lecture 4.7 example 4

preliminaries

```
#clear workspace
rm(list=ls())
# load data
data = read.csv("~/Desktop/wages1.csv")

data=data[,]

# build variables
wage = data$wage
school = data$school
exper = data$exper
```

build model objects and functions

```
#build parameter grid
stepBeta0Grid = 0.05
stepBeta1Grid = 0.005
stepBeta2Grid = 0.005
stepSigmaGrid = 0.05
beta0Grid = seq(1.05,1.75, by = stepBeta0Grid)
beta1Grid = seq(-0.25,0.5, by = stepBeta1Grid)
beta2Grid = seq(-0.25,0.25, by = stepBeta2Grid)
sigmaGrid = seq(0.5,0.7, by = stepSigmaGrid)

nBeta0Grid = length(beta0Grid)
nBeta1Grid = length(beta1Grid)
nBeta2Grid = length(beta2Grid)
nSigmaGrid = length(sigmaGrid)

# uninformed priors
buildPrior = function() {
  print('=========')
  print("building prior")
  print('=========')
  prior = array( rep(1, nBeta0Grid * nBeta1Grid * nBeta2Grid * nSigmaGrid ),
                 dim = c(nBeta0Grid, nBeta1Grid, nBeta2Grid, nSigmaGrid ))
  for (nB0 in 1:nBeta0Grid) {
    print(paste("nB0 = ", nB0))
    for (nB1 in 1:nBeta1Grid) {
      for (nB2 in 1:nBeta2Grid) {
        for (nSig in 1:nSigmaGrid) {
          #prior[nB0,nB1,nB2, nSig] = dnorm(beta0Grid[nB0]) * dnorm(beta1Grid[nB1]) * dnorm(beta2Grid[n
          prior[nB0,nB1,nB2, nSig] = 1
        }
      }
    }
```

```
  }
  return(prior)
}


#likelihood
likelihood = function(y,x1, x2, b0L, b1L, b2L, sL){
  loglike = sum(log(dnorm(y-b0L-b1L*x1-b2L*x2, mean = 0, sd=sL)))
  like = exp(loglike)
  return(like)
}

#compute posterior function
compPost = function(y,x1, x2, prior){
  #initialize local posterior
  post = array( rep(-1, nBeta0Grid * nBeta1Grid * nBeta2Grid * nSigmaGrid ),
                dim = c(nBeta0Grid, nBeta1Grid, nBeta2Grid, nSigmaGrid ))
  # compute posterior
  for (nBeta0 in 1:nBeta0Grid) {
    print(paste("beta0 =  ",beta0Grid[nBeta0] ))
    b0 = beta0Grid[nBeta0]
    for (nBeta1 in 1:nBeta1Grid) {
      b1 = beta1Grid[nBeta1]
      for (nBeta2 in 1:nBeta2Grid) {
        b2 = beta2Grid[nBeta2]
        for (nSigma in 1:nSigmaGrid) {
          s = sigmaGrid[nSigma]
          post[nBeta0,nBeta1,nBeta2,nSigma] = likelihood(y,x1,x2,b0,b1,b2,s) * prior[nBeta0,nBeta1,nBeta
        }
      }
    }
  }
  # normalize posterior
  post = post / (sum(post) * stepBeta0Grid * stepBeta1Grid * stepBeta2Grid * stepSigmaGrid)
  # return
  return(post)
}
```

compute posterior

```
prior = buildPrior()
```

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## [1] "building prior"
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## [1] "nB0 =  12"
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## [1] "nB0 =  14"
## [1] "nB0 =  15"
```

