

# Package ‘msaeHB’

July 23, 2025

**Type** Package

**Title** Multivariate Small Area Estimation using Hierarchical Bayesian Method

**Version** 0.1.0

**Author** Azka Ubaidillah [aut], Novia Permatasari [aut, cre]

**Maintainer** Novia Permatasari <novia.permatasari@bps.go.id>

**Description** Implements area level of multivariate small area estimation using Hierarchical Bayesian method under Normal and T distribution. The 'rjags' package is employed to obtain parameter estimates. For the reference, see Rao and Molina (2015) <[doi:10.1002/9781118735855](https://doi.org/10.1002/9781118735855)>.

**License** GPL-3

**Imports** rjags,coda

**Encoding** UTF-8

**LazyData** true

**RoxygenNote** 7.1.2

**Depends** R (>= 2.10)

**NeedsCompilation** no

**Repository** CRAN

**Date/Publication** 2022-03-11 09:50:05 UTC

## Contents

|                       |          |
|-----------------------|----------|
| datasaeNorm . . . . . | 2        |
| datasaeT . . . . .    | 3        |
| df2R . . . . .        | 4        |
| mHBNormal . . . . .   | 4        |
| mHBT . . . . .        | 5        |
| msaeHB . . . . .      | 7        |
| <b>Index</b>          | <b>8</b> |

---

datasaeNorm

*Sample Data for Small Area Estimation using Hierarchical Bayesian Method under Multivariate Normal distribution*

---

### Description

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

This data is generated by these following steps:

1. Generate sampling error  $e$ , random effect  $u$ , and auxiliary variables  $X1$   $X2$ .
  - For sampling error  $e$ , we set  $e_d \sim N_3(0, V_{ed})$ , where  $V_{ed} = (\sigma_{dij})_{i,j=1,2,3}$ , with  $\sigma_{ii} \sim InvGamma(a, b)$  and  $\rho_e = 0.5$ .
  - For random effect  $u$ , we set  $u \sim N_3(0, V_u)$ .
  - For auxiliary variables  $X1$  and  $X2$ , we set  $X1 \sim UNIF(1, 2)$  and  $X2 \sim UNIF(1, 10)$ .
2. Calculate direct estimation  $Y1$   $Y2$  and  $Y3$ , where  $Y_i = X * \beta + u_i + e_i$ . We take  $\beta_1 = 1$  and  $\beta_2 = 1$ .

Auxiliary variables  $X1$   $X2$ , direct estimation  $Y1$   $Y2$   $Y3$ , and sampling variance-covariance  $v1$   $v2$   $v3$   $v12$   $v13$   $v23$  are combined into a dataframe called `datasaeNorm`

### Usage

`datasaeNorm`

### Format

A data frame with 30 rows and 11 variables:

**X1** Auxiliary variable of  $X1$

**X2** Auxiliary variable of  $X2$

**Y1** Direct Estimation of  $Y1$

**Y2** Direct Estimation of  $Y2$

**Y3** Direct Estimation of  $Y3$

**v1** Sampling Variance of  $Y1$

**v12** Sampling Covariance of  $Y1$  and  $Y2$

**v13** Sampling Covariance of  $Y1$  and  $Y3$

**v2** Sampling Variance of  $Y2$

**v23** Sampling Covariance of  $Y2$  and  $Y3$

**v3** Sampling Variance of  $Y3$

datasaeT

*Sample Data for Small Area Estimation using Hierarchical Bayesian Method under Multivariate T distribution*

## Description

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

This data is generated by these following steps:

1. Generate sampling error  $e$ , random effect  $u$ , and auxiliary variables  $X1$   $X2$ .
  - For sampling error  $e$ , we set  $e_d$  is multivariate T distributed where the vector of noncentrality parameters is zero, scale matrix  $V_{ed} = (\sigma_{dij})_{i,j=1,2,3}$ , with  $\sigma_{ii} \sim InvGamma(a, b)$  and  $\rho_e = 0.5$ , and degree of freedom  $df \sim InvGamma(a, b)$ .
  - For random effect  $u$ , we set  $u \sim N_3(0, V_u)$ .
  - For auxiliary variables  $X1$  and  $X2$ , we set  $X1 \sim UNIF(1, 2)$  and  $X2 \sim UNIF(1, 10)$ .
2. Calculate direct estimation  $Y1$   $Y2$  and  $Y3$ , where  $Y_i = X * \beta + u_i + e_i$ . We take  $\beta_1 = 1$  and  $\beta_2 = 1$ .

Auxiliary variables  $X1$   $X2$ , direct estimation  $Y1$   $Y2$   $Y3$ , and sampling variance-covariance  $v1$   $v2$   $v3$   $v12$   $v13$   $v23$  are combined into a dataframe called `datasaeT`

## Usage

`datasaeT`

## Format

A data frame with 30 rows and 11 variables:

**X1** Auxiliary variable of  $X1$

**X2** Auxiliary variable of  $X2$

**Y1** Direct Estimation of  $Y1$

**Y2** Direct Estimation of  $Y2$

**Y3** Direct Estimation of  $Y3$

**v1** Sampling Variance of  $Y1$

**v12** Sampling Covariance of  $Y1$  and  $Y2$

**v13** Sampling Covariance of  $Y1$  and  $Y3$

**v2** Sampling Variance of  $Y2$

**v23** Sampling Covariance of  $Y2$  and  $Y3$

**v3** Sampling Variance of  $Y3$

---

df2R

*Transform Dataframe to Matrix R*


---

### Description

This function transforms dataframe contains sampling variance to a diagonal matrix R

### Usage

```
df2R(R, r)
```

### Arguments

R                      dataframe of sampling variances of direct estimators.  
r                      number of variables

### Value

Block diagonal matrix R

### Examples

```
NULL
```

---

mHBNormal

*Multivariate Small Area Estimation using Hierarchical Bayesian under Normal Distribution*


---

### Description

This function implements small area estimation using hierarchical bayesian to variable of interest that assumed to be a multivariate normal distribution.

