# Computer_lab3_task1_task3

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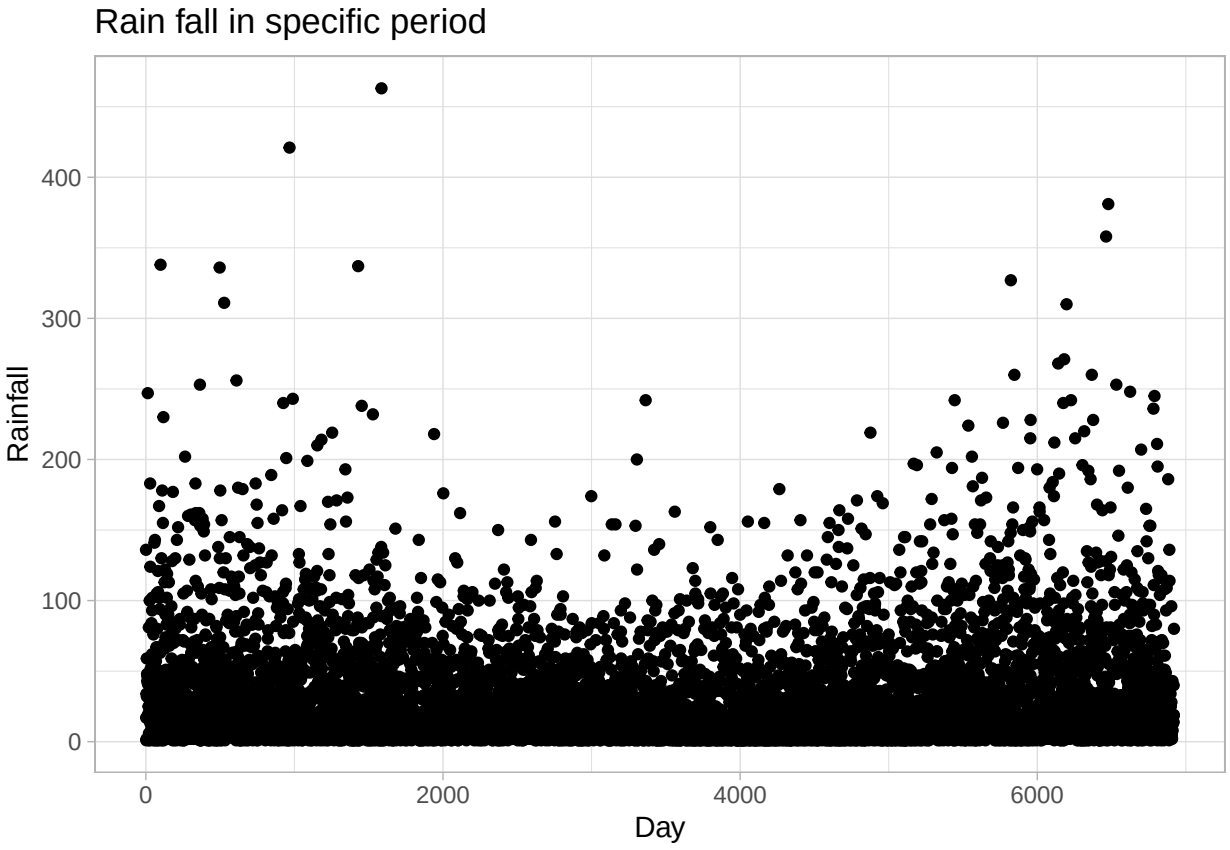
## Question1: Gibbs sampler for a normal model

