lab-4-stat3925

Mason

21st March 2022

Question 1

We show that the roots of $1 - 0.4\omega + 0.7\omega^2 = 0$ are complex such that $|\omega| > 1$ or both are lying outside the unit circle

```
roots = polyroot(c(1, -0.4, 0.7))
roots
```

```
## [1] 0.285714+1.160577i 0.285714-1.160577i
```

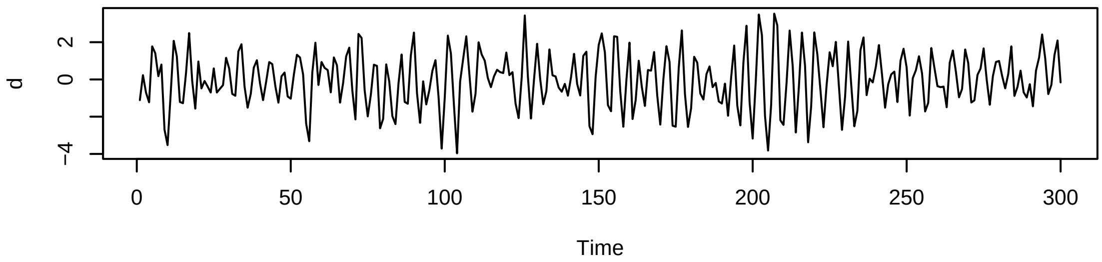
```
abs_roots = abs(roots)
abs_roots
```

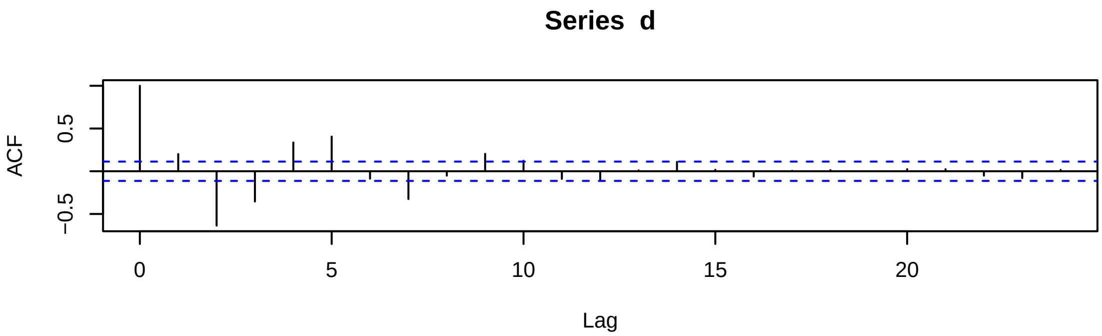
```
## [1] 1.195229 1.195229
```

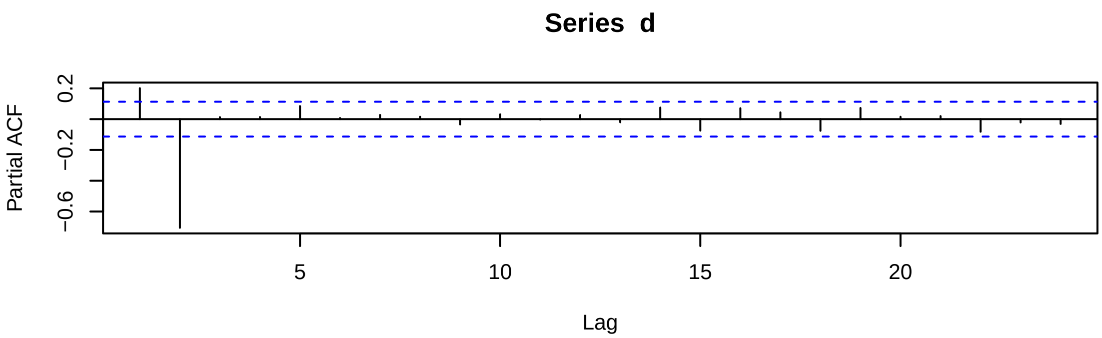
Hence we have that both roots are outside the unit circle.

