HW#1 Simulation

ADAPTIVE FILTER

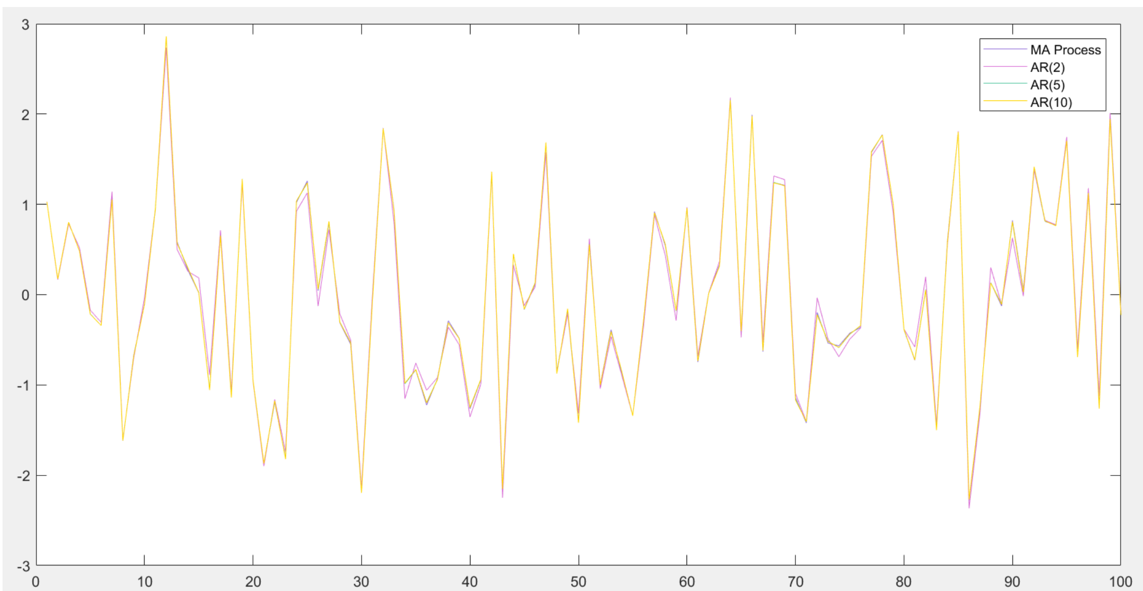
Fatemeh Noorzad | 810198271 | Mehr 98

Part B :

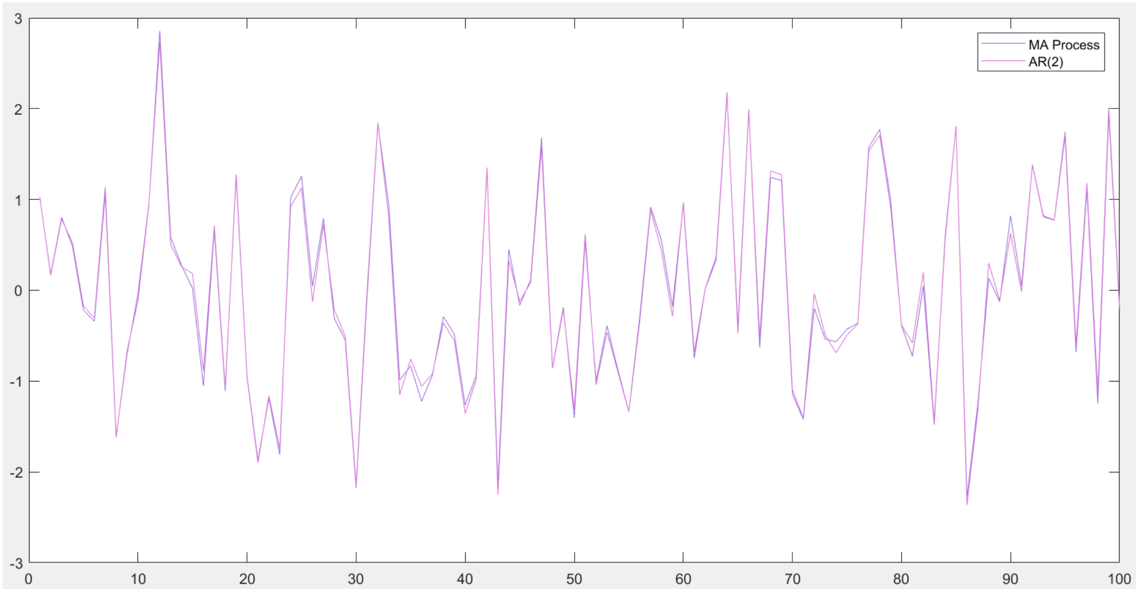
In this part we were asked to simulate a MA process and its AR process approximation.

For this goal first using “normrnd” function a white noise with mean = 0 and s.d = 1 is made (number of iterations is set to 100). Then with WN a MA process called x[n] is simulated.

