Package ‘saeHB’

November 2, 2021

Type Package

Title Small Area Estimation using Hierarchical Bayesian Method

Version 0.1.0

Author Azka Ubaidillah [aut], Ika Yuni Wulansari [aut], Zaza Yuda Perwira [aut, cre]

Maintainer Zaza Yuda Perwira <221710086@stis.ac.id>

Description Provides several functions for area level of small area estimation using hierarchical Bayesian (HB) method with Univariate Normal distribution and Univariate Beta distribution for variables of interest. Some dataset produced by a data generation are also provided. The 'rjags' package is employed to obtain parameter estimates. Model-based estimators involve the HB estimators which include the mean and the variation of mean. For the reference, see Rao and Molina (2015) <doi:10.1002/9781118735855>.

License GPL-3

Encoding UTF-8

LazyData true

RoxygenNote 7.1.1

URL https://github.com/zazaperwira/saeHB

BugReports https://github.com/zazaperwira/saeHB/issues

Suggests knitr, rmarkdown

VignetteBuilder knitr

Imports stringr, coda, rjags, stats, grDevices, graphics

SystemRequirements JAGS (http://mcmc-jags.sourceforge.net)

Depends R (>= 2.10)

NeedsCompilation no

Repository CRAN

Date/Publication 2021-11-02 08:40:02 UTC
Beta

R topics documented:

Beta .................................................. 2
dataBeta ............................................. 3
dataBetaNs .......................................... 4
dataNormal .......................................... 5
dataNormalNs ....................................... 6
Normal ................................................ 6
saeHB .................................................. 8

Index 9

---

**Description**

This function is implemented to variable of interest \((y)\) that assumed to be a Beta Distribution. The range of data must be \(0 < y < 1\). The data proportion is supposed to be implemented with this function.

**Usage**

```r
Beta(
  formula,
  iter.update = 3,
  iter.mcmc = 2000,
  thin = 1,
  burn.in = 1000,
  data
)
```

**Arguments**

- `formula` Formula that describe the fitted model
- `iter.update` Number of updates with default 3
- `iter.mcmc` Number of total iterations per chain with default 2000
- `thin` Thinning rate, must be a positive integer with default 1
- `burn.in` Number of iterations to discard at the begining with default 1000
- `data` The data frame
Value

This function returns a list of the following objects:

- **Est**: A vector with the values of Small Area mean Estimates using Hierarchical bayesian method
- **sd**: A vector with the values of Standard deviation of Small Area Mean Estimates using Hierarchical bayesian method
- **refVar**: Estimated random effect variances
- **coefficient**: A dataframe with the estimated model coefficient
- **plot**: Trace, Dencity, Autocorrelation Function Plot of MCMC samples

Examples

```r
#Compute Fitted Model
#y ∼ x1 +x2

## For data without any nonsampled area
## Load Dataset
data(dataBeta)

saeHBbeta <- Beta(formula = y~x1+x2,iter.update=1,iter.mcmc = 1000,
                   burn.in = 200,data = dataBeta)

#the setting of iter.update, iter.mcmc, and burn.in in this example
#is considered to make the example execution time be faster.

#Result
saeHBbeta$Est #Small Area mean Estimates
saeHBbeta$sd #Standard deviation of Small Area Mean Estimates
saeHBbeta$refVar #refVar
saeHBbeta$coefficient #coefficient

#Load Library 'coda' to execute the plot
#autocorr.plot(saeHBbeta$plot[[3]]) is used to #ACF Plot
#plot(saeHBbeta$plot[[3]]) is used to    #Dencity and trace plot

## For data without any nonsampled area use dataBetaNs
```

---

**dataBeta**  
*Sample Data for Small Area Estimation using Hierarchical Bayesian Method under Beta distribution*
Description

Dataset to simulate Small Area Estimation using Hierarchical Bayesian Method under Beta distribution

This data is generated by these following steps:

1. Generate sampling random area effect \( u \) with \( u \sim N(0,1) \). The auxiliary variables are generated by uniform distribution with \( x_1 \sim U(0,1) \) and \( x_2 \sim U(1,5) \). The coefficient parameters \( \beta_0, \beta_1, \text{and} \beta_2 \) are set with a certain values. we set \( \pi = 1 \).

   \[
   \mu = \frac{\exp(\beta_0 + x_1 \beta_1 + x_2 \beta_2 + u)}{1 + \exp(\beta_0 + x_1 \beta_1 + x_2 \beta_2 + u)}
   \]

   Calculate \( \mu \) = \( \frac{\exp(\beta_0 + x_1 \beta_1 + x_2 \beta_2 + u)}{1 + \exp(\beta_0 + x_1 \beta_1 + x_2 \beta_2 + u)} \)

   For parameter of Beta Distribution, we set \( \pi = 1 \), then calculate \( A = \mu \pi \) and \( B = (1 - \mu) \pi \)

   Generate direct estimate with \( y \sim \text{Beta}(A,B) \)

   Calculate the variance of \( y \) with \( \text{var}(y) \) = \( \frac{A \cdot B}{((A+B+1) \cdot (A+B)^2)} \)

2. Auxiliary variables \( x_1, x_2 \), direct estimation \( (y) \) and \( \text{vardir} \) are combined in a dataframe called dataBeta

Usage

dataBeta

Format

A data frame with 50 rows and 4 variables:

- \( y \)  Direct Estimation of \( y \)
- \( x_1 \)  Auxiliary variable of \( x_1 \)
- \( x_2 \)  Auxiliary variable of \( x_2 \)
- \( \text{vardir} \)  Sampling Variance of \( y \)

---

dataBetaNs  

Sample Data for Small Area Estimation using Hierarchical Bayesian Method under Beta distribution with non-sampled areas

Description

Dataset to simulate Small Area Estimation using Hierarchical Bayesian Method under Beta distribution with non-sampled areas

This data contains NA values that indicates no sampled at one or more small areas. It uses the dataBeta with the direct estimates and the related variances in 5 small areas are missing.