Question 2

```
set.seed(127)
par(mfrow = c(3, 1))
d = arima.sim(mode = list(ar = c(0.4, -0.7)), n = 450)
d = d[151:450]
ts.plot(d)
acf(d)
pacf(d)
```







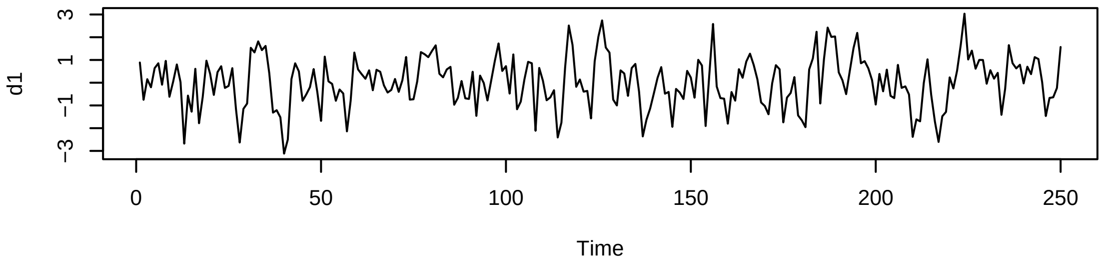
We see that:

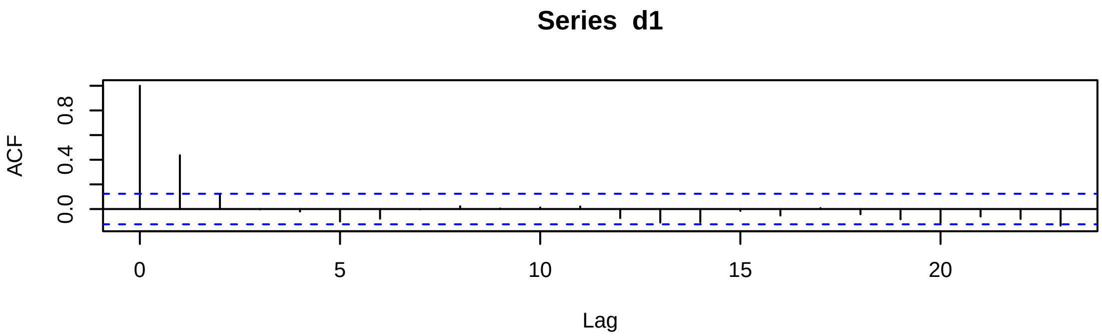
- The time series plot has roughly constant variance and constant mean
- The ACF plot decays very quickly
- There are two significant spikes for the PACF plot.

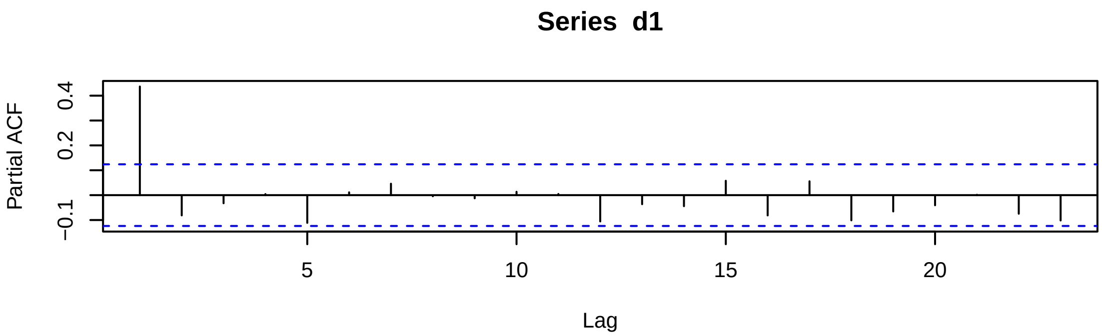
Hence a reasonable model is the $AR(2)$ model which is stationary.