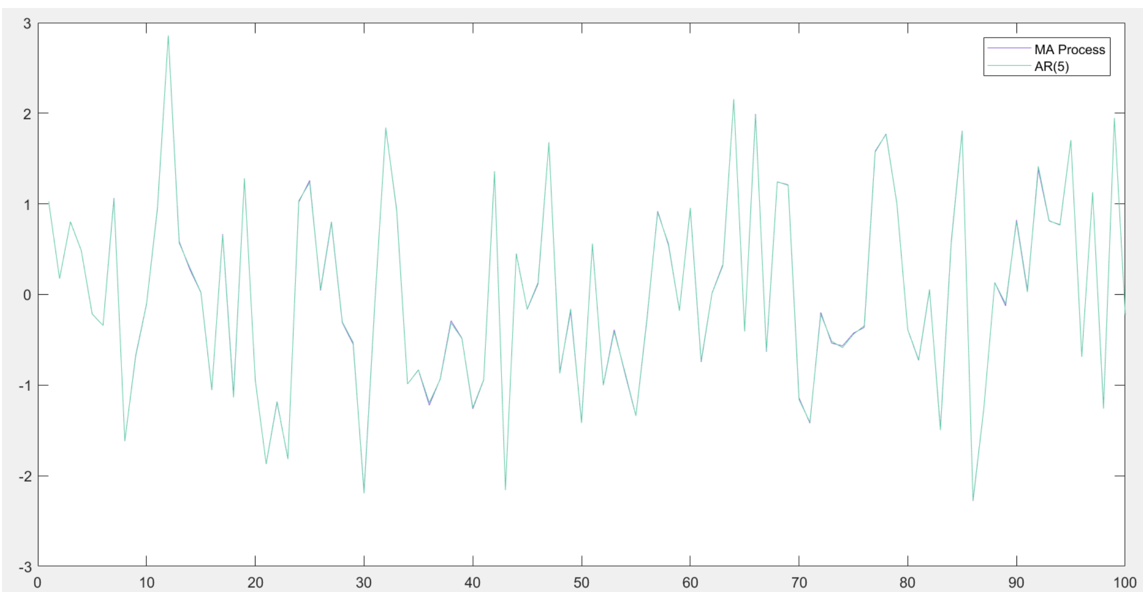
Using coefficients found in HW AR(2), AR(5) and AR(10) are created and plotted. As can be seen with M increasing AR(M) approximation becomes more accurate i.e. its MSE decreases. This results can be seen in the plots below.



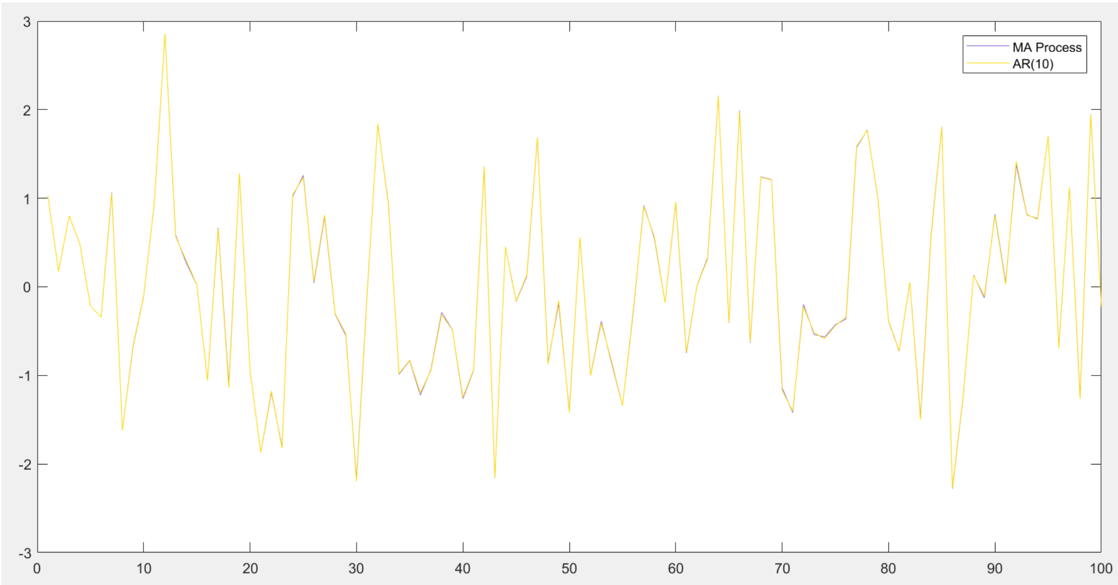
Plot1. All the processes are plotted


MA Process
AR(2)
3
2
1
0
-1
-2
-3
0
10
20
30
40
50
60
70
80
90
100

Plot2


MA Process
AR(5)
3
2
1
0
-1
-2
-3
0
10
20
30
40
50
60
70
80
90
100

Plot3



Plot4.

Comparing plots show the statement being stated above is true.

Part C:

As been said in the last part as M increases the similarity increases too which is obviously shown by these numbers:

err_ar10 = 1.5092e-04 , err_ar5 = 1.2977e-04 , err_ar2 = 0.0041

Part D:

