Package: LRQVB (via r-universe)

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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 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 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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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.

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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