Package 'vasicekreg'

May 8, 2026

Type Package

Title Regression Modeling Using Vasicek Distribution

Version 1.0.2

Date 2026-01-12

Description Provides probability density, cumulative distribution, quantile, and random number generation functions for the Vasicek distribution. In addition, two functions are available for fitting Generalized Additive Models for Location, Scale and Shape introduced by Rigby and Stasinopoulos (2005, <doi:10.1111/j.1467-9876.2005.00510.x>). Some functions are written in 'C++' using 'Rcpp', developed by Eddelbuettel and Francois (2011, <doi:10.18637/jss.v040.i08>).

License MIT + file LICENSE

Encoding UTF-8

ByteCompile yes

LazyData true

Depends R (>= 3.6)

Imports Rcpp, stats, gamlss, gamlss.dist, mvtnorm

LinkingTo Rcpp

Suggests testthat (>= 3.0.0)

RoxygenNote 7.3.3

NeedsCompilation yes

Author Josmar Mazucheli [aut, cre],
Bruna Alves [ctb]

Maintainer Josmar Mazucheli <jmazucheli@gmail.com>

Repository CRAN

Date/Publication 2026-01-12 14:50:01 UTC

Contents

`vasicekreg-package` *Overview of the vasicekreg package*

Description

The **vasicekreg** package implements probability density, cumulative distribution, quantile, and random number generation functions for the Vasicek distribution parameterized either by its mean or by its τ-th quantile, with $0 < \tau < 1$. In addition, two GAMLSS frameworks for regression analysis are provided. Some functions are written in C++ using **Rcpp**.

Details

`bodyfat`: Body fat dataset.

`VASIM`: Mean modeling conditional or unconditional on covariates.

`VASIQ`: Quantile modeling conditional or unconditional on covariates.

Author(s)

Josmar Mazucheli <jmazucheli@gmail.com>

Bruna Alves <pg402900@uem.br>

`bodyfat` *Percentage of Body Fat Dataset*

Description

Percentage of body fat measurements from individuals assisted in a public hospital in Curitiba, Paraná, Brazil.

Usage

```
bodyfat
```

Format

A data frame with 298 observations and 9 variables:

- ARMS: arms fat percentage.
- LEGS: legs fat percentage.
- BODY: body fat percentage.
- ANDROID: android fat percentage.
- GYNECOID: gynoid fat percentage.
- AGE: age of individuals.
- BMI: body mass index.
- SEX: 1 for female and 2 for male.
- IPAQ: physical activity level according to IPAQ (0 = sedentary, 1 = insufficiently active, 2 = active).

Author(s)

Josmar Mazucheli <jmazucheli@gmail.com>

Bruna Alves <pg402900@uem.br>

References

Mazucheli, J., Alves, B., Korkmaz, M. Ç., and Leiva, V. (2022). Vasicek quantile and mean regression models for bounded data: New formulation, mathematical derivations, and numerical applications. *Mathematics*, **10**, 1389.

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). Multivariate quasi-beta regression models for continuous bounded data. *The International Journal of Biostatistics*, **17**(1), 39–53.

Examples

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

bodyfat$BMI <- bodyfat$BMI / 100
bodyfat$SEX <- as.factor(bodyfat$SEX)
bodyfat$IPAQ <- as.factor(bodyfat$IPAQ)

library(gamlss)

## Mean regression model
fitmean <- gamlss(
  ARMS ~ AGE + BMI + SEX + IPAQ,
  data = bodyfat,
  family = VASIM(mu.link = "logit", sigma.link = "logit")
```

```
)

## Not run:
## Quantile regression models for different tau levels
fittaus <- lapply(c(0.10, 0.25, 0.50, 0.75, 0.90), function(Tau) {
  tau <<- Tau
  gamlss(
    ARMS ~ AGE + BMI + SEX + IPAQ,
    data = bodyfat,
    family = VASIQ(mu.link = "logit", sigma.link = "logit")
  )
})

sapply(fittaus, summary)

## End(Not run)
```

VASIM *Vasicek distribution with mean parameterization*

Description

The function `VASIM()` defines the Vasicek distribution under a mean-based parameterization for use as a `gamlss.family` object in GAMLSS models. In this formulation, μ represents the mean of the distribution and σ is a shape parameter. The functions `dVASIM`, `pVASIM`, `qVASIM`, and `rVASIM` provide the density, distribution, quantile, and random generation functions, respectively.

Usage

