MH4500 Lab2

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Lab2

Part 1

```
# Read Data
global = scan("globtemp.dat")

# Save into PDF File
pdf("globalplot.pdf")
plot.ts(global)
dev.off()
```

```
## pdf
##   2
```

```
# Get Diff
globaldiff = diff(global)
# Diff Plot
pdf("globaldiffplot.pdf")
plot.ts(globaldiff)
dev.off()
```

```
## pdf
##   2
```

```
# ACF plot
pdf("globalacf.pdf")
acf(global)
dev.off()
```

```
## pdf
##   2
```

```
# Diff ACF plot
pdf("globaldiffacf.pdf")
acf(globaldiff)
dev.off()
```

```
## pdf
##   2
```

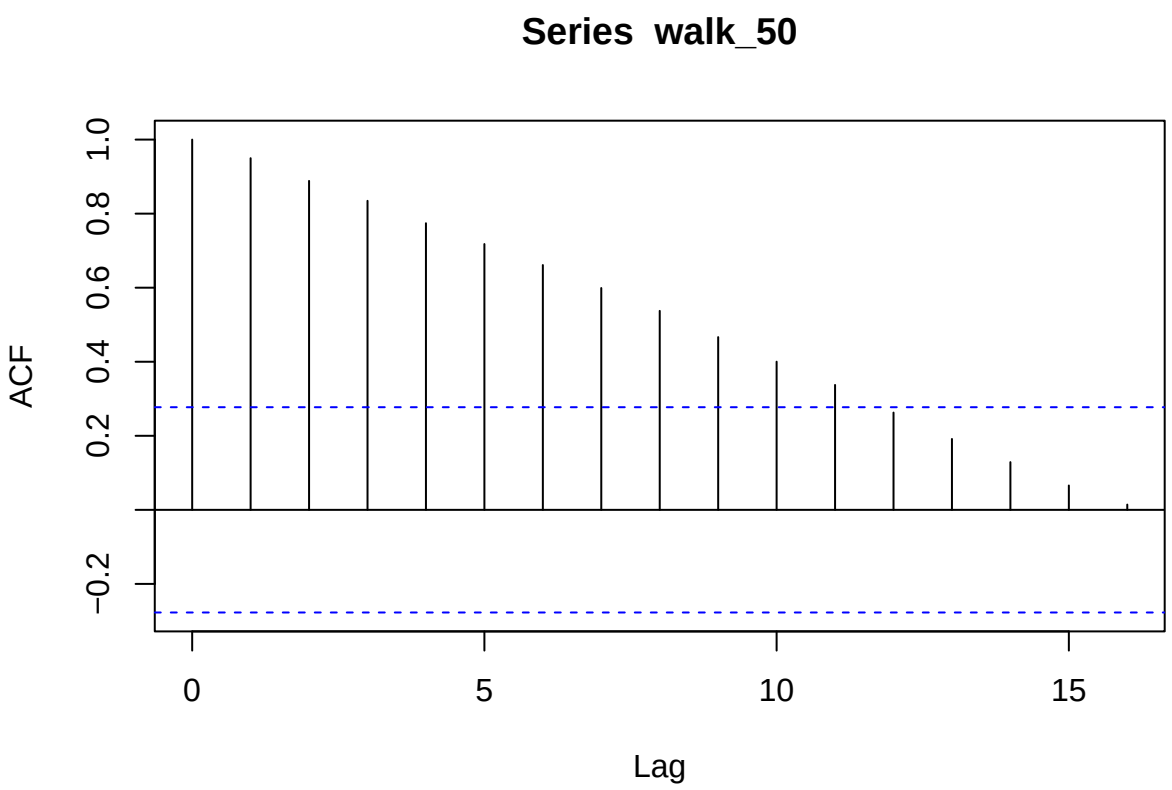
Writing Functions

```
# Simple Add result
add = function(a,b){
```