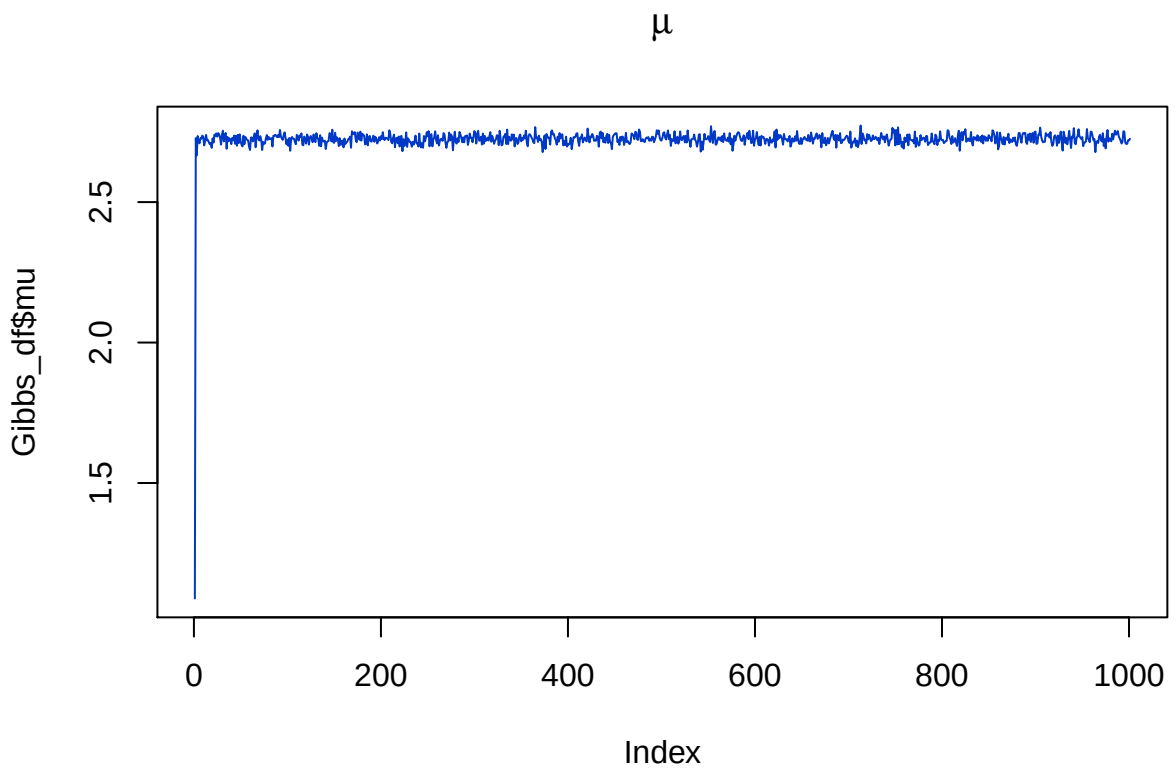
### a

```
setwd("D:/Linkoping university/second semester/second/bayesian learning/lab/lab3")
rainfall <- read.table("rainfall.dat", header=FALSE)
rainfall$day <- c(1:nrow(rainfall))
colnames(rainfall)<- c("rainfall", "day")

ggplot(rainfall)+
  geom_point(aes(x=day,y=rainfall), fill="#dedede")+
  labs(title="Rain fall in specific period", y="Rainfall", x="Day",color="Legend")+
  theme_light()
```

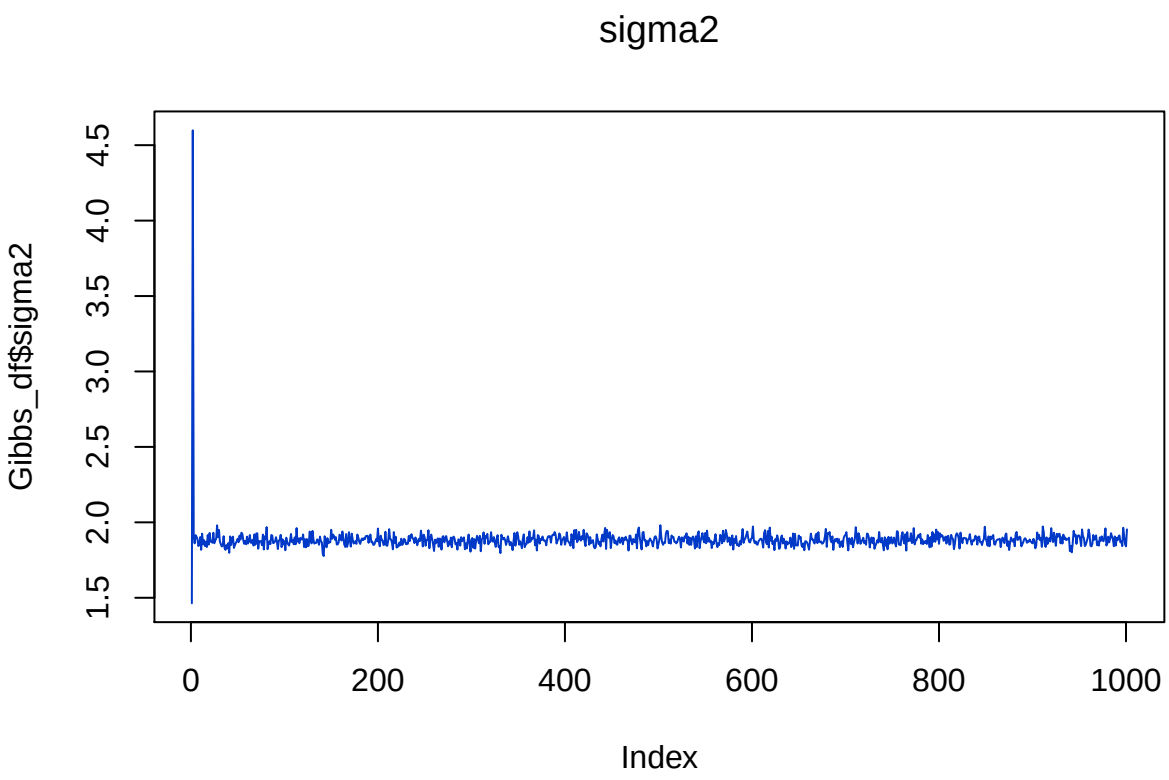



```r
Gibbs_Sampling <- function(data, N_iter, mu_0, tau2_0, nu_0, sigma2_0){

  n <- nrow(data)
  x_hat <- mean(log(data[,1]))
  nu_n <- nu_0 + n
  mu <- c()
  sigma2 <- c()
  mu[1] <- rnorm(1, mu_0, sqrt(tau2_0))
  sigma2[1] <- (nu_0 * sigma2_0)/rchisq(n = 1, df = nu_0)

  for (i in 1:N_iter){

    w <- (n/sigma2[i])/((n/sigma2[i]) + (1/tau2_0))
    mu_n <- w*x_hat + (1-w)*mu_0
    tau2_n <- (n/sigma2[i] + 1/tau2_0)^-1
    mu[i+1] <- rnorm(n = 1, mu_n, sd = sqrt(tau2_n))

    sigma2_n <- ((nu_0*sigma2_0) + sum((log(data[,1]) - mu[i])^2))/ (n+nu_0)
    sigma2[i+1] <- (nu_n * sigma2_n)/rchisq(1, df = nu_n)
  }

  df <- data.frame("mu" = mu, "sigma2" = sigma2)
  return(df)
}
```