```
#compute posterior function iteratively using batches of 100 observations
for (k in 1:floor(length(wage)/100)) {
  print('=========')
  print(k)
  print('=========')
  y = log(wage[(1+(k-1)*100):(k*100)])
  x1 = school[(1+(k-1)*100):(k*100)] - mean(school)
  x2 = exper[(1+(k-1)*100):(k*100)] - mean(exper)
  post = compPost(y,x1,x2,prior)
  prior = post
}
```

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## [1] "beta0 =   1.4"
## [1] "beta0 =   1.45"
## [1] "beta0 =   1.5"
## [1] "beta0 =   1.55"
## [1] "beta0 =   1.6"
## [1] "beta0 =   1.65"
## [1] "beta0 =   1.7"
## [1] "beta0 =   1.75"
## [1] "=========="
## [1] 28
## [1] "=========="
## [1] "beta0 =   1.05"
## [1] "beta0 =   1.1"
## [1] "beta0 =   1.15"
## [1] "beta0 =   1.2"
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## [1] "=========="
## [1] "beta0 =   1.05"
## [1] "beta0 =   1.1"
## [1] "beta0 =   1.15"
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## [1] "beta0 =   1.6"
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```
## [1] "beta0 =   1.7"
## [1] "beta0 =   1.75"
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## [1] "=========="
## [1] "beta0 =   1.05"
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## [1] "beta0 =   1.15"
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## [1] "beta0 =   1.65"
## [1] "beta0 =   1.7"
## [1] "beta0 =   1.75"
## [1] "=========="
## [1] 31
## [1] "=========="
## [1] "beta0 =   1.05"
## [1] "beta0 =   1.1"
## [1] "beta0 =   1.15"
## [1] "beta0 =   1.2"
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## [1] "beta0 =   1.65"
## [1] "beta0 =   1.7"
## [1] "beta0 =   1.75"
## [1] "=========="
## [1] 32
## [1] "=========="
## [1] "beta0 =   1.05"
## [1] "beta0 =   1.1"
## [1] "beta0 =   1.15"
## [1] "beta0 =   1.2"
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## [1] "beta0 =   1.35"
## [1] "beta0 =   1.4"
## [1] "beta0 =   1.45"
## [1] "beta0 =   1.5"
## [1] "beta0 =   1.55"
## [1] "beta0 =   1.6"
## [1] "beta0 =   1.65"
```

```
## [1] "beta0 =   1.7"
## [1] "beta0 =   1.75"
```

```
#compute marginal posteriors
margPostBeta0 = apply(post,c(1),sum)
margPostBeta0 = margPostBeta0 / (sum(margPostBeta0) * stepBeta0Grid)

margPostBeta1 = apply(post,c(2),sum)
margPostBeta1 = margPostBeta1 / (sum(margPostBeta1) * stepBeta1Grid)

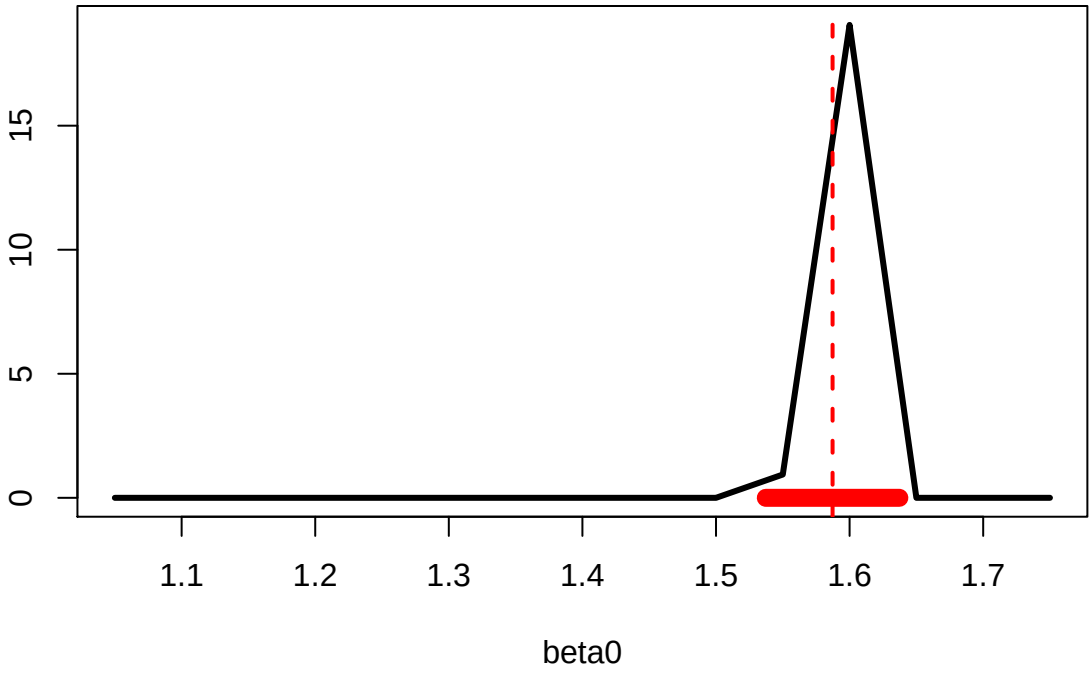
margPostBeta2 = apply(post,c(3),sum)
margPostBeta2 = margPostBeta2 / (sum(margPostBeta2) * stepBeta2Grid)

margPostSigma = apply(post,c(4),sum)
margPostSigma = margPostSigma / (sum(margPostSigma) * stepSigmaGrid)
```