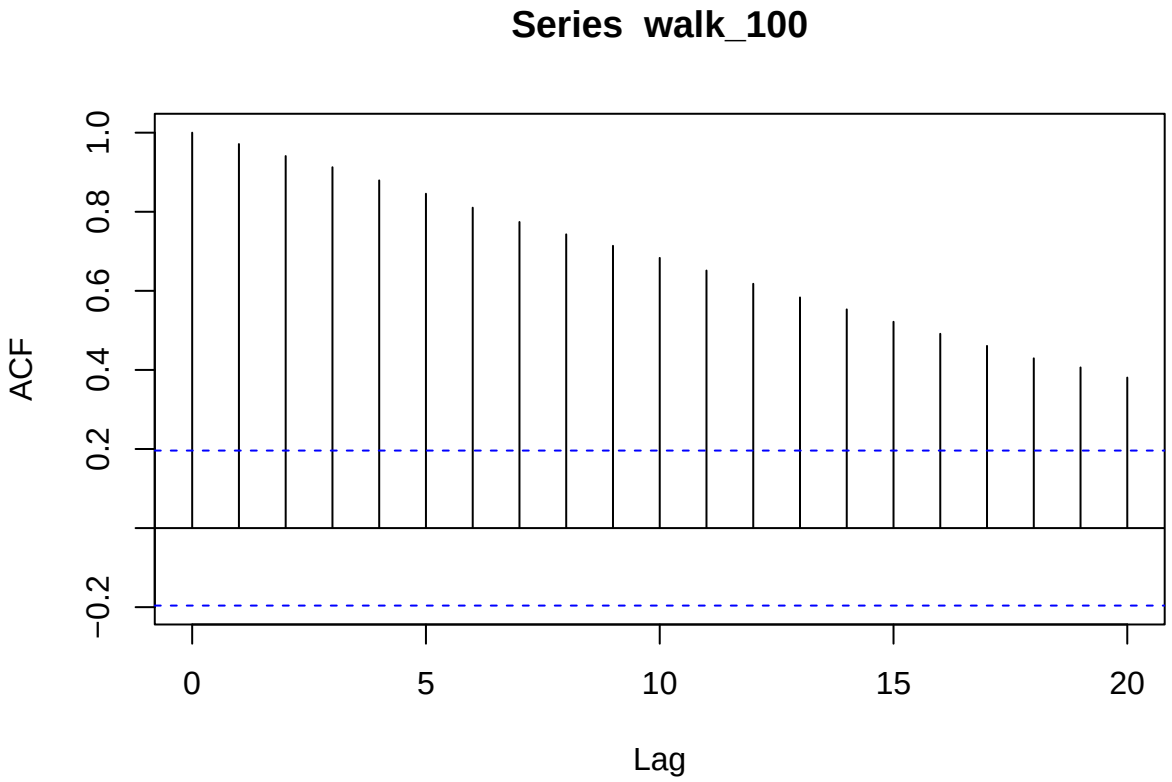
```
  result=a+b
  return(result)
}

add(2,3)
```

```
## [1] 5
```

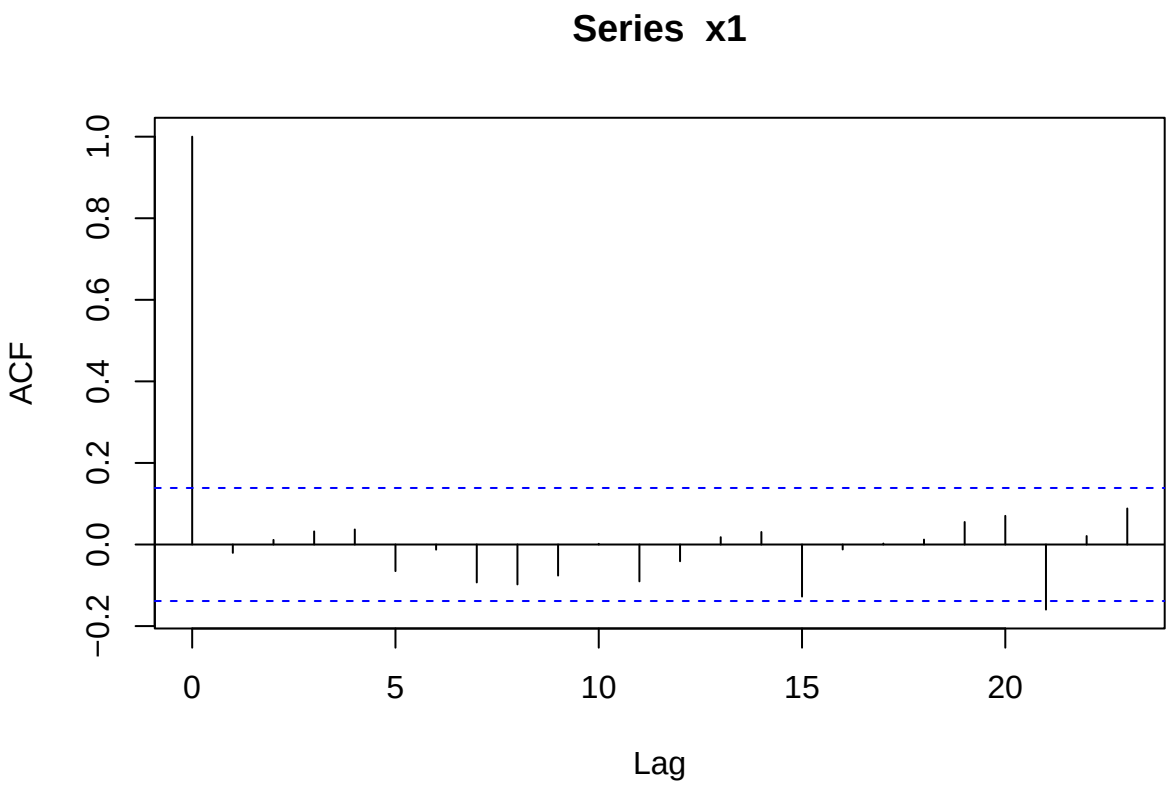
```
# Random Walk

randomwalk = function(sigsq, T){
  x = rep(0,T)
  w = rnorm(T, sd=sqrt(sigsq))
  for (i in 2:T){
    x[i] = x[i-1] + w[i]
  }
  return(x)
}

walk_50 <- randomwalk(1, 50)
acf(walk_50)
```



