,nu=1), 0.0, 20,
 main = "The PE  density mu=10,sigma=2,nu=1")
# platykurtotic
plot(function(x) dPE(x, mu=10,sigma=2,nu=4), 0.0, 20,
 main = "The PE  density mu=10,sigma=2,nu=4")
```

PIG *The Poisson-inverse Gaussian distribution for fitting a GAMLSS model*

Description

The `PIG()` function defines the Poisson-inverse Gaussian distribution, a two parameter distribution, for a `gamlss.family` object to be used in GAMLSS fitting using the function `gamlss()`. The functions `dPIG`, `pPIG`, `qPIG` and `rPIG` define the density, distribution function, quantile function and random generation for the Poisson-inverse Gaussian `PIG()`, distribution.

Usage

```
PIG(mu.link = "log", sigma.link = "log")
dPIG(x, mu = 0.5, sigma = 0.02, log = FALSE)
pPIG(q, mu = 0.5, sigma = 0.02, lower.tail = TRUE, log.p = FALSE)
qPIG(p, mu = 0.5, sigma = 0.02, lower.tail = TRUE, log.p = FALSE,
     max.value = 10000)
rPIG(n, mu = 0.5, sigma = 0.02)
```

Arguments

`mu.link`	Defines the `mu.link`, with "log" link as the default for the mu parameter
`sigma.link`	Defines the `sigma.link`, with "log" link as the default for the sigma parameter
`x`	vector of (non-negative integer) quantiles
`mu`	vector of positive means
`sigma`	vector of positive despersion parameter
`p`	vector of probabilities
`q`	vector of quantiles
`n`	number of random values to return
`log, log.p`	logical; if TRUE, probabilities p are given as log(p)

`lower.tail` logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]

`max.value` a constant, set to the default value of 10000 for how far the algorithm should look for q

Details

The probability function of the Poisson-inverse Gaussian distribution, is given by

$$f(y|\mu,\sigma) = \left(\frac{2\alpha}{\pi}^{\frac{1}{2}}\right) \frac{\mu^y e^{\frac{1}{\sigma}} K_{y-\frac{1}{2}}(\alpha)}{(\alpha\sigma)^y y!}$$

where $\alpha^2 = \frac{1}{\sigma^2} + \frac{2\mu}{\sigma}$, for $y = 0, 1, 2, ..., \infty$ where $\mu > 0$ and $\sigma > 0$ and $K_\lambda(t) = \frac{1}{2}\int_0^\infty x^{\lambda-1} \exp\{-\frac{1}{2}t(x + x^{-1})\}dx$ is the modified Bessel function of the third kind. [Note that the above parameterization was used by Dean, Lawless and Willmot(1989). It is also a special case of the Sichel distribution `SI()` when $\nu = -\frac{1}{2}$.]

Value

Returns a `gamlss.family` object which can be used to fit a Poisson-inverse Gaussian distribution in the `gamlss()` function.

Author(s)

Mikis Stasinopoulos ans Bob Rigby

References

Dean, C., Lawless, J. F. and Willmot, G. E., A mixed poisson-inverse-Gaussian regression model, *Canadian J. Statist.*, **17**, 2, pp 171-181

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Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

`gamlss.family`, `NBI`, `NBII`, `SI`, `SICHEL`

Examples

```
PIG()# gives information about the default links for the  Poisson-inverse Gaussian distribution
#plot the pdf using plot
plot(function(y) dPIG(y, mu=10, sigma = 1 ), from=0, to=50, n=50+1, type="h") # pdf
# plot the cdf
```

```
plot(seq(from=0,to=50),pPIG(seq(from=0,to=50), mu=10, sigma=1), type="h")   # cdf
# generate random sample
tN <- table(Ni <- rPIG(100, mu=5, sigma=1))
r <- barplot(tN, col='lightblue')
# fit a model to the data
# library(gamlss)
# gamlss(Ni~1,family=PIG)
```

PO *Poisson distribution for fitting a GAMLSS model*

Description

This function `PO` defines the Poisson distribution, an one parameter distribution, for a `gamlss.family` object to be used in GAMLSS fitting using the function `gamlss()`. The functions `dPO`, `pPO`, `qPO` and `rPO` define the density, distribution function, quantile function and random generation for the Poisson, `PO()`, distribution.

Usage

```
PO(mu.link = "log")
dPO(x, mu = 1, log = FALSE)
pPO(q, mu = 1, lower.tail = TRUE, log.p = FALSE)
qPO(p, mu = 1, lower.tail = TRUE, log.p = FALSE)
rPO(n, mu = 1)
```

Arguments

`mu.link`	Defines the `mu.link`, with "log" link as the default for the mu parameter
`x`	vector of (non-negative integer) quantiles
`mu`	vector of positive means
`p`	vector of probabilities
`q`	vector of quantiles
`n`	number of random values to return
`log, log.p`	logical; if TRUE, probabilities p are given as log(p)
`lower.tail`	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]

Details

Definition file for Poisson distribution.

$$f(y|\mu) = \frac{e^{-\mu}\mu^y}{\Gamma(y+1)}$$

for $y = 0, 1, 2, ...$ and $\mu > 0$.

Value

returns a `gamlss.family` object which can be used to fit a Poisson distribution in the `gamlss()` function.

Note

μ is the mean of the Poisson distribution

Author(s)

Bob Rigby <r.rigby@londonmet.ac.uk>, Mikis Stasinopoulos <d.stasinopoulos@londonmet.ac.uk>, and Kalliope Akantziliotou

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

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Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

`gamlss.family`, `NBI`, `NBII`, `SI`, `SICHEL`

Examples

```
PO()# gives information about the default links for the Poisson distribution
# fitting data using PO()

# plotting the distribution
plot(function(y) dPO(y, mu=10 ), from=0, to=20, n=20+1, type="h")
# creating random variables and plot them
tN <- table(Ni <- rPO(1000, mu=5))
 r <- barplot(tN, col='lightblue')
# library(gamlss)
# data(aids)
# h<-gamlss(y~cs(x,df=7)+qrt, family=PO, data=aids) # fits the constant+x+qrt model
# plot(h)
# pdf.plot(family=PO, mu=10, min=0, max=20, step=1)
```

RG *The Reverse Gumbel distribution for fitting a GAMLSS*

Description

The function RG defines the reverse Gumbel distribution, a two parameter distribution, for a gamlss.family object to be used in GAMLSS fitting using the function gamlss(). The functions dRG, pRG, qRG and rRG define the density, distribution function, quantile function and random generation for the specific parameterization of the reverse Gumbel distribution.

Usage

```
RG(mu.link = "identity", sigma.link = "log")
dRG(x, mu = 0, sigma = 1, log = FALSE)
pRG(q, mu = 0, sigma = 1, lower.tail = TRUE, log.p = FALSE)
qRG(p, mu = 0, sigma = 1, lower.tail = TRUE, log.p = FALSE)
rRG(n, mu = 0, sigma = 1)
```

Arguments

mu.link	Defines the mu.link, with "identity" link as the default for the mu parameter. other available link is "inverse", "log" and "own"
sigma.link	Defines the sigma.link, with "log" link as the default for the sigma parameter, other links are the "inverse", "identity" and "own"
x,q	vector of quantiles
mu	vector of location parameter values
sigma	vector of scale parameter values
log, log.p	logical; if TRUE, probabilities p are given as log(p).
lower.tail	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
p	vector of probabilities.
n	number of observations. If length(n) > 1, the length is taken to be the number required

Details

The specific parameterization of the reverse Gumbel distribution used in RG is

$$f(y|\mu,\sigma) = \frac{1}{\sigma}\,\exp\left\{-\left(\frac{y-\mu}{\sigma}\right) - \exp\left[-\frac{(y-\mu)}{\sigma}\right]\right\}$$

for $y = (-\infty, \infty)$, $\mu = (-\infty, +\infty)$ and $\sigma > 0$.

Value

RG() returns a gamlss.family object which can be used to fit a Gumbel distribution in the gamlss() function. dRG() gives the density, pGU() gives the distribution function, qRG() gives the quantile function, and rRG() generates random deviates.

Note

The mean of the distribution is $\mu + 0.57722\sigma$ and the variance is $\pi^2\sigma^2/6$.

Author(s)

Mikis Stasinopoulos `<d.stasinopoulos@londonmet.ac.uk>`, Bob Rigby `<r.rigby@londonmet.ac.uk>` and Calliope Akantziliotou

References

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See Also

`gamlss.family`

Examples

```
plot(function(x) dRG(x, mu=0,sigma=1), -3, 6,
 main = "{Reverse Gumbel  density mu=0,sigma=1}")
RG()# gives information about the default links for the Gumbel distribution
dat<-rRG(100, mu=10, sigma=2) # generates 100 random observations
# library(gamlss)
# gamlss(dat~1,family=RG) # fits a constant for each parameter mu and sigma
```

RGE   *Reverse generalized extreme family distribution for fitting a GAMLSS*

Description

The function `RGE` defines the reverse generalized extreme family distribution, a three parameter distribution, for a `gamlss.family` object to be used in GAMLSS fitting using the function `gamlss()`. The functions `dRGE`, `pRGE`, `qRGE` and `rRGE` define the density, distribution function, quantile function and random generation for the specific parameterization of the reverse generalized extreme distribution given in details below.

Usage

```
RGE(mu.link = "identity", sigma.link = "log", nu.link = "log")
dRGE(x, mu = 1, sigma = 0.1, nu = 1, log = FALSE)
pRGE(q, mu = 1, sigma = 0.1, nu = 1, lower.tail = TRUE, log.p = FALSE)
qRGE(p, mu = 1, sigma = 0.1, nu = 1, lower.tail = TRUE, log.p = FALSE)
rRGE(n, mu = 1, sigma = 0.1, nu = 1)
```

Arguments

`mu.link`	Defines the `mu.link`, with "identity" link as the default for the mu parameter
`sigma.link`	Defines the `sigma.link`, with "log" link as the default for the sigma parameter
`nu.link`	Defines the `nu.link`, with "log" link as the default for the nu parameter
`x,q`	vector of quantiles
`mu`	vector of location parameter values
`sigma`	vector of scale parameter values
`nu`	vector of the shape parameter values
`log, log.p`	logical; if TRUE, probabilities p are given as log(p).
`lower.tail`	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
`p`	vector of probabilities.
`n`	number of observations. If `length(n) > 1`, the length is taken to be the number required

Details

Definition file for reverse generalized extreme family distribution.

The probability density function of the generalized extreme value distribution is obtained from Johnson *et al.* (1995), Volume 2, p76, equation (22.184) [where $(\xi, \theta, \gamma) \longrightarrow (\mu, \sigma, \nu)$].

The probability density function of the reverse generalized extreme value distribution is then obtained by replacing y by -y and μ by $-\mu$.

Hence the probability density function of the reverse generalized extreme value distribution with $\nu > 0$ is given by

$$f(y|\mu, \sigma, \nu) = \frac{1}{\sigma}\left[1 + \frac{\nu(y-\mu)}{\sigma}\right]^{\frac{1}{\nu}-1} S_1(y|\mu, \sigma, \nu)$$

for

$$\mu - \frac{\sigma}{\nu} < y < \infty$$

where

$$S_1(y|\mu, \sigma, \nu) = \exp\left\{-\left[1 + \frac{\nu(y-\mu)}{\sigma}\right]^{\frac{1}{\nu}}\right\}$$

and where $-\infty < \mu < y + \frac{\sigma}{\nu}$, $\sigma > 0$ and $\nu > 0$. Note that only the case $\nu > 0$ is allowed here. The reverse generalized extreme value distribution is denoted as RGE(μ, σ, ν) or as Reverse Generalized.Extreme.Family(μ, σ, ν).

Note the the above distribution is a reparameterization of the three parameter Weibull distribution given by

$$f(y|\alpha_1, \alpha_2, \alpha_3) = \frac{\alpha_3}{\alpha_2}\left[\frac{y-\alpha_1}{\alpha_2}\right]^{\alpha_3-1} \exp\left[-\left(\frac{y-\alpha_1}{\alpha_2}\right)^{\alpha_3}\right]$$

given by setting $\alpha_1 = \mu - \sigma/\nu$, $\alpha_2 = \sigma/\nu$, $\alpha_3 = 1/\nu$.

Value

`RGE()` returns a `gamlss.family` object which can be used to fit a reverse generalized extreme distribution in the `gamlss()` function. `dRGE()` gives the density, `pRGE()` gives the distribution function, `qRGE()` gives the quantile function, and `rRGE()` generates random deviates.

Note

This distribution is very difficult to fit because the y values depends on the parameter values. The `RS()` and `CG()` algorithms are not appropriate for this type of problem.

Author(s)

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References

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See Also

`gamlss.family`

Examples