Question 3

```
par(mfrow = c(3, 1))
d1 = arima.sim(mode = list(ar = c(0.6)), n = 400)
d1 = d1[151:400]
ts.plot(d1)
acf(d1)
pacf(d1)
```

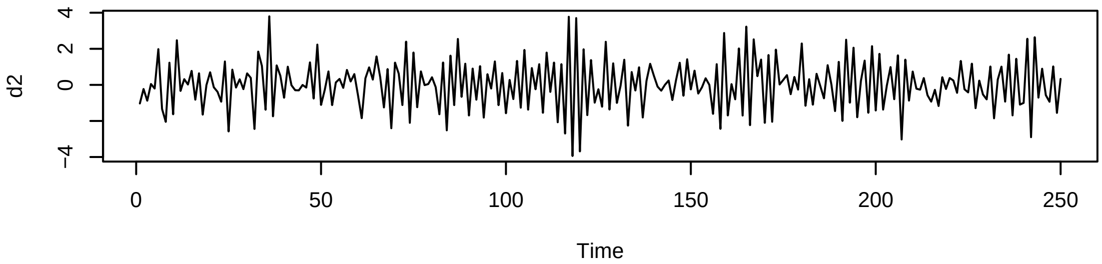


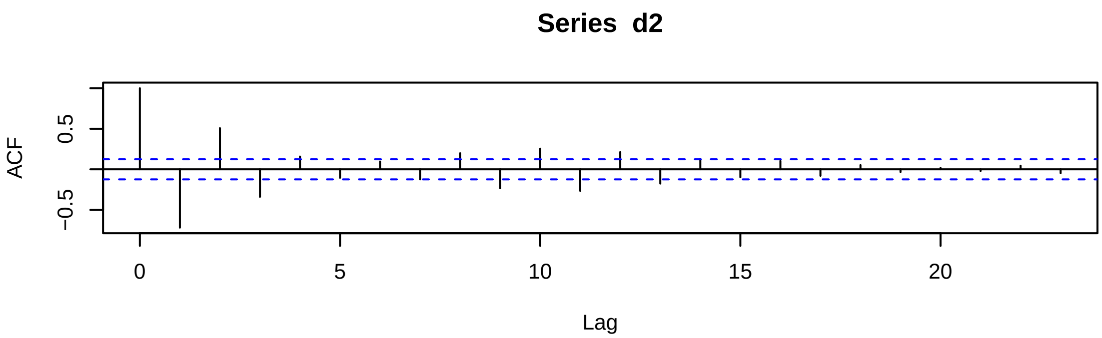


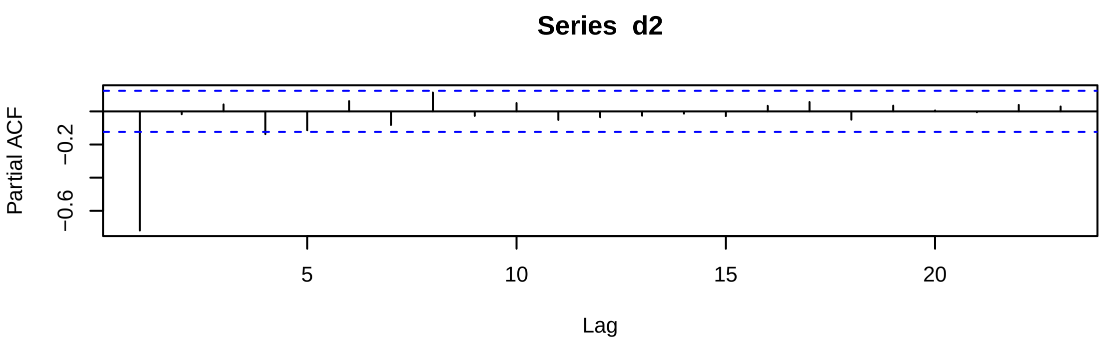


- time series plot has constant mean and constant variance
- ACF decays quickly
- PACF has one significant spike

```
par(mfrow = c(3, 1))
d2 = arima.sim(mode = list(ar = c(-0.8)), n = 400)
d2 = d2[151:400]
ts.plot(d2)
acf(d2)
pacf(d2)
```

