HW5

Question 1

1. Install the library "astsa" using the function: install.packages("astsa")

```
install.packages('astsa')
```

2. Load the library: library(astsa)

```
library(astsa)
```

3. Use the function str() to see the information of a particular data series, such as str(EQ5) for the Seismic Trace of Earthquake number 5 series

```
str(EQ5)
```

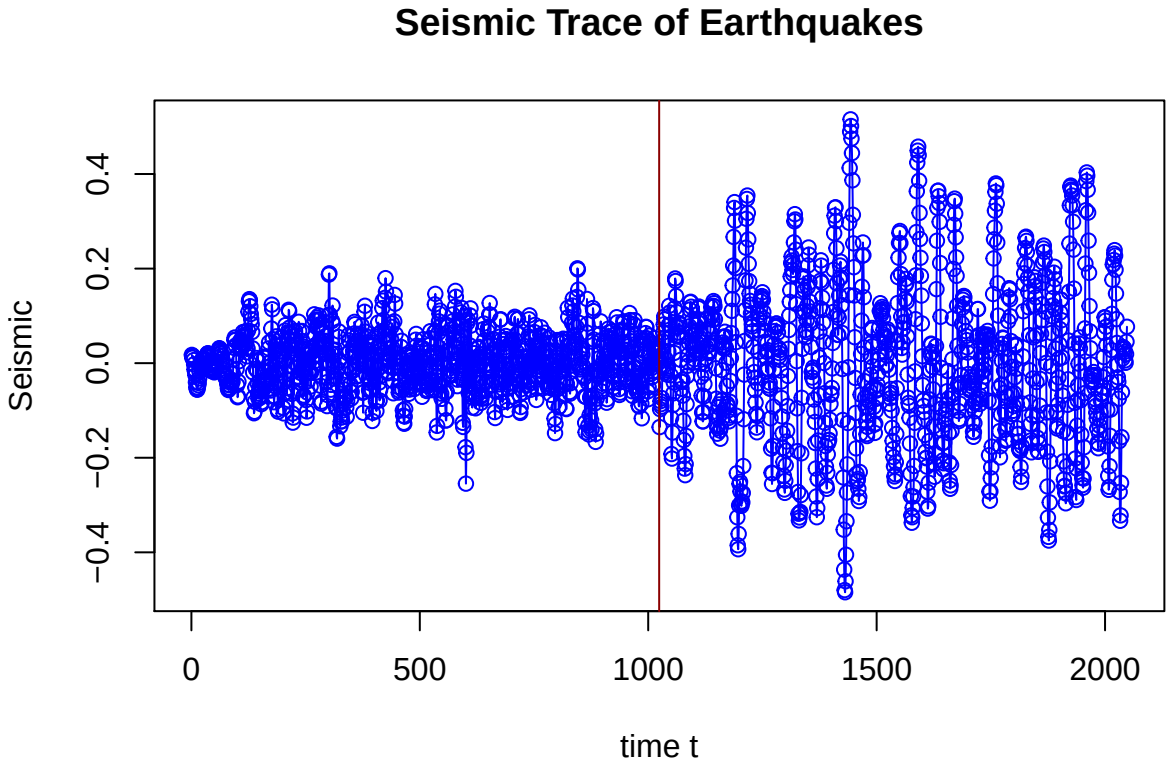
```
##  Time-Series [1:2048] from 1 to 2048: 0.01749 0.01139 0.01512 0.01477 0.00651 ...
```

4. Plot the time series plots and histograms of the following 3 series. Feel free to use the codes provided in the R scripts. Make sure that each of your graph has a title, the axis ticks are clear, the axes are well-labelled, and use color intelligently.