```
RGE()# gives information about the default links for the reverse generalized extreme family distribution
newdata<-rRGE(100,mu=0,sigma=1,nu=5) # generates 100 random observations
# library(gamlss)
# gamlss(newdata~1, family=RGE, method=mixed(5,50)) # difficult to converse
```

SEP *The Skew Power exponential (SEP) distribution for fitting a GAMLSS*

Description

This function defines the Skew Power exponential (SEP) distribution, a four parameter distribution, for a `gamlss.family` object to be used for a GAMLSS fitting using the function `gamlss()`. The functions `dSEP`, `pSEP`, `qSEP` and `rSEP` define the density, distribution function, quantile function and random generation for the Skew Power exponential (SEP) distribution.

Usage

```
SEP(mu.link = "identity", sigma.link = "log", nu.link = "identity",
    tau.link = "log")
dSEP(x, mu = 0, sigma = 1, nu = 0, tau = 2, log = FALSE)
pSEP(q, mu = 0, sigma = 1, nu = 0, tau = 2, lower.tail = TRUE,
     log.p = FALSE)
qSEP(p, mu = 0, sigma = 1, nu = 0, tau = 2, lower.tail = TRUE,
     log.p = FALSE, lower.limit = mu - 5 * sigma,
     upper.limit = mu + 5 * sigma)
rSEP(n, mu = 0, sigma = 1, nu = 0, tau = 2)
```

Arguments

`mu.link`	Defines the `mu.link`, with "identity" link as the default for the `mu` parameter. Other links are "$1/mu^2$" and "log"
`sigma.link`	Defines the `sigma.link`, with "log" link as the default for the `sigma` parameter. Other links are "inverse" and "identity"
`nu.link`	Defines the `nu.link`, with "identity" link as the default for the `nu` parameter. Other links are "$1/nu^2$" and "log"
`tau.link`	Defines the `tau.link`, with "log" link as the default for the `tau` parameter. Other links are "$1/tau^2$", and "identity
`x,q`	vector of quantiles
`mu`	vector of location parameter values
`sigma`	vector of scale parameter values
`nu`	vector of skewness `nu` parameter values
`tau`	vector of kurtosis `tau` parameter values
`log, log.p`	logical; if TRUE, probabilities p are given as log(p).
`lower.tail`	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
`p`	vector of probabilities.
`n`	number of observations. If `length(n) > 1`, the length is taken to be the number required
`lower.limit`	lower limit for the golden search to find quantiles from probabilities
`upper.limit`	upper limit for the golden search to find quantiles from probabilities

Details

The probability density function of the Skew Power exponential distribution, (SEP), is defined as

$$f(y|n,\mu,\sigma\,\nu,\tau) == \frac{z}{\sigma}\Phi(\omega)\; f_{EP}(z,0,1,\tau)$$

for $-\infty < y < \infty$, $\mu = (-\infty, +\infty)$, $\sigma > 0$, $\nu = (-\infty, +\infty)$ and $\tau > 0$. where $z = \frac{y-\mu}{\sigma}$, $\omega = sign(z)|z|^{\tau/2}\nu\sqrt{2/\tau}$ and $f_{EP}(z,0,1,\tau)$ is the pdf of an Exponential Power distribution.

Value

`SEP()` returns a `gamlss.family` object which can be used to fit the SEP distribution in the `gamlss()` function. `dSEP()` gives the density, `pSEP()` gives the distribution function, `qSEP()` gives the quantile function, and `rSEP()` generates random deviates.

Warning

The qSEP and rSEP are slow since they are relying on golden section for finding the quantiles

Author(s)

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References

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See Also

gamlss.family, JSU, BCT

Examples

```
SEP()   #
plot(function(x)dSEP(x, mu=0,sigma=1, nu=1, tau=2), -5, 5,
 main = "The SEP  density mu=0,sigma=1,nu=1, tau=2")
plot(function(x) pSEP(x, mu=0,sigma=1,nu=1, tau=2), -5, 5,
 main = "The BCPE  cdf mu=0, sigma=1, nu=1, tau=2")
dat <- rSEP(100,mu=10,sigma=1,nu=-1,tau=1.5)
# library(gamlss)
# gamlss(dat~1,family=SEP, control=gamlss.control(n.cyc=30))
```

SEP1 *The Skew Power exponential type 1-4 distribution for fitting a GAMLSS*

Description

These functions define the Skew Power exponential type 1 to 4 distributions. All of them are four parameter distributions and can be used to fit a GAMLSS model. The functions dSEP1, dSEP2, dSEP3 and dSEP4 define the probability distribution functions, the functions pSEP1, pSEP2, pSEP3 and pSEP4 define the cumulative distribution functions the functions qSEP1, qSEP2, qSEP3 and qSEP4 define the inverse cumulative distribution functions and the functions rSEP1, rSEP2, rSEP3 and rSEP4 define the random generation for the Skew exponential power distributions.

Usage

```
SEP1(mu.link = "identity", sigma.link = "log", nu.link = "identity",
     tau.link = "log")
dSEP1(x, mu = 0, sigma = 1, nu = 0, tau = 2, log = FALSE)
pSEP1(q, mu = 0, sigma = 1, nu = 0, tau = 2, lower.tail = TRUE,
     log.p = FALSE)
qSEP1(p, mu = 0, sigma = 1, nu = 0, tau = 2, lower.tail = TRUE,
     log.p = FALSE)
rSEP1(n, mu = 0, sigma = 1, nu = 0, tau = 2)

SEP2(mu.link = "identity", sigma.link = "log", nu.link = "identity",
      tau.link = "log")
dSEP2(x, mu = 0, sigma = 1, nu = 0, tau = 2, log = FALSE)
pSEP2(q, mu = 0, sigma = 1, nu = 0, tau = 2, lower.tail = TRUE,
      log.p = FALSE)
qSEP2(p, mu = 0, sigma = 1, nu = 0, tau = 2, lower.tail = TRUE,
      log.p = FALSE)
rSEP2(n, mu = 0, sigma = 1, nu = 0, tau = 2)

SEP3(mu.link = "identity", sigma.link = "log", nu.link = "log",
      tau.link = "log")
dSEP3(x, mu = 0, sigma = 1, nu = 2, tau = 2, log = FALSE)
pSEP3(q, mu = 0, sigma = 1, nu = 2, tau = 2, lower.tail = TRUE,
      log.p = FALSE)
qSEP3(p, mu = 0, sigma = 1, nu = 2, tau = 2, lower.tail = TRUE,
      log.p = FALSE)

SEP4(mu.link = "identity", sigma.link = "log", nu.link = "log",
      tau.link = "log")
dSEP4(x, mu = 0, sigma = 1, nu = 2, tau = 2, log = FALSE)
pSEP4(q, mu = 0, sigma = 1, nu = 2, tau = 2, lower.tail = TRUE,
      log.p = FALSE)
qSEP4(p, mu = 0, sigma = 1, nu = 2, tau = 2, lower.tail = TRUE,
```

```
        log.p = FALSE)
rSEP4(n, mu = 0, sigma = 1, nu = 2, tau = 2)
```

Arguments

`mu.link`	Defines the `mu.link`, with "identity" link as the default for the `mu` parameter. Other links are "inverse" and "log"
`sigma.link`	Defines the `sigma.link`, with "log" link as the default for the `sigma` parameter. Other links are "inverse" and "identity"
`nu.link`	Defines the `nu.link`, with "log" link as the default for the `nu` parameter. Other links are "identity" and "inverse"
`tau.link`	Defines the `tau.link`, with "log" link as the default for the `tau` parameter. Other links are "inverse", and "identity
`x,q`	vector of quantiles
`mu`	vector of location parameter values
`sigma`	vector of scale parameter values
`nu`	vector of skewness `nu` parameter values
`tau`	vector of kurtosis `tau` parameter values
`log, log.p`	logical; if TRUE, probabilities p are given as log(p).
`lower.tail`	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
`p`	vector of probabilities.
`n`	number of observations. If `length(n) > 1`, the length is taken to be the number required

Details

The probability density function of the Skew Power exponential distribution type 2, (`SEP2`), is defined as

$$f_Y(y|\mu, \sigma\, \nu, \tau) = \frac{\nu}{\sigma(1+\nu^2)2^{1/\tau}\Gamma(1+1/\tau)} \left\{ \exp\left(-\frac{1}{2}\left|\frac{\nu(y-\mu)}{\sigma}\right|^{\tau}\right) I(y<\mu) + \exp\left(-\frac{1}{2}\left|\frac{(y-\mu)}{\sigma\nu}\right|^{\tau}\right) I(y \geq \mu) \right\}$$

for $-\infty < y < \infty$, $\mu = (-\infty, +\infty)$, $\sigma > 0$, $\nu > 0)$ and $\tau > 0$.

Value

`SEP2()` returns a `gamlss.family` object which can be used to fit the SEP2 distribution in the `gamlss()` function. `dSEP2()` gives the density, `pSEP2()` gives the distribution function, `qSEP2()` gives the quantile function, and `rSEP2()` generates random deviates.

Author(s)

Bob Rigby <`r.rigby@londonmet.ac.uk`> and Mikis Stasinopoulos <`d.stasinopoulos@londonmet.ac.uk`>

References

Fernadez C., Osiewalski J. and Steel M.F.J.(1995) Modelling and inference with v-spherical distributions. *JASA*, **90**, pp 1331-1340.

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Stasinopoulos D. M. Rigby R. A. and Akantziliotou C. (2006) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.com/).

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

gamlss.family, SEP

Examples

```
SEP1()
curve(dSEP4(x, mu=5 ,sigma=1, nu=2, tau=1.5), -2, 10, main = "The SEP4  density mu=5 ,sigma=1, nu=1, tau=1.5")
# library(gamlss)
#y<- rSEP4(100, mu=5, sigma=1, nu=2, tau=1.5);hist(y)
#m1<-gamlss(y~1, family=SEP1, n.cyc=50)
#m2<-gamlss(y~1, family=SEP2, n.cyc=50)
#m3<-gamlss(y~1, family=SEP3, n.cyc=50)
#m4<-gamlss(y~1, family=SEP4, n.cyc=50)
#GAIC(m1,m2,m3,m4)
```

SHASH *The Sinh-Arcsinh (SHASH) distribution for fitting a GAMLSS*

Description

The Sinh-Arcsinh (SHASH) distribution is a four parameter distribution, for a `gamlss.family` object to be used for a GAMLSS fitting using the function `gamlss()`. The functions `dSHASH`, `pSHASH`, `qSHASH` and `rSHASH` define the density, distribution function, quantile function and random generation for the Sinh-Arcsinh (SHASH) distribution.

There are 3 different SHASH distributions implemented in GAMLSS.

Usage

```
SHASH(mu.link = "identity", sigma.link = "log", nu.link = "log",
      tau.link = "log")
dSHASH(x, mu = 0, sigma = 1, nu = 0.5, tau = 0.5, log = FALSE)
pSHASH(q, mu = 0, sigma = 1, nu = 0.5, tau = 0.5, lower.tail = TRUE,
     log.p = FALSE)
```

```
qSHASH(p, mu = 0, sigma = 1, nu = 0.5, tau = 0.5, lower.tail = TRUE,
     log.p = FALSE)
rSHASH(n, mu = 0, sigma = 1, nu = 0.5, tau = 0.5)

SHASHo(mu.link = "identity", sigma.link = "log", nu.link = "identity",
      tau.link = "log")
dSHASHo(x, mu = 0, sigma = 1, nu = 0, tau = 1, log = FALSE)
pSHASHo(q, mu = 0, sigma = 1, nu = 0, tau = 1, lower.tail = TRUE,
     log.p = FALSE)
qSHASHo(p, mu = 0, sigma = 1, nu = 0, tau = 1, lower.tail = TRUE,
     log.p = FALSE)
rSHASHo(n, mu = 0, sigma = 1, nu = 0, tau = 1)