Usage

dataBetaNs
Description

Dataset to simulate Small Area Estimation using Hierarchical Bayesian Method under Normal distribution

This data is generated by these following steps:

1. Generate sampling random area effect $u$ with $u \sim N(0,1)$. The auxiliary variables are generated by uniform distribution with $x_1 \sim U(0,1)$, $x_2 \sim U(1,5)$ and $x_3 \sim U(8,15)$. The coefficient parameters $\beta_0, \beta_1, \beta_2, and \beta_3$ are set as 1.
   Calculate $\mu = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + u$
   Generate variance of direct estimate, vardir, with $\sigma_e^2 \sim \text{InvGamma}(a,b)$
   Generate sampling error $e$ with $e \sim N(0, \sigma_e^2)$
   Auxiliary variables $x_1, x_2, x_3$, direct estimation (y) and vardir are combined in a dataframe called dataBeta

2. Calculate the direct estimate of mu, i.e $y = \mu + e$

Usage

dataNormal

Format

A data frame with 50 rows and 4 variables:

- **y** Direct Estimation of y
- **x1** Auxiliary variable of x1
- **x2** Auxiliary variable of x2
- **x3** Auxiliary variable of x3
- **vardir** Sampling Variance of y
dataNormalNs

Sample Data for Small Area Estimation using Hierarchical Bayesian Method under Normal distribution with non-sampled areas

**Description**

Dataset to simulate Small Area Estimation using Hierarchical Bayesian Method under Normal distribution with non-sampled areas.

This data contains NA values that indicates no sampled at one or more small areas. It uses the dataNormal with the direct estimates and the related variances in 5 small areas are missing.

**Usage**

dataNormalNs

**Format**

A data frame with 50 rows and 5 variables:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>y</td>
<td>Direct Estimation of y</td>
</tr>
<tr>
<td>x1</td>
<td>Auxiliary variable of x1</td>
</tr>
<tr>
<td>x2</td>
<td>Auxiliary variable of x2</td>
</tr>
<tr>
<td>x3</td>
<td>Auxiliary variable of x3</td>
</tr>
<tr>
<td>vardir</td>
<td>Sampling Variance of y</td>
</tr>
</tbody>
</table>

Normal

Small Area Estimation using Hierarchical Bayesian under Normal Distribution

**Description**

This function is implemented to variable of interest \(y\) that assumed to be a Normal Distribution. The range of data is \((-\infty < y < \infty)\).

**Usage**

```r
Normal(
  formula,
  vardir,
  iter.update = 3,
  iter.mcmc = 2000,
  thin = 1,
  burn.in = 1000,
  data
)
```
Arguments

- **formula**: Formula that describe the fitted model
- **vardir**: Sampling variances of direct estimations
- **iter.update**: Number of updates with default 3
- **iter.mcmc**: Number of total iterations per chain with default 2000
- **thin**: Thinning rate, must be a positive integer with default 1
- **burn.in**: Number of iterations to discard at the begining with default 1000
- **data**: The data frame

Value

This function returns a list of the following objects:

- **Est**: A vector with the values of Small Area mean Estimates using Hierarchical bayesian method
- **sd**: A vector with the values of Standard deviation of Small Area Mean Estimates using Hierarchical bayesian method
- **refVar**: Estimated random effect variances
- **coefficient**: A dataframe with the estimated model coefficient
- **plot**: Trace, Dencity, Autocorrelation Function Plot of MCMC samples

Examples

```r
#Compute Fitted Model
#y ~ x1 +x2 +x3

## For data without any nonsampled area
##Load Dataset
data(dataNormal)
saeHBnormal<-Normal(formula=y~x1+x2+x3,iter.update=1,vardir ="vardir",data=dataNormal )
saeHBnormal$Est #Small Area mean Estimates
saeHBnormal$sd #Standard deviation of Small Area Mean Estimates
saeHBnormal$refVar #refVar
saeHBnormal$coefficient #coefficient
#Load Library 'coda' to execute the plot
#autocorr.plot(saeHBnormal$plot[[3]]) is used to gerate ACF Plot
#plot(saeHBnormal$plot[[3]]) is used to generate Dencity and trace plot

## For data with nonsampled area use dataNormalNs
```
Description

Provides several functions for area level of small area estimation using hierarchical Bayesian (HB) method with Univariate Normal distribution and Univariate Beta distribution for variables of interest. Some dataset produced by a data generation are also provided. The ‘rjags’ package is employed to obtain parameter estimates. Model-based estimators involves the HB estimators which include the mean and the variation of mean. For the reference, see Rao and Molina (2015) <doi:10.1002/9781118735855>.

Author(s)

Azka Ubaidillah <azka@stis.ac.id>, Ika Yuni Wulansari <ikayuni@stis.ac.id> and Zaza Yuda Perwira <221710086@stis.ac.id>

Maintainer: Zaza Yuda Perwira <221710086@stis.ac.id>

Functions

Beta Produces HB estimators, standard error, random effect variance, coefficient and plot under beta distribution

Normal Produces HB estimators, standard error, random effect variance, coefficient and plot under normal distribution

Reference

Index

* datasets
  dataBeta, 3
  dataBetaNs, 4
  dataNormal, 5
  dataNormalNs, 6

Beta, 2

dataBeta, 3
dataBetaNs, 4
dataNormal, 5
dataNormalNs, 6

Normal, 6

saeHB, 8