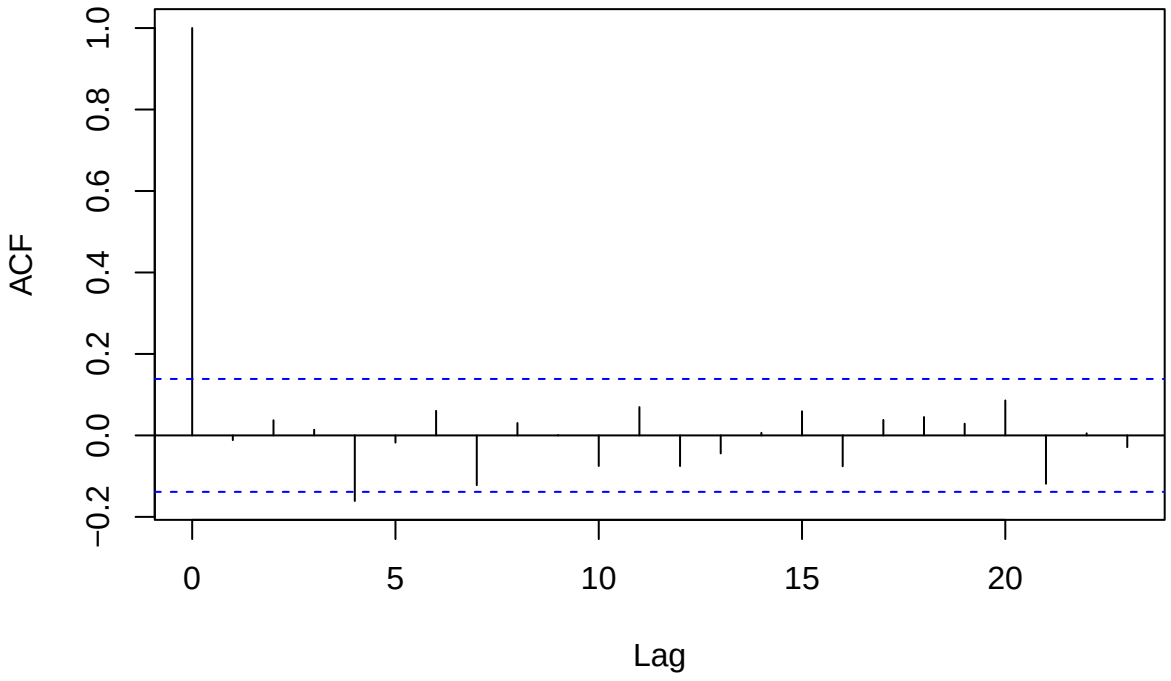

```
walk_100 <- randomwalk(1, 100)
acf(walk_100)
```




```
arsim = function(phis, sigsq, T){
  p <- length(phis)
  noise <- rnorm(T+p, sd=sqrt(sigsq))
  x = c(noise[1:p], rep(0, T))
  for ( i in (p+1) : (T+p)) {
    x[i] = phis %*% x[i-(1-p)] + noise[i]
  }
  x=x[(p+1):(T+p)]
  return(x)
}

x1 <- arsim(c(0.5), 1, 200)
acf(x1)
```