SHASHo2(mu.link = "identity", sigma.link = "log", nu.link = "identity",
      tau.link = "log")
dSHASHo2(x, mu = 0, sigma = 1, nu = 0, tau = 1, log = FALSE)
pSHASHo2(q, mu = 0, sigma = 1, nu = 0, tau = 1, lower.tail = TRUE,
     log.p = FALSE)
qSHASHo2(p, mu = 0, sigma = 1, nu = 0, tau = 1, lower.tail = TRUE,
     log.p = FALSE)
rSHASHo2(n, mu = 0, sigma = 1, nu = 0, tau = 1)
```

Arguments

`mu.link`	Defines the `mu.link`, with "identity" link as the default for the `mu` parameter.
`sigma.link`	Defines the `sigma.link`, with "log" link as the default for the `sigma` parameter.
`nu.link`	Defines the `nu.link`, with "log" link as the default for the `nu` parameter.
`tau.link`	Defines the `tau.link`, with "log" link as the default for the `tau` parameter.
`x,q`	vector of quantiles
`mu`	vector of location parameter values
`sigma`	vector of scale parameter values
`nu`	vector of skewness `nu` parameter values
`tau`	vector of kurtosis `tau` parameter values
`log, log.p`	logical; if TRUE, probabilities p are given as log(p).
`lower.tail`	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
`p`	vector of probabilities.
`n`	number of observations. If `length(n) > 1`, the length is taken to be the number required

Details

The probability density function of the Sinh-Arcsinh distribution, (`SHASH`), Jones(2005), is defined as

$$f(y|\mu, \sigma\, \nu, \tau) = \frac{c}{\sqrt{2\pi}\sigma(1+z^2)^{1/2}} e^{-r^2/2}$$

where

$$r = \frac{1}{2}\left\{\exp\left[\tau \sinh^{-1}(z)\right] - \exp\left[-\nu \sinh^{-1}(z)\right]\right\}$$

and

$$c = \frac{1}{2}\left\{\tau \exp\left[\tau \sinh^{-1}(z)\right] + \nu \exp\left[-\nu \sinh^{-1}(z)\right]\right\}$$

and $z = (y-\mu)/\sigma$ for $-\infty < y < \infty$, $\mu = (-\infty, +\infty)$, $\sigma > 0$, $\nu > 0$ and $\tau > 0$.

The parameters μ and σ are the location and scale of the distribution. The parameter ν determines the left hand tail of the distribution with $\nu > 1$ indicating a lighter tail than the normal and $\nu < 1$ heavier tail than the normal. The parameter τ determines the right hand tail of the distribution in the same way.

The second form of the Sinh-Arcsinh distribution can be found in Jones and Pewsey (2009, p.2) denoted by `SHASHo` and the probability density function is defined as,

$$f(y|\mu,\sigma,\nu,\tau) = \frac{\tau}{\sigma}\frac{c}{\sqrt{2\pi}}\frac{1}{2\sqrt{1+z^2}}\exp\left(-\frac{r^2}{2}\right)$$

where

$$r = \sinh(\tau \ \mathrm{arcsin}(z) - \nu)$$

and

$$c = \cosh(\tau \, \mathrm{arcsin}(z) - \nu)$$

and $z = (y-\mu)/\sigma$ for $-\infty < y < \infty$, $\mu = (-\infty, +\infty)$, $\sigma > 0$, $\nu = (-\infty, +\infty)$ and $\tau > 0$.

The third form of the Sinh-Arcsinh distribution (Jones and Pewsey, 2009, p.8) divides the distribution by sigma for the density of the unstandardized variable. This distribution is denoted by `SHASHo2` and has pdf

$$f(y|\mu,\sigma,\nu,\tau) = \frac{c}{\sigma}\frac{\tau}{\sqrt{2\pi}}\frac{1}{\sqrt{1+z^2}} - \exp -\frac{r^2}{2}$$

where $z = (y-\mu)/(\sigma\tau)$, with r and c as for the pdf of the `SHASHo` distribution, for $-\infty < y < \infty$, $\mu = (-\infty, +\infty)$, $\sigma > 0$, $\nu = (-\infty, +\infty)$ and $\tau > 0$.

Value

`SHASH()` returns a `gamlss.family` object which can be used to fit the SHASH distribution in the `gamlss()` function. `dSHASH()` gives the density, `pSHASH()` gives the distribution function, `qSHASH()` gives the quantile function, and `rSHASH()` generates random deviates.

Warning

The qSHASH and rSHASH are slow since they are relying on golden section for finding the quantiles

Author(s)

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Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

gamlss.family, JSU, BCT

Examples

```
SHASH()   #
plot(function(x)dSHASH(x, mu=0,sigma=1, nu=1, tau=2), -5, 5,
 main = "The SHASH  density mu=0,sigma=1,nu=1, tau=2")
plot(function(x) pSHASH(x, mu=0,sigma=1,nu=1, tau=2), -5, 5,
 main = "The BCPE  cdf mu=0, sigma=1, nu=1, tau=2")
dat<-rSHASH(100,mu=10,sigma=1,nu=1,tau=1.5)
hist(dat)
# library(gamlss)
# gamlss(dat~1,family=SHASH, control=gamlss.control(n.cyc=30))
```

SI *The Sichel dustribution for fitting a GAMLSS model*

Description

The `SI()` function defines the Sichel distribution, a three parameter discrete distribution, for a `gamlss.family` object to be used in GAMLSS fitting using the function `gamlss()`. The functions `dSI`, `pSI`, `qSI` and `rSI` define the density, distribution function, quantile function and random generation for the Sichel `SI()`, distribution.

Usage

```
SI(mu.link = "log", sigma.link = "log", nu.link = "identity")
dSI(x, mu = 0.5, sigma = 0.02, nu = -0.5, log = FALSE)
pSI(q, mu = 0.5, sigma = 0.02, nu = -0.5, lower.tail = TRUE,
       log.p = FALSE)
qSI(p, mu = 0.5, sigma = 0.02, nu = -0.5, lower.tail = TRUE,
    log.p = FALSE, max.value = 10000)
rSI(n, mu = 0.5, sigma = 0.02, nu = -0.5)
```

Arguments

`mu.link`	Defines the `mu.link`, with "log" link as the default for the mu parameter
`sigma.link`	Defines the `sigma.link`, with "log" link as the default for the sigma parameter
`nu.link`	Defines the `nu.link`, with "identity" link as the default for the nu parameter
`x`	vector of (non-negative integer) quantiles
`mu`	vector of positive mu
`sigma`	vector of positive despersion parameter
`nu`	vector of nu
`p`	vector of probabilities
`q`	vector of quantiles
`n`	number of random values to return
`log, log.p`	logical; if TRUE, probabilities p are given as log(p)
`lower.tail`	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
`max.value`	a constant, set to the default value of 10000 for how far the algorithm should look for q

Details

The probability function of the Sichel distribution is given by

$$f(y|\mu,\sigma,\nu) = \frac{\mu^y K_{y+\nu}(\alpha)}{(\alpha\sigma)^{y+\nu} y! K_\nu(\frac{1}{\sigma})}$$

where $\alpha^2 = \frac{1}{\sigma^2} + \frac{2\mu}{\sigma}$, for $y = 0, 1, 2, ..., \infty$ where $\mu > 0$, $\sigma > 0$ and $-\infty < \nu < \infty$ and $K_\lambda(t) = \frac{1}{2}\int_0^\infty x^{\lambda-1} \exp\{-\frac{1}{2}t(x + x^{-1})\}dx$ is the modified Bessel function of the third kind. Note that the above parameterization is different from Stein, Zucchini and Juritz (1988) who use the above probability function but treat μ, α and ν as the parameters. Note that $\sigma = [(\mu^2+\alpha^2)^{\frac{1}{2}} - \mu]^{-1}$.

Value

Returns a `gamlss.family` object which can be used to fit a Sichel distribution in the `gamlss()` function.

Author(s)

Akantziliotou C., Rigby, R. A. and Stasinopoulos D. M.

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

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Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

Stein, G. Z., Zucchini, W. and Juritz, J. M. (1987). Parameter Estimation of the Sichel Distribution and its Multivariate Extension. *Journal of American Statistical Association*, **82**, 938-944.

See Also

gamlss.family, PIG, NBI, NBII

Examples

```
SI()# gives information about the default links for the  Sichel distribution
#plot the pdf using plot
plot(function(y) dSI(y, mu=10, sigma=1, nu=1), from=0, to=100, n=100+1, type="h") # pdf
# plot the cdf
plot(seq(from=0,to=100),pSI(seq(from=0,to=100), mu=10, sigma=1, nu=1), type="h")   # cdf
# generate random sample
tN <- table(Ni <- rSI(100, mu=5, sigma=1, nu=1))
r <- barplot(tN, col='lightblue')
# fit a model to the data
# library(gamlss)
# gamlss(Ni~1,family=SI, control=gamlss.control(n.cyc=50))
```

SICHEL *The Sichel distribution for fitting a GAMLSS model*

Description

The `SICHEL()` function defines the Sichel distribution, a three parameter discrete distribution, for a `gamlss.family` object to be used in GAMLSS fitting using the function `gamlss()`. The functions `dSICHEL`, `pSICHEL`, `qSICHEL` and `rSICHEL` define the density, distribution function, quantile function and random generation for the Sichel `SICHEL()`, distribution. The function `VSICHEL` gives the variance of a fitted Sichel model.

Usage

```
SICHEL(mu.link = "log", sigma.link = "log", nu.link = "identity")
dSICHEL(x, mu=1, sigma=1, nu=-0.5, log=FALSE)
pSICHEL(q, mu=1, sigma=1, nu=-0.5, lower.tail = TRUE,
         log.p = FALSE)
```

```
qSICHEL(p, mu=1, sigma=1, nu=-0.5,  lower.tail = TRUE,
        log.p = FALSE, max.value = 10000)
rSICHEL(n, mu=1, sigma=1, nu=-0.5, max.value = 10000)
VSICHEL(obj)
```

Arguments

`mu.link`	Defines the `mu.link`, with "log" link as the default for the mu parameter
`sigma.link`	Defines the `sigma.link`, with "log" link as the default for the sigma parameter
`nu.link`	Defines the `nu.link`, with "identity" link as the default for the nu parameter
`x`	vector of (non-negative integer) quantiles
`mu`	vector of positive mu
`sigma`	vector of positive despersion parameter
`nu`	vector of nu
`p`	vector of probabilities
`q`	vector of quantiles
`n`	number of random values to return
`log, log.p`	logical; if TRUE, probabilities p are given as log(p)
`lower.tail`	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
`max.value`	a constant, set to the default value of 10000 for how far the algorithm should look for q
`obj`	a fitted Sichel gamlss model

Details

The probability function of the Sichel distribution is given by

$$f(y|\mu, \sigma, \nu) = \frac{\mu^y K_{y+\nu}(\alpha)}{c^y(\alpha\sigma)^{y+\nu} y! K_\nu(\frac{1}{\sigma})}$$

where $\alpha^2 = \frac{1}{\sigma^2} + \frac{2\mu}{c\sigma}$, and $c = R_\nu(1/\sigma) = K_{\nu+1}(1/\sigma)\left[K_\nu(1/\sigma)\right]^{-1}$ for $y = 0, 1, 2, ..., \infty$ where $\mu > 0$, $\sigma > 0$ and $-\infty < \nu < \infty$ and $K_\lambda(t) = \frac{1}{2}\int_0^\infty x^{\lambda-1}\exp\{-\frac{1}{2}t(x + x^{-1})\}dx$ is the modified Bessel function of the third kind. Note that the above parameterization is different from Stein, Zucchini and Juritz (1988) who use the above probability function but treat μ, α and ν as the parameters.

Value

Returns a `gamlss.family` object which can be used to fit a Sichel distribution in the `gamlss()` function.

Note

The mean of the above Sichel distribution is μ and the variance is $\mu^2\left[\frac{2\sigma(\nu+1)}{c} + \frac{1}{c^2} - 1\right]$

Author(s)

Rigby, R. A., Stasinopoulos D. M. and Akantziliotou C.

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

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Stasinopoulos D. M., Rigby R.A. and Akantziliotou C. (2003) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.com/).

Stein, G. Z., Zucchini, W. and Juritz, J. M. (1987). Parameter Estimation of the Sichel Distribution and its Multivariate Extension. *Journal of American Statistical Association*, **82**, 938-944.

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See Also

gamlss.family, PIG , SI

Examples