5. Write a few sentences to describe each of the series.

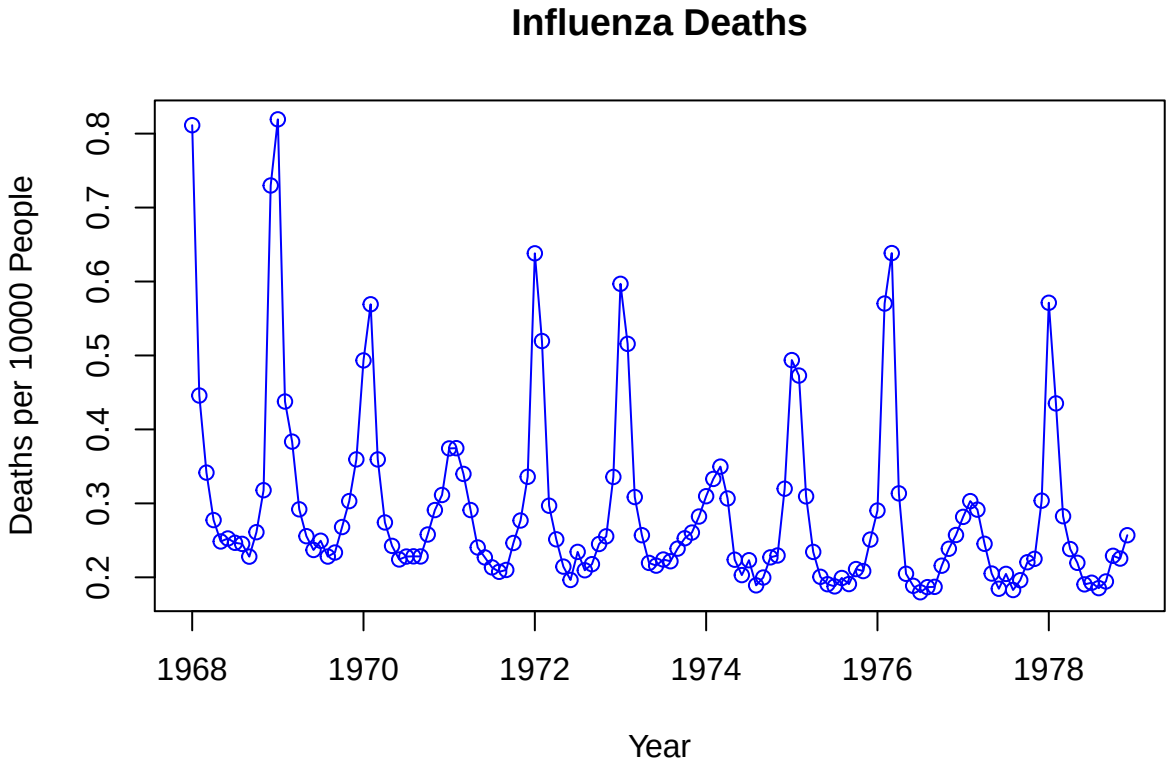
- EQ5
- flue
- gas

```
plot(EQ5,type="o", main="Seismic Trace of Earthquakes",
     ylab="Seismic",
     xlab="time t", col="blue")
abline(v=1024, col='darkred')
```



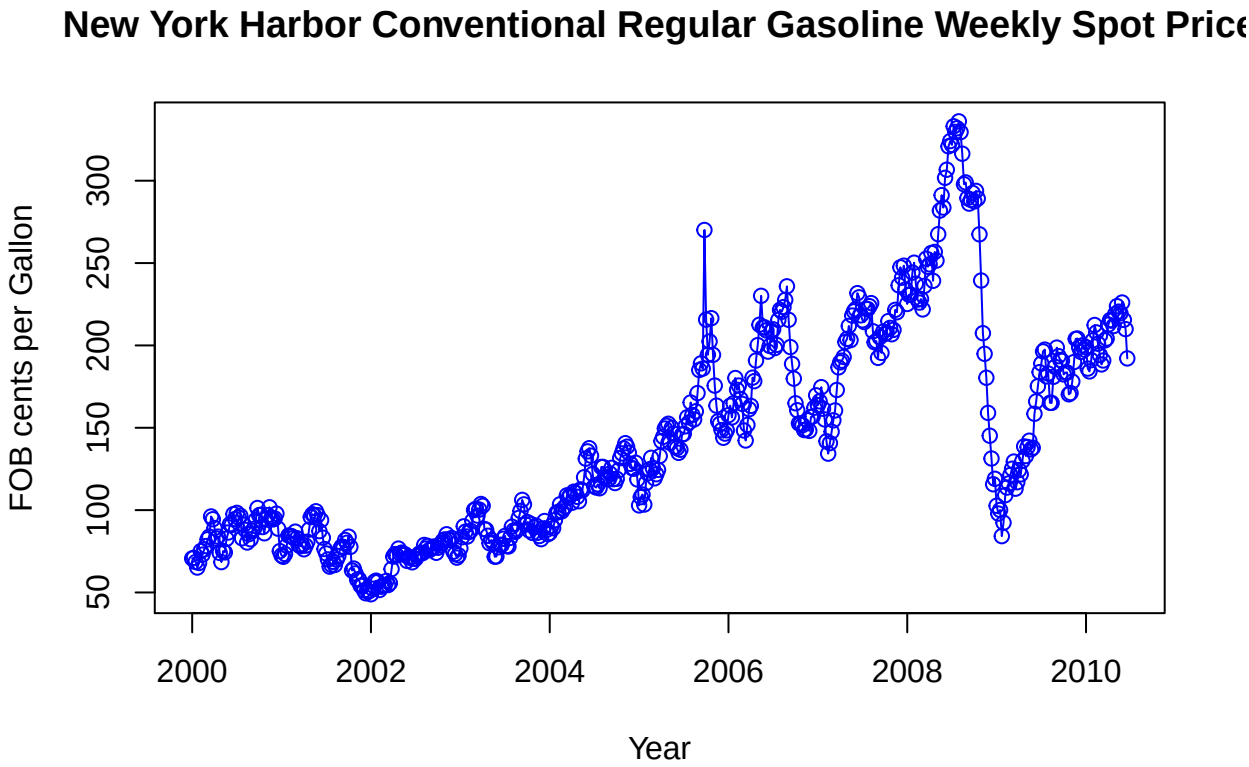
The *EQ5* series represents seismic trace of an earthquake [two phases or arrivals along the surface, the primary wave (t = 1,. . . ,1024) and the shear wave (t = 1025, . . . , 2048)] recorded at a seismic station. The vertical line in the graph is a visual aid to see the primary and shear waves.

```
plot(flu,type="o", main="Influenza Deaths",
     ylab="Deaths per 10000 People",
     xlab="Year", col="blue")
```