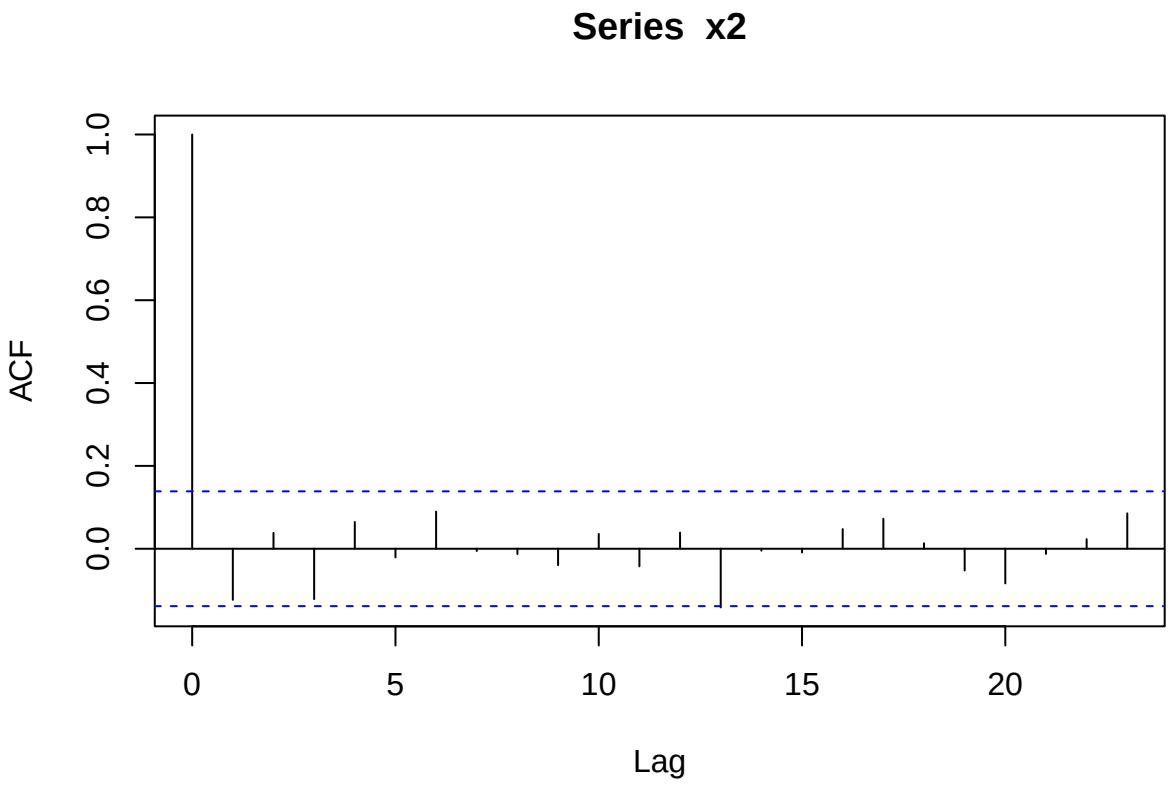



```
x1_negative <- arsim(c(-0.5), 1, 200)
acf(x1_negative)
```




```
x2 <- arsim(c(1.1), 1, 200)
```

```r
acf(x2)
```



Homework

Question 1

The masim function generates a simulated Moving Average (MA) process of order q based on specified parameters. The function models a time series where each observation is a linear combination of past white noise terms, weighted by given MA coefficients (theta values).

Function Arguments: - thetas: A numeric vector of length q, representing the MA coefficients - sigsq: A positive numeric value representing the variance of the white noise process. - T: An integer specifying the length of the simulated time series.

