

Package ‘betaBayes’

May 7, 2026

Type Package

Title Bayesian Beta Regression

Version 1.0.1

Date 2022-05-08

Description Provides a class of Bayesian beta regression models for the analysis of continuous data with support restricted to an unknown finite support. The response variable is modeled using a four-parameter beta distribution with the mean or mode parameter depending linearly on covariates through a link function. When the response support is known to be (0,1), the above class of models reduce to traditional (0,1) supported beta regression models. Model choice is carried out via the logarithm of the pseudo marginal likelihood (LPML), the deviance information criterion (DIC), and the Watanabe-Akaike information criterion (WAIC). See Zhou and Huang (2022) <[doi:10.1016/j.csda.2021.107345](https://doi.org/10.1016/j.csda.2021.107345)>.

License GPL (>= 2)

Depends R (>= 3.5.0)

Imports Rcpp (>= 0.11.1), methods, betareg

LinkingTo Rcpp, RcppArmadillo (>= 0.4.300.0)

NeedsCompilation yes

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Repository CRAN

Date/Publication 2022-05-09 12:00:02 UTC

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beta4reg

*Bayesian Beta Regression Models***Description**

This function fits Bayesian beta regression models. The response distribution can be either the beta with the support on (0,1) or the four-parameter beta with an unknown final support. The logarithm of the pseudo marginal likelihood (LPML), the deviance information criterion (DIC), and the Watanabe-Akaike information criterion (WAIC) are provided for model comparison.

Usage

```
beta4reg(formula, data, na.action, link="logit", model = "mode",
         mcmc=list(nburn=3000, nsave=2000, nskip=0, ndisplay=500),
         prior=NULL, start=NULL, Xpred=NULL)
```

Arguments

formula	a formula expression of the form $y \sim x$.
data	a data frame in which to interpret the variables named in the formula argument.
na.action	a missing-data filter function, applied to the model.frame.
link	a character string for the link function. Choices include "logit", "probit", "loglog" and "cloglog".
model	a character string for the regression type. The options include "mean" for a mean regression, "mode" for a mode regression.
mcmc	a list giving the MCMC parameters. The list must include the following elements: nburn an integer giving the number of burn-in scans, nskip an integer giving the thinning interval, nsave an integer giving the total number of scans to be saved, ndisplay an integer giving the number of saved scans to be displayed on screen (the function reports on the screen when every ndisplay iterations have been carried out).
prior	a list giving the prior information. The function itself provides all default priors. The following components can be specified here: ma_0 and mb_0 for the prior of marginal population mode or mean, ϕ_{1a_0} and ϕ_{1b_0} for the precision parameter, β_{a_0} and S_0 for the coefficients beta, th_{1a_0} and th_{1b_0} for the lower bound of the support, th_{2a_0} and th_{2b_0} for the upper bound of the support.
start	a list giving the starting values of the parameters. The function itself provides all default choices. The following components can be specified here: beta, theta, phi.
Xpred	A new design matrix at which estimates of the response model or mean are required. The default is the design matrix returned by the argument formula.

Value

This class of objects is returned by the `beta4reg` function to represent a fitted Bayesian beta regression model. Objects of this class have methods for the functions `print` and `summary`.

The `beta4reg` object is a list containing the following components:

<code>modelName</code>	the name of the fitted model
<code>terms</code>	the <code>terms</code> object used
<code>link</code>	the link function used
<code>model</code>	the model fitted: mean or mode
<code>coefficients</code>	a named vector of coefficients. The last two elements are the estimates of θ_1 and θ_2 involved in the support of the four-parameter beta distribution.
<code>call</code>	the matched call
<code>prior</code>	the list of hyperparameters used in all priors.
<code>start</code>	the list of starting values used for all parameters.
<code>mcmc</code>	the list of MCMC parameters used
<code>n</code>	the number of row observations used in fitting the model
<code>p</code>	the number of columns in the model matrix
<code>y</code>	the response observations
<code>X</code>	the n by $(p+1)$ original design matrix
<code>beta</code>	the $(p+1)$ by <code>nsave</code> matrix of posterior samples for the coefficients in the linear predictors
<code>theta</code>	the 2 by <code>nsave</code> matrix of posterior samples for θ_1 and θ_2 involved in the support.
<code>phi</code>	the vector of posterior samples for the precision parameter.
<code>cpo</code>	the length n vector of the stabilized estimate of CPO; used for calculating LPML
<code>pD</code>	the effective number of parameters involved in DIC
<code>DIC</code>	the deviance information criterion (DIC)
<code>pW</code>	the effective number of parameters involved in WAIC
<code>WAIC</code>	the Watanabe-Akaike information criterion (WAIC)
<code>ratetheta</code>	the acceptance rate in the posterior sampling of θ vector involved in the support
<code>ratebeta</code>	the acceptance rate in the posterior sampling of β coefficient vector
<code>ratephi</code>	the acceptance rate in the posterior sampling of precision parameter

The use of the `summary` function to the object will return new object with the following additional components:

<code>coeff</code>	A table that presents the posterior summaries for the regression coefficients
<code>bounds</code>	A table that presents the posterior summaries for the support boundaries θ_1 and θ_2
<code>phivar</code>	A table that presents the posterior summaries for the precision ϕ .

