STAT 626
Homework 2

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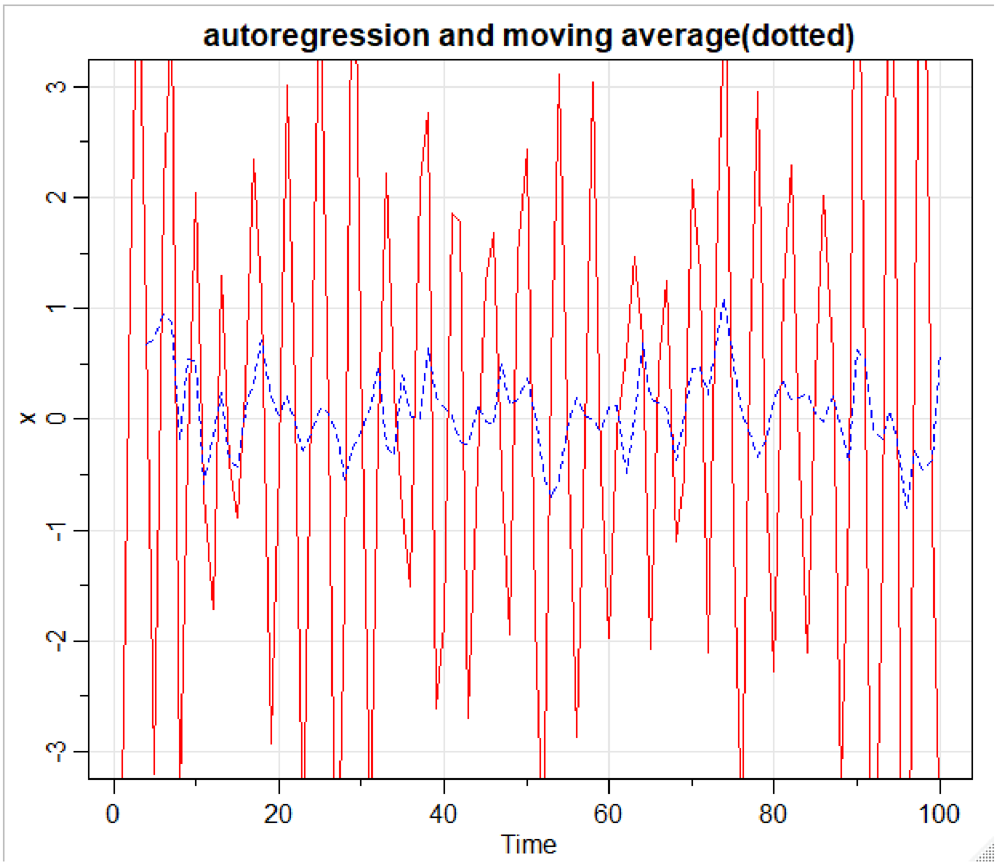
Q1)