Function Logic: - The function generates T + q independent and identically distributed (i.i.d.) normal noise values with mean zero and variance sigsq. - The function appends 1 to the beginning of thetas, ensuring that $\theta_0 = 1$, which is conventional in some MA representations. - The function iterates over time indices 1 to T, computing each observation

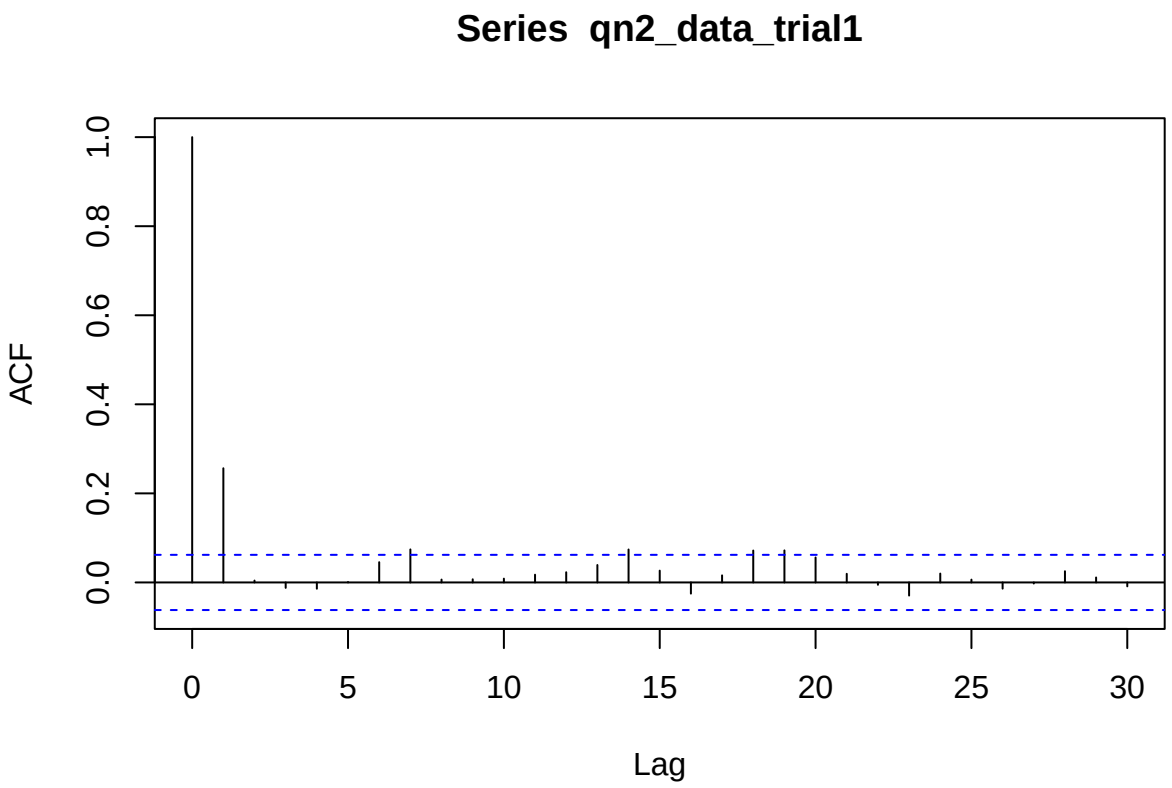
```r
# Question 1
masim <- function(thetas, sigsq, T){
  # Get number of Q
  q <- length(thetas)
  # Initialize noise
  noise <- rnorm(T + q, sd=sqrt(sigsq))
  x <- rep(0, T)
  # Generate the MA(q) process
  for (t in 1:T) {
    x[t] <- sum(thetas * noise[t + (q:1)])  # Proper lagging of noise
  }
```

```
  return(x)
}
```