The *flu* series represents monthly pneumonia and influenza deaths per 10,000 people in the United States for 11 years, 1968 to 1978. There appear to be two seasonalities involved - a winter and summer cycle and an overall downward trend.

```
plot(gas,type="o", main="New York Harbor Conventional Regular Gasoline Weekly Spot Price",
     ylab="FOB cents per Gallon",
     xlab="Year", col="blue")
```



The *gas* series represents the New York Harbor conventional regular gasoline weekly spot price FOB (in cents per gallon) from 2000 to 2010. There is a general upward trend that is interrupted by some event causing a spike then large drop in price.

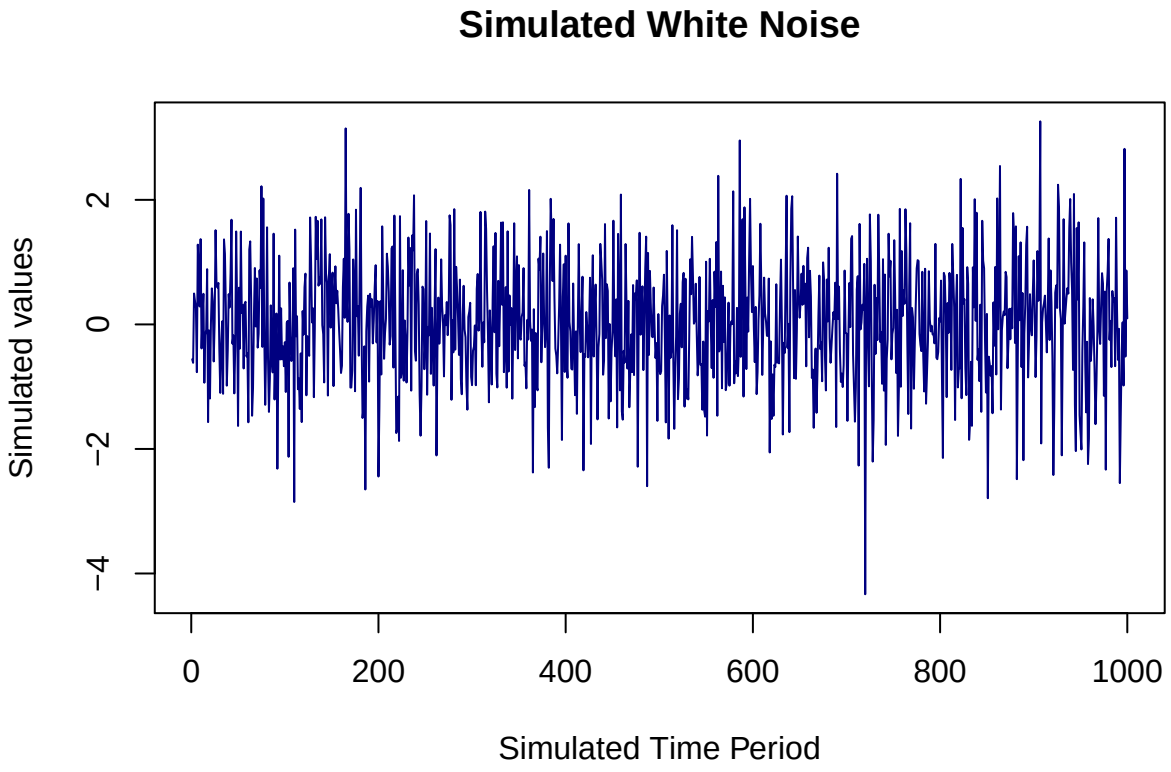
Question 2

Describe 3 examples you have used in your work or encounter in real life. Ideally, you can even load at least one of these time series, plot it, and the write a few statements to describe its characteristics.