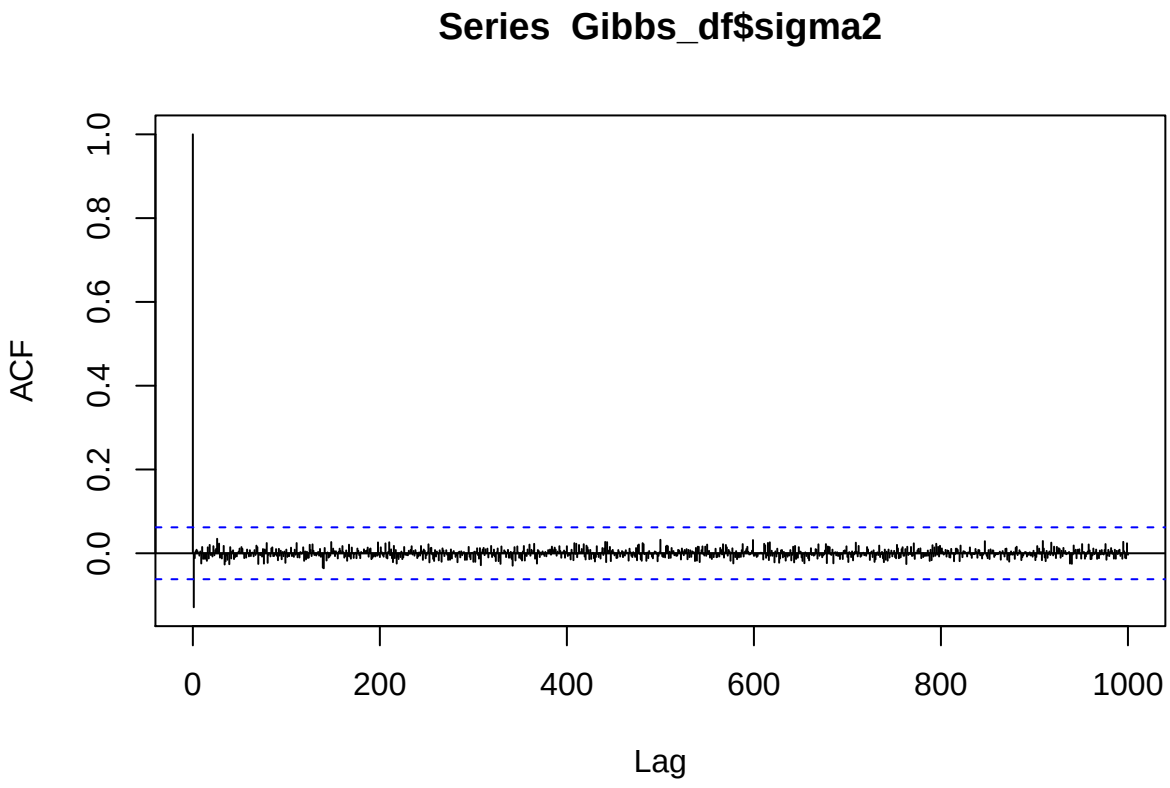
```
Gibbs_df <- Gibbs_Sampling(data = rainfall,
                           N_iter = 1000,
                           mu_0 = 1,
                           tau2_0 = 0.9,
                           nu_0 = 1,
                           sigma2_0 = 1)
plot(Gibbs_df$mu,type='l',col="#0039C7",main=expression(mu))
```