```
SICHEL()# gives information about the default links for the  Sichel distribution
#plot the pdf using plot
plot(function(y) dSICHEL(y, mu=10, sigma=1, nu=1), from=0, to=100, n=100+1, type="h") # pdf
# plot the cdf
plot(seq(from=0,to=100),pSICHEL(seq(from=0,to=100), mu=10, sigma=1, nu=1), type="h")   # cdf
# generate random sample
tN <- table(Ni <- rSICHEL(100, mu=5, sigma=1, nu=1))
r <- barplot(tN, col='lightblue')
# fit a model to the data
# library(gamlss)
# gamlss(Ni~1,family=SICHEL, control=gamlss.control(n.cyc=50))
```

SN1 *Skew Normal Type 1 distribution for fitting a GAMLSS*

Description

The function SN1() defines the Skew Normal Type 1 distribution, a three parameter distribution, for a gamlss.family object to be used in GAMLSS fitting using the function gamlss(), with parameters mu, sigma and nu. The functions dSN1, pSN1, qSN1 and rSN1 define the density, distribution function, quantile function and random generation for the SN1 parameterization of the Skew Normal Type 1 distribution.

Usage

```
SN1(mu.link = "identity", sigma.link = "log", nu.link="identity")
dSN1(x, mu = 0, sigma = 1, nu = 0, log = FALSE)
pSN1(q, mu = 0, sigma = 1, nu = 0, lower.tail = TRUE, log.p = FALSE)
qSN1(p, mu = 0, sigma = 1, nu = 0, lower.tail = TRUE, log.p = FALSE)
rSN1(n, mu = 0, sigma = 1, nu = 0)
```

Arguments

`mu.link`	Defines the `mu.link`, with "‘identity"’ links the default for the mu parameter
`sigma.link`	Defines the `sigma.link`, with "‘log"’ as the default for the sigma parameter
`nu.link`	Defines the `nu.link`, with "‘identity"’ as the default for the sigma parameter
`x, q`	vector of quantiles
`mu`	vector of location parameter values
`sigma`	vector of scale parameter values
`nu`	vector of scale parameter values
`log, log.p`	logical; if TRUE, probabilities p are given as log(p)
`lower.tail`	logical; if TRUE (default), probabilities are P[X <= x], otherwise P[X > x]
`p`	vector of probabilities
`n`	number of observations. If `length(n) > 1`, the length is taken to be the number required

Details

The parameterization of the Skew Normal Type 1 distribution in the function `SN1` is ...

Value

returns a gamlss.family object which can be used to fit a Skew Normal Type 1 distribution in the `gamlss()` function.

Note

This is a special case of the Skew Exponential Power type 1 distribution (`SEP1`)where `tau=2`.

Author(s)

Mikis Stasinopoulos, Bob Rigby and Fiona McElduff

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Stasinopoulos D. M., Rigby R.A. and Akantziliotou C. (2006) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.com/).

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

gamlss.family

Examples

```
par(mfrow=c(2,2))
y<-seq(-3,3,0.2)
plot(y, dSN1(y), type="l" , lwd=2)
q<-seq(-3,3,0.2)
plot(q, pSN1(q), ylim=c(0,1), type="l", lwd=2)
p<-seq(0.0001,0.999,0.05)
plot(p, qSN1(p), type="l", lwd=2)
dat <- rSN1(100)
hist(rSN1(100), nclass=30)
```

SN2 *Skew Normal Type 2 distribution for fitting a GAMLSS*

Description

The function SN2() defines the Skew Normal Type 2 distribution, a three parameter distribution, for a gamlss.family object to be used in GAMLSS fitting using the function gamlss(), with parameters mu, sigma and nu. The functions dSN2, pSN2, qSN2 and rSN2 define the density, distribution function, quantile function and random generation for the SN2 parameterization of the Skew Normal Type 2 distribution.

Usage

```
SN2(mu.link = "identity", sigma.link = "log", nu.link = "log")
dSN2(x, mu = 0, sigma = 1, nu = 2, log = FALSE)
pSN2(q, mu = 0, sigma = 1, nu = 2, lower.tail = TRUE, log.p = FALSE)
qSN2(p, mu = 0, sigma = 1, nu = 2, lower.tail = TRUE, log.p = FALSE)
rSN2(n, mu = 0, sigma = 1, nu = 2)
```

Arguments

mu.link	Defines the mu.link, with "‘identity"’ links the default for the mu parameter
sigma.link	Defines the sigma.link, with "‘log"’ as the default for the sigma parameter
nu.link	Defines the nu.link, with "‘log"’ as the default for the sigma parameter
x, q	vector of quantiles
mu	vector of location parameter values
sigma	vector of scale parameter values
nu	vector of scale parameter values
log, log.p	logical; if TRUE, probabilities p are given as log(p)
lower.tail	logical; if TRUE (default), probabilities are P[X <= x], otherwise P[X > x]
p	vector of probabilities
n	number of observations. If length(n) > 1, the length is taken to be the number required

Details

The parameterization of the Skew Normal Type 2 distribution in the function SN2 is ...

Value

returns a gamlss.family object which can be used to fit a Skew Normal Type 2 distribution in the gamlss() function.

Note

This is a special case of the Skew Exponential Power type 3 distribution (SEP3)where tau=2.

Author(s)

Mikis Stasinopoulos, Bob Rigby and Fiona McElduff.

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Stasinopoulos D. M., Rigby R.A. and Akantziliotou C. (2006) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.com/).

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

gamlss.family

Examples

```
par(mfrow=c(2,2))
y<-seq(-3,3,0.2)
plot(y, dSN2(y), type="l" , lwd=2)
q<-seq(-3,3,0.2)
plot(q, pSN2(q), ylim=c(0,1), type="l", lwd=2)
p<-seq(0.0001,0.999,0.05)
plot(p, qSN2(p), type="l", lwd=2)
dat <- rSN2(100)
hist(rSN2(100), nclass=30)
```

ST1 *The skew t distributions, type 1 to 5*

Description

There are 5 different skew t distributions implemented in GAMLSS.

The Skew t type 3 distribution Jones and Faddy (2003). The functions `dST3`, `pST3`, `qST3` and `rST3` define the density, distribution function, quantile function and random generation for the skew t distribution type 3. The `SST` is a reparametrised version of `dST3` where `sigma` is the standard deviation of the distribution.

Usage

```
ST1(mu.link = "identity", sigma.link = "log", nu.link = "identity", tau.link="log")
dST1(x, mu = 0, sigma = 1, nu = 0, tau = 2, log = FALSE)
pST1(q, mu = 0, sigma = 1, nu = 0, tau = 2, lower.tail = TRUE, log.p = FALSE)
qST1(p, mu = 0, sigma = 1, nu = 0, tau = 2, lower.tail = TRUE, log.p = FALSE)
rST1(n, mu = 0, sigma = 1, nu = 0, tau = 2)

ST2(mu.link = "identity", sigma.link = "log", nu.link = "identity", tau.link = "log")
dST2(x, mu = 0, sigma = 1, nu = 0, tau = 2, log = FALSE)
pST2(q, mu = 0, sigma = 1, nu = 0, tau = 2, lower.tail = TRUE, log.p = FALSE)
qST2(p, mu = 1, sigma = 1, nu = 0, tau = 2, lower.tail = TRUE, log.p = FALSE)
rST2(n, mu = 0, sigma = 1, nu = 0, tau = 2)

ST3(mu.link = "identity", sigma.link = "log", nu.link = "log", tau.link = "log")
dST3(x, mu = 0, sigma = 1, nu = 1, tau = 10, log = FALSE)
pST3(q, mu = 0, sigma = 1, nu = 1, tau = 10, lower.tail = TRUE, log.p = FALSE)
qST3(p, mu = 0, sigma = 1, nu = 1, tau = 10, lower.tail = TRUE, log.p = FALSE)
rST3(n, mu = 0, sigma = 1, nu = 1, tau = 10)

SST(mu.link = "identity", sigma.link = "log", nu.link = "log",
   tau.link = "logshiftto2")
dSST(x, mu = 0, sigma = 1, nu = 0.8, tau = 7, log = FALSE)
pSST(q, mu = 0, sigma = 1, nu = 0.8, tau = 7, lower.tail = TRUE, log.p = FALSE)
qSST(p, mu = 0, sigma = 1, nu = 0.8, tau = 7, lower.tail = TRUE, log.p = FALSE)
```

```
rSST(n, mu = 0, sigma = 1, nu = 0.8, tau = 7)

ST4(mu.link = "identity", sigma.link = "log", nu.link = "log", tau.link = "log")
dST4(x, mu = 0, sigma = 1, nu = 1, tau = 10, log = FALSE)
pST4(q, mu = 0, sigma = 1, nu = 1, tau = 10, lower.tail = TRUE, log.p = FALSE)
qST4(p, mu = 0, sigma = 1, nu = 1, tau = 10, lower.tail = TRUE, log.p = FALSE)
rST4(n, mu = 0, sigma = 1, nu = 1, tau = 10)

ST5(mu.link = "identity", sigma.link = "log", nu.link = "identity", tau.link = "log")
dST5(x, mu = 0, sigma = 1, nu = 0, tau = 1, log = FALSE)
pST5(q, mu = 0, sigma = 1, nu = 0, tau = 1, lower.tail = TRUE, log.p = FALSE)
qST5(p, mu = 0, sigma = 1, nu = 0, tau = 1, lower.tail = TRUE, log.p = FALSE)
rST5(n, mu = 0, sigma = 1, nu = 0, tau = 1)
```

Arguments

`mu.link`	Defines the `mu.link`, with "identity" link as the default for the `mu` parameter. Other links are "$1/mu^2$" and "log"
`sigma.link`	Defines the `sigma.link`, with "log" link as the default for the `sigma` parameter. Other links are "inverse" and "identity"
`nu.link`	Defines the `nu.link`, with "identity" link as the default for the `nu` parameter. Other links are "$1/mu^2$" and "log"
`tau.link`	Defines the `nu.link`, with "log" link as the default for the `nu` parameter. Other links are "inverse", "identity"
`x,q`	vector of quantiles
`mu`	vector of `mu` parameter values
`sigma`	vector of scale parameter values
`nu`	vector of `nu` parameter values
`tau`	vector of `tau` parameter values
`log, log.p`	logical; if TRUE, probabilities p are given as log(p).
`lower.tail`	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
`p`	vector of probabilities.
`n`	number of observations. If `length(n) > 1`, the length is taken to be the number required
`...`	for extra arguments

Details

The probability density function of the skew t distribution type 1, (`ST1`), Azzalini (1986) is defined as

$$f(y|\mu,\sigma,\nu,\tau) = \frac{z}{\sigma}\ f_z(z)\ F_z(\nu z)$$

for $-\infty < y < \infty$ and $z \sim TF(0,1,\tau)$ has a t distribution with $\tau > 0$ degrees of freedom with τ treated as a continuous parameter.

The probability density function of the skew t distribution type 2, (ST2), Azzalini and Capitano (2003), is defined as

$$f(y|\mu, \sigma, \nu, \frac{z}{\sigma}\; f_{z_1}(z)\; F_{z_2}(w)\tau) =$$

for $-\infty < y < \infty$, where $z = (y-\mu)/\sigma$, $w = \nu\lambda^{1/2}z$, $\lambda = (\tau+1)/(\tau+z^2)$ and $z_1 \sim TF(0,1,\tau)$ and $z_2 \sim TF(0,1,\tau+1)$.

The probability density function of the skew t distribution type q, (ST3), is defined in Chapter 10 of the GAMLSS manual.

The probability density function of the skew t distribution type q, (ST4), is defined in Chapter of the GAMLSS manual.

The probability density function of the skew t distribution type 5, (ST5), is defined as

$$f(y|\mu, \sigma, \nu, \tau) = \frac{1}{c}\left[1 + \frac{z}{(a+b+z^2)^{1/2}}\right]^{a+1/2}\left[1 - \frac{z}{(a+b+z^2)^{1/2}}\right]^{b+1/2}$$

where $c = 2^{a+b-1}(a+b)^{1/2}B(a,b)$, and $B(a,b) = \Gamma(a)\Gamma(b)/\Gamma(a+b)$ and $z = (y-\mu)/\sigma$ and $\nu = (a-b)/\left[ab(a+b)\right]^{1/2}$ and $\tau = 2/(a+b)$ for $-\infty < y < \infty$, $-\infty < \mu < \infty$, $\sigma > 0$, $-\infty < \nu > \infty$ and $\tau > 0$.

Value

`ST1()`, `ST2()`, `ST3()`, `ST4()` and `ST5()` return a `gamlss.family` object which can be used to fit the skew t type 1-5 distribution in the `gamlss()` function. `dST1()`, `dST2()`, `dST3()`, `dST4()` and `dST5()` give the density functions, `pST1()`, `pST2()`, `pST3()`, `pST4()` and `pST5()` give the cumulative distribution functions, `qST1()`, `qST2()`, `qST3()`, `qST4()` and `qST5()` give the quantile function, and `rST1()`, `rST2()`, `rST3()`, `rST4()` and `rST3()` generates random deviates.

Note

The mean of the ex-Gaussian is $\mu + \nu$ and the variance is $\sigma^2 + \nu^2$.

Author(s)

Bob Rigby and Mikis Stasinopoulos

References

Jones, M.C. and Faddy, M. J. (2003) A skew extension of the t distribution, with applications. *Journal of the Royal Statistical Society*, Series B, **65**, pp 159-174.

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

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Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

gamlss.family, BCCG, GA, IG LNO

Examples