```
dVASIM(x, mu, sigma, log = FALSE)

pVASIM(q, mu, sigma, lower.tail = TRUE, log.p = FALSE)

qVASIM(p, mu, sigma, lower.tail = TRUE, log.p = FALSE)

rVASIM(n, mu, sigma)

VASIM(mu.link = "logit", sigma.link = "logit")
```

Arguments

`x`, `q`	Vector of quantiles in the interval $(0, 1)$.
`mu`	Vector of mean values.
`sigma`	Vector of shape parameter values.
`log`, `log.p`	Logical; if `TRUE`, probabilities are given on the log scale.
`lower.tail`	Logical; if `TRUE`, probabilities $P(X \leq x)$ are returned.
`p`	Vector of probabilities.

`n`	Number of observations.
`mu.link`	Link function for the μ parameter.
`sigma.link`	Link function for the σ parameter.

Details

The probability density function is given by

$$f(x \mid \mu, \sigma) = \sqrt{\frac{1-\sigma}{\sigma}} \exp\left\{\frac{1}{2}\left[\Phi^{-1}(x)^2 - \left(\frac{\Phi^{-1}(x)\sqrt{1-\sigma} - \Phi^{-1}(\mu)}{\sqrt{\sigma}}\right)^2\right]\right\}.$$

The cumulative distribution function is

$$F(x \mid \mu, \sigma) = \Phi\left(\frac{\Phi^{-1}(x)\sqrt{1-\sigma} - \Phi^{-1}(\mu)}{\sqrt{\sigma}}\right).$$

The quantile function is

$$Q(\tau \mid \mu, \sigma) = \Phi\left(\frac{\Phi^{-1}(\mu) + \Phi^{-1}(\tau)\sqrt{\sigma}}{\sqrt{1-\sigma}}\right).$$

Value

`VASIM()` returns a `gamlss.family` object.

Note

In the `VASIM()` parameterization, μ corresponds to the mean of the distribution and σ is a shape parameter.

Author(s)

Josmar Mazucheli <jmazucheli@gmail.com>

Bruna Alves <pg402900@uem.br>

References

Hastie, T. J. and Tibshirani, R. J. (1990). *Generalized Additive Models*. Chapman and Hall, London.

Mazucheli, J., Alves, B., Korkmaz, M.Ç., and Leiva, V. (2022). Vasicek quantile and mean regression models for bounded data: New formulation, mathematical derivations, and numerical applications. *Mathematics*, **10**, 1389. doi:10.3390/math10091389

Rigby, R. A. and Stasinopoulos, D. M. (2005). Generalized additive models for location, scale and shape (with discussion). *Applied Statistics*, **54**(3), 507–554.

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.

Vasicek, O. A. (1987). Probability of loss on loan portfolio. *KMV Corporation*.

Vasicek, O. A. (2002). The distribution of loan portfolio value. *Risk*, **15**(12), 1–10.

See Also

VASIQ, pmvnorm

Examples

```
set.seed(123)
x <- rVASIM(n = 1000, mu = 0.5, sigma = 0.69)

hist(x, probability = TRUE, main = "Vasicek distribution")

## Not run:
library(gamlss)
data <- data.frame(y = x[1:100])
fit <- gamlss(y ~ 1, data = data,
              family = VASIM(mu.link = "logit",
                             sigma.link = "logit"))
summary(fit)

## End(Not run)
```

VASIQ *The Vasicek distribution: quantile parameterization*

Description

The function VASIQ() defines the Vasicek distribution as a gamlss.family object to be used in GAMLSS fitting. In this parameterization, μ corresponds to the fixed τ-th quantile, and σ is a shape parameter. The functions dVASIQ, pVASIQ, qVASIQ, and rVASIQ define the density, distribution function, quantile function, and random generation for the Vasicek distribution, respectively.

Usage

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

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

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

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

VASIQ(mu.link = "logit", sigma.link = "logit")
```

Arguments

x, q	Vector of quantiles in the interval $(0, 1)$.
mu	Vector of τ-th quantile parameter values.
sigma	Vector of shape parameter values.
tau	Fixed quantile level τ used in the d, p, q, and r functions for VASIQ.
log, log.p	Logical; if TRUE, probabilities are returned on the log scale.
lower.tail	Logical; if TRUE (default), $P(X \leq x)$ is returned; 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.
mu.link	Link function for the μ parameter.
sigma.link	Link function for the σ parameter.