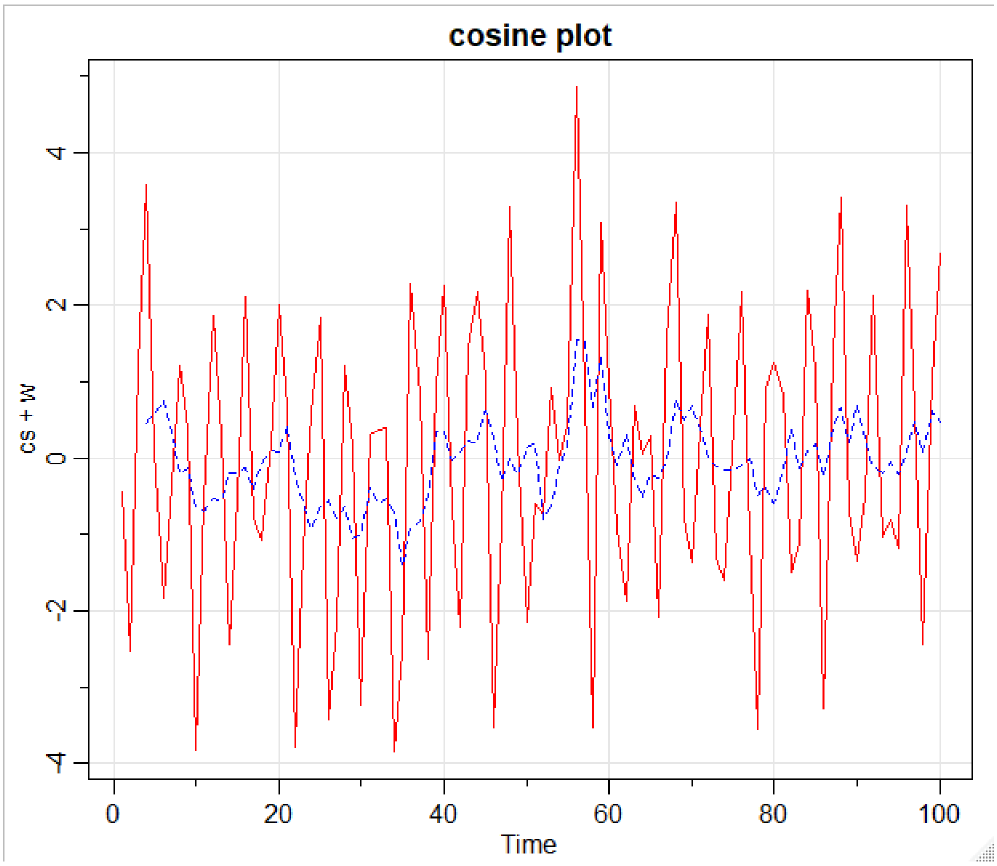
1.1

a)



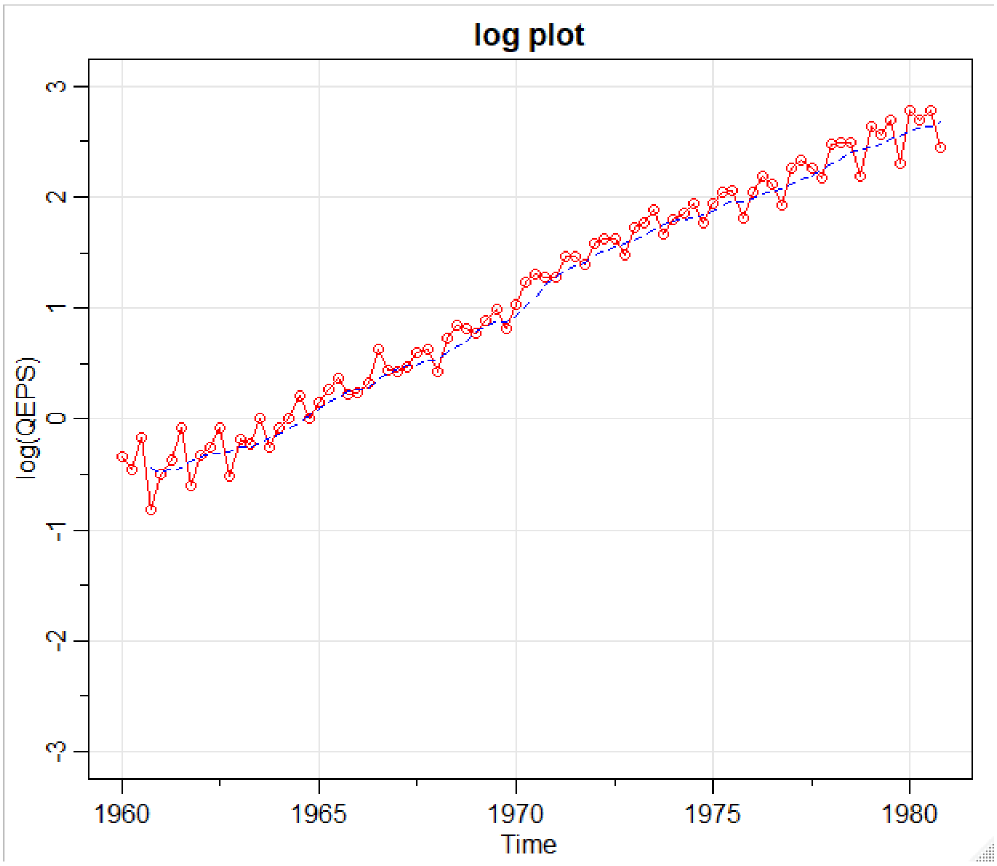
autoregression and moving average(dotted)
x
Time
0
20
40
60
80
100
-3
-2
-1
0
1
2
3

