Package 'LRQVB'

October 25, 2025

Title Low Rank Correction Quantile Variational Bayesian Algorithm for
Multi-Source Heterogeneous Models

Version 1.0.0

Description

A Low Rank Correction Variational Bayesian algorithm for high-dimensional multi-source
heterogeneous quantile 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 Sz-
abo (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 parameter
estimation are output: one is the standard variational Bayesian estimation,
and the other is the variational Bayesian estimation corrected with low-rank adjustment.

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RoxygenNote 7.3.2

Imports Rcpp (>= 1.0.0), glmnet, lava, stats, MASS

LinkingTo Rcpp, RcppEigen

NeedsCompilation yes

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Contents

`lr_qvb_global`   *Global Low Rank Correction Quantile VB*

Description

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

Usage

```
lr_qvb_global(X, Z, y, tau, eps = 0.001)
```

Arguments

X	Homogeneous covariates
Z	Heterogeneous covariates
y	Response covariates
tau	Quantile Levels
eps	Algorithm convergence tolerance, Defaut:1e-3

Value

The mean of the homogeneous coefficient:mu; Low-rank correction of homogeneous coefficients:lr_mu; The variance of homogeneous coefficient:sigma; Selection homogeneous coefficient:rho; The mean of the heterogeneous coefficient:beta; Low-rank correction of heterogeneous coefficients:lr_beta; The variance of heterogeneous coefficient:sigma_beta; Selection heterogeneous coefficient:rho_beta.

`lr_qvb_local`   *Local Low Rank Correction Quantile VB*

Description

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

Usage

```
lr_qvb_local(X, Z, y, tau, eps = 0.001)
```

Arguments

X	Homogeneous covariates
Z	Heterogeneous covariates
y	Response covariates
tau	Quantile Levels
eps	Algorithm convergence tolerance, Default:1e-3

Value

The mean of the homogeneous coefficient:mu; Low-rank correction of homogeneous coefficients:lr_mu; The variance of homogeneous coefficient:sigma; Selection coefficient:rho; The mean of the heterogeneous coefficient:beta; The variance of heterogeneous coefficient:sigma_beta.

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

Description

This package implements a variational Bayesian algorithm for high-dimensional multi-source quantile 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 parameter estimation are output: one is the standard variational #' Bayesian estimation, and the other is the variational Bayesian estimation corrected with low-rank adjustment.

Usage

```
vbms(X, Z, y, global, tau, eps = 0.001)
```

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.
tau	Quantile Levels
eps	Algorithm convergence tolerance, Defaut:1e-3

Value

mu_hom   The mean of the homogeneous coefficients

lr_mu_hom   The low rank correction estimation of homogeneous coefficients

sigma_hom   The variance of homogeneous coefficients

gamma_hom   Selection indicators for homogeneous coefficients

mu_het   The mean of the heterogeneous coefficients

lr_mu_het   The low rank correction estimation of 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
tau <- 0.5

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, tau=tau)

# View results
print(head(res$mu_hom))       # Homogeneous coefficients mean
print(head(res$lr_mu_hom))      # Low rank correction estimation
print(head(res$gamma_hom))    # Homogeneous variable selection
print(res$mu_het)             # Heterogeneous coefficients mean
```

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