Question 3

Simulate a white noise series with 1000 random draws and plot (1) a time series plot and (2) a histogram. The usual reqirements on graphics (described) in Question 1) applied.

```
w=rnorm(1000,0,1) # 1000 draws from a random normal distribution
plot.ts(w, main="Simulated White Noise", col="navy",
          ylab="Simulated values", xlab="Simulated Time Period")
```




```
dev.off()
```

```
## null device
##           1
```

```
hist(w,main="Simulated White Noise", col="blue",
     xlab="Simulated Values")
```

Question 4:

Simulate (with 1000 random draws) two the following two zero-mean autoregressive model with order 1 (i.e. AR(1)) models:

$$y_t = 0.9y_{t1} + w$$

$$y_t = 0.2y_{t1} + w$$

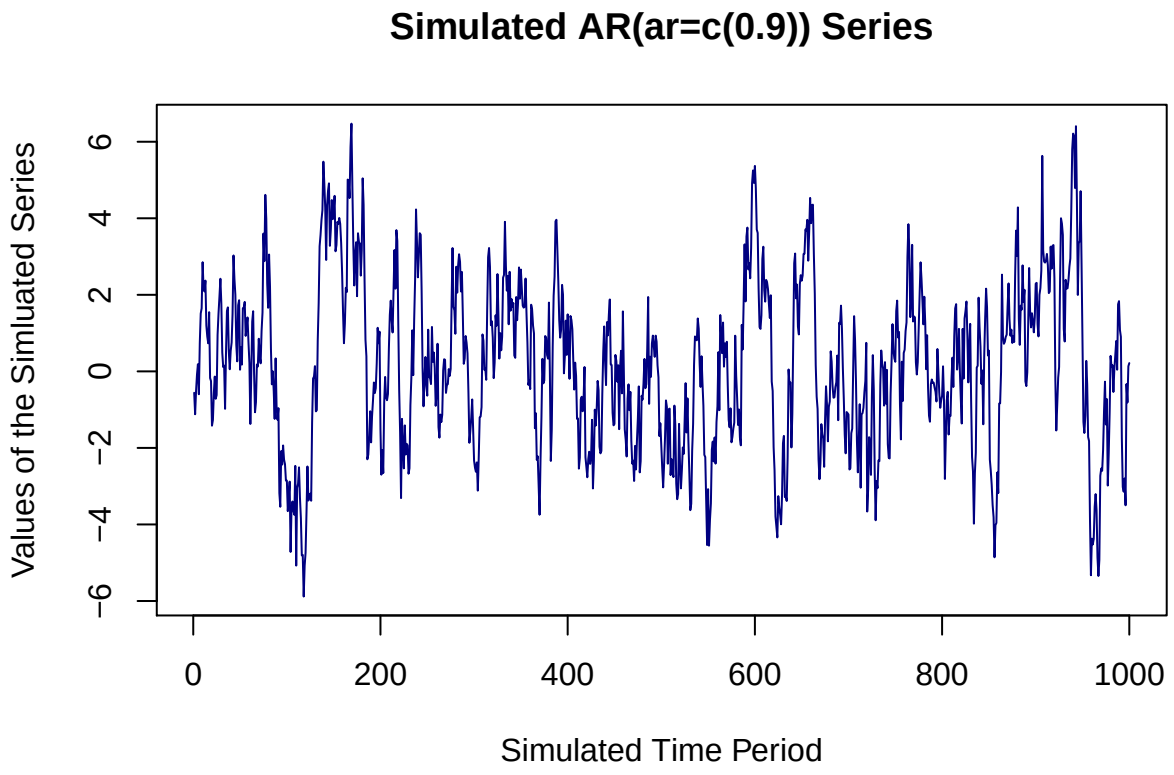
Plot a time plot for each of the simulated series. Graph a histogram for each of thes simulated series. Write a few statements to compare the two series.

```
length(w)
```