Question 2

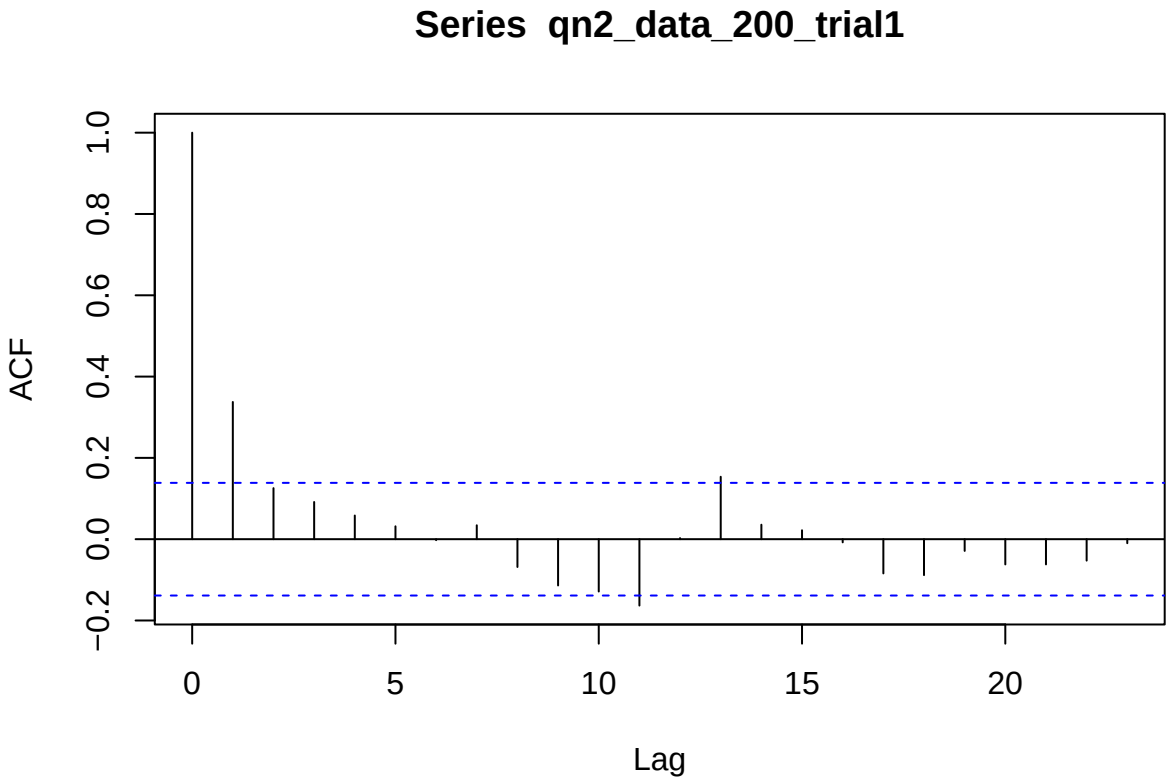
By simulating a model with 1000 observations, we can see that all the acf cuts off after q = 2, demonstrate that the ACF for a MA(q) time series cut-off after lag q.

```
# Trial 1
qn2_data_trial1 <- masim(c(0.5, 2), 1, 1000)
acf(qn2_data_trial1)
```