```
y<- rST5(200, mu=5, sigma=1, nu=.1)
hist(y)
curve(dST5(x, mu=30 ,sigma=5,nu=-1), -50, 50, main = "The ST5  density mu=30 ,sigma=5,nu=1")
# library(gamlss)
# m1<-gamlss(y~1, family=ST1)
# m2<-gamlss(y~1, family=ST2)
# m3<-gamlss(y~1, family=ST3)
# m4<-gamlss(y~1, family=ST4)
# m5<-gamlss(y~1, family=ST5)
# GAIC(m1,m2,m3,m4,m5)
```

TF *t family distribution for fitting a GAMLSS*

Description

The function TF defines the t-family distribution, a three parameter distribution, for a gamlss.family object to be used in GAMLSS fitting using the function gamlss(). The functions dTF, pTF, qTF and rTF define the density, distribution function, quantile function and random generation for the specific parameterization of the t distribution given in details below, with mean equal to μ and standard deviation equal to $\sigma(\frac{\nu}{\nu-2})^{0.5}$ with the degrees of freedom ν The function TF2 is a different parametrization where sigma is the standard deviation.

Usage

```
TF(mu.link = "identity", sigma.link = "log", nu.link = "log")
dTF(x, mu = 0, sigma = 1, nu = 10, log = FALSE)
pTF(q, mu = 0, sigma = 1, nu = 10, lower.tail = TRUE, log.p = FALSE)
qTF(p, mu = 0, sigma = 1, nu = 10, lower.tail = TRUE, log.p = FALSE)
rTF(n, mu = 0, sigma = 1, nu = 10)

TF2(mu.link = "identity", sigma.link = "log", nu.link = "logshiftto2")
dTF2(x, mu = 0, sigma = 1, nu = 10, log = FALSE)
pTF2(q, mu = 0, sigma = 1, nu = 10, lower.tail = TRUE, log.p = FALSE)
qTF2(p, mu = 0, sigma = 1, nu = 10, lower.tail = TRUE, log.p = FALSE)
rTF2(n, mu = 0, sigma = 1, nu = 10)
```

Arguments

mu.link	Defines the mu.link, with "identity" link as the default for the mu parameter
sigma.link	Defines the sigma.link, with "log" link as the default for the sigma parameter

nu.link	Defines the nu.link, with "log" link as the default for the nu parameter
x,q	vector of quantiles
mu	vector of location parameter values
sigma	vector of scale parameter values
nu	vector of the degrees of freedom parameter values
log, log.p	logical; if TRUE, probabilities p are given as log(p).
lower.tail	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
p	vector of probabilities.
n	number of observations. If length(n) > 1, the length is taken to be the number required

Details

Definition file for t family distribution.

$$f(y|\mu,\sigma,\nu) = \frac{\Gamma((\nu+1)/2)}{\sigma\Gamma(1/2)\Gamma(\nu/2)\nu^{0.5}}\left[1+\frac{(y-\mu)^2}{\nu\sigma^2}\right]^{-(\nu+1)/2}$$

$y = (-\infty, +\infty)$, $\mu = (-\infty, +\infty)$, $\sigma > 0$ and $\nu > 0$. Note that $z = (y-\mu)/\sigma$ has a standard t distribution with degrees of freedom ν.

Value

TF() returns a gamlss.family object which can be used to fit a t distribution in the gamlss() function. dTF() gives the density, pTF() gives the distribution function, qTF() gives the quantile function, and rTF() generates random deviates. The latest functions are based on the equivalent R functions for gamma distribution.

Note

μ is the mean and $\sigma[\nu/(\nu-2)]^{0.5}$ is the standard deviation of the t family distribution. $\nu > 0$ is a positive real valued parameter.

Author(s)

Mikis Stasinopoulos <d.stasinopoulos@londonmet.ac.uk>, Bob Rigby <r.rigby@londonmet.ac.uk> and Kalliope Akantziliotou

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

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Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

gamlss.family

Examples

```
TF()# gives information about the default links for the t-family distribution
# library(gamlss)
#data(abdom)
#h<-gamlss(y~cs(x,df=3), sigma.formula=~cs(x,1), family=TF, data=abdom) # fits
#plot(h)
newdata<-rTF(1000,mu=0,sigma=1,nu=5) # generates 1000 random observations
hist(newdata)
```

WARING *Waring distribution for fitting a GAMLSS model*

Description

The function `WARING()` defines the Waring distribution, a two parameter distribution, for a `gamlss.family` object to be used in GAMLSS fitting using the function `gamlss()`, with mean equal to the parameter `mu` and scale parameter `sigma`. The functions `dWARING`, `pWARING`, `qWARING` and `rWARING` define the density, distribution function, quantile function and random generation for the `WARING` parameterization of the Waring distribution.

Usage

```
WARING(mu.link = "log", sigma.link = "log")
dWARING(x, mu = 2, sigma = 2, log = FALSE)
pWARING(q, mu = 2, sigma = 2, lower.tail = TRUE, log.p = FALSE)
qWARING(p, mu = 2, sigma = 2, lower.tail = TRUE, log.p = FALSE,
    max.value = 10000)
rWARING(n, mu = 2, sigma = 2)
```

Arguments

`mu.link`	Defines the `mu.link`, with "log" link as the default for the mu parameter
`sigma.link`	Defines the `sigma.link`, with "log" link as the default for the sigma parameter
`x`	vector of (non-negative integer) quantiles.
`q`	vector of quantiles.
`p`	vector of probabilities.
`n`	number of random values to return.
`mu`	vector of positive `mu` values.
`sigma`	vector of positive `sigma` values.
`lower.tail`	logical; if `TRUE` (default) probabilities are $P[Y \leq y]$, otherwise, $P[Y > y]$.
`log, log.p`	logical; if `TRUE` probabilities p are given as log(p).
`max.value`	constant; generates a sequence of values for the cdf function.

Details

The Waring distribution has density,

$$f(y|\mu,\sigma) = \frac{(1-\sigma)\,\Gamma(y+\frac{\mu}{\sigma})\,\Gamma(\frac{\mu+\sigma+1}{\sigma})}{\sigma\,\Gamma(y+\frac{\mu+1}{\sigma}+2)\,\Gamma(\frac{\mu}{\sigma})}$$

for $y = 0, 1, 2, \ldots, mu > 0$ and $sigma > 0$.

Value

Returns a `gamlss.family` object which can be used to fit a Waring distribution in the `gamlss()` function.

Author(s)

Fiona McElduff, Bob Rigby and Mikis Stasinopoulos. <f.mcelduff@ich.ucl.ac.uk>

References

Wimmer, G. and Altmann, G. (1999) *Thesaurus of univariate discrete probability distributions.* Stamm.

See Also

`gamlss.family`

Examples

```
par(mfrow=c(2,2))
y<-seq(0,20,1)
plot(y, dWARING(y), type="h")
q <- seq(0, 20, 1)
plot(q, pWARING(q), type="h")
p<-seq(0.0001,0.999,0.05)
plot(p , qWARING(p), type="s")
dat <- rWARING(100)
hist(dat)
#summary(gamlss(dat~1, family=WARING))
```

WEI *Weibull distribution for fitting a GAMLSS*

Description

The function `WEI` can be used to define the Weibull distribution, a two parameter distribution, for a `gamlss.family` object to be used in GAMLSS fitting using the function `gamlss()`. [Note that the GAMLSS function `WEI2` uses a different parameterization for fitting the Weibull distribution.] The functions `dWEI`, `pWEI`, `qWEI` and `rWEI` define the density, distribution function, quantile function and random generation for the specific parameterization of the Weibul distribution.

Usage

```
WEI(mu.link = "log", sigma.link = "log")
dWEI(x, mu = 1, sigma = 1, log = FALSE)
pWEI(q, mu = 1, sigma = 1, lower.tail = TRUE, log.p = FALSE)
qWEI(p, mu = 1, sigma = 1, lower.tail = TRUE, log.p = FALSE)
rWEI(n, mu = 1, sigma = 1)
```

Arguments

`mu.link`	Defines the `mu.link`, with "log" link as the default for the mu parameter, other links are "inverse", "identity" and "own"
`sigma.link`	Defines the `sigma.link`, with "log" link as the default for the sigma parameter, other link is the "inverse", "identity" and "own"
`x,q`	vector of quantiles
`mu`	vector of the mu parameter
`sigma`	vector of sigma parameter
`log, log.p`	logical; if TRUE, probabilities p are given as log(p).
`lower.tail`	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
`p`	vector of probabilities.
`n`	number of observations. If `length(n) > 1`, the length is taken to be the number required

Details

The parameterization of the function `WEI` is given by

$$f(y|\mu,\sigma) = \frac{\sigma y^{\sigma-1}}{\mu^{\sigma}} \ \exp\left[-\left(\frac{y}{\mu}\right)^{\sigma}\right]$$

for $y > 0$, $\mu > 0$ and $\sigma > 0$. The GAMLSS functions `dWEI`, `pWEI`, `qWEI`, and `rWEI` can be used to provide the pdf, the cdf, the quantiles and random generated numbers for the Weibull distribution with argument `mu`, and `sigma`. [See the GAMLSS function `WEI2` for a different parameterization of the Weibull.]

Value

`WEI()` returns a `gamlss.family` object which can be used to fit a Weibull distribution in the `gamlss()` function. `dWEI()` gives the density, `pWEI()` gives the distribution function, `qWEI()` gives the quantile function, and `rWEI()` generates random deviates. The latest functions are based on the equivalent `R` functions for Weibull distribution.

Note

The mean in `WEI` is given by $\mu\Gamma(\frac{1}{\sigma}+1)$ and the variance $\mu^2\left[\Gamma(\frac{2}{\sigma}+1)-(\Gamma(\frac{1}{\sigma}+1))^2\right]$

Author(s)

Mikis Stasinopoulos <d.stasinopoulos@londonmet.ac.uk>, Bob Rigby <r.rigby@londonmet.ac.uk> and Calliope Akantziliotou

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Stasinopoulos D. M., Rigby R.A. and Akantziliotou C. (2006) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.com/).

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

gamlss.family, WEI2, WEI3

Examples

```
WEI()
dat<-rWEI(100, mu=10, sigma=2)
# library(gamlss)
# gamlss(dat~1, family=WEI)
```

WEI2 — *A specific parameterization of the Weibull distribution for fitting a GAMLSS*

Description

The function WEI2 can be used to define the Weibull distribution, a two parameter distribution, for a gamlss.family object to be used in GAMLSS fitting using the function gamlss(). This is the parameterization of the Weibull distribution usually used in proportional hazard models and is defined in details below. [Note that the GAMLSS function WEI uses a different parameterization for fitting the Weibull distribution.] The functions dWEI2, pWEI2, qWEI2 and rWEI2 define the density, distribution function, quantile function and random generation for the specific parameterization of the Weibull distribution.

Usage