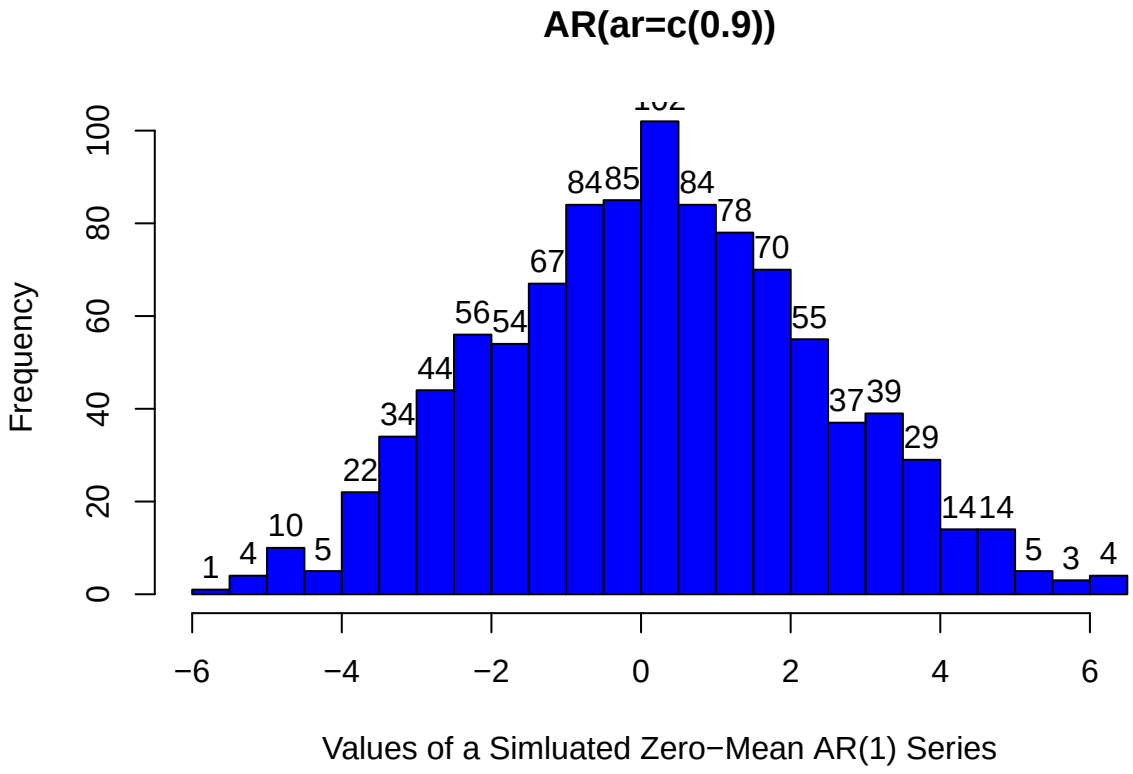
```
## [1] 1000
```

```
z <- w
q <- w
for (t in 2:length(w)){
  z[t] <- 0.9*z[t-1] + w[t]
}
for (t in 2:length(w)){
  q[t] <- 0.2*q[t-1] + w[t]
}
```

