Description

mh.lm: This function produces one or multiple Metropolis-Hastings *independence* chains for normal linear regression models. The function works for models with zero, one or two explanatory variables:

$$M_0 : y = a + \varepsilon$$
$$M_1 : y = a + bx_1 + \varepsilon$$
$$M_2 : y = a + b_1 x_1 + b_2 x_2 + \varepsilon$$

with $\varepsilon \sim N(0, \sigma^2)$ and prior specification under each model

M_0: $a \sim N(0, k\left(\mathbf{X}_0\mathbf{X}_0^T\right)^{-1}\sigma^2)$, $\sigma^2 \sim IG(A, B)$

M_1: $\left(a, b_1\right)^T \sim N_2(\mathbf{0}, k\left(\mathbf{X}_1\mathbf{X}_1^T\right)^{-1}\sigma^2)$, $\sigma^2 \sim IG(A, B)$

M_2: $\left(a, b_1, b_2\right)^T \sim N_3(\mathbf{0}, k\left(\mathbf{X}_2\mathbf{X}_2^T\right)^{-1}\sigma^2)$, $\sigma^2 \sim IG(A, B)$

$\mathbf{X}_j$ is the corresponding design matrix for each model for $j = 0,1,2$.

The proposal distributions under each model are

$$M_0 : q^t \sim N_2\left(\left(a^{\text{mode}}, \log\sigma^{\text{mode}}\right)^T, \mathbf{V}_0\right)$$
$$M_1 : q^t \sim N_3\left(\left(a^{\text{mode}}, b_1^{\text{mode}}, \log\sigma^{\text{mode}}\right)^T, \mathbf{V}_1\right)$$
$$M_2 : q^t \sim N_4\left(\left(a^{\text{mode}}, b_1^{\text{mode}}, b_2^{\text{mode}}, \log\sigma^{\text{mode}}\right)^T, \mathbf{V}_2\right)$$

The upper script (mode) stands for the mode of the log-target density while $\mathbf{V}_j$, for $j = 0,1,2$, is the inverse of the negative Hessian of the log-target density evaluated at the mode.

Usage

```
mh.lm(y, x, n, l=1, discard=n/2, initial.matrix, pos.mode, hyper.par=c(0.001,0.001), prior.var='square',
      plot=TRUE)
```

This function requires the R-package mvtnorm to be installed and loaded.

Arguments

y: the dependent variable vector.

x: the independent variable vector or matrix. This argument can be a vector (model with 1 explanatory variable), a matrix (model with 2 explanatory variables each corresponding to a column) or a character set equal to ‘none’ (for the null model).

n: the number of Metropolis-Hastings iterations.

l: the number of Metropolis-Hastings chains to be produced, the default choice is 1 chain.

discard: the number of discarded iterations for the "burn-in" period. The default value n/2 discards the first half of the chain. This arguments must *always* be smaller than *n*.

initial.matrix: A matrix which contains the initial values for the simulation. This argument must be given in matrix form. The dimension of the matrix depends on the number of Metropolis-Hastings chains and on the number of parameters. The rows must equal the number of chains (argument *l*) while the columns must equal the number of parameters. For example, for a regression model with parameters (a, b_1, σ) and 5 parallel Metropolis-Hastings chains, the dimension must be 5×3.

pos.mode: a vector corresponding to the posterior mode estimate. The length of this vector must equal the number of parameters.

hyper.par: a vector of size 2 corresponding to the values of the hyper parameters A and B. The default values are $A=B=0.001$.

prior.var: A character related to the multiplying parameter *k*. The options are 'square', 'simple' or 'regressors'.

If set to 'square' then $k = (sample.size)^2$

If set to 'simple' then $k = (sample.size)$

If set to 'regressors' then $k = (number.of.regressor.parameters)^2$

The last case refers *only* to regressor parameters and *not* to the constant term, therefore *k* cannot be set to 'regressors' for a model with no independent variables (null model). The default choice is 'square'.

plot: A logical argument. If TRUE and l=1 (one chain) then time series plots, autocorrelation plots and histograms for the draws of parameters *a, b* and σ are returned. If true and l>1 (multilple chains) then ergodic mean plots and histograms for the draws of parameters *a, b* and σ are returned.

Components

mh.lm returns the following components:

D: A vector used in the calculation of Chib-Jeliaskov's estimator.

candidates: The draws of parameters from the proposal distribution.

parameters: The draws of parameters from the posterior distribution.

proposals.cov: The covariance matrix of the proposal distribution (the inverse of the negative Hessian of the log-target density evaluated at the mode).

acceptance_ratio: The acceptance ratio of each chain.

R_root: The calculated R reduction measure (returned only if $l>1$).

lengths: The size of the MCMC sample kept for inference.

means: The posterior means of the parameters.

standard.deviations: The posterior standard deviations of the parameters.

correlations: The posterior correlation matrix of the parameters.

quantiles: The posterior quantiles of the parameters.