# Computer lab 4: Metropolis Hastings

## Learning objectives

The main objective of this computer lab is to make the student familiar with different variants of the Metropolis-Hastings algorithm.

After completing the lab the student shall be able to:

1. Understand the need for tuning of Metropolis-Hastings algorithm and how the acceptance rate can be used for monitoring.
2. Implement M-H algorithms in a standard regression setting.

## Recommended reading

Chapter 6 in Robert and Casella (2009)

Chapter 7 in Givens and Hoeting (2013)

## Assignment 1: Different versions of the Metropolis-Hastings algorithm

a.) The function normm is simulating from a normal with zero mean and unit variance

using a Metropolis algorithm with uniform proposal distribution. The exercise is to try the following a = 0.1,1 and 200 for 2000 iterations. Present trace plots of line type and histograms with interpretations. Tune the sampler by finding a value of a that gives an acceptance probability of 0.3. You have to modify the code in order to save the acceptance rate. Explain the code with comments.

normm<-function (Nsim, a)

{

vec <- vector("numeric", Nsim)

x <- 0

vec[1] <- x

for (i in 2:Nsim) {

innov <- runif(1, -a, a)

Xstar <- x + innov

aprob <- min(1, dnorm(Xstar)/dnorm(x))

u <- runif(1)

if (u < aprob)

x <- Xstar

vec[i] <- x

}

vec

}

b.) Function gammh is a Metropolis-Hastings independence sampling algorithm with normal proposal distribution with the same mean and variance as the desired gamma. Try a = 0.1, 2 and b = 0.01, 2. Present trace plots and histograms with interpretations. Explain the code with comments.

gammh<-function (Nsim, a, b)

{

mu <- a/b

sig <- sqrt(a/(b \* b))

vec <- vector("numeric", Nsim)

x <- a/b

vec[1] <- x

for (i in 2:Nsim) {

can <- rnorm(1, mu, sig)

aprob <- min(1, (dgamma(can, a, b)/dgamma(x,

a, b))/(dnorm(can, mu, sig)/dnorm(x,mu, sig)))

u <- runif(1)

if (u < aprob)

x <- can

vec[i] <- x

}

vec

}

## Assignment 2: Bayesian model selection using the Metropolis-Hastings algorithm

The task in this assignment is to use the code from Example 6.8 (p. 188-192 in Robert and Casella, 2009) to analyse the housing.txt data that you used in Lab 3 with marginal Bayesian model selection. Read through the example carefully so you understand if any changes need to be done to the code. Run the MH sampler for 25 000 iterations and discard the first 5 000 as burn-in, i.e. the sample to analyse should be the last 20 000 iterations. Calculate the probability that each variable is included within the model and find the model probabilities of the 5 best models (Hint: use the data.frame() and table() functions). Compare your results with those from the Simulated annealing and Genetic algorithms.

## To hand in

A written report (Word, pdf, html) where you summarize your main findings in the assignments. Submit your report via Moodle before the deadline.