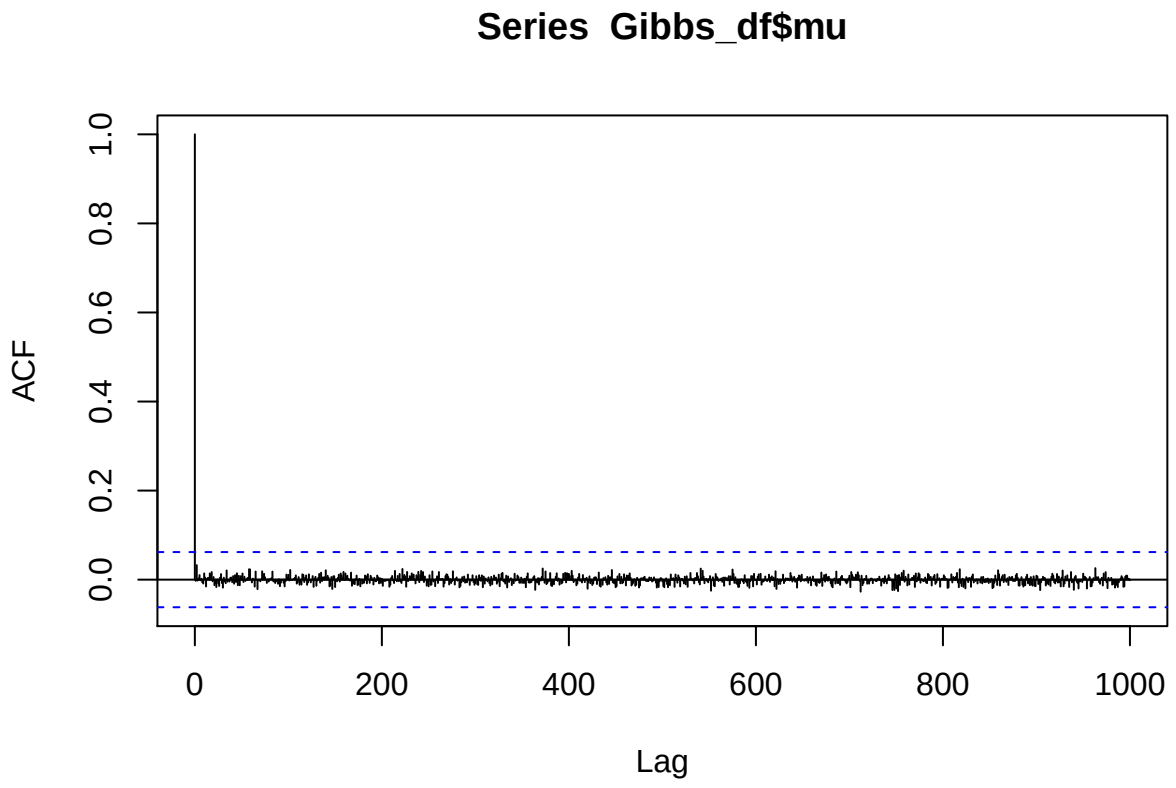

```
plot(Gibbs_df$sigma2,type='l',col="#0039C7",main=expression(sigma2))
```




```
sigma_gibbs <- acf(x=Gibbs_df$sigma2, lag.max = 1000)
```



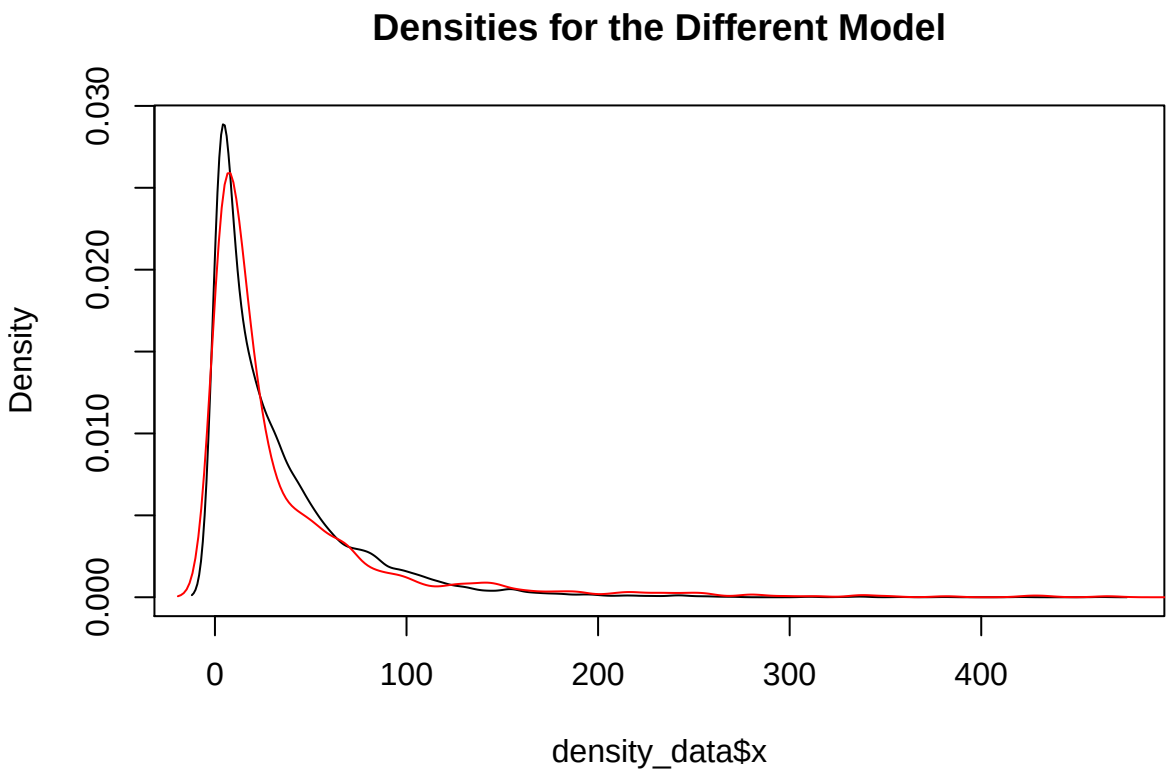

```
IF_Gibbs <- 1+2*sum(sigma_gibbs$acf[-1])
mu_gibbs <- acf(x=Gibbs_df$mu, lag.max = 1000)
```




```
IF_Gibbs2 <- 1+2*sum(mu_gibbs$acf[-1])
```

**b**

```
density_data = density(rainfall$rainfall)
Gibbs_simu<-as.matrix(rbind(Gibbs_df$mu,Gibbs_df$sigma2))
pred<-c()
for(i in 1:ncol(Gibbs_simu))
{
pred[i]<-rnorm(1,mean=Gibbs_simu[1,i],sd=sqrt(Gibbs_simu[2,i]))
}
gibbs_density<-density(exp(pred))
plot(density_data$x,density_data$y,type="l",main="Densities for the Different Model", ylab = "Density")
lines(gibbs_density$x,gibbs_density$y,col='red')
```

