

Package ‘ugomquantreg’

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Type Package

Title Quantile Regression Modeling for Unit-Gompertz Responses

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Description Unit-Gompertz density, cumulative distribution, quantile functions and random deviate generation of the unit-Gompertz distribution. In addition, there are a function for fitting the Generalized Additive Models for Location, Scale and Shape.

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Encoding UTF-8

ByteCompile yes

LazyData true

LinkingTo Rcpp

Imports Rcpp, stats, gamlss, gamlss.dist, pracma

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ugomquantreg-package *Overview of the ugomquantreg package*

Description

The **ugomquantreg** package implements the probability density function, quantile function, cumulative distribution function and random number generation function for unit-Gompertz distribution parameterized as a function of its τ -th quantile, $0 < \tau < 1$. Some function are written in C++ using **Rcpp**.

Details

ammonia: Ammonia oxidized to acid nitric data set.

bodyfat: Body fat data set.

UGOM: For quantile modeling (con/in)ditional on covariate(s).

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ammonia *Ammonia oxidized to acid nitric data set*

Description

The data come from experiments with a plant where ammonia is oxidized to acid nitric.

Usage

```
data(ammonia, package = "ugomquantreg")
```

Format

A data-frame with 21 observations and 4 columns:

- **stackloss**: the percentage of ammonia lost.
- **airflow**: the air flow to the plant.
- **watertemp**: the cooling water inlet temperature.
- **acidconc**: the acid concentration.

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Source

<https://support.sas.com/rnd/app/stat/examples/BayesQuantile/quantile.htm>

References

Brownlee, K. A., (1965). Statistical Theory and Methodology in Science and Engineering. *New York: John Wiley & Sons.*

Yu, K., and Moyeed, R. A., (2001). Bayesian quantile regression. *Statistics and Probability Letters*, **54**(4) 437–447.

Examples

```
data(ammonia, package = "ugomquantreg")

library(gamlss)

tau <- 0.50
fit.logit <- gamlss(stackloss ~ airflow + watertemp + acidconc, data = ammonia,
family = UGOM(sigma.link="identity"))

tau <- 0.50
fit.probit <- gamlss(stackloss ~ airflow + watertemp + acidconc,
data = ammonia, family = UGOM(mu.link = "probit", sigma.link = "log"))

fittaus <- lapply(c(0.10, 0.25, 0.50, 0.75, 0.90), function(Tau){
  tau <- Tau;
  gamlss(stackloss ~ airflow + watertemp + acidconc, data = ammonia,
family = UGOM(mu.link = "logit", sigma.link = "log"))
})

sapply(fittaus, coef)
```

bodyfat

Percentage of body fat data set

Description

The body fat percentage of individuals assisted in a public hospital in Curitiba, Paraná, Brazil.

Usage

```
data(bodyfat, package = "ugomquantreg")
```

Format

A data-frame with 298 observations and 9 columns:

- ARMS: arms fat percentage.

- LEGS: legs fat percentage.
- BODY: body fat percentage.
- ANDROID: android fat percentage.
- GYNECOID: ginecoid fat percentage.
- AGE: age of individuals.
- BMI: body mass index.
- SEX: 1 for female, 2 for male.
- IPAQ: 0 for IPAQ = sedentary, 1 for IPAQ = insufficiently active and 2 for IPAQ = active.

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Source

<http://www.leg.ufpr.br/doku.php/publications:papercompanions:multquasibeta>

References

Mazucheli, J., Leiva, V., Alves, B., and Menezes A. F. B., (2021). A new quantile regression for modeling bounded data under a unit Birnbaum-Saunders distribution with applications in medicine and politics. *Symmetry*, **13**(4) 1–21.

Petterle, R. R., Bonat, W. H., Scarpin, C. T., Jonasson, T., and Borba, V. Z. C., (2020). Multi-variate quasi-beta regression models for continuous bounded data. *The International Journal of Biostatistics*, 1–15, (preprint).

Examples

```
data(bodyfat, package = "ugomquantreg")

library(gamlss)

tau <- 0.50
fit.logit <- gamlss(ARMS ~ AGE + I(BMI / 100) + as.factor(SEX) + as.factor(IPAQ),
data = bodyfat, family = UGOM(mu.link = "logit", sigma.link = "log"))

tau <- 0.50;
fit.probit <- gamlss(ARMS ~ AGE + I(BMI / 100) + as.factor(SEX) + as.factor(IPAQ),
data = bodyfat, family = UGOM(mu.link = "probit", sigma.link = "log"))
```

Description

The function `UGOM()` define the unit-Gompertz distribution for a `gamlss.family` object to be used in GAMLSS fitting. `UGOM()` has the τ -th quantile equal to the parameter `mu` and `sigma` as the shape parameter. The functions `dUGOM`, `pUGOM`, `qUGOM` and `rUGOM` define the density, distribution function, quantile function and random generation for unit-Gompertz distribution.