Details

Probability density function:

$$f\left(x \mid \mu, \sigma, \tau\right) = \sqrt{\frac{1-\sigma}{\sigma}} \exp\left\{\frac{1}{2}\left[\Phi^{-1}(x)^2 - \left(\frac{\sqrt{1-\sigma}\left(\Phi^{-1}(x) - \Phi^{-1}(\mu)\right) - \sqrt{\sigma}\,\Phi^{-1}(\tau)}{\sqrt{\sigma}}\right)^2\right]\right\}.$$

Cumulative distribution function:

$$F\left(x \mid \mu, \sigma, \tau\right) = \Phi\left(\frac{\sqrt{1-\sigma}\left(\Phi^{-1}(x) - \Phi^{-1}(\mu)\right) - \sqrt{\sigma}\,\Phi^{-1}(\tau)}{\sqrt{\sigma}}\right).$$

where $0 < (x, \mu, \tau, \sigma) < 1$, μ is the τ-th quantile, and σ is the shape parameter.

Value

VASIQ() returns a gamlss.family object that can be used to fit a Vasicek distribution using the gamlss function.

Note

For VASIQ(), μ corresponds to the τ-th quantile and σ is a shape parameter. Parameter estimation is performed using the gamlss function.

Author(s)

Josmar Mazucheli <jmazucheli@gmail.com>

Bruna Alves <pg402900@uem.br>

References

Hastie, T. J. and Tibshirani, R. J. (1990). *Generalized Additive Models*. Chapman and Hall, London.

Mazucheli, J., Alves, B., Korkmaz, M. Ç., and Leiva, V. (2022). Vasicek quantile and mean regression models for bounded data: New formulation, mathematical derivations, and numerical applications. *Mathematics*, **10**, 1389.

Rigby, R. A. and Stasinopoulos, D. M. (2005). Generalized additive models for location, scale and shape (with discussion). *Applied Statistics*, **54**(3), 507–554.

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.

Vasicek, O. A. (1987). Probability of loss on loan portfolio. *KMV Corporation*.

Vasicek, O. A. (2002). The distribution of loan portfolio value. *Risk*, **15**(12), 1–10.

See Also

VASIM

Examples

```
set.seed(123)
x <- rVASIQ(n = 1000, mu = 0.50, sigma = 0.69, tau = 0.50)
R <- range(x)
S <- seq(from = R[1], to = R[2], length.out = 1000)

hist(x, prob = TRUE, main = "Vasicek")
lines(S, dVASIQ(x = S, mu = 0.50, sigma = 0.69, tau = 0.50), col = 2)

plot(ecdf(x))
lines(S, pVASIQ(q = S, mu = 0.50, sigma = 0.69, tau = 0.50), col = 2)

plot(quantile(x, probs = S), type = "l")
lines(qVASIQ(p = S, mu = 0.50, sigma = 0.69, tau = 0.50), col = 2)

library(gamlss)
set.seed(123)
data <- data.frame(y = rVASIQ(n = 100, mu = 0.50, sigma = 0.69, tau = 0.50))

tau <- 0.5
fit <- gamlss(y ~ 1, data = data,
              family = VASIQ(mu.link = "logit",
                             sigma.link = "logit"))
1 / (1 + exp(-fit$mu.coefficients))
1 / (1 + exp(-fit$sigma.coefficients))

set.seed(123)
```

```
n <- 100
x <- rbinom(n, size = 1, prob = 0.5)
eta <- 0.5 + 1 * x
mu <- 1 / (1 + exp(-eta))
sigma <- 0.5
y <- rVASIQ(n, mu, sigma, tau = 0.5)
data <- data.frame(y, x, tau = 0.5)

tau <- 0.5
fit <- gamlss(y ~ x, data = data, family = VASIQ)

fittaus <- lapply(c(0.10, 0.25, 0.50, 0.75, 0.90), function(Tau) {
  tau <<- Tau
  gamlss(y ~ x, data = data, family = VASIQ)
})

sapply(fittaus, summary)
```

Index