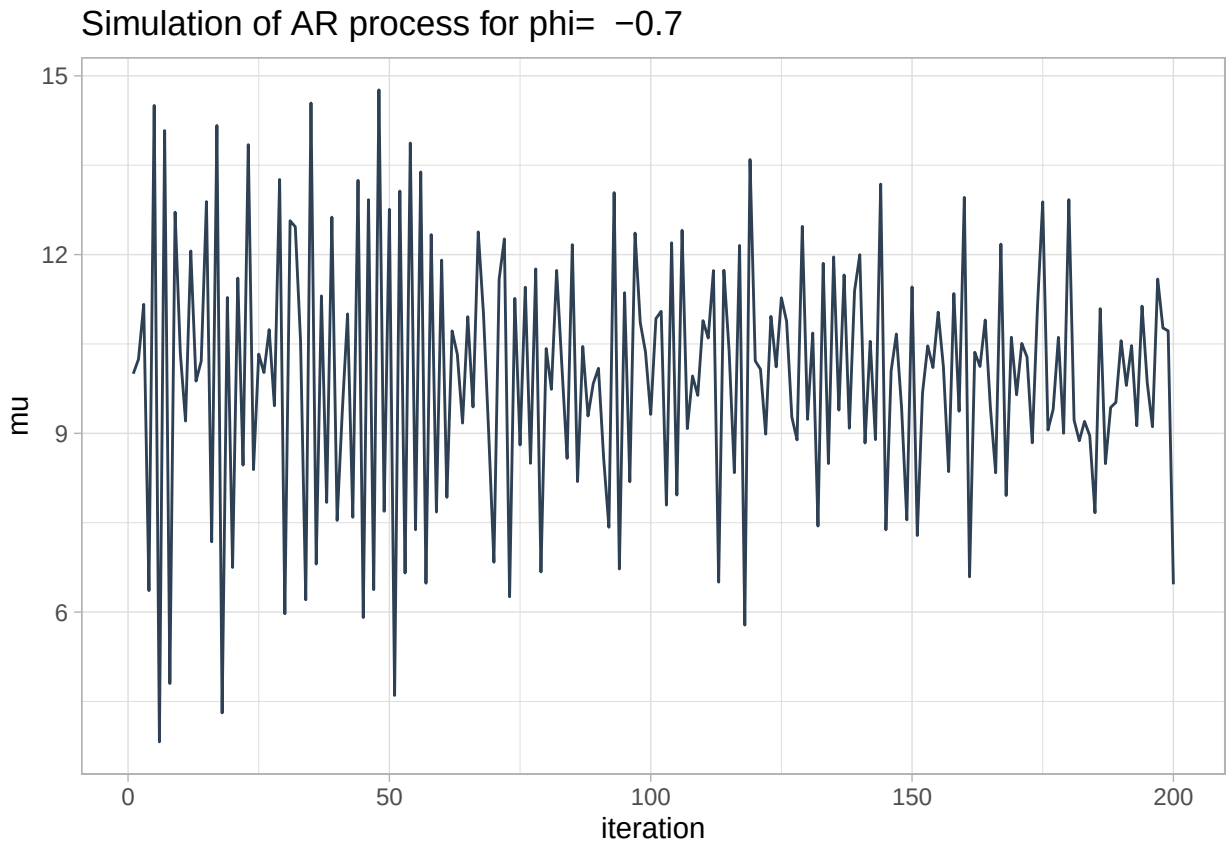



## 3

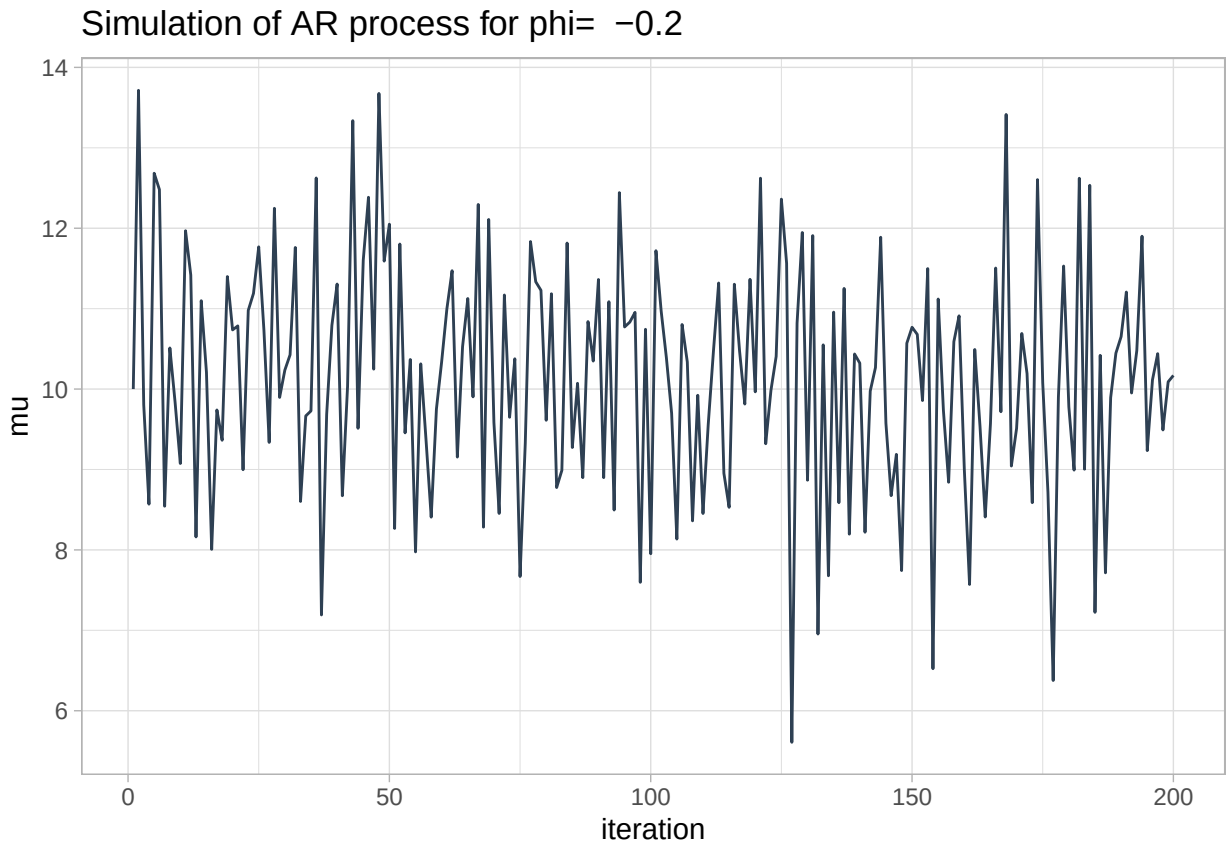
### a

```
T<-200
mu<- 20
sigma_sq<- 4
AR_process <- function(mu, phi,  T,sigma_sq){
  x<- rep(0, T)
  x[1]<- mu

  for (t in 1:(T-1)){
    x[t+1] <- mu + phi * (x[t] - mu) + rnorm(1, mean=0, sd=sqrt(sigma_sq))
  }

return(x)
}
simulation_AR <- function(mu, phi,  T,sigma_sq ){
  sim <- AR_process(mu, phi,  T,sigma_sq)
  AR_df <- data.frame(x=1:T, y=sim)
  AR_plot <- ggplot(AR_df)+
    geom_line(aes(x=x, y=y), color= "#2E4053")+
    labs(title= paste("Simulation of AR process for phi= ",phi), x="iteration", y="mu",color="legend")+
```