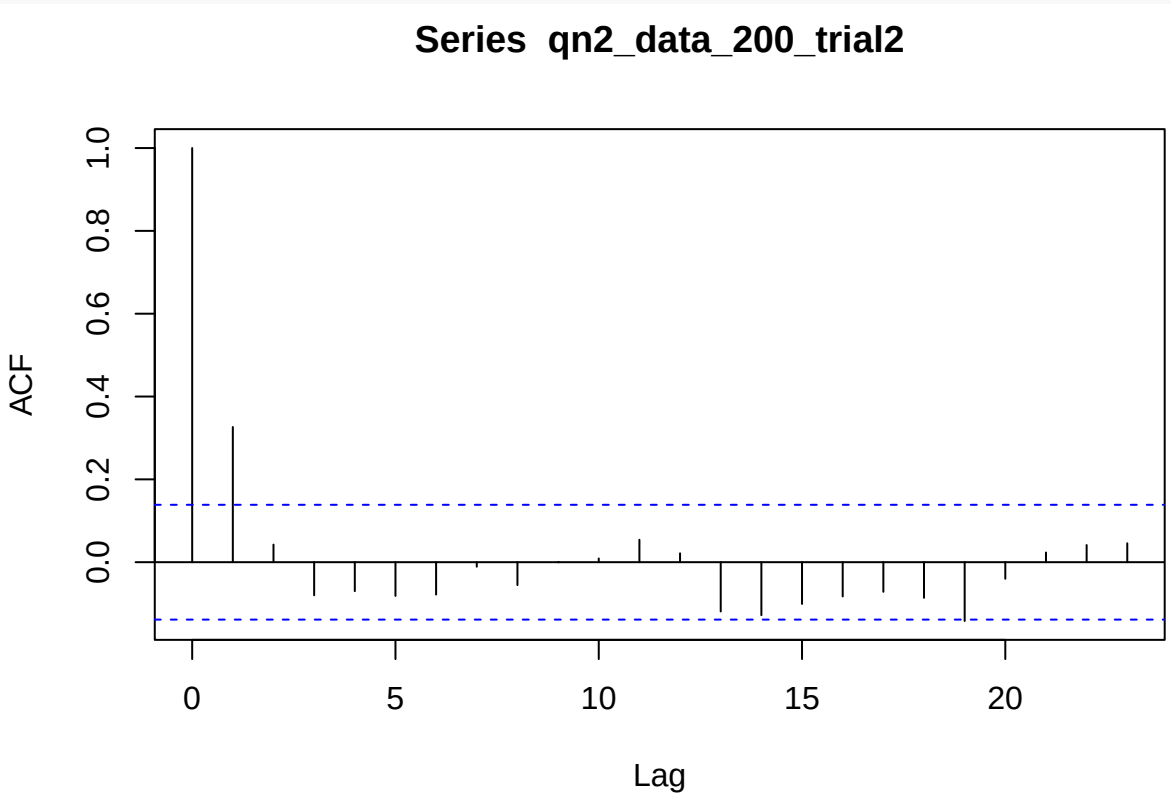


We then generated a model with 200 observations and repeated this for a few time. We can see that the width between the dotted blue lines is wider than the 1000 observations. This indicates that the standard deviation is larger for 200 samples

```
# Trial 1
qn2_data_200_trial1 <- masim(c(0.5, 2), 1, 200)
acf(qn2_data_200_trial1)
```

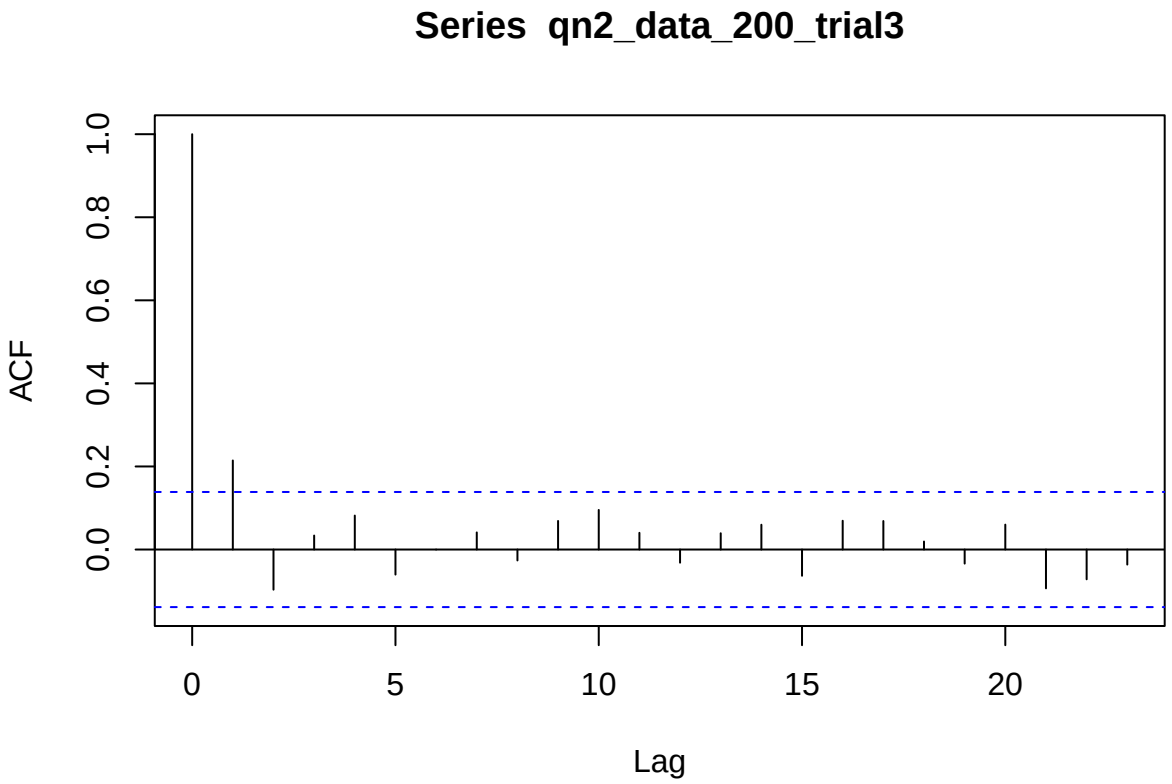



```
qn2_data_200_trial2 <- masim(c(0.5, 2), 1, 200)
acf(qn2_data_200_trial2)
```