```
WEI2(mu.link = "log", sigma.link = "log")
dWEI2(x, mu = 1, sigma = 1, log = FALSE)
pWEI2(q, mu = 1, sigma = 1, lower.tail = TRUE, log.p = FALSE)
qWEI2(p, mu = 1, sigma = 1, lower.tail = TRUE, log.p = FALSE)
rWEI2(n, mu = 1, sigma = 1)
```

Arguments

`mu.link`	Defines the `mu.link`, with "log" link as the default for the mu parameter, other links are "inverse" and "identity"
`sigma.link`	Defines the `sigma.link`, with "log" link as the default for the sigma parameter, other link is the "inverse" and "identity"
`x,q`	vector of quantiles
`mu`	vector of the mu parameter values
`sigma`	vector of sigma parameter values
`log, log.p`	logical; if TRUE, probabilities p are given as log(p).
`lower.tail`	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
`p`	vector of probabilities.
`n`	number of observations. If `length(n) > 1`, the length is taken to be the number required

Details

The parameterization of the function `WEI2` is given by

$$f(y|\mu, \sigma) = \sigma \mu y^{\sigma-1} e^{-\mu y^{\sigma}}$$

for $y > 0$, $\mu > 0$ and $\sigma > 0$. The GAMLSS functions `dWEI2`, `pWEI2`, `qWEI2`, and `rWEI2` can be used to provide the pdf, the cdf, the quantiles and random generated numbers for the Weibull distribution with argument `mu`, and `sigma`. [See the GAMLSS function `WEI` for a different parameterization of the Weibull.]

Value

`WEI2()` returns a `gamlss.family` object which can be used to fit a Weibull distribution in the `gamlss()` function. `dWEI2()` gives the density, `pWEI2()` gives the distribution function, `qWEI2()` gives the quantile function, and `rWEI2()` generates random deviates. The latest functions are based on the equivalent `R` functions for Weibull distribution.

Warning

In `WEI2` the estimated parameters `mu` and `sigma` can be highly correlated so it is advisable to use the `CG()` method for fitting [as the RS() method can be veru slow in this situation.]

Note

The mean in `WEI2` is given by $\mu^{-1/\sigma}\Gamma(\frac{1}{\sigma}+1)$ and the variance $\mu^{-2/\sigma}(\Gamma(\frac{2}{\sigma}+1) - \left[\Gamma(\frac{1}{\sigma}+1)\right]^2)$

Author(s)

Mikis Stasinopoulos <d.stasinopoulos@londonmet.ac.uk>, Bob Rigby <r.rigby@londonmet.ac.uk> and Calliope Akantziliotou

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Stasinopoulos D. M., Rigby R.A. and Akantziliotou C. (2006) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.com/).

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

gamlss.family, WEI,WEI3,

Examples

```
WEI2()
dat<-rWEI(100, mu=.1, sigma=2)
hist(dat)
# library(gamlss)
# gamlss(dat~1, family=WEI2, method=CG())
```

WEI3 *A specific parameterization of the Weibull distribution for fitting a GAMLSS*

Description

The function WEI3 can be used to define the Weibull distribution, a two parameter distribution, for a gamlss.family object to be used in GAMLSS fitting using the function gamlss(). This is a parameterization of the Weibull distribution where μ is the mean of the distribution. [Note that the GAMLSS functions WEI and WEI2 use different parameterizations for fitting the Weibull distribution.] The functions dWEI3, pWEI3, qWEI3 and rWEI3 define the density, distribution function, quantile function and random generation for the specific parameterization of the Weibull distribution.

Usage

```
WEI3(mu.link = "log", sigma.link = "log")
dWEI3(x, mu = 1, sigma = 1, log = FALSE)
pWEI3(q, mu = 1, sigma = 1, lower.tail = TRUE, log.p = FALSE)
qWEI3(p, mu = 1, sigma = 1, lower.tail = TRUE, log.p = FALSE)
rWEI3(n, mu = 1, sigma = 1)
```

Arguments

`mu.link`	Defines the `mu.link`, with "log" link as the default for the mu parameter, other links are "inverse" and "identity"
`sigma.link`	Defines the `sigma.link`, with "log" link as the default for the sigma parameter, other link is the "inverse" and "identity"
`x,q`	vector of quantiles
`mu`	vector of the mu parameter values
`sigma`	vector of sigma parameter values
`log, log.p`	logical; if TRUE, probabilities p are given as log(p).
`lower.tail`	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
`p`	vector of probabilities.
`n`	number of observations. If `length(n) > 1`, the length is taken to be the number required

Details

The parameterization of the function `WEI3` is given by

$$f(y|\mu, \sigma) = \frac{\sigma}{\beta} \left(\frac{y}{\beta}\right)^{\sigma-1} e^{-\left(\frac{y}{\beta}\right)^{\sigma}}$$

where $\beta = \frac{\mu}{\Gamma((1/\sigma)+1)}$ for $y > 0$, $\mu > 0$ and $\sigma > 0$. The GAMLSS functions `dWEI3`, `pWEI3`, `qWEI3`, and `rWEI3` can be used to provide the pdf, the cdf, the quantiles and random generated numbers for the Weibull distribution with argument `mu`, and `sigma`. [See the GAMLSS function `WEI` for a different parameterization of the Weibull.]

Value

`WEI3()` returns a `gamlss.family` object which can be used to fit a Weibull distribution in the `gamlss()` function. `dWEI3()` gives the density, `pWEI3()` gives the distribution function, `qWEI3()` gives the quantile function, and `rWEI3()` generates random deviates. The latest functions are based on the equivalent `R` functions for Weibull distribution.

Warning

In `WEI3` the estimated parameters `mu` and `sigma` can be highly correlated so it is advisable to use the `CG()` method for fitting [as the RS() method can be very slow in this situation.]

Note

The mean in `WEI3` is given by μ and the variance $\mu^2 \left\{\Gamma(2/\sigma + 1)/ \left[\Gamma(1/\sigma + 1)\right]^2 - 1\right\}$

Author(s)

Bob Rigby <r.rigby@londonmet.ac.uk> and Mikis Stasinopoulos <d.stasinopoulos@londonmet.ac.uk>

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Stasinopoulos D. M., Rigby R.A. and Akantziliotou C. (2006) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.com/).

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

gamlss.family, WEI, WEI2

Examples

```
WEI3()
dat<-rWEI(100, mu=.1, sigma=2)
# library(gamlss)
# gamlss(dat~1, family=WEI3, method=CG())
```

YULE *Yule distribution for fitting a GAMLSS model*

Description

The function YULE defines the Yule distribution, a one parameter distribution, for a gamlss.family object to be used in GAMLSS fitting using the function gamlss(), with mean equal to the parameter mu. The functions dYULE, pYULE, qYULE and rYULE define the density, distribution function, quantile function and random generation for the YULE parameterization of the Yule distribution.

Usage

```
YULE(mu.link = "log")
dYULE(x, mu = 2, log = FALSE)
pYULE(q, mu = 2, lower.tail = TRUE, log.p = FALSE)
qYULE(p, mu = 2, lower.tail = TRUE, log.p = FALSE,
    max.value = 10000)
rYULE(n, mu = 2)
```

Arguments

mu.link	Defines the mu.link, with "log" link as the default for the mu parameter
x	vector of (non-negative integer) quantiles.
q	vector of quantiles.

p	vector of probabilities.
n	number of random values to return.
mu	vector of positive mu values.
lower.tail	logical; if TRUE (default) probabilities are $P[Y \leq y]$, otherwise, $P[Y > y]$.
log, log.p	logical; if TRUE probabilities p are given as log(p).
max.value	constant; generates a sequence of values for the cdf function.

Details

The Yule distribution has density

$$p(y) = beta(lambda + 1, x + 1)/beta(lambda, 1)$$

where

$$lambda = (mu + 1)/mu$$

for $y = 0, 1, 2, \ldots$ and $mu > 0$.

Value

Returns a gamlss.family object which can be used to fit a Yule distribution in the gamlss() function.

Author(s)

Fiona McElduff, Bob Rigby and Mikis Stasinopoulos.

References

Wimmer, G. and Altmann, G. (1999) *Thesaurus of univariate discrete probability distributions.* Stamm.

See Also

gamlss.family

Examples

```
par(mfrow=c(2,2))
y<-seq(0,20,1)
plot(y, dYULE(y), type="h")
q <- seq(0, 20, 1)
plot(q, pYULE(q), type="h")
p<-seq(0.0001,0.999,0.05)
plot(p , qYULE(p), type="s")
dat <- rYULE(100)
hist(dat)
#summary(gamlss(dat~1, family=YULE))
```

ZABB *Zero inflated and zero adjusted Binomial distribution for fitting in GAMLSS*

Description

The function ZIBB defines the zero inflated beta binomial distribution, a three parameter distribution, for a gamlss.family object to be used in GAMLSS fitting using the function gamlss(). The functions dZIBB, pZIBB, qZIBB and rZINN define the density, distribution function, quantile function and random generation for the zero inflated beta binomial, ZIBB, distribution.

The function ZABB defines the zero adjusted beta binomial distribution, a three parameter distribution, for a gamlss.family object to be used in GAMLSS fitting using the function gamlss(). The functions dZABB, pZABB, qZABB and rZABB define the density, distribution function, quantile function and random generation for the zero inflated beta binomial, ZABB(), distribution.

Usage

```
ZABB(mu.link = "logit", sigma.link = "log", nu.link = "logit")
ZIBB(mu.link = "logit", sigma.link = "log", nu.link = "logit")

dZIBB(x, mu = 0.5, sigma = 0.5, nu = 0.1, bd = 1, log = FALSE)
dZABB(x, mu = 0.5, sigma = 0.1, nu = 0.1, bd = 1, log = FALSE)

pZIBB(q, mu = 0.5, sigma = 0.5, nu = 0.1, bd = 1, lower.tail = TRUE, log.p = FALSE)
pZABB(q, mu = 0.5, sigma = 0.1, nu = 0.1, bd = 1, lower.tail = TRUE, log.p = FALSE)

qZIBB(p, mu = 0.5, sigma = 0.5, nu = 0.1, bd = 1, lower.tail = TRUE, log.p = FALSE)
qZABB(p, mu = 0.5, sigma = 0.1, nu = 0.1, bd = 1, lower.tail = TRUE, log.p = FALSE)

rZIBB(n, mu = 0.5, sigma = 0.5, nu = 0.1, bd = 1)
rZABB(n, mu = 0.5, sigma = 0.1, nu = 0.1, bd = 1)
```

Arguments

mu.link	Defines the mu.link, with "logit" link as the default for the mu parameter. Other links are "probit" and "cloglog"'(complementary log-log)
sigma.link	Defines the sigma.link, with "log" link as the default for the sigma parameter.
nu.link	Defines the sigma.link, with "logit" link as the default for the mu parameter. Other links are "probit" and "cloglog"'(complementary log-log)
x	vector of (non-negative integer) quantiles
mu	vector of positive probabilities
sigma	vector of positive dispertion parameter
nu	vector of positive probabilities
bd	vector of binomial denominators

p	vector of probabilities
q	vector of quantiles
n	number of random values to return
log, log.p	logical; if TRUE, probabilities p are given as log(p)
lower.tail	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]

Details

For the definition of the distributions see Rigby and Stasinopoulos (2010) below.

Value

The functions ZIBB and ZABB return a gamlss.family object which can be used to fit a zero inflated or zero adjusted beta binomial distribution respectively in the gamlss() function.

Author(s)

Mikis Stasinopoulos <d.stasinopoulos@londonmet.ac.uk>, Bob Rigby <r.rigby@londonmet.ac.uk>

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Stasinopoulos D. M., Rigby R.A. and Akantziliotou C. (2006) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.com/).

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

Rigby, R. A. and Stasinopoulos D. M. (2010) The gamlss.family distributions, (distributed with this package or see http://www.gamlss.com/)

See Also

gamlss.family, NBI, NBII

Examples

```
ZIBB()
ZABB()
# creating data and plotting them
 dat <- rZIBB(1000, mu=.5, sigma=.5, nu=0.1, bd=10)
   r <- barplot(table(dat), col='lightblue')
dat1 <- rZABB(1000, mu=.5, sigma=.2, nu=0.1, bd=10)
   r1 <- barplot(table(dat1), col='lightblue')
```

ZABI — *Zero inflated and zero adjusted Binomial distribution for fitting in GAMLSS*

Description

The ZABI() function defines the zero adjusted binomial distribution, a two parameter distribution, for a gamlss.family object to be used in GAMLSS fitting using the function gamlss(). The functions dZABI, pZABI, qZABI and rZABI define the density, distribution function, quantile function and random generation for the zero adjusted binomial, ZABI(), distribution.

The ZIBI() function defines the zero inflated binomial distribution, a two parameter distribution, for a gamlss.family object to be used in GAMLSS fitting using the function gamlss(). The functions dZIBI, pZIBI, qZIBI and rZIBI define the density, distribution function, quantile function and random generation for the zero inflated binomial, ZIBI(), distribution.

Usage

```
 ZABI(mu.link = "logit", sigma.link = "logit")
dZABI(x, bd = 1, mu = 0.5, sigma = 0.1, log = FALSE)
pZABI(q, bd = 1, mu = 0.5, sigma = 0.1, lower.tail = TRUE, log.p = FALSE)
qZABI(p, bd = 1, mu = 0.5, sigma = 0.1, lower.tail = TRUE, log.p = FALSE)
rZABI(n, bd = 1, mu = 0.5, sigma = 0.1)

