# Package ‘MLModelSelection’

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**Type** Package

**Title** Model Selection in Multivariate Longitudinal Data Analysis

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**Author** Kuo-Jung Lee

**Maintainer** Kuo-Jung Lee <kuojunglee@mail.ncku.edu.tw>

**Description** An efficient Gibbs sampling algorithm is developed for Bayesian multivariate longitudinal data analysis with the focus on selection of important elements in the generalized autoregressive matrix. It provides posterior samples and estimates of parameters. In addition, estimates of several information criteria such as Akaike information criterion (AIC), Bayesian information criterion (BIC), deviance information criterion (DIC) and prediction accuracy such as the marginal predictive likelihood (MPL) and the mean squared prediction error (MSPE) are provided for model selection.

**URL** https://github.com/kuojunglee/

**Depends** R(>= 3.5.0)

**License** GPL-2

**Imports** Rcpp (>= 1.0.1), MASS

**Suggests** testthat

**LinkingTo** Rcpp, RcppArmadillo, RcppDist

**NeedsCompilation** yes

**Repository** CRAN

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## R topics documented:

MLModelSelectionMCMC *Model estimation for multivariate longitudinal models.*

## Description

Using MCMC procedure to generate posterior samples and provide AIC, BIC, DIC, MPL, MSPE, and predicted values.

## Usage

```
MLModelSelectionMCMC(Num.of.iterations, list.Data, list.InitialValues, list.HyperPara,
list.UpdatePara, list.TuningPara)
```

## Arguments

`Num.of.iterations`
: Number of iterations.

`list.Data`
: *List* of data set containing response $Y$, design matrix $X$, avialable time points for each subject, GARP model, and ISD model.

`list.InitialValues`
: *List* of initial values for parameters.

`list.HyperPara`
: *List* of given hyperparameters in priors.

`list.UpdatePara`
: Determine which parameter will be updated.

`list.TuningPara`
: Provide turning parameters in proposal distributions.

## Details

We set the subject $i$ ($i = 1, \ldots, N$) has $K$ continuous responses at each time point $t$ ($t = 1, \ldots, n_i$). Assume that the measurement times are common across subjects, but not necessarily equally-spaced. Let $y_{it} = (y_{it1}, \ldots, y_{itK})$ denote the response vector containing $K$ continuous responses for $i$th subject at time $t$ along with a $p \times 1$ vectof of covariates, $x_{it} = (x_{it1}, \ldots, x_{itp})$. An efficient Gibbs sampling algorithm is developed for model estimation in the multivariate longitudinal model given by

$$y_{i1k} = x'_{it}\beta_k + e_{i1k}, t = 1;$$

$$y_{itk} = x'_{it}\beta_k + \sum_{g=1}^{K}\sum_{j=1}^{t-1} \phi_{itj,kg}(y_{ijg} - x'_{ij}\beta_g) + e_{itk}, t \geq 2,$$

where $\beta_k = (\beta_{k1}, \ldots, \beta_{kp})'$ is a vector of regression coefficients of length $p$, $\phi_{itj,kg}$ is a generalized autoregressive parameter (GARP) to explain the serial dependence of responses across time. Moreover,

$$\phi_{itj,kg} = \alpha_{kg}\mathbf{1}\{|t-j| = 1\},\ \log(\sigma_{itk}) = \lambda_{k0} + \lambda_{k1}h_{it},\ \log\left(\frac{\omega_{ilm}}{\pi - \omega_{ilm}}\right) = \nu_l + \nu_m.$$

The priors for the parameters in the model given by

$$\beta \sim \mathcal{N}(0, \sigma_\beta^2 I);$$

$$\lambda_k \sim \mathcal{N}(0, \sigma_\lambda^2 I);$$

$$\nu_k \sim \mathcal{N}(0, \sigma_\nu^2 I), \quad k = 1, \ldots, K,$$

where $\sigma_\beta^2$, $\sigma_\lambda^2$, and $\sigma_\nu^2$ are prespecified values. For $k, g = 1, \ldots, K$ and $m = 1, \ldots, a$, we further assume

$$\alpha_{kgm} \sim \delta_{kgm}\mathcal{N}(0, \sigma_\delta^2) + (1 - \delta_{kgm})\eta_0,$$

where $\sigma_\delta^2$ is prespecified value and $\eta_0$ is the point mass at 0.