Author(s)

Haiming Zhou and Xianzheng Huang

References

Zhou, H. and Huang, X. (2022). Bayesian beta regression for bounded responses with unknown supports. *Computational Statistics & Data Analysis*, 167, 107345.

See Also

[cox.snell.beta4reg](#)

Examples

```
library(betaBayes)
library(betareg)

## Data from Ferrari and Cribari-Neto (2004)
data("GasolineYield", package = "betareg")
data("FoodExpenditure", package = "betareg")

## four-parameter beta mean regression
mcmc=list(nburn=2000, nsave=1000, nskip=4, ndisplay=1000);
# Note larger nburn, nsave and nskip should be used in practice.
prior = list(th1a0 = 0, th2b0 = 1)
# here the natural bound (0,1) is used to specify the prior
# GasolineYield
set.seed(100)
gy_res1 <- beta4reg(yield ~ batch + temp, data = GasolineYield,
                  link = "logit", model = "mean",
                  mcmc = mcmc, prior = prior)
(gy_sfit1 <- summary(gy_res1))
cox.snell.beta4reg(gy_res1) # Cox-Snell plot
# FoodExpenditure
set.seed(100)
fe_res1 <- beta4reg(I(food/income) ~ income + persons, data = FoodExpenditure,
                  link = "logit", model = "mean",
                  mcmc = mcmc, prior = prior)
(fe_sfit1 <- summary(fe_res1))
cox.snell.beta4reg(fe_res1) # Cox-Snell plot

## two-parameter beta mean regression with support (0,1)
mcmc=list(nburn=2000, nsave=1000, nskip=4, ndisplay=1000);
# Note larger nburn, nsave and nskip should be used in practice.
prior = list(th1a0 = 0, th1b0 = 0, th2a0 = 1, th2b0 = 1)
# this setting forces the support to be (0,1)
# GasolineYield
set.seed(100)
gy_res2 <- beta4reg(yield ~ batch + temp, data = GasolineYield,
                  link = "logit", model = "mean",
                  mcmc = mcmc, prior = prior)
(gy_sfit2 <- summary(gy_res2))
```

```
cox.snell.beta4reg(gy_res2) # Cox-Snell plot
# FoodExpenditure
set.seed(100)
fe_res2 <- beta4reg(I(food/income) ~ income + persons, data = FoodExpenditure,
                  link = "logit", model = "mean",
                  mcmc = mcmc, prior = prior)
(fe_sfit2 <- summary(fe_res2))
cox.snell.beta4reg(fe_res2) # Cox-Snell plot
```

covid

COVID-19 County Level Data

Description

A county level COVID-19 dataset in US. It is of interest to examine the association between several county-level characteristics and the cumulative numbers of confirmed cases and deaths. County-level characteristics are based on the 2018 ACS 5-year estimates.

Usage

```
data(covid)
```

Format

FIPS:	FIPS county code
PopE:	total population
MaleP:	percentage of people who are male
WhiteP:	percentage of people who are white
BlackP:	percentage of people who are black or African American
Age65plusP:	percentage of people who are 65 years and over
PovertyP:	percentage of people whose income in the past 12 months is below poverty
RUCC_2013:	2013 Rural Urban Continuum Code, with a higher value indicating a more rural county
State:	two-letter state abbreviation code
deaths:	cumulative number of deaths as of October 13, 2020
cases:	cumulative number of confirmed cases as of October 13, 2020

Examples

```
data(covid)
head(covid)
```

cox.snell.beta4reg *Cox-Snell Diagnostic Plot*

Description

This function provides the Cox-Snell diagnostic plot for fitting for Bayesian beta regression models.

Usage

```
cox.snell.beta4reg(x, ncurves = 10, CI = 0.95, PLOT = TRUE)
```

Arguments

x	an object obtained from the function beta4reg .
ncurves	the number of posterior draws.
CI	the level of confidence for point-wise credible intervals.
PLOT	a logical value indicating whether the Cox-Snell residuals will be plotted.

Value

The function returns the plot (if PLOT = TRUE) and a list with the following components:

tgrid	the x-axis values with length, say ngrid
Hhat	the ngrid by 1 averaged cumulative hazard values across the nsave posterior samples
Hhatlow	the ngrid by 1 lower bound cumulative hazard values
Hhatup	the ngrid by 1 upper bound cumulative hazard values
H	the ngrid by nsave cumulative hazard values

Author(s)

Haiming Zhou and Xianzheng Huang

See Also

[beta4reg](#)

`predict.beta4reg` *Predict method for beta4 model fits*

Description

Posterior predicted response values based on beta4 model object

Usage

```
## S3 method for class 'beta4reg'  
predict(object, newx, ...)
```

Arguments

<code>object</code>	an object obtained from the function beta4reg .
<code>newx</code>	an m by p matrix at which predictions are required. If not specified, the original design matrix will be used.
<code>...</code>	further arguments passed to or from other methods.

Value

The function returns an m by nsave matrix of posterior samples for response predictions at newx.

Author(s)

Haiming Zhou and Xianzheng Huang

See Also

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