 ZIBI(mu.link = "logit", sigma.link = "logit")
dZIBI(x, bd = 1, mu = 0.5, sigma = 0.1, log = FALSE)
pZIBI(q, bd = 1, mu = 0.5, sigma = 0.1, lower.tail = TRUE, log.p = FALSE)
qZIBI(p, bd = 1, mu = 0.5, sigma = 0.1, lower.tail = TRUE, log.p = FALSE)
rZIBI(n, bd = 1, mu = 0.5, sigma = 0.1)
```

Arguments

mu.link	Defines the mu.link, with "logit" link as the default for the mu parameter. Other links are "probit" and "cloglog"'(complementary log-log)
sigma.link	Defines the sigma.link, with "logit" link as the default for the mu parameter. Other links are "probit" and "cloglog"'(complementary log-log)
x	vector of (non-negative integer) quantiles
mu	vector of positive probabilities
sigma	vector of positive probabilities
bd	vector of binomial denominators
p	vector of probabilities
q	vector of quantiles
n	number of random values to return
log, log.p	logical; if TRUE, probabilities p are given as log(p)
lower.tail	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]

Details

For the definition of the distributions see Rigby and Stasinopoulos (2010) below.

Value

The functions `ZABI` and `ZIBI` return a `gamlss.family` object which can be used to fit a binomial distribution in the `gamlss()` function.

Note

The response variable should be a matrix containing two columns, the first with the count of successes and the second with the count of failures.

Author(s)

Mikis Stasinopoulos, Bob Rigby

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Stasinopoulos D. M., Rigby R.A. and Akantziliotou C. (2006) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.com/).

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

Rigby, R. A. and Stasinopoulos D. M. (2010) The gamlss.family distributions, (distributed with this package or see http://www.gamlss.com/)

See Also

`gamlss.family`, `BI`

Examples

```
ZABI()
curve(dZABI(x, mu = .5, bd=10), from=0, to=10, n=10+1, type="h")
tN <- table(Ni <- rZABI(1000, mu=.2, sigma=.3, bd=10))
r <- barplot(tN, col='lightblue')

ZIBI()
curve(dZIBI(x, mu = .5, bd=10), from=0, to=10, n=10+1, type="h")
tN <- table(Ni <- rZIBI(1000, mu=.2, sigma=.3, bd=10))
r <- barplot(tN, col='lightblue')
```

ZAGA *The zero adjusted Gamma distribution for fitting a GAMLSS model*

Description

The function ZAGA() defines the zero adjusted Gamma distribution, a three parameter distribution, for a gamlss.family object to be used in GAMLSS fitting using the function gamlss(). The zero adjusted Gamma distribution is similar to the Gamma distribution but allows zeros as y values. The extra parameter nu models the probabilities at zero. The functions dZAGA, pZAGA, qZAGA and rZAGA define the density, distribution function, quartile function and random generation for the ZAGA parameterization of the zero adjusted Gamma distribution. plotZAGA can be used to plot the distribution. meanZAGA calculates the expected value of the response for a fitted model.

Usage

```
ZAGA(mu.link = "log", sigma.link = "log", nu.link = "logit")
dZAGA(x, mu = 1, sigma = 1, nu = 0.1, log = FALSE)
pZAGA(q, mu = 1, sigma = 1, nu = 0.1, lower.tail = TRUE,
      log.p = FALSE)
qZAGA(p, mu = 1, sigma = 1, nu = 0.1, lower.tail = TRUE,
       log.p = FALSE,
       upper.limit = mu + 10 * sqrt(sigma^2 * mu^2))
rZAGA(n, mu = 1, sigma = 1, nu = 0.1, ...)
plotZAGA(mu = 5, sigma = 1, nu = 0.1, from = 0, to = 10,
          n = 101, ...)
meanZAGA(obj)
```

Arguments

mu.link	Defines the mu.link, with "log" link as the default for the mu parameter
sigma.link	Defines the sigma.link, with "log" link as the default for the sigma parameter
nu.link	Defines the nu.link, with "logit" link as the default for the sigma parameter
x,q	vector of quantiles
mu	vector of location parameter values
sigma	vector of scale parameter values
nu	vector of probability at zero parameter values
log, log.p	logical; if TRUE, probabilities p are given as log(p).
lower.tail	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]
upper.limit	the argument upper.limit sets the upper limit in the golden section search for q, the default is 10 time its standard deviation
p	vector of probabilities.
n	number of observations. If length(n) > 1, the length is taken to be the number required

from	where to start plotting the distribution from
to	up to where to plot the distribution
obj	a fitted gamlss object
...	... can be used to pass the uppr.limit argument to qIG

Details

The Zero adjusted GA distribution is given as

$$f(y|\mu, \sigma\, \nu) = \nu$$

if (y=0)

$$f(y|\mu, \sigma, \nu) = (1-\nu)\left[\frac{1}{(\sigma^2\mu)^{1/\sigma^2}}\ \frac{y^{\frac{1}{\sigma^2}-1}\ e^{-y/(\sigma^2\mu)}}{\Gamma(1/\sigma^2)}\right]$$

otherwise

for $y = (0, \infty)$, $\mu > 0$, $\sigma > 0$ and $0 < \nu < 1$. $E(y) = (1-\nu)\mu$ and $Var(y) = (1-\nu)\mu^2(\nu+\sigma^2)$.

Value

The function ZAGA returns a gamlss.family object which can be used to fit a zero adjusted Gamma distribution in the gamlss() function.

Author(s)

Bob Rigby and Mikis Stasinopoulos

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Stasinopoulos D. M., Rigby R.A. and Akantziliotou C. (2006) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.com/).

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

gamlss.family, GA, ZAIG

Examples

```
ZAGA()# gives information about the default links for the ZAGA distribution
# plotting the function
PPP <- par(mfrow=c(2,2))
plotZAGA(mu=1, sigma=.5, nu=.2, from=0,to=3)
#curve(dZAGA(x,mu=1, sigma=.5, nu=.2), 0,3) # pdf
```

```
curve(pZAGA(x,mu=1, sigma=.5, nu=.2), 0,3,  ylim=c(0,1)) # cdf
curve(qZAGA(x,mu=1, sigma=.5, nu=.2), 0,.99) # inverse cdf
y<-rZAGA(100, mu=1, sigma=.5, nu=.2) # randomly generated values
hist(y)
par(PPP)
# check that the  positive part sums up to .8 (since nu=0.2)
integrate(function(x) dZAGA(x,mu=1, sigma=.5, nu=.2), 0,Inf)
```

ZAIG *The zero adjusted Inverse Gaussian distribution for fitting a GAMLSS model*

Description

The function ZAIG() defines the zero adjusted Inverse Gaussian distribution, a three parameter distribution, for a gamlss.family object to be used in GAMLSS fitting using the function gamlss(). The zero adjusted Inverse Gaussian distribution is similar to the Inverse Gaussian distribution but allows zeros as y values. The extra parameter models the probabilities at zero. The functions dZAIG, pZAIG, qZAIG and rZAIG define the density, distribution function, quantile function and random generation for the ZAIG parameterization of the zero adjusted Inverse Gaussian distribution. plotZAIG can be used to plot the distribution. meanZAIG calculates the expected value of the response for a fitted model.

Usage

```
ZAIG(mu.link = "log", sigma.link = "log", nu.link = "logit")
dZAIG(x, mu = 1, sigma = 1, nu = 0.1, log = FALSE)
pZAIG(q, mu = 1, sigma = 1, nu = 0.1, lower.tail = TRUE, log.p = FALSE)
qZAIG(p, mu = 1, sigma = 1, nu = 0.1, lower.tail = TRUE, log.p = FALSE,
     upper.limit = mu + 10 * sqrt(sigma^2 * mu^3))
rZAIG(n, mu = 1, sigma = 1, nu = 0.1, ...)
plotZAIG(mu = 5, sigma = 1, nu = 0.1, from = 0, to = 10, n = 101, ...)
meanZAIG(obj)
```

Arguments

mu.link	Defines the mu.link, with "log" link as the default for the mu parameter
sigma.link	Defines the sigma.link, with "log" link as the default for the sigma parameter
nu.link	Defines the nu.link, with "logit" link as the default for the sigma parameter
x,q	vector of quantiles
mu	vector of location parameter values
sigma	vector of scale parameter values
nu	vector of probability at zero parameter values
log, log.p	logical; if TRUE, probabilities p are given as log(p).
lower.tail	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]

`upper.limit`	the argument `upper.limit` sets the upper limit in the golden section search for q, the default is 10 time its standard deviation
`p`	vector of probabilities.
`n`	number of observations. If `length(n) > 1`, the length is taken to be the number required
`from`	where to start plotting the distribution from
`to`	up to where to plot the distribution
`obj`	a fitted `BEINF` object
`...`	... can be used to pass the uppr.limit argument to `qIG`

Details

The Zero adjusted IG distribution is given as

$$f(y|\mu, \sigma\, \nu) = \nu$$

if (y=0)

$$f(y|\mu, \sigma, \nu) = (1-\nu)\frac{1}{\sqrt{2\pi\sigma^2 y^3}} \exp(-\frac{(y-\mu)^2}{2\mu^2\sigma^2 y})$$

otherwise

for $y = (0, \infty)$, $\mu > 0$, $\sigma > 0$ and $0 < \nu < 1$. $E(y) = (1-\nu)\mu$ and $Var(y) = (1-\nu)\mu^2(\nu+\mu\sigma^2)$.

Value

returns a `gamlss.family` object which can be used to fit a zero adjusted inverse Gaussian distribution in the `gamlss()` function.

Author(s)

Bob Rigby and Mikis Stasinopoulos

References

Heller, G. Stasinopoulos M and Rigby R.A. (2006) The zero-adjusted Inverse Gaussian distribution as a model for insurance claims. in *Proceedings of the 21th International Workshop on Statistial Modelling*, eds J. Hinde, J. Einbeck and J. Newell, pp 226-233, Galway, Ireland.

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Stasinopoulos D. M., Rigby R.A. and Akantziliotou C. (2006) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.com/).

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

gamlss.family, IG

Examples

```
ZAIG()# gives information about the default links for the ZAIG distribution
# plotting the distribution
plotZAIG( mu =10 , sigma=.5, nu = 0.1, from = 0, to=10, n = 101)
# plotting the cdf
plot(function(y) pZAIG(y, mu=10 ,sigma=.5, nu = 0.1 ), 0, 1)
# plotting the inverse cdf
plot(function(y) qZAIG(y, mu=10 ,sigma=.5, nu = 0.1 ), 0.001, .99)
# generate random numbers
dat <- rZAIG(100,mu=10,sigma=.5, nu=.1)
# fit a model to the data
# library(gamlss)
# m1<-gamlss(dat~1,family=ZAIG)
# meanZAIG(m1)[1]
```

ZANBI *Zero inflated and zero adjusted negative binomial distributions for fitting a GAMLSS model*

Description

The function ZINBI defines the zero inflated negative binomial distribution, a three parameter distribution, for a gamlss.family object to be used in GAMLSS fitting using the function gamlss(). The functions dZINBI, pZINBI, qZINBI and rZINBI define the density, distribution function, quantile function and random generation for the zero inflated negative binomial, ZINBI(), distribution.

The function ZANBI defines the zero adjusted negative binomial distribution, a three parameter distribution, for a gamlss.family object to be used in GAMLSS fitting using the function gamlss(). The functions dZANBI, pZANBI, qZANBI and rZANBI define the density, distribution function, quantile function and random generation for the zero inflated negative binomial, ZANBI(), distribution.

Usage

```
ZINBI(mu.link = "log", sigma.link = "log", nu.link = "logit")
dZINBI(x, mu = 1, sigma = 1, nu = 0.3, log = FALSE)
pZINBI(q, mu = 1, sigma = 1, nu = 0.3, lower.tail = TRUE, log.p = FALSE)
qZINBI(p, mu = 1, sigma = 1, nu = 0.3, lower.tail = TRUE, log.p = FALSE)
rZINBI(n, mu = 1, sigma = 1, nu = 0.3)
ZANBI(mu.link = "log", sigma.link = "log", nu.link = "logit")
dZANBI(x, mu = 1, sigma = 1, nu = 0.3, log = FALSE)
pZANBI(q, mu = 1, sigma = 1, nu = 0.3, lower.tail = TRUE, log.p = FALSE)
qZANBI(p, mu = 1, sigma = 1, nu = 0.3, lower.tail = TRUE, log.p = FALSE)
rZANBI(n, mu = 1, sigma = 1, nu = 0.3)
```

Arguments

`mu.link`	Defines the `mu.link`, with "log" link as the default for the mu parameter
`sigma.link`	Defines the `sigma.link`, with "log" link as the default for the sigma parameter
`nu.link`	Defines the `mu.link`, with "logit" link as the default for the nu parameter
`x`	vector of (non-negative integer) quantiles
`mu`	vector of positive means
`sigma`	vector of positive despersion parameter
`nu`	vector of zero probability parameter
`p`	vector of probabilities
`q`	vector of quantiles
`n`	number of random values to return
`log, log.p`	logical; if TRUE, probabilities p are given as log(p)
`lower.tail`	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]

Details

The definition for the zero inflated Negative Binomial type I distribution and for the zero adjusted Negative Binomial type I distribution is given in Rigby and Stasinopoulos (2010) below

Value

The functions `ZINBI` and `ZANBI` return a `gamlss.family` object which can be used to fit a zero inflated or zero adjusted Negative Binomial type I distribution respectively in the `gamlss()` function.

Author(s)

Mikis Stasinopoulos <`d.stasinopoulos@londonmet.ac.uk`>, Bob Rigby <`r.rigby@londonmet.ac.uk`>

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Stasinopoulos D. M., Rigby R.A. and Akantziliotou C. (2006) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.com/).

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

Rigby, R. A. and Stasinopoulos D. M. (2010) The gamlss.family distributions, (distributed with this package or see http://www.gamlss.com/)

See Also

`gamlss.family`, `NBI`, `NBII`

Examples

```
ZINBI()
ZANBI()
# creating data and plotting them
 dat <- rZINBI(1000, mu=5, sigma=.5, nu=0.1)
   r <- barplot(table(dat), col='lightblue')
dat1 <- rZANBI(1000, mu=5, sigma=.5, nu=0.1)
   r1 <- barplot(table(dat1), col='lightblue')
```

ZAP *Zero adjusted poisson distribution for fitting a GAMLSS model*

Description

The function ZAP defines the zero adjusted Poisson distribution, a two parameter distribution, for a gamlss.family object to be used in GAMLSS fitting using the function gamlss(). The functions dZAP, pZAP, qZAP and rZAP define the density, distribution function, quantile function and random generation for the inflated poisson, ZAP(), distribution.

Usage

```
ZAP(mu.link = "log", sigma.link = "logit")
dZAP(x, mu = 5, sigma = 0.1, log = FALSE)
pZAP(q, mu = 5, sigma = 0.1, lower.tail = TRUE, log.p = FALSE)
qZAP(p, mu = 5, sigma = 0.1, lower.tail = TRUE, log.p = FALSE)
rZAP(n, mu = 5, sigma = 0.1)
```

Arguments

mu.link	defines the mu.link, with "log" link as the default for the mu parameter
sigma.link	defines the sigma.link, with "logit" link as the default for the sigma parameter which in this case is the probability at zero. Other links are "probit" and "cloglog"'(complementary log-log)
x	vector of (non-negative integer)
mu	vector of positive means
sigma	vector of probabilities at zero
p	vector of probabilities
q	vector of quantiles
n	number of random values to return
log, log.p	logical; if TRUE, probabilities p are given as log(p)
lower.tail	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]

Details

For the definition of the distribution see Rigby and Stasinopoulos (2010) below.

Value

The function ZAP returns a gamlss.family object which can be used to fit a zero inflated poisson distribution in the gamlss() function.

Author(s)

Mikis Stasinopoulos <d.stasinopoulos@londonmet.ac.uk>, Bob Rigby <r.rigby@londonmet.ac.uk>

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Stasinopoulos D. M., Rigby R.A. and Akantziliotou C. (2006) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.com/).

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

Rigby, R. A. and Stasinopoulos D. M. (2010) The gamlss.family distributions, (distributed with this package or see http://www.gamlss.com/)

See Also

gamlss.family, PO, ZIP, ZIP2, ZALG

Examples

```
ZAP()
# creating data and plotting them
dat<-rZAP(1000, mu=5, sigma=.1)
r <- barplot(table(dat), col='lightblue')
```

ZIP *Zero inflated poisson distribution for fitting a GAMLSS model*

Description

The function ZIP defines the zero inflated Poisson distribution, a two parameter distribution, for a gamlss.family object to be used in GAMLSS fitting using the function gamlss(). The functions dZIP, pZIP, qZIP and rZIP define the density, distribution function, quantile function and random generation for the inflated poisson, ZIP(), distribution.

Usage

```
ZIP(mu.link = "log", sigma.link = "logit")
dZIP(x, mu = 5, sigma = 0.1, log = FALSE)
pZIP(q, mu = 5, sigma = 0.1, lower.tail = TRUE, log.p = FALSE)
qZIP(p, mu = 5, sigma = 0.1, lower.tail = TRUE, log.p = FALSE)
rZIP(n, mu = 5, sigma = 0.1)
```

Arguments

`mu.link`	defines the `mu.link`, with "log" link as the default for the `mu` parameter
`sigma.link`	defines the `sigma.link`, with "logit" link as the default for the sigma parameter which in this case is the probability at zero. Other links are "probit" and "cloglog"'(complementary log-log)
`x`	vector of (non-negative integer) quantiles
`mu`	vector of positive means
`sigma`	vector of probabilities at zero
`p`	vector of probabilities
`q`	vector of quantiles
`n`	number of random values to return
`log, log.p`	logical; if TRUE, probabilities p are given as log(p)
`lower.tail`	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]

Details

Let $Y = 0$ with probability σ and $Y \sim Po(\mu)$ with probability $(1-\sigma)$ the Y has a Zero inflated Poisson Distribution given by

$$f(y) = \sigma + (1-\sigma)e^{-\mu}$$

if (y=0)

$$f(y) = (1-\sigma)\frac{e^{-\mu}\mu^y}{y!}$$

if (y>0) for $y = 0, 1, ...,$.

Value

returns a `gamlss.family` object which can be used to fit a zero inflated poisson distribution in the `gamlss()` function.

Author(s)

Mikis Stasinopoulos <`d.stasinopoulos@londonmet.ac.uk`>, Bob Rigby <`r.rigby@londonmet.ac.uk`>

References

Lambert, D. (1992), Zero-inflated Poisson Regression with an application to defects in Manufacturing, *Technometrics*, **34**, pp 1-14.

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Stasinopoulos D. M., Rigby R.A. and Akantziliotou C. (2006) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.com/).

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

gamlss.family, PO, ZIP2

Examples

```
ZIP()# gives information about the default links for the normal distribution
# creating data and plotting them
dat<-rZIP(1000, mu=5, sigma=.1)
r <- barplot(table(dat), col='lightblue')
# library(gamlss)
# fit the distribution
# mod1<-gamlss(dat~1, family=ZIP)# fits a constant for mu and sigma
# fitted(mod1)[1]
# fitted(mod1,"sigma")[1]
```

ZIP2 *Zero inflated poisson distribution for fitting a GAMLSS model*

Description

The function ZIP2 defines the zero inflated Poisson type 2 distribution, a two parameter distribution, for a gamlss.family object to be used in GAMLSS fitting using the function gamlss(). The functions dZIP2, pZIP2, qZIP2 and rZIP2 define the density, distribution function, quantile function and random generation for the inflated poisson, ZIP2(), distribution. The ZIP2 is a different parameterization of the ZIP distribution. In the ZIP2 the mu is the mean of the distribution.

Usage

```
ZIP2(mu.link = "log", sigma.link = "logit")
dZIP2(x, mu = 5, sigma = 0.1, log = FALSE)
pZIP2(q, mu = 5, sigma = 0.1, lower.tail = TRUE, log.p = FALSE)
qZIP2(p, mu = 5, sigma = 0.1, lower.tail = TRUE, log.p = FALSE)
rZIP2(n, mu = 5, sigma = 0.1)
```

Arguments

`mu.link`	defines the `mu.link`, with "log" link as the default for the `mu` parameter
`sigma.link`	defines the `sigma.link`, with "logit" link as the default for the sigma parameter which in this case is the probability at zero. Other links are "probit" and "cloglog"'(complementary log-log)
`x`	vector of (non-negative integer) quantiles
`mu`	vector of positive means
`sigma`	vector of probabilities at zero
`p`	vector of probabilities
`q`	vector of quantiles
`n`	number of random values to return
`log, log.p`	logical; if TRUE, probabilities p are given as log(p)
`lower.tail`	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]

Details

Let $Y = 0$ with probability σ and $Y \sim Po(\mu/\left[1-\sigma\right])$ with probability $(1-\sigma)$ then Y has a Zero inflated Poisson type 2 distribution given by

$$f(y|\mu,\sigma) = \sigma + (1-\sigma)e^{-\mu/(1-\sigma)} \quad \text{if } y = 0$$

$$f(y|\mu,\sigma) = (1-\sigma)\frac{e^{-\mu/(1-\sigma)}\left[\mu/(1-\sigma)\right]^y}{y!} \quad \text{if } y = 1, 2, 3, \ldots$$

The mean of the distribution in this parameterization is `mu`.

Value

returns a `gamlss.family` object which can be used to fit a zero inflated poisson distribution in the `gamlss()` function.

Author(s)

Bob Rigby, Gillian Heller and Mikis Stasinopoulos

References

Lambert, D. (1992), Zero-inflated Poisson Regression with an application to defects in Manufacturing, *Technometrics*, **34**, pp 1-14.

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Stasinopoulos D. M., Rigby R.A. and Akantziliotou C. (2006) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.com/).

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

See Also

gamlss.family, ZIP

Examples

```
ZIP2()# gives information about the default links for the normal distribution
# creating data and plotting them
dat<-rZIP2(1000, mu=5, sigma=.1)
r <- barplot(table(dat), col='lightblue')
# fit the disteibution
# library(gamlss)
# mod1<-gamlss(dat~1, family=ZIP2)# fits a constant for mu and sigma
# fitted(mod1)[1]
# fitted(mod1,"sigma")[1]
```

ZIPIG — *Zero inflated Poisson inverse Gaussian distributions for fitting a GAMLSS model*

Description

The function ZIPIG defines the zero inflated Poisson inverse Gaussian distribution, a three parameter distribution, for a gamlss.family object to be used in GAMLSS fitting using the function gamlss(). The functions dZIPIG, pZIPIG, qZIPIG and rZIPIG define the density, distribution function, quantile function and random generation for the zero inflated negative binomial, ZIPIG(), distribution.

Usage

```
ZIPIG(mu.link = "log", sigma.link = "log", nu.link = "logit")
dZIPIG(x, mu = 1, sigma = 1, nu = 0.3, log = FALSE)
pZIPIG(q, mu = 1, sigma = 1, nu = 0.3, lower.tail = TRUE, log.p = FALSE)
qZIPIG(p, mu = 1, sigma = 1, nu = 0.3, lower.tail = TRUE, log.p = FALSE)
rZIPIG(n, mu = 1, sigma = 1, nu = 0.3)
```

Arguments

mu.link	Defines the mu.link, with "log" link as the default for the mu parameter
sigma.link	Defines the sigma.link, with "log" link as the default for the sigma parameter
nu.link	Defines the mu.link, with "logit" link as the default for the nu parameter
x	vector of (non-negative integer) quantiles
mu	vector of positive means
sigma	vector of positive despersion parameter
nu	vector of zero probability parameter
p	vector of probabilities

q	vector of quantiles
n	number of random values to return
log, log.p	logical; if TRUE, probabilities p are given as log(p)
lower.tail	logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x]

Details

For the definition of the distribution see Rigby and Stasinopoulos (2010) below.

Value

The function ZIPIG return a gamlss.family object which can be used to fit a zero inflated Poisson inverse Gaussian in the gamlss() function

Author(s)

Mikis Stasinopoulos <d.stasinopoulos@londonmet.ac.uk>, Bob Rigby <r.rigby@londonmet.ac.uk>

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Stasinopoulos D. M., Rigby R.A. and Akantziliotou C. (2006) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also http://www.gamlss.com/).

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, Vol. **23**, Issue 7, Dec 2007, http://www.jstatsoft.org/v23/i07.

Rigby, R. A. and Stasinopoulos D. M. (2010) The gamlss.family distributions, (distributed with this package or see http://www.gamlss.com/)

See Also

gamlss.family, PIG

Examples

```
ZIPIG()
# creating data and plotting them
 dat <- rZIPIG(1000, mu=5, sigma=.5, nu=0.1)
   r <- barplot(table(dat), col='lightblue')
```

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