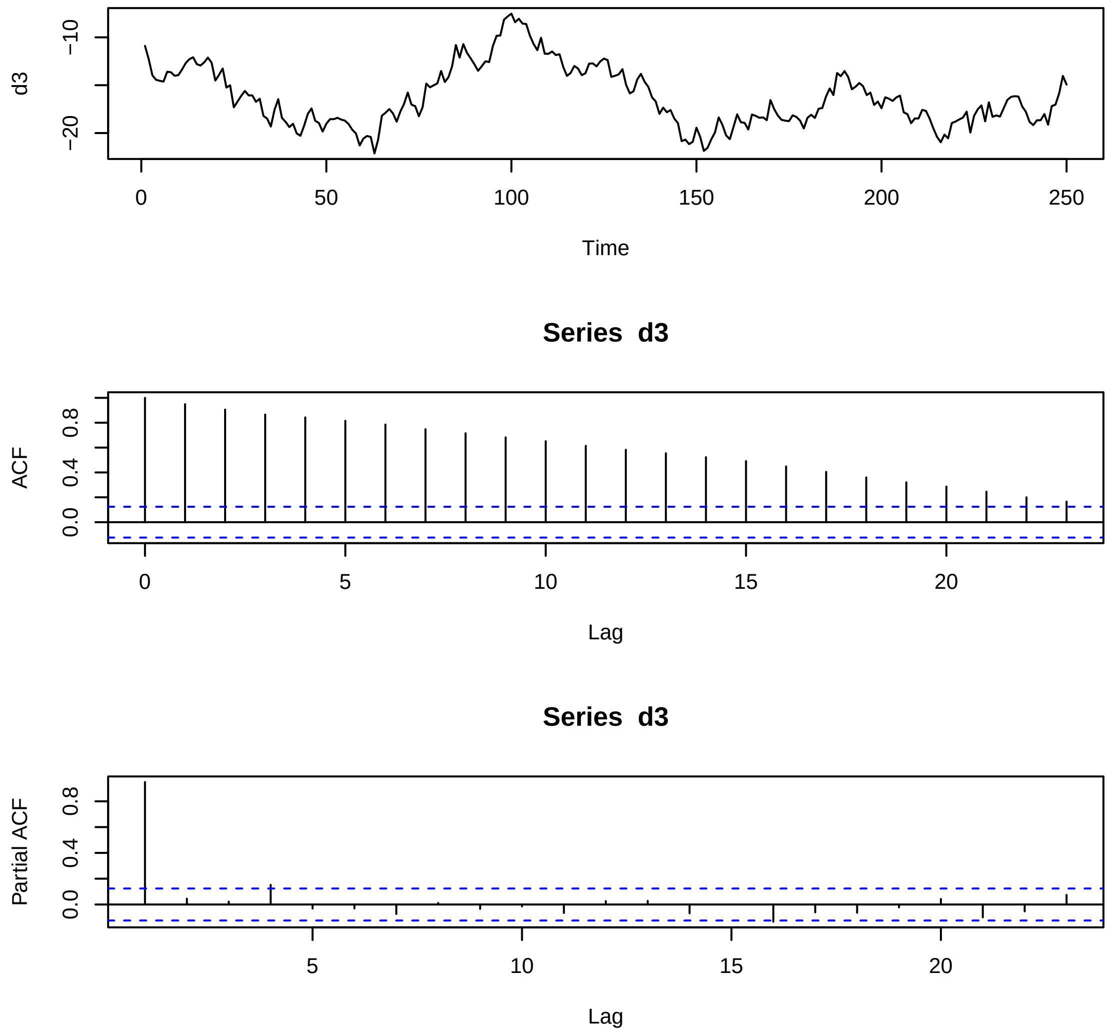






- time series plot has constant mean and constant variance
- ACF decays quickly
- PACF has one significant spike

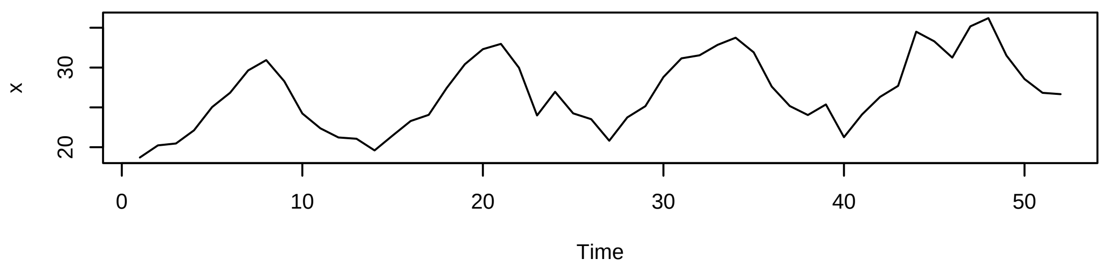
```
par(mfrow = c(3, 1))
d3 = arima.sim(mode = list(ar = c(0.9999)), n = 400)
d3 = d3[151:400]
ts.plot(d3)
acf(d3)
pacf(d3)
```