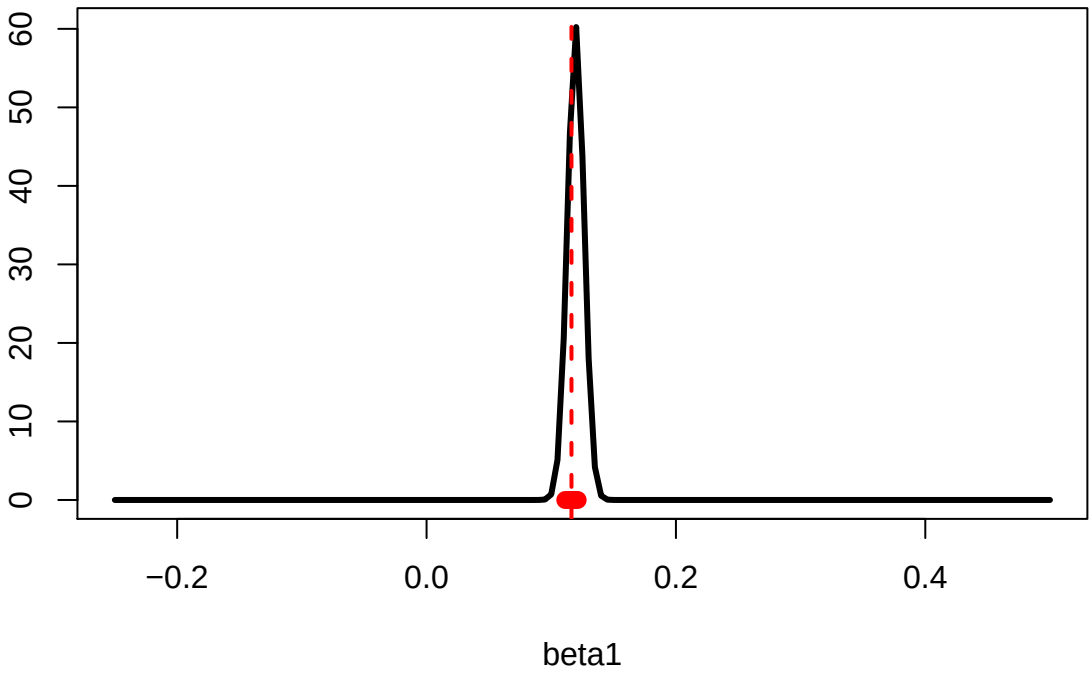
visualize posteriors

```
# compute beta-hat estimates using classical linear regression
sC = school - mean(school)
eC = exper - mean(exper)
m = lm(log(wage) ~ sC+eC)
betaHat0 = coef(m)[1]
betaHat1 = coef(m)[2]
betaHat2 = coef(m)[3]
```

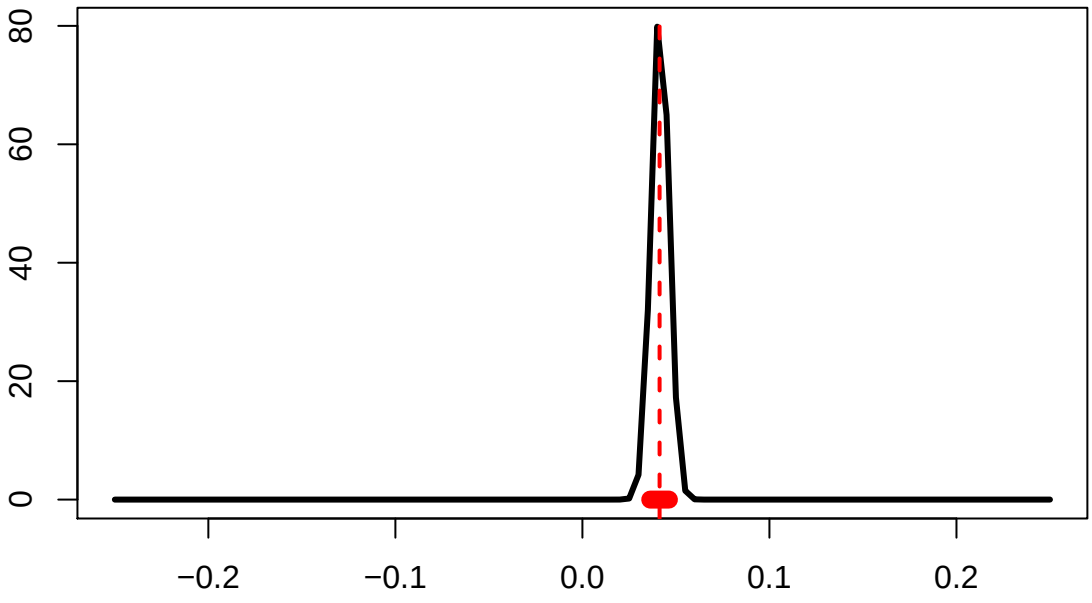
```
#posteriors beta0
plot(beta0Grid, margPostBeta0,
     xlab = "beta0", ylab="",
     type = "l", lwd = 3)
abline(v=betaHat0, lty=2, lwd=2, col="red")
segments(betaHat0-stepBeta0Grid, 0,betaHat0+stepBeta0Grid,0, lwd=9, col="red" )
```