b)



cosine plot
cs + w
Time
0
20
40
60
80
100
-4
-2
0
2
4

c)



d)

Seasonal adjustment is a statistical method used to remove the seasonal component of a time series that follows a seasonal pattern.

This method is used to analyze the trend of a time series which is independent of seasonal component.

Example:

The sales of running shoes bought in the summer exceed the quantity bought in the winter. The increase is due to the seasonal factor that more people participate in outdoor activities which require shoes in the summer.

So, a seasonal adjustment in the aforementioned example is required to get an idea of the general trend of the sales of running shoes.

e)

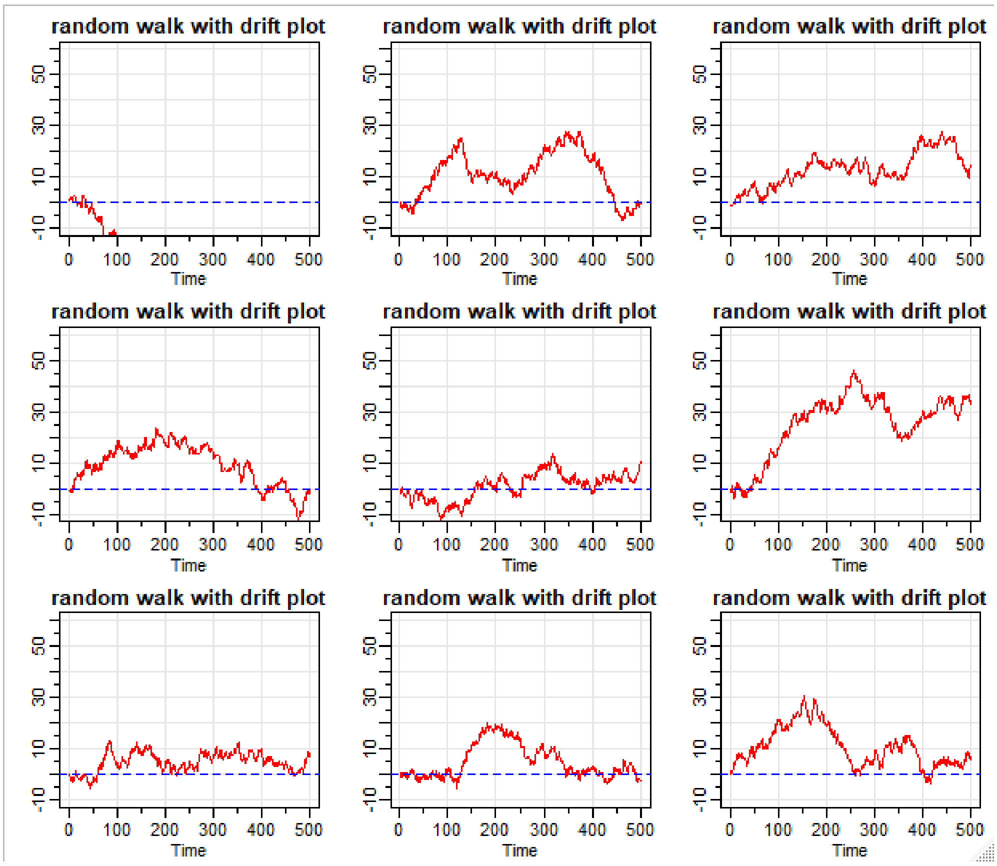
The following were the learnings in this exercise:

- Importance of seasonal adjustment in time series data
- Autoregression is a relation between current time and past data points in a time series data
- Moving average smoothens the series, i.e reduces the variability as the present value depend on a set of past values (as defined)

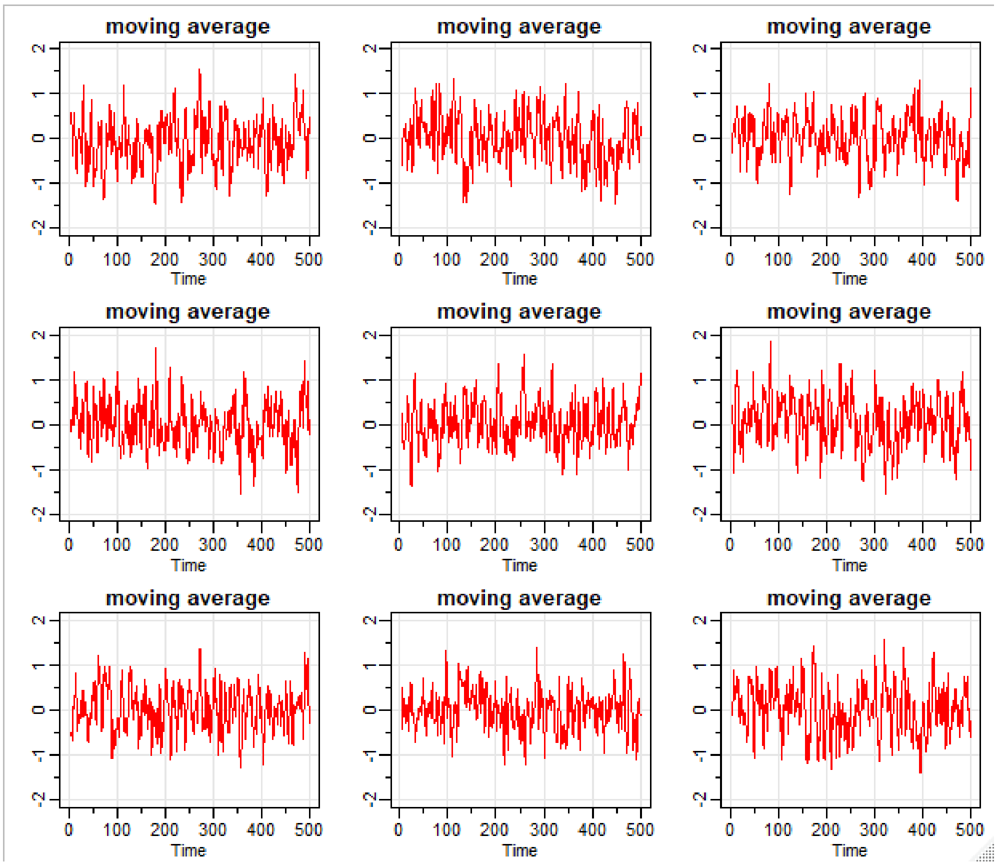
Q2)

1.3

a)



b)



c)