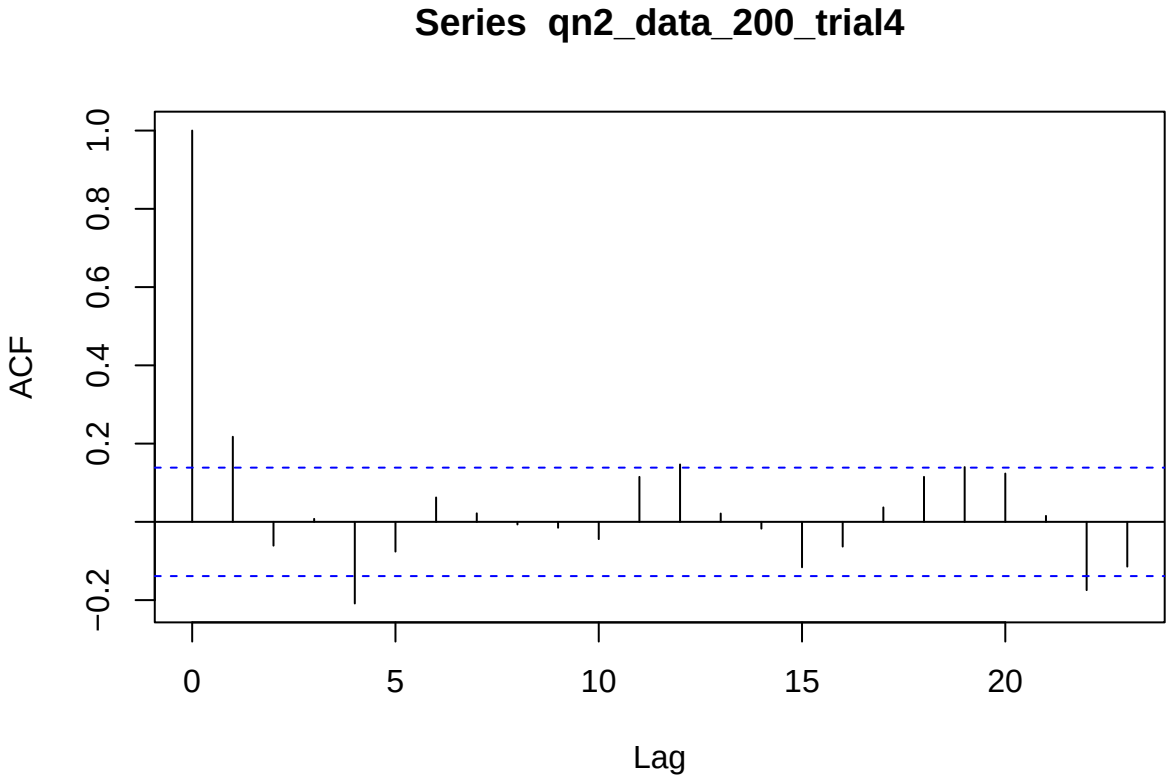



```
qn2_data_200_trial3 <- masim(c(0.5, 2), 1, 200)
```

```r
acf(qn2_data_200_trial3)
```




```r
qn2_data_200_trial4 <- masim(c(0.5, 2), 1, 200)
acf(qn2_data_200_trial4)
```



Question 3

We than fitted a model using arima for the data generated for 1000 observations. Because we are generating a MA(2) model. So we are using with order = (0,0,2). We can see that because the root of $1 + 0.5B + 2B^2$ is inside unit circle. This MA model is non-invertible.

```
# By default use the data in trial 1
fit <- arima(qn2_data_trial1, order=c(0,0,2))
summary(fit)
```

```
##           Length Class  Mode
## coef         3   -none- numeric
## sigma2       1   -none- numeric
## var.coef     9   -none- numeric
## mask         3   -none- logical
## loglik       1   -none- numeric
## aic          1   -none- numeric
## arma         7   -none- numeric
## residuals 1000   ts     numeric
## call         3   -none- call
## series       1   -none- character
## code         1   -none- numeric
## n.cond       1   -none- numeric
## nobs         1   -none- numeric
## model       10   -none- list
```

```
fit
```

```
##
## Call:
## arima(x = qn2_data_trial1, order = c(0, 0, 2))
##
## Coefficients:
##          ma1     ma2  intercept
##       0.2739  0.0095     0.0237
## s.e.  0.0317  0.0320     0.0803
##
## sigma^2 estimated as 3.918:  log likelihood = -2101.8,  aic = 4211.6
```