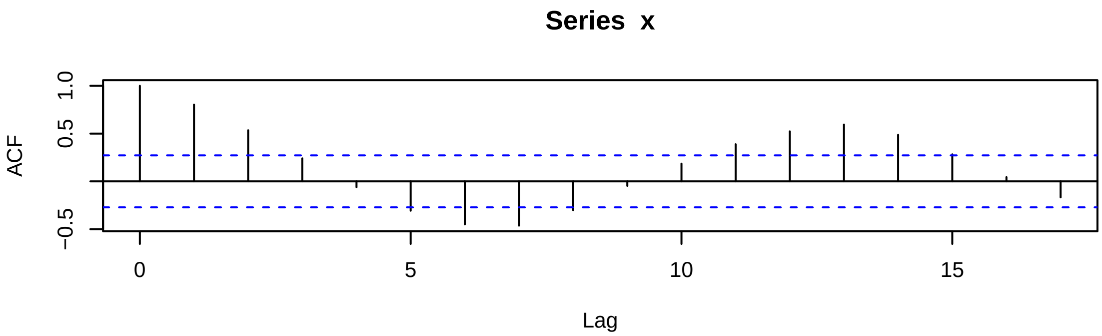


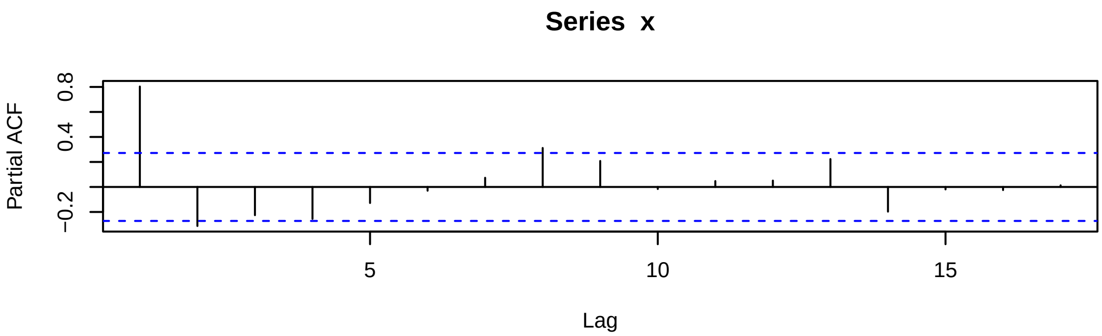
This series is still stationary. But we would say that we would say that it's nearly non-stationary. Note that the ACF doesn't decay very qickly but the PACF still has one spike.

Question 4

```
x = c(18.705, 20.232, 20.467, 22.123, 25.036, 26.839, 29.64, 30.935, 28.278, 24.235,
    22.37, 21.224, 21.061, 19.598, 21.463, 23.287, 24.065, 27.447, 30.413, 32.307,
    32.974, 29.973, 23.986, 26.953, 24.25, 23.518, 20.816, 23.743, 25.152, 28.804,
    31.158, 31.54, 32.849, 33.748, 31.91, 27.609, 25.17, 24.04, 25.368, 21.26, 24.109,
    26.32, 27.701, 34.502, 33.297, 31.252, 35.173, 36.207, 31.511, 28.56, 26.828,
    26.66)
par(mfrow = c(3, 1))
ts.plot(x)
acf(x)
pacf(x)
```