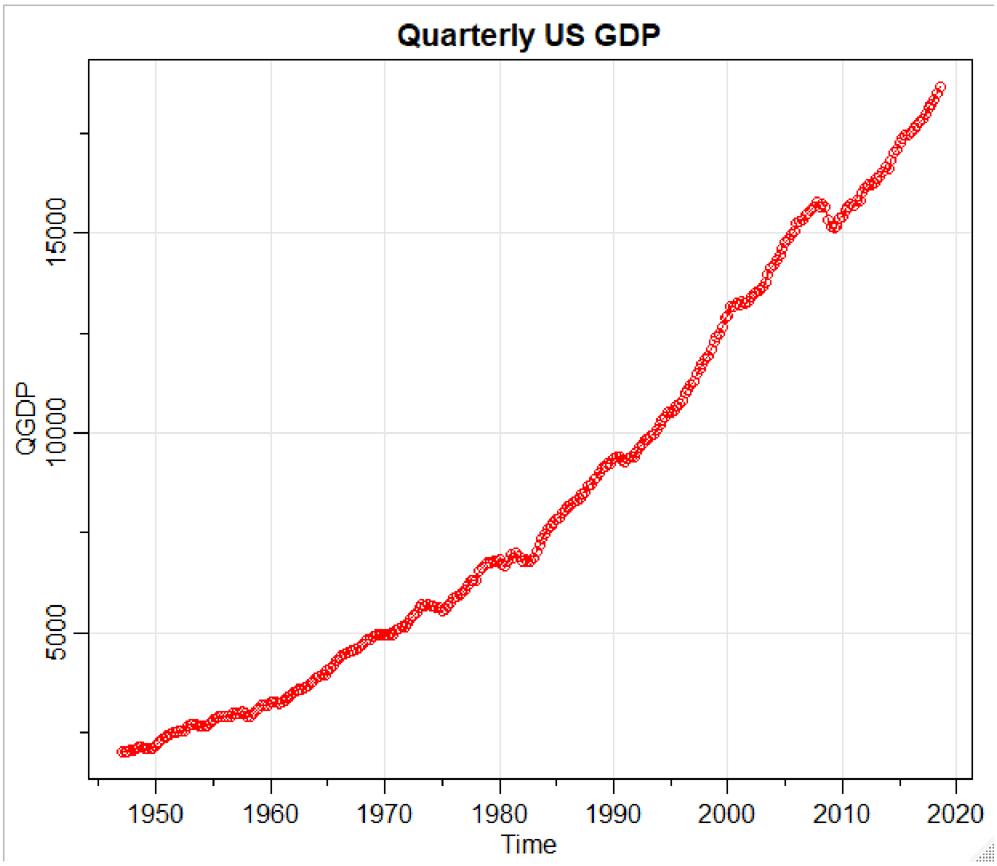
The major difference between the two plots are:

- Moving average plot fluctuates between -1 and 1 whereas random walk ranges from -10 to 40 using the same random values
- Both uses past data points to determine the next data point however, moving average can use more than one historical data (here 4) thus leveling out the fluctuation.

Q3)

