RegressionCoef

Simulated Model : $Y = 1 + 2X1 + 3X2 + \epsilon$, where $\epsilon \sim N(0,2I_{20})$.

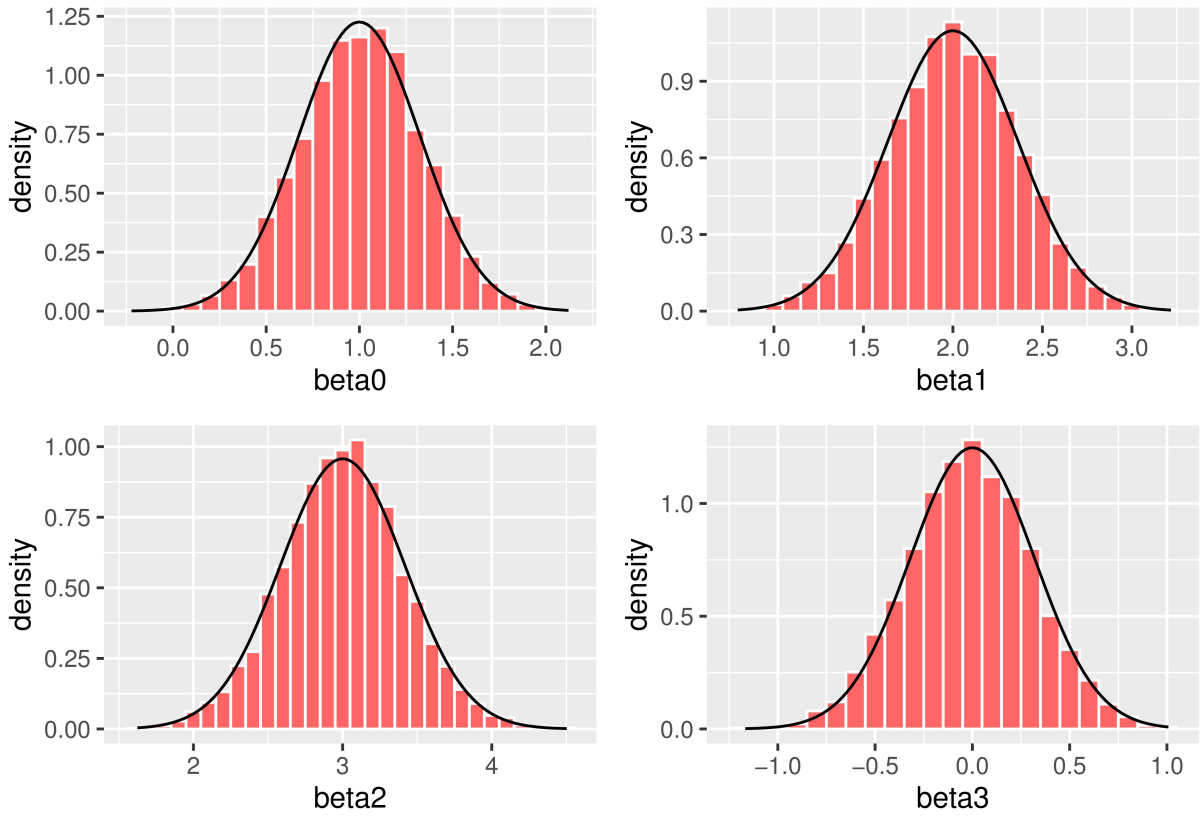
The beta coefficients are retained for each simulations and a distribution is plotted which is overlaid with the theoretical distribution.

```
library(ggplot2)
library(patchwork)
```