Usage

```
dUGOM(x, mu, sigma, tau = 0.5, log = FALSE)

pUGOM(q, mu, sigma, tau = 0.5, lower.tail = TRUE, log.p = FALSE)

qUGOM(p, mu, sigma, tau = 0.5, lower.tail = TRUE, log.p = FALSE)

rUGOM(n, mu, sigma, tau = 0.5)

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

Arguments

<code>x, q</code>	vector of quantiles on the (0,1) interval.
<code>mu</code>	vector of quantile parameter values.
<code>sigma</code>	vector of shape parameter values.
<code>tau</code>	the τ -th fixed quantile in [d-p-q-r]-UGOM function.
<code>log, log.p</code>	logical; If TRUE, probabilities <code>p</code> are given as $\log(p)$.
<code>lower.tail</code>	logical; If TRUE, (default), $P(X \leq x)$ are returned, otherwise $P(X > x)$.
<code>p</code>	vector of probabilities.
<code>n</code>	the number of observations. If $\text{length}(n) > 1$, the length is taken to be the number required.
<code>mu.link</code>	the mu link function with default logit.
<code>sigma.link</code>	the sigma link function with default logit.

Details

Probability density function

$$f(x \mid \mu, \sigma, \tau) = \left(\frac{\log(\tau)}{1 - \mu^{-\sigma}} \right) \sigma x^{-(1+\sigma)} \exp \left[\left(\frac{\log(\tau)}{1 - \mu^{-\sigma}} \right) (1 - x^{-\sigma}) \right]$$

Cumulative distribution function

$$F(x \mid \mu, \sigma, \tau) = \exp \left[\left(\frac{\log(\tau)}{1 - \mu^{-\sigma}} \right) (1 - x^{-\sigma}) \right]$$

Mean

$$E(X) = \left(\frac{\log(\tau)}{1 - \mu^{-\sigma}} \right)^{\frac{1}{\sigma}} \exp \left(\frac{\log(\tau)}{1 - \mu^{-\sigma}} \right) \Gamma \left(\frac{\sigma - 1}{\sigma}, \frac{\log(\tau)}{1 - \mu^{-\sigma}} \right)$$

where $0 < (x, \mu) < 1$, μ is, for a fixed and known value of τ , the τ -th quantile, σ is the shape parameter and $\Gamma(a, b)$ is the upper incomplete gamma function.

Value

UGOM() return a `gamlss.family` object which can be used to fit a unit-Gompertz distribution by `gamlss()` function.

Note

Note that for UGOM(), `mu` is the τ -th quantile and `sigma` a shape parameter. The `gamlss` function is used for parameters estimation.

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References

- Hastie, T. J. and Tibshirani, R. J. (1990). *Generalized Additive Models*. Chapman and Hall, London.
- Mazucheli, J., Alve, B. (2021). The Unit-Gompertz quantile regression model for bounded responses. *preprint*, **0**(0), 1-20.
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- Rigby, R. A., Stasinopoulos, D. M., Heller, G. Z. and De Bastiani, F. (2019). *Distributions for modeling location, scale, and shape: Using GAMLSS in R*. Chapman and Hall/CRC.
- Stasinopoulos, D. M. and Rigby, R. A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, **23**(7), 1–45.
- Stasinopoulos, D. M., Rigby, R. A., Heller, G., Voudouris, V. and De Bastiani F. (2017) *Flexible Regression and Smoothing: Using GAMLSS in R*, Chapman and Hall/CRC.

Examples

```
set.seed(123)
x <- rUGOM(n = 1000, mu = 0.50, sigma = 1.69, tau = 0.50)
R <- range(x)
S <- seq(from = R[1], to = R[2], length.out = 1000)

hist(x, prob = TRUE, main = 'unit-Gompertz')
lines(S, dUGOM(x = S, mu = 0.50, sigma = 1.69, tau = 0.50), col = 2)
```

```
plot(ecdf(x))
lines(S, pUGOM(q = S, mu = 0.50, sigma = 1.69, tau = 0.50), col = 2)

plot(quantile(x, probs = S), type = "l")
lines(qUGOM(p = S, mu = 0.50, sigma = 1.69, tau = 0.50), col = 2)

library(gamlss)
set.seed(123)
data <- data.frame(y = rUGOM(n = 100, mu = 0.5, sigma = 2.0, tau = 0.5))

tau <- 0.50
fit <- gamlss(y ~ 1, data = data, family = UGOM)

set.seed(123)
n <- 100
x <- rbinom(n, size = 1, prob = 0.5)
eta <- 0.5 + 1 * x;
mu <- 1 / (1 + exp(-eta));
sigma <- 1.5;
y <- rUGOM(n, mu, sigma, tau = 0.5)
data <- data.frame(y, x)

tau <- 0.50
fit <- gamlss(y ~ x, data = data, family = UGOM(mu.link = "logit", sigma.link = "log"))
```

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