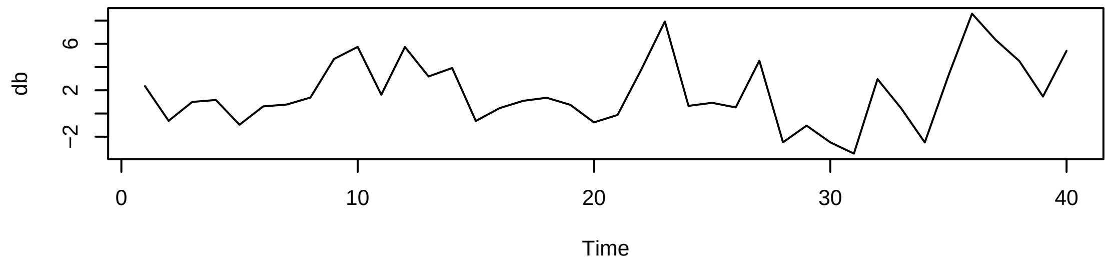


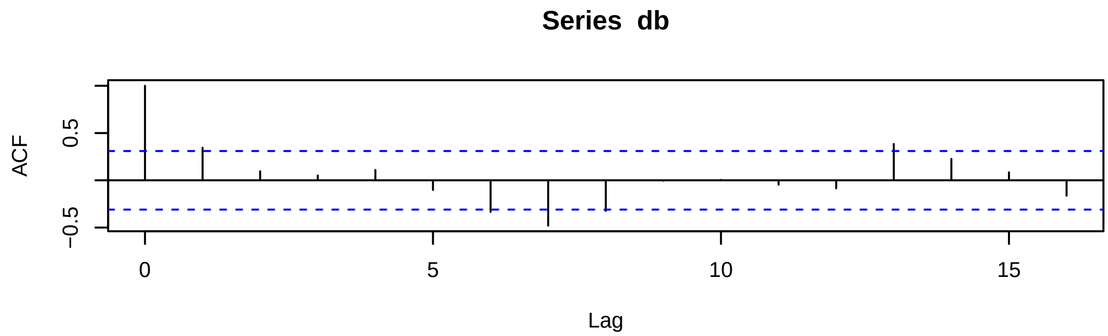


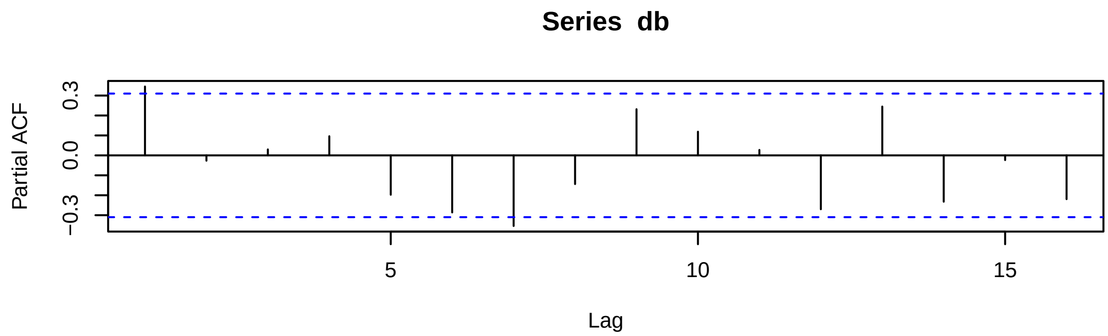
(i) There is seasonality and a linear trend.

(ii) Since the observations are taken monthly, the period is naturally every year. That is every 12 months.

```
db = diff(x, lag = 12)
par(mfrow = c(3, 1))
ts.plot(db)
acf(db)
pacf(db)
```







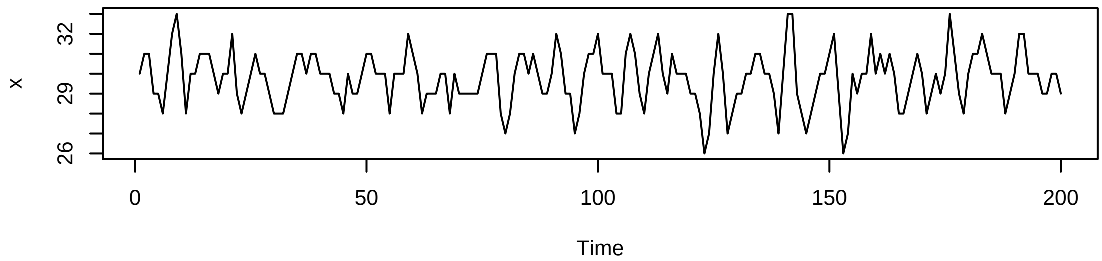
(iii) Hence we see that there is not more seasonality from the main components but there is still seasonlity from the error components.