### Usage

```
mHBNormal(  
  formula,  
  vardir,  
  iter.update = 3,  
  iter.mcmc = 10000,  
  thin = 2,  
  burn.in = 2000,  
  data  
)
```

**Arguments**

|                          |                                                                                                                                                                                                                                                                       |
|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>formula</code>     | an object of class list of formula, describe the model to be fitted                                                                                                                                                                                                   |
| <code>vardir</code>      | vector containing name of sampling variances of direct estimators in the following order: <code>var1</code> , <code>var2</code> , . . . , <code>var(k)</code> , <code>cov12</code> , . . . <code>cov1k</code> , <code>cov23</code> , . . . , <code>cov(k-1)(k)</code> |
| <code>iter.update</code> | number of updates with default 3                                                                                                                                                                                                                                      |
| <code>iter.mcmc</code>   | number of total iterations per chain with default 10000                                                                                                                                                                                                               |
| <code>thin</code>        | thinning rate, must be a positive integer with default 2                                                                                                                                                                                                              |
| <code>burn.in</code>     | number of iterations to discard at the beginning with default 2000                                                                                                                                                                                                    |
| <code>data</code>        | dataframe containing the variables named in <code>formula</code> and <code>vardir</code>                                                                                                                                                                              |

**Value**

The function returns a list with the following objects:

**Est** A vector with the values of Small Area mean Estimates using Hierarchical bayesian method

**coefficient** A dataframe with the estimated model coefficient

**plot** Trace, Density, Autocorrelation Function Plot of MCMC samples

**Examples**

```
## Load dataset
data(datasaeNorm)
## Using parameter 'data'
Fo <- list(f1=Y1~X1+X2,
           f2=Y2~X1+X2)
vardir <- c("v1", "v2", "v12")
m1 <- mHBNormal(formula=Fo, vardir=vardir,
  iter.update = 1, iter.mcmc = 1000,
  thin = 2, burn.in = 200, data=datasaeNorm)
```

---

mHBT

---

*Multivariate Small Area Estimation using Hierarchical Bayesian under T Distribution*


---

**Description**

This function implements small area estimation using hierarchical bayesian to variable of interest that assumed to be a multivariate T distribution.

**Usage**

```
mHBT(
  formula,
  vardir,
  iter.update = 3,
  iter.mcmc = 10000,
  thin = 2,
  burn.in = 2000,
  data
)
```

**Arguments**

|                          |                                                                                                                                                                                                                                                                       |
|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>formula</code>     | an object of class list of formula, describe the model to be fitted                                                                                                                                                                                                   |
| <code>vardir</code>      | vector containing name of sampling variances of direct estimators in the following order: <code>var1</code> , <code>var2</code> , . . . , <code>var(k)</code> , <code>cov12</code> , . . . <code>cov1k</code> , <code>cov23</code> , . . . , <code>cov(k-1)(k)</code> |
| <code>iter.update</code> | number of updates with default 3                                                                                                                                                                                                                                      |
| <code>iter.mcmc</code>   | number of total iterations per chain with default 10000                                                                                                                                                                                                               |
| <code>thin</code>        | thinning rate, must be a positive integer with default 2                                                                                                                                                                                                              |
| <code>burn.in</code>     | number of iterations to discard at the beginning with default 2000                                                                                                                                                                                                    |
| <code>data</code>        | dataframe containing the variables named in <code>formula</code> and <code>vardir</code>                                                                                                                                                                              |

**Value**

The function returns a list with the following objects:

**Est** A vector with the values of Small Area mean Estimates using Hierarchical bayesian method

**coefficient** A dataframe with the estimated model coefficient

**plot** Trace, Density, Autocorrelation Function Plot of MCMC samples

**Examples**

```
## Load dataset
data(datasaeT)
## Using parameter 'data'
Fo <- list(f1=Y1~X1+X2,
           f2=Y2~X1+X2)
vardir <- c("v1", "v2", "v12")
m1 <- mHBT(formula=Fo, vardir=vardir,
            iter.update = 1, iter.mcmc = 1000,
            thin = 2, burn.in = 200, data=datasaeT)
```

---

msaeHB*msaeHB : Multivariate Small Area Estimation using Hierarchical Bayesian Method*

---

**Description**

Implements area level of multivariate small area estimation using hierarchical Bayesian (HB) method under Normal and T distribution. The 'rjags' package is employed to obtain parameter estimates. For the reference, see Rao and Molina (2015) <doi:10.1002/9781118735855>.

**Author(s)**

Azka Ubaidillah <azka@stis.ac.id> and Novia Permatasari <novia.permatasari@bps.go.id>

**Maintainer:** Novia Permatasari <novia.permatasari@bps.go.id>

**Functions**

mHBNormal Estimate multivariate small area estimation under normal distribution

mHBT Estimate multivariate small area estimation under normal distribution

**Reference**

- Rao, J.N.K & Molina. (2015). Small Area Estimation 2nd Edition. New York: John Wiley and Sons, Inc. <doi:10.1002/9781118735855>.

# Index

## \* **datasets**

datasaeNorm, [2](#)

datasaeT, [3](#)

datasaeNorm, [2](#)

datasaeT, [3](#)

df2R, [4](#)

mHBNormal, [4](#)

mHBT, [5](#)

msaeHB, [7](#)