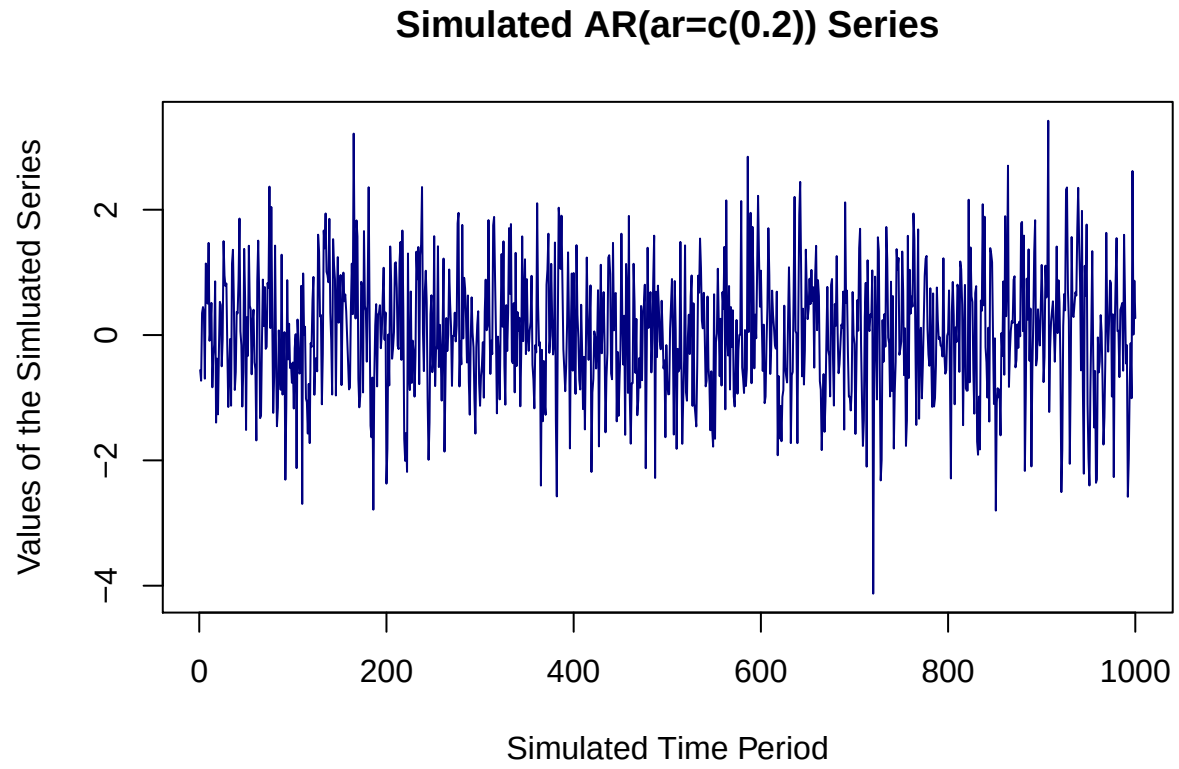
```
plot.ts(z, main="Simulated AR(ar=c(0.9)) Series", col="navy",
        ylab="Values of the Simluated Series",
        xlab="Simulated Time Period")
```



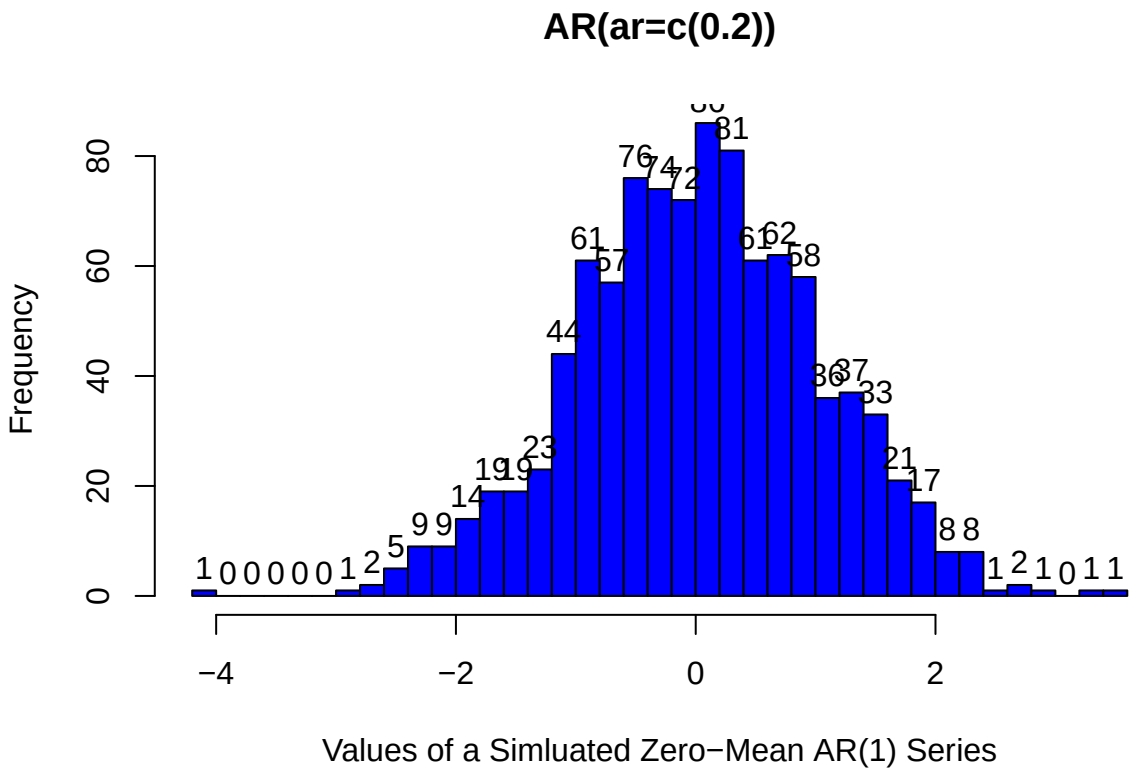

```
hist(z, breaks="FD",
     main="AR(ar=c(0.9))",
     xlab="Values of a Simluated Zero-Mean AR(1) Series",
     col="blue", labels=TRUE)
```




```
plot.ts(q, main="Simulated AR(ar=c(0.2)) Series", col="navy",
        ylab="Values of the Simluated Series",
        xlab="Simulated Time Period")
```



```r
hist(q, breaks="FD",
     main="AR(ar=c(0.2))",
     xlab="Values of a Simluated Zero-Mean AR(1) Series",
     col="blue", labels=TRUE)
```