## Value

Lists of posterior samples, parameters estimates, AIC, BIC, DIC, MPL, MSPE, and predicted values are returned

## Note

We'll provide the reference for details of the model and the algorithm for performing model estimation whenever the manuscript is accepted.

## Author(s)

Kuo-Jung Lee

## References

Keunbaik Lee et al. (2015) Estimation of covariance matrix of multivariate longitudinal data using modified Choleksky and hypersphere decompositions. *Biometrics*. **75-86, 2020**. doi: 10.1111/biom.13113.

## Examples

```
library(MASS)
library(MLModelSelection)


AR.Order = 6 #denote \phi_{itj, kg} = \alpha_{kg} \mathbf{1}{|t-j|=1}
ISD.Model = 1 #denote \log(\sigma_{itk}) = \lambda_{k0} + \lambda_{k1} h_{it}

data(SimulatedData)

N = dim(SimulatedData$Y)[1] # the number of subjects
T = dim(SimulatedData$Y)[2] # time points
K = dim(SimulatedData$Y)[3] # the number of attributes
P = dim(SimulatedData$X)[3] # the number of covariates
M = AR.Order  # the demension of alpha
nlamb = ISD.Model + 1 # the dimension of lambda
```

```
Data = list(Y = SimulatedData$Y, X = SimulatedData$X,
TimePointsAvailable = SimulatedData$TimePointsAvailable,
AR.Order = AR.Order, ISD.Model = ISD.Model)

beta.ini = matrix(rnorm(P*K), P, K)
delta.ini = array(rbinom(K*K*M, 1, 0.1), c(K, K, M))
alpha.ini = array(runif(K*K*M, -1, 1), c(K, K, M))
lambda.ini = matrix(rnorm(nlamb*K), K, nlamb, byrow=T)
nu.ini = rnorm(K)


InitialValues = list(beta = beta.ini, delta = delta.ini, alpha = alpha.ini,
lambda = lambda.ini, nu = nu.ini)

# Hyperparameters in priors
sigma2.beta = 1
sigma2.alpha = 10
sigma2.lambda = 0.01
sigma2.nu = 0.01

# Whehter the parameter will be updated
UpdateBeta = TRUE
UpdateDelta = TRUE
UpdateAlpha = TRUE
UpdateLambda = TRUE
UpdateNu = TRUE


HyperPara = list(sigma2.beta = sigma2.beta, sigma2.alpha=sigma2.alpha,
sigma2.lambda=sigma2.lambda, sigma2.nu=sigma2.nu)


UpdatePara = list(UpdateBeta = UpdateBeta, UpdateAlpha = UpdateAlpha, UpdateDelta = UpdateDelta,
              UpdateLambda = UpdateLambda, UpdateNu = UpdateNu)

# Tuning parameters in proposal distribution within MCMC
TuningPara = list(TuningAlpha = 0.01, TuningLambda = 0.005, TuningNu = 0.005)

num.of.iter = 100

start.time <- Sys.time()

PosteriorSamplesEstimation = MLModelSelectionMCMC(num.of.iter, Data, InitialValues,
HyperPara, UpdatePara, TuningPara)

end.time <- Sys.time()

cat("Estimate of beta\n")
print(PosteriorSamplesEstimation$PosteriorEstimates$beta.mean)
```

SimulatedData *Simulated data*

## Description

A simulated multivariate longitudinal data for demonstration.

## Usage

```
data("SimulatedData")
```

## Format

A `list` consists of `Y` the observations 100 subjects in 3 attributes along 10 time points, `X` the design matrix with 6 covariate including the intercept, `TimePointsAvailable` the avilable time points for each subject.

`Y` The response variables.

`X` The design matrix.

`TimePointsAvailable` The available time points for each subject.

## Examples

```
library(MLModelSelection)
data(SimulatedData)
SimulatedData = data(SimulatedData)
```

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