Package: VBMS (via r-universe)

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Title Variational Bayesian Algorithm for Multi-Source Heterogeneous Models

Version 1.0.0

Description A Variational Bayesian algorithm for high-dimensional multi-source heterogeneous linear models. More details have been written up in a paper submitted to the journal Statistics in Medicine, and the details of variational Bayesian methods can be found in Ray and Szabo (2021) <doi:10.1080/01621459.2020.1847121>. It simultaneously performs parameter estimation and variable selection. The algorithm supports two model settings: (1) local models, where variable selection is only applied to homogeneous coefficients, and (2) global models, where variable selection is also performed on heterogeneous coefficients. Two forms of Spike-and-Slab priors are available: the Laplace distribution and the Gaussian distribution as the Slab component.

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Author Lu Luo [aut, cre], Huiqiong Li [aut]

Maintainer Lu Luo <luolu@stu.ynu.edu.cn>

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Contents

vb_gauss_global 2
vb_gauss_local 3
vb_lap_global 3
vb_lap_local 4
vbms 5

Index **7**

`vb_gauss_global` *Global Gauss VB*

Description

A variational Bayesian algorithm is proposed for multi-source heterogeneous models under the Laplace Spike-and-Slab prior, enabling simultaneous variable selection for both homogeneous and #' heterogeneous covariates.

Usage

```
vb_gauss_global(
  X,
  Z,
  Y,
  max_iter = 1000,
  tol = 1e-06,
  a = 1,
  b = 10,
  lambda = 1
)
```

Arguments

`X`	Homogeneous covariates
`Z`	Heterogeneous covariates
`Y`	Response covariates
`max_iter`	Maximum number of iterations, Defaut:1000
`tol`	Algorithm convergence tolerance, Defaut:1e-6
`a`	A prior of Beta distribution, Defaut:1
`b`	A prior of Beta distribution, Defaut:10
`lambda`	A prior of Laplace distribution, Defaut:1

Value

The mean of the homogeneity coefficient:mu1; The variance of homogeneity coefficient:sigma1; Selection coefficient:gamma1; The mean of the heterogeneous coefficient:mu2; The variance of heterogeneous coefficient:sigma2; Selection heterogeneous:gamma2.

vb_gauss_local *Local Gauss VB*

Description

A variational Bayesian algorithm, based on the Gauss Spike-and-Slab prior, is tailored for multi-source heterogeneous models and focuses on variable selection exclusively for the homogeneous covariates.

Usage

```
vb_gauss_local(X, Z, Y, max_iter, tol, a = 1, b = 10, lambda = 1)
```

Arguments

X	Homogeneous covariates
Z	Heterogeneous covariates
Y	Response covariates
max_iter	Maximum number of iterations, Defaut:1000
tol	Algorithm convergence tolerance, Defaut:1e-6
a	A prior of Beta distribution, Defaut:1
b	A prior of Beta distribution, Defaut:10
lambda	A prior of Laplace distribution, Defaut:1

Value

The mean of the homogeneity coefficient:mu; The variance of homogeneity coefficient:sigma; Selection coefficient:gamma; Mean and covariance of heterogeneity coefficients:m, s2.

vb_lap_global *Global Laplace VB*

Description

A variational Bayesian algorithm is proposed for multi-source heterogeneous models under the Laplace Spike-and-Slab prior, enabling simultaneous variable selection for both homogeneous and #' heterogeneous covariates.

Usage

```
vb_lap_global(X, Z, Y, max_iter = 1000, tol = 1e-06, a = 1, b = 10, lambda = 1)
```

Arguments

X	Homogeneous covariates
Z	Heterogeneous covariates
Y	Response covariates
max_iter	Maximum number of iterations, Defaut:1000
tol	Algorithm convergence tolerance, Defaut:1e-6
a	A prior of Beta distribution, Defaut:1
b	A prior of Beta distribution, Defaut:10
lambda	A prior of Laplace distribution, Defaut:1

Value

The mean of the homogeneity coefficient:mu1; The variance of homogeneity coefficient:sigma1; Selection coefficient:gamma1; The mean of the heterogeneous coefficient:mu2; The variance of heterogeneous coefficient:sigma2; Selection heterogeneous:gamma2.