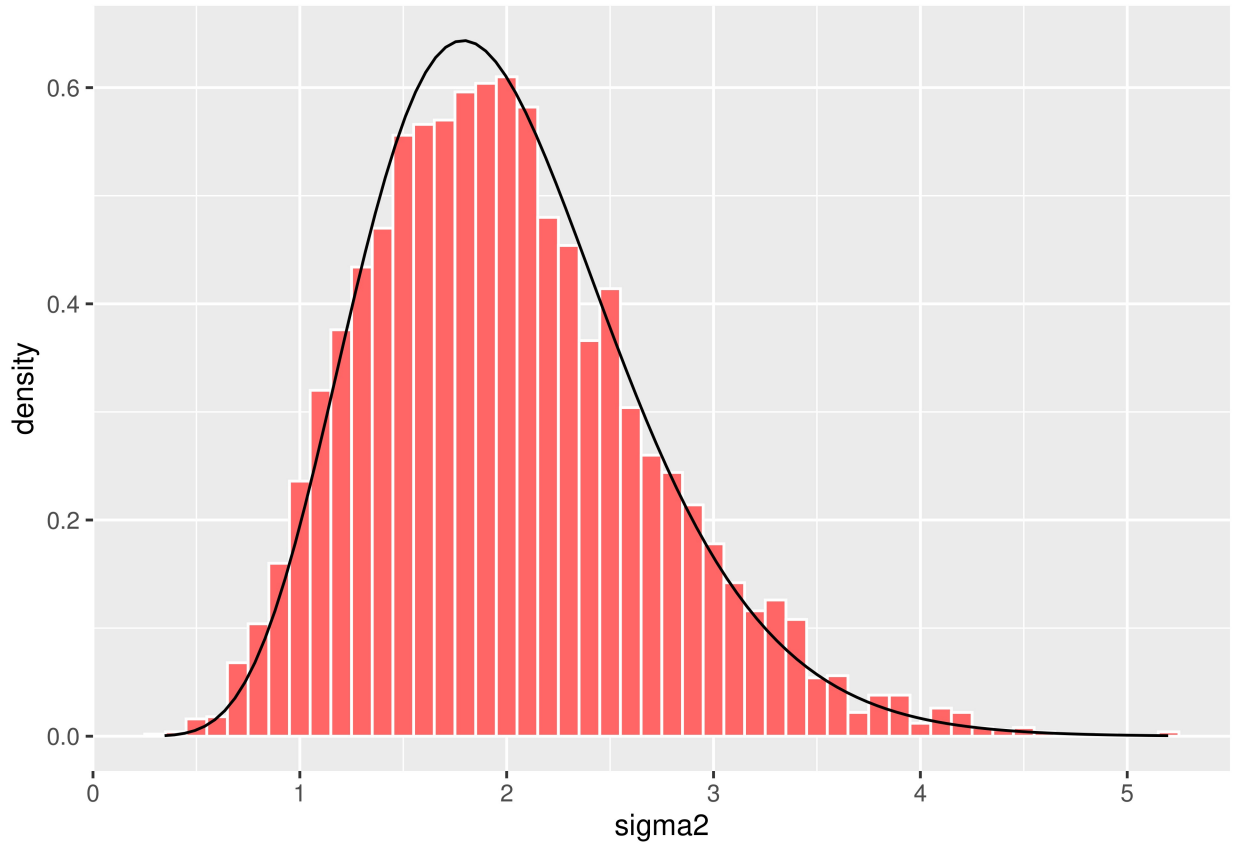
```
## Warning: package 'patchwork' was built under R version 4.1.2
```

```
simdata <- read.csv("HW4sim.csv")
varE <- 2
beta0 <- length(5000)
beta1 <- length(5000)
beta2 <- length(5000)
beta3 <- length(5000)
sigma2 <- length(5000)
diff <- length(5000)

for (i in 1:5000){

  y <- 1 + 2*simdata$X1 + 3*simdata$X2 + cbind(rnorm(20, 0, sqrt(varE)))
  simdata$Y <- y
  simfit <- lm(Y ~ X1 + X2 + X3 , data = simdata)

  beta0[i] <- simfit$coefficients[1]
  beta1[i] <- simfit$coefficients[2]
  beta2[i] <- simfit$coefficients[3]
  beta3[i] <- simfit$coefficients[4]
  sigma2[i] <- summary(simfit)$sigma^2
  diff[i] <- (beta1[i] - 2)/(summary(simfit)$coefficients[2,2])
}

matx <- model.matrix(simfit)
var_beta <- varE*solve(t(matx)%*%matx)
betaframe <- data.frame(beta0,beta1,beta2,beta3,sigma2,diff)

p0 <- ggplot(data = betaframe, aes(x=beta0)) + geom_histogram(aes(y = ..density..), color= "white", fil
stat_function(fun=dnorm, args = list(mean= 1, sd = sqrt(var_beta[1,1])), color = "black")

p1 <- ggplot(data = betaframe, aes(x=beta1)) + geom_histogram(aes(y = ..density..), color= "white", fil
stat_function(fun=dnorm, args = list(mean= 2, sd = sqrt(var_beta[2,2])), color = "black")

p2 <- ggplot(data = betaframe, aes(x=beta2)) + geom_histogram(aes(y = ..density..), color= "white", fil
stat_function(fun=dnorm, args = list(mean= 3, sd = sqrt(var_beta[3,3])), color = "black")
```

```
p3 <- ggplot(data = betaframe, aes(x=beta3)) + geom_histogram(aes(y = ..density..), color= "white", fil
stat_function(fun=dnorm, args = list(mean= 0, sd = sqrt(var_beta[4,4])), color = "black")

p0 + p1 + p2 + p3
```




```
s1  <- ggplot(data = betaframe, aes(x=sigma2)) + geom_histogram(aes(y = ..density..), color= "white", f
stat_function(fun=dgamma, args = list(shape= 9.5, rate =1/(2*2/19)), color = "black")
s1
```



Theoretical distributions:

$\beta_0 \sim$ N(1, 0.105)

$\beta_1 \sim$ N(2, 0.132)

$\beta_2 \sim$ N(3, 0.173)

$\beta_3 \sim$ N(0, 0.102)

$\sigma^2 \sim$ Gamma(9.5, 4.75)