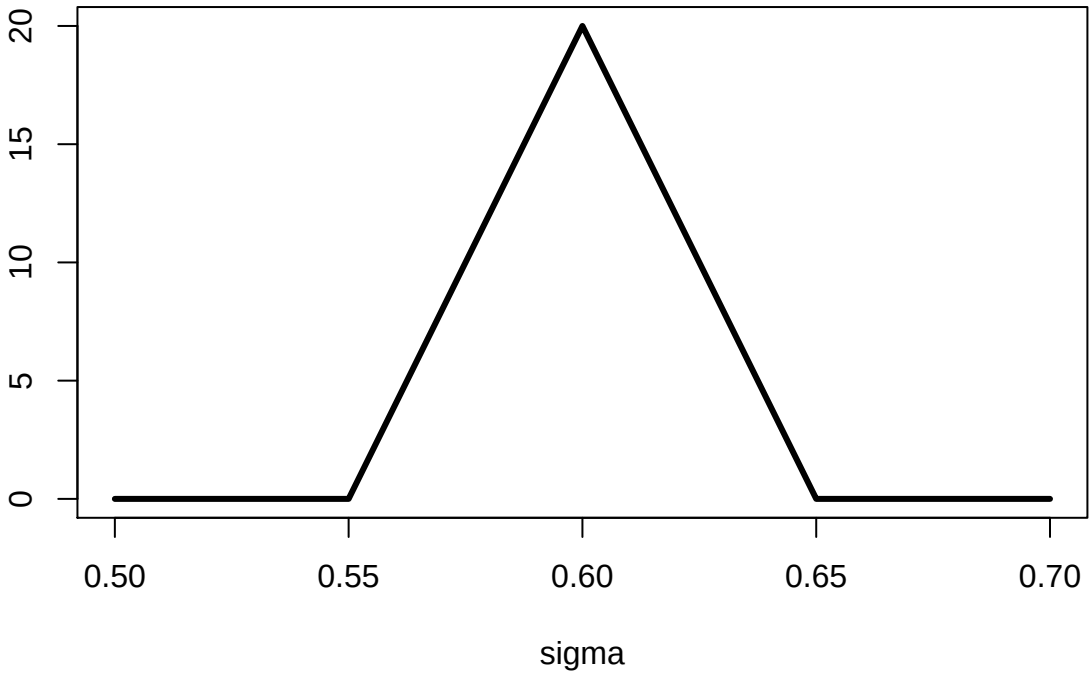
```r
#posteriors beta1
plot(beta1Grid, margPostBeta1,
     xlab = "beta1", ylab="",
     type = "l", lwd = 3)
abline(v=betaHat1, lty=2,lwd=2, col="red")
segments(betaHat1-stepBeta1Grid, 0,betaHat1+stepBeta1Grid,0, lwd=9, col="red" )
```




```r
#posteriors beta2
plot(beta2Grid, margPostBeta2,
     xlab = "beta2", ylab="",
     type = "l", lwd = 3)
abline(v=betaHat2, lty=2,lwd=2, col="red")
segments(betaHat2-stepBeta2Grid, 0,betaHat2+stepBeta2Grid,0, lwd=9, col="red" )
```




```
#posteriors sigma
plot(sigmaGrid, margPostSigma,
     xlab = "sigma", ylab="",
     type = "l", lwd = 3)
```




```
# joint posteriors
jointPost = apply(post,c(2,3),sum)
jointPost = jointPost / (sum(jointPost) * stepBeta1Grid* stepBeta2Grid)
library(lattice)
new.palette=colorRampPalette(c("white","red","yellow","white"),space="rgb")
levelplot(jointPost, col.regions=new.palette(20),
```

```
        xlab = "beta_schooling", ylab = "beta_experience",
        scales=list(x=list(at=c(1,length(beta1Grid)),
                           labels=c(-0.25,0.5)),
                    y=list(at=c(1,length(beta2Grid)),
                           labels=c(-0.25,0.5))))
```