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vb_lap_local *Local Laplace VB*

Description

A variational Bayesian algorithm, based on the Laplace Spike-and-Slab prior, is tailored for multi-source heterogeneous models and focuses on variable selection exclusively for the homogeneous covariates.

Usage

```
vb_lap_local(X, Z, Y, max_iter = 1000, tol = 1e-06, a = 1, b = 10, lambda = 1)
```

Arguments

X	Homogeneous covariates
Z	Heterogeneous covariates
Y	Response covariates
max_iter	Maximum number of iterations, Defaut:1000
tol	Algorithm convergence tolerance, Defaut:1e-6
a	A prior of Beta distribution, Defaut:1
b	A prior of Beta distribution, Defaut:10
lambda	A prior of Laplace distribution, Defaut:1

Value

The mean of the homogeneity coefficient:mu; The variance of homogeneity coefficient:sigma; Selection coefficient:gamma; Mean and covariance of heterogeneity coefficients:m, s2.

vbms *Variational Bayesian Algorithm for Multi-Source Heterogeneous Models.*

Description

This package implements a variational Bayesian algorithm for high-dimensional multi-source heterogeneous linear models. It simultaneously performs parameter estimation and variable selection. The algorithm supports two model settings: (1) local models, where variable selection is only #' applied to homogeneous coefficients, and (2) global models, where variable selection is also #' performed on heterogeneous coefficients. Two forms of Spike-and-Slab priors are available: the #' Laplace distribution and the Gaussian distribution as the Slab component.

Usage

```
vbms(
  X,
  Z,
  Y,
  global,
  prior,
  max_iter = 1000,
  tol = 1e-06,
  a = 1,
  b = 10,
  lambda = 1
)
```

Arguments

X	Homogeneous covariates
Z	Heterogeneous covariates
Y	Response covariates
global	Indicates whether variable selection is required for het coefficients, if TRUE, Variable selection will be made for het coefficients.
prior	Forms of Slab distribution in Spike-and-Slab prior, "laplace" or "gauss".
max_iter	Maximum number of iterations, Defaut:1000
tol	Algorithm convergence tolerance, Defaut:1e-6
a	A prior of Beta distribution, Defaut:1
b	A prior of Beta distribution, Defaut:10
lambda	A prior of Laplace distribution, Defaut:1

Value

mu_hom	The mean of the homogeneous coefficients
sigma_hom	The variance of homogeneous coefficients
gamma_hom	Selection indicators for homogeneous coefficients
mu_het	The mean of the heterogeneous coefficients
sigma_het	The variance of heterogeneous coefficients
gamma_het	Selection indicators for heterogeneous coefficients (NULL for local models)

Examples

```
# Simulate multi-source heterogeneous data
n <- 50  # number of samples per source
K <- 3   # number of sources
p <- 100  # number of homogeneous covariates
q <- 5    # number of heterogeneous covariates

set.seed(1)
theta <- matrix(c(c(-1,0.5,1,-0.5,2),rep(0,p-5)), ncol = 1)
beta <- matrix(1, nrow = q, ncol = K)
for (k in 1:K) {
  beta[,k] <- matrix(c(rep(log(k+1),5),rep(0,q-5)), ncol = 1)
}

zdata <- MASS::mvrnorm(K*n, rep(0,q), diag(q))
Z <- array(data=zdata,dim=c(n,q,K))
xdata <- MASS::mvrnorm(K*n, rep(0,p), diag(p))
X <- array(data=xdata,dim=c(n,p,K))
Y <- matrix(0, nrow = n, ncol = K)

for (k in 1:K) {
  Y[,k] <- MASS::mvrnorm(1, X[,,k]%*%theta+Z[,,k]%*%beta[,k], diag(n))
}

# Fit local model with Laplace prior
res <- vbms(X, Z, Y, global=FALSE, prior='laplace')

# View results
print(head(res$mu_hom))      # Homogeneous coefficients mean
print(head(res$gamma_hom))   # Homogeneous variable selection
print(res$mu_het)            # Heterogeneous coefficients mean
```

Index

vb_gauss_global, 2
vb_gauss_local, 3
vb_lap_global, 3
vb_lap_local, 4
vbms, 5