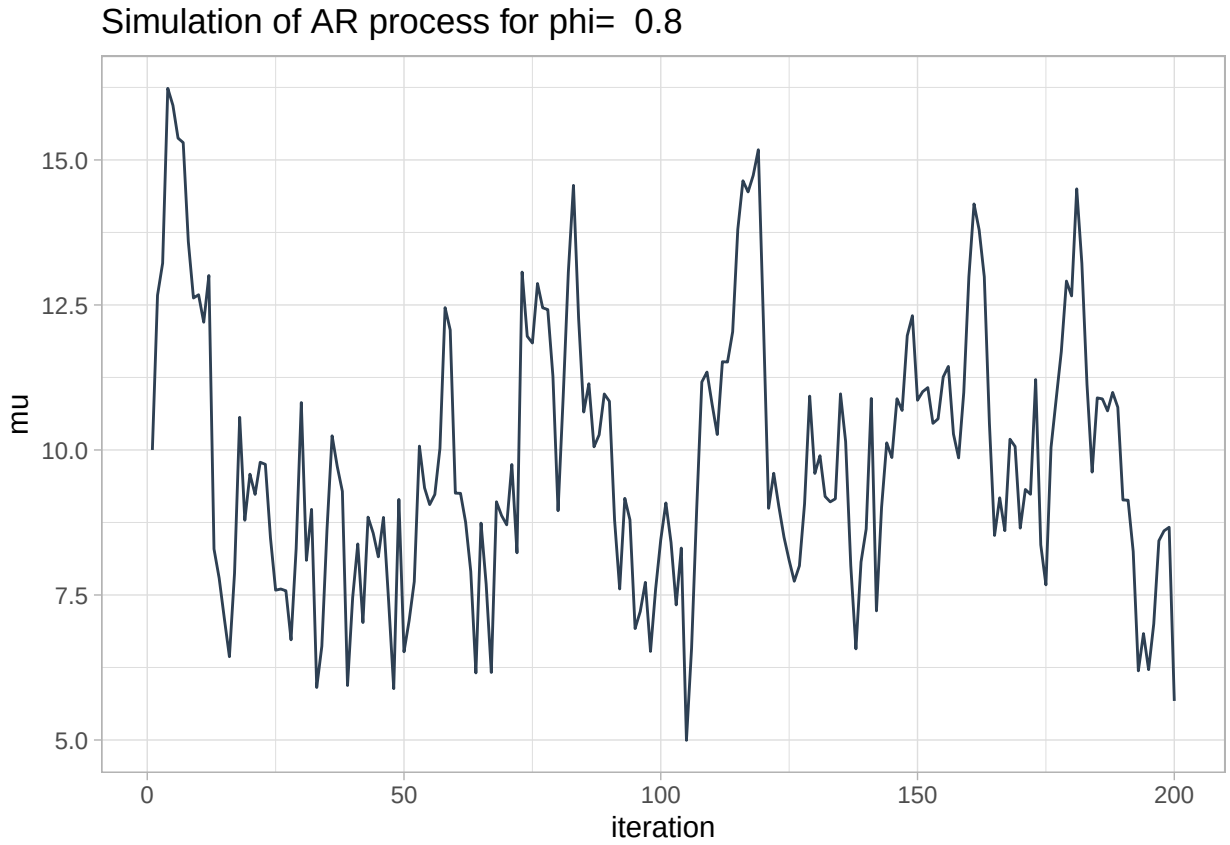
```
    theme_light()

  return(AR_plot)
}

plot1 <- simulation_AR(mu= 10, phi=-0.7, T=200, sigma_sq=2)
plot2 <- simulation_AR(mu= 10, phi=-0.2, T=200, sigma_sq=2)
plot3 <- simulation_AR(mu= 10, phi=0.8, T=200, sigma_sq=2)
plot4 <- simulation_AR(mu= 10, phi=1, T=200, sigma_sq=2)
par(mfrow=c(3,3))
plot1
```



