

# Lab 3

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# 1 - Normal model, mixture of normal model with semi-conjugate prior

## 1a) - Normal model

The code for the Gibbs implementation can be seen below.

```
# draw mu
drawMu <- function(prevMu, prevSigma) {
  tauSq <- 1/( (n/prevSigma) + (1/tau0^2) )
  w <- (n/prevSigma)/((n/prevSigma) + (1/tau0^2))
  mu <- w*dataMean + (1-w)*mu0
  draw <- rnorm(1, mu, sqrt(tauSq))
  return (draw)
}

#inv chi square
invChiSquare <- function(v, s) {
  return(v*s / rchisq(1,v))
}

# draw sigma
drawSigma <- function(mu) {
  sum <- 0
  for (i in 1:n) {
    sum <- sum + (data[i,1] - mu)^2
  }
  s <- (v0*sigma0 + sum)/(n+v0)
  return(invChiSquare(vn, s))
}

mu <- c()
sigma2 <- c()

currMu <- 32
currSigma <- sigma0
for (i in 1:iter) {
  if(i %% 2 == 0) {
    currMu <- drawMu(currMu, currSigma)
  } else {
    currSigma <- drawSigma(currMu)
  }
  mu <- c(mu, currMu)
  sigma2 <- c(sigma2, currSigma)
}
```

By plotting the trajectories of the sampled Markov chains it can be seen that  $\sigma$  and  $\mu$  converges around 39 and 32 respectively.

## 1b) - Mixture normal model

The results of the Gibbs sampling data augmentation algorithm given in NormalMixtureModel.R resulted can be seen below.

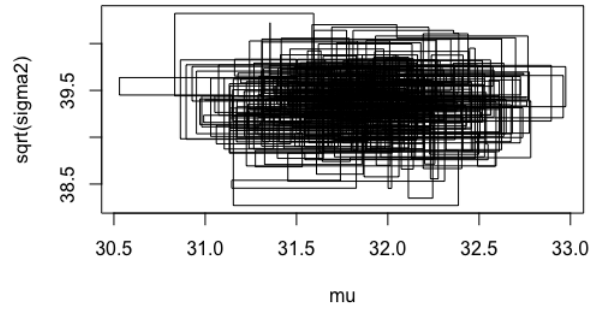
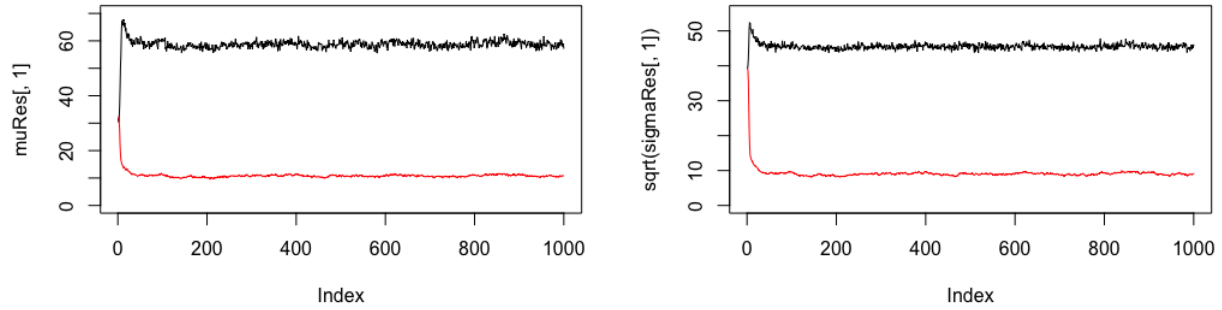


Figure 1: Analyzing the convergence



Both  $\mu$  and  $\sigma$  converged after a few samples.

### 1c) - Graphical comparison

The figure below shows a comparison between the samplers. The blue line represents the normal density from exercise a, and the green line represents the mixture of normals density from exercise b. Both of the models have limitations when it comes to fit the data.

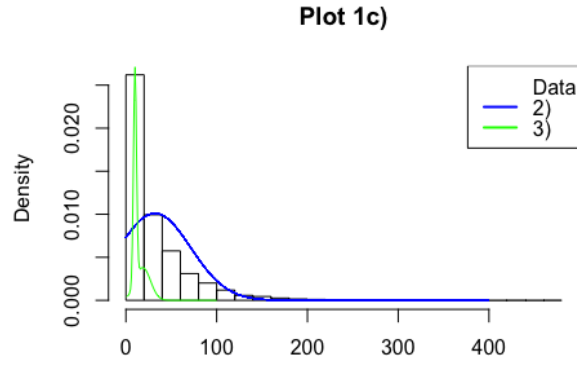
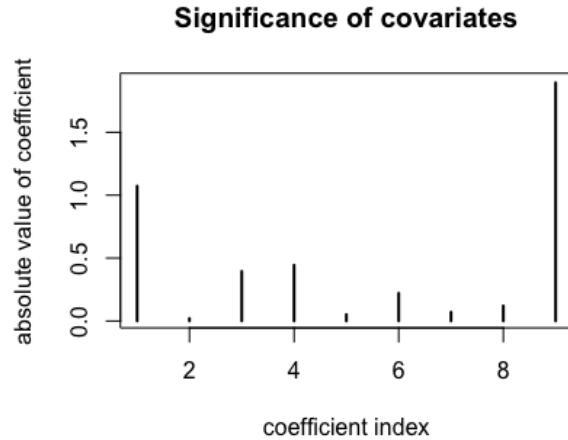


Figure 2: Graphical comparison

## 2 - Metropolis Random Walk for Poisson regression

2a)

The absolute values of the parameters obtained by a maximum likelihood estimation is shown below.



The figure shows that the ninth parameter, meaning minBidShare, is the most significant covariate, whereas PowerSeller is the least significant.

2b)

The bayesian regression resulted in the following values for  $\beta$ s

2c)

The result below is from 50 000 sample draws from the posterior. In order to analyze the convergence,  $\beta[1]$  and  $\beta[2]$  are plotted in the same plot. As can be seen, most of the samples are drawn from a oval-shaped

Const	PowerSeller	VerifyID	Sealed	Minblem	MajBlem	LargNeg	LogBook	MinBidShare	
0.4932	0.6767	1.4006	1.0888	1.0942	1.7190	1.1535		0.5236	1.0231545
.33285	-0.28581	0.03928	-0.14391	-0.21800	-0.19890	-0.19947		-0.15492	-0.22178

Table 1:  $\mu_0$

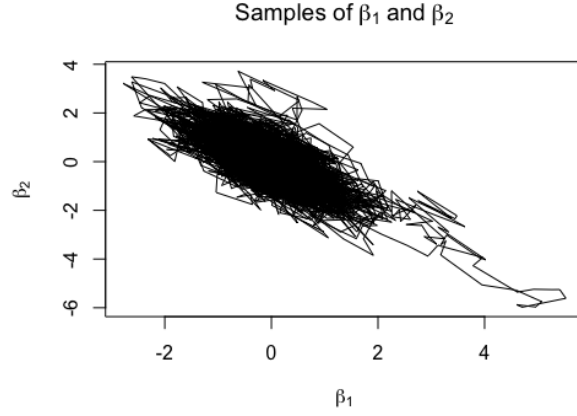


Figure 3: Significance of covariates

distribution centered around the modes of the betas. Thus, the algorithm has converged.