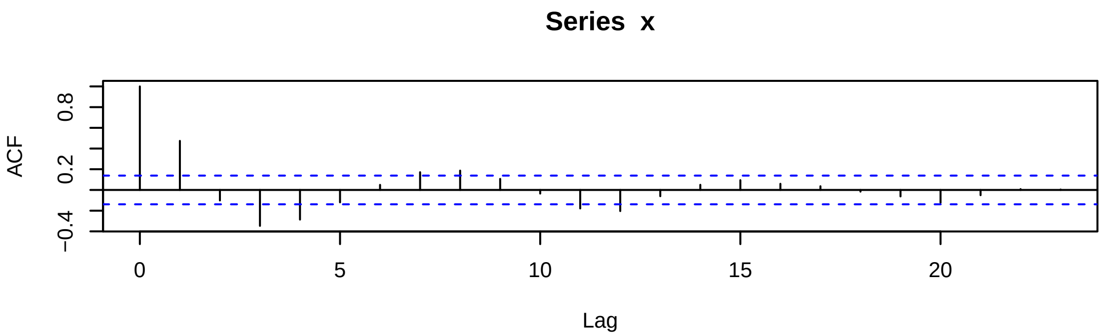
(iv) We see that from the PACF model there is 1 significant spike so we could use an AR(1).

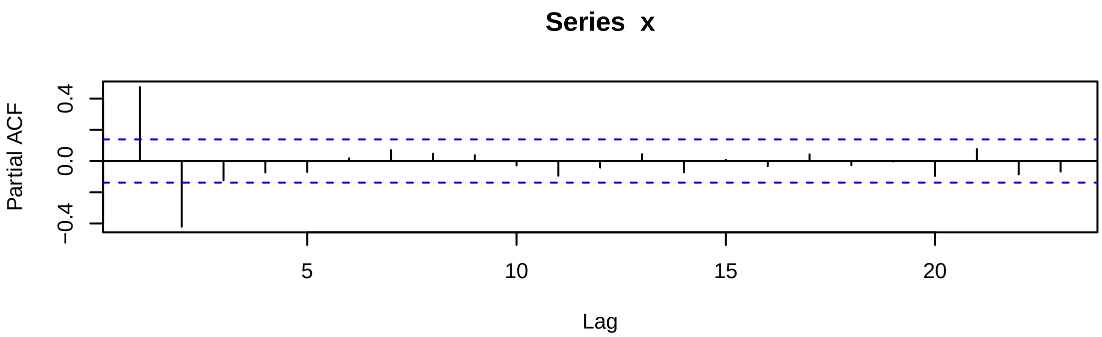
Question 5

```
x = c(30, 31, 31, 29, 29, 28, 30, 32, 33, 31, 28, 30, 30, 31, 31, 31, 30, 29, 30,
    30, 32, 29, 28, 29, 30, 31, 30, 30, 29, 28, 28, 28, 29, 30, 31, 31, 30, 31, 31,
    30, 30, 30, 29, 29, 28, 30, 29, 29, 30, 31, 31, 30, 30, 30, 28, 30, 30, 30, 32,
    31, 30, 28, 29, 29, 29, 30, 30, 28, 30, 29, 29, 29, 29, 29, 30, 31, 31, 31, 28,
    27, 28, 30, 31, 31, 30, 31, 30, 29, 29, 30, 32, 31, 29, 29, 27, 28, 30, 31, 31,
    32, 30, 30, 30, 28, 28, 31, 32, 31, 29, 28, 30, 31, 32, 30, 29, 31, 30, 30, 30,
    29, 29, 28, 26, 27, 30, 32, 30, 27, 28, 29, 29, 30, 30, 31, 31, 30, 30, 29, 27,
    30, 33, 33, 29, 28, 27, 28, 29, 30, 30, 31, 32, 29, 26, 27, 30, 29, 30, 30, 32,
    30, 31, 30, 31, 30, 28, 28, 29, 30, 31, 30, 28, 29, 30, 29, 30, 33, 31, 29, 28,
    30, 31, 31, 32, 31, 30, 30, 30, 28, 29, 30, 32, 32, 30, 30, 30, 29, 29, 30, 30,
    29)
par(mfrow = c(3, 1))
ts.plot(x)
```

```
acf(x)
pacf(x)
```







(ii) MA(1), MA(3) or MA(4) and AR(2) models could possibly work