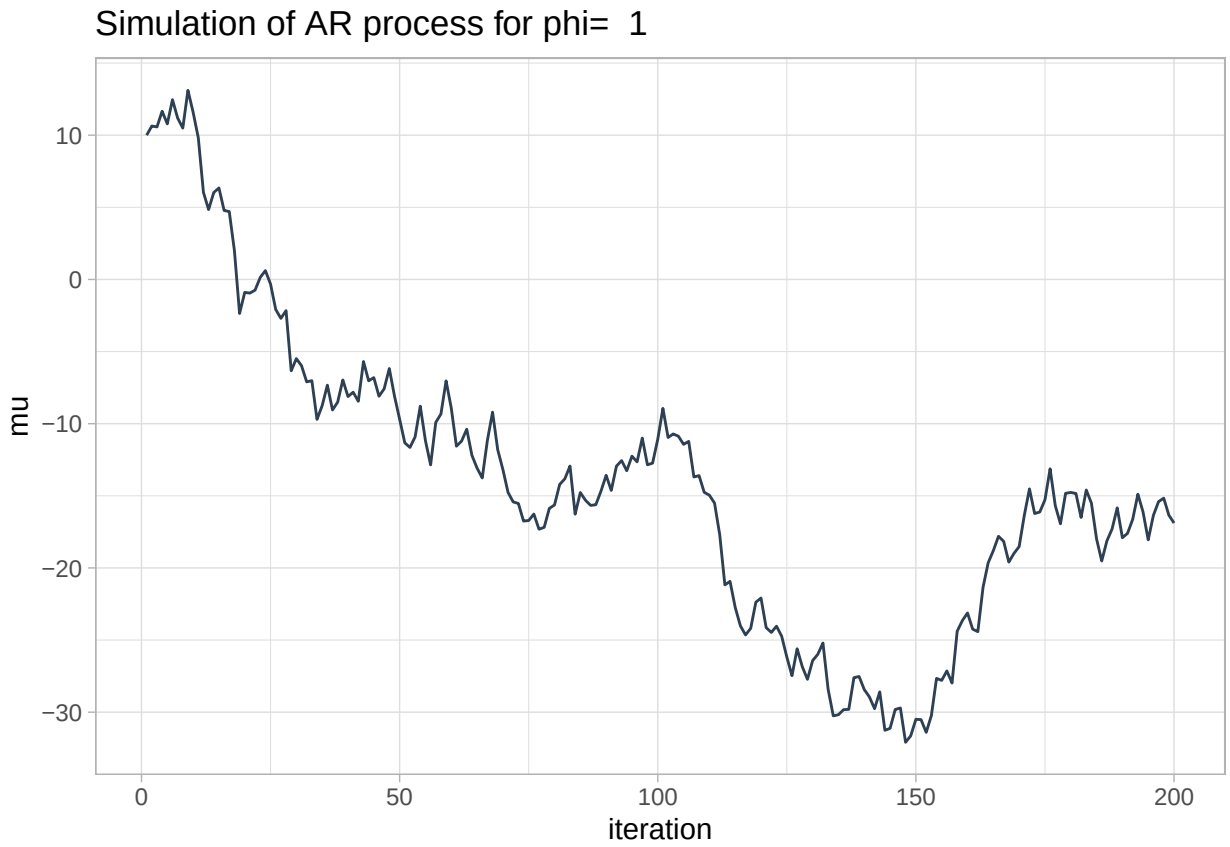

```
plot2
```


Simulation of AR process for phi= −0.2
14
12
10
8
6
mu
0
50
100
150
200
iteration

```
plot3
```


Simulation of AR process for phi= 0.8
mu
15.0
12.5
10.0
7.5
5.0
0
50
100
150
200
iteration

```
plot4
```


Simulation of AR process for phi= 1
mu
10
0
−10
−20
−30
0
50
100
150
200
iteration