Question 5:

Simulate (with 1000 random draws) the following 3 models: 1. A deterministic linear (time) trend of the form: $y_t = 10 + 0.5t$
2. Random walk without drift
3. Random walk with drift = 0.5

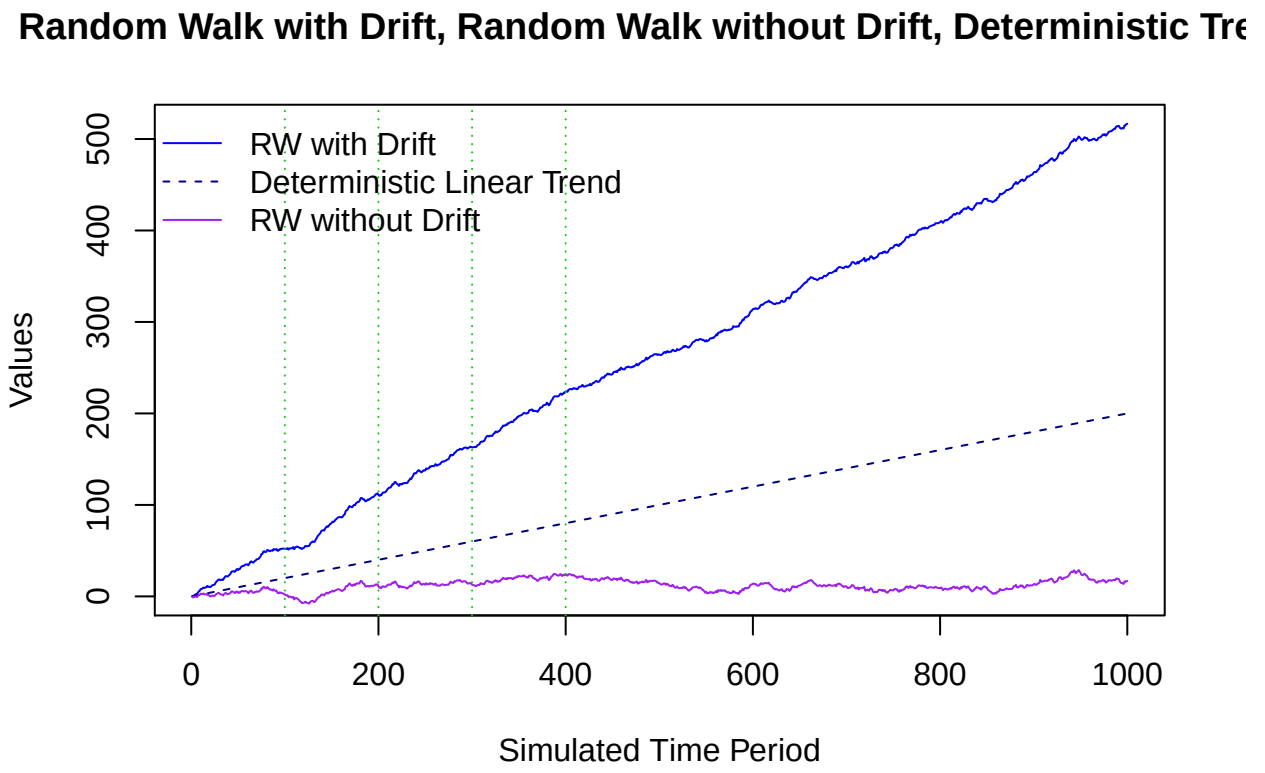
Plot a time plot for each of the simulated series. Graph a histogram for each of thes simulated series. Write a few statements to compare the two series.

```r
# Random walk with zero drift
x=cumsum(w)

# Random walk with drift = 0.5
wd = 0.5 + w;
xd = cumsum(wd)
```