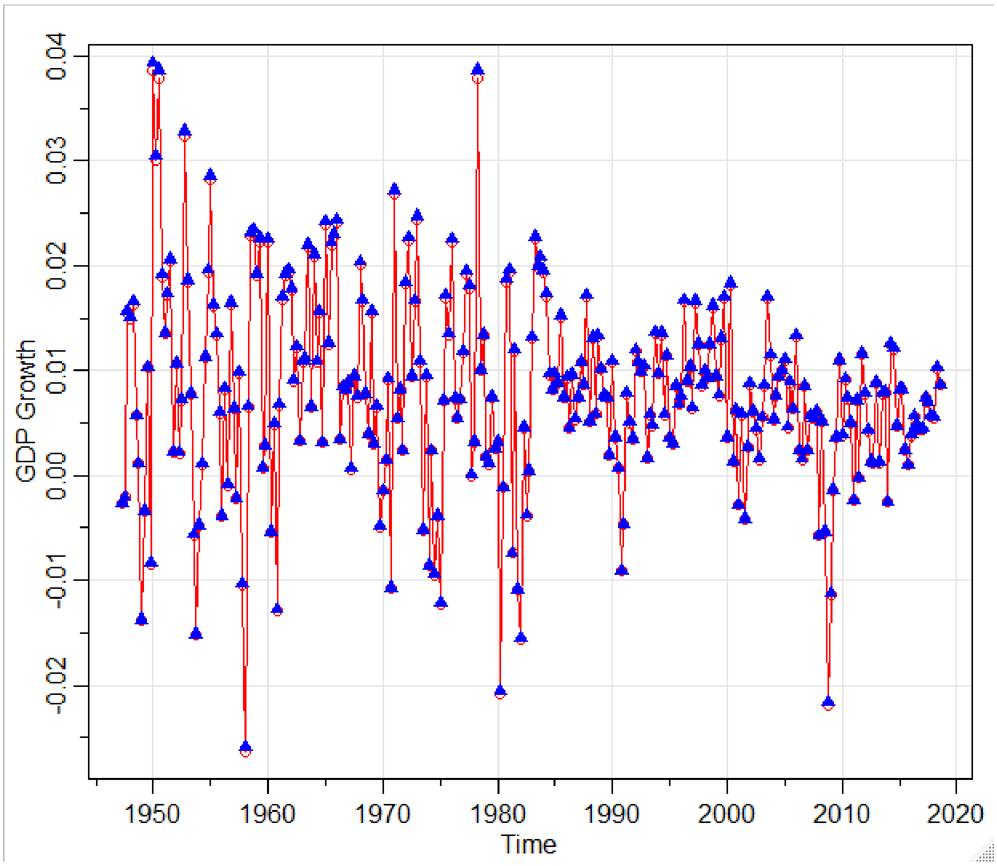
1.4

a)



Comparing with the autoregression time series model, both models predict the future observation using previous year observations. However, in case of the autoregression example, there can be an issue of start up values so an initial value has to be assigned.

b)



c)

Autoregression time series model best explains the behavior of the US GDP. It predicts for the future years using the observations from the previous years.

II.

1.] Prove $\sum_{i=1}^{n}(x_i - \bar{x}) = 0$

Proof:

$$\sum_{i=1}^{n}(x_i - \bar{x})$$

$$= \sum_{i=1}^{n} x_i - \sum_{i=1}^{n} \bar{x}$$

$$= x_1 + x_2 + \dots x_n - n \cdot \bar{x}$$

$$= n \cdot \bar{x} - n \cdot \bar{x}$$

$$= 0$$

$= RHS$

Hence Proved.

$$\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y}) = \sum_{i=1}^{n}(x_i - \bar{x}) \cdot y_i$$

Proof

LHS

$$= \sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})$$

$$= \sum (x_i - \bar{x}) y_i - \sum (x_i - \bar{x}) \bar{y}$$

$$= \sum_{i=1}^{n} y_i (x_i - \bar{x}) - \bar{y} \underbrace{\sum_{i=1}^{n} (x_i - \bar{x})}_{0}$$

0 (From Above)

$$= \sum_{i=1}^{n} y_i (x_i - \bar{x})$$

$= RHS$

Hence Proved.

2.] $S_x^{-2} \sum_{i=1}^{n} (x_i - \bar{x})(y_i - \bar{y}) = \sum_{i=1}^{n} c_i y_i$

$c_i = \frac{x_i - \bar{x}}{S_x^2}$, $S_x^2 = \sum_{i=1}^{n} (x_i - \bar{x})^2$

LHS

$$= \frac{\sum_{i=1}^{n} (x_i - \bar{x})(y_i - \bar{y})}{S_x^2}$$

$$= \frac{\sum_{i=1}^{n} y_i (x_i - \bar{x})}{S_x^2}$$ [Proof in Part 1]

$$= \sum_{i=1}^{n} \left[\frac{y_i (x_i - \bar{x})}{S_x^2} \right]$$ $\because S_x^2$ is a constant

$$= \sum_{i=1}^{n} c_i y_i$$

$=$ RHS

Hence Proved.