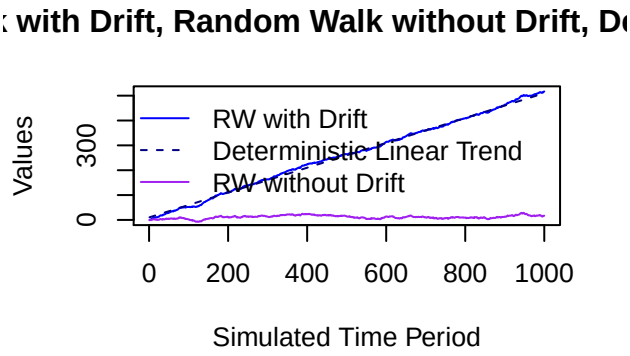
```r
par(mfrow=c(1,1))
plot.ts(xd, main="Random Walk with Drift, Random Walk without Drift, Deterministic Trend",
        col="blue", ylab="Values", xlab="Simulated Time Period", bg=38)
lines(0.2*(1:length(xd)), lty="dashed", col="navy")
lines(x, col="purple")
  # Add vertical lines
```

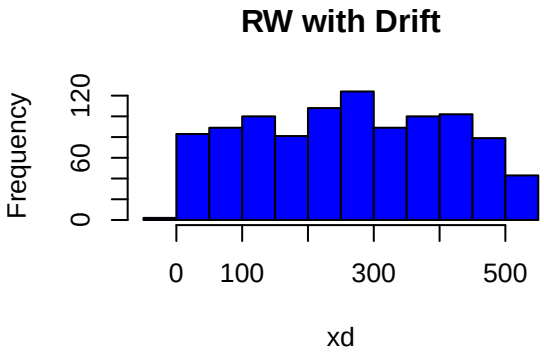
```
  abline(v=c(100,200,300,400),col=3,lty=3)
  # Add Legend
  leg.txt <- c("RW with Drift", "Deterministic Linear Trend", "RW without Drift")
  legend("topleft", legend=leg.txt, lty=c(1,2,1), col=c("blue","navy","purple"),
         bty='n', cex=1, merge = TRUE, bg=336)
```

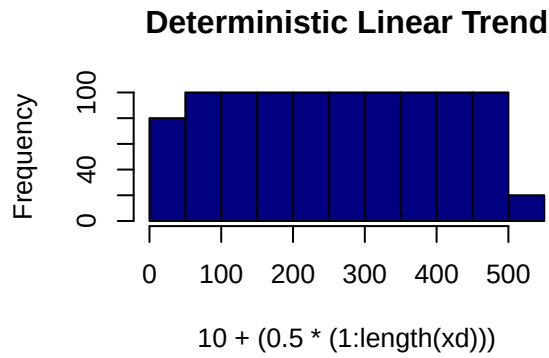


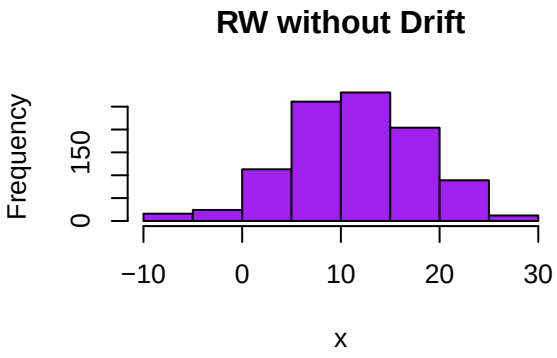

```
par(mfrow=c(2,2))
plot.ts(xd, main="Random Walk with Drift, Random Walk without Drift, Deterministic Trend",
        col="blue", ylab="Values", xlab="Simulated Time Period", bg=38)
lines(10+(0.5*(1:length(xd))), lty="dashed", col="navy")
lines(x, col="purple")
leg.txt <- c("RW with Drift", "Deterministic Linear Trend", "RW without Drift")
legend("topleft", legend=leg.txt, lty=c(1,2,1), col=c("blue","navy","purple"),
       bty='n', cex=1, merge = TRUE, bg=336)

hist(xd, main="RW with Drift", col="blue")
hist(10+(0.5*(1:length(xd))), main="Deterministic Linear Trend", col="navy")
hist(x, main="RW without Drift", col="purple")
```


with Drift, Random Walk without Drift, D
RW with Drift
Deterministic Linear Trend
RW without Drift
Values
0
300
0
200
400
600
800
1000
Simulated Time Period


RW with Drift
Frequency
0
60
120
0
100
300
500
xd


Deterministic Linear Trend
Frequency
0
40
100
0
100
200
300
400
500
10 + (0.5 * (1:length(xd)))


RW without Drift
Frequency
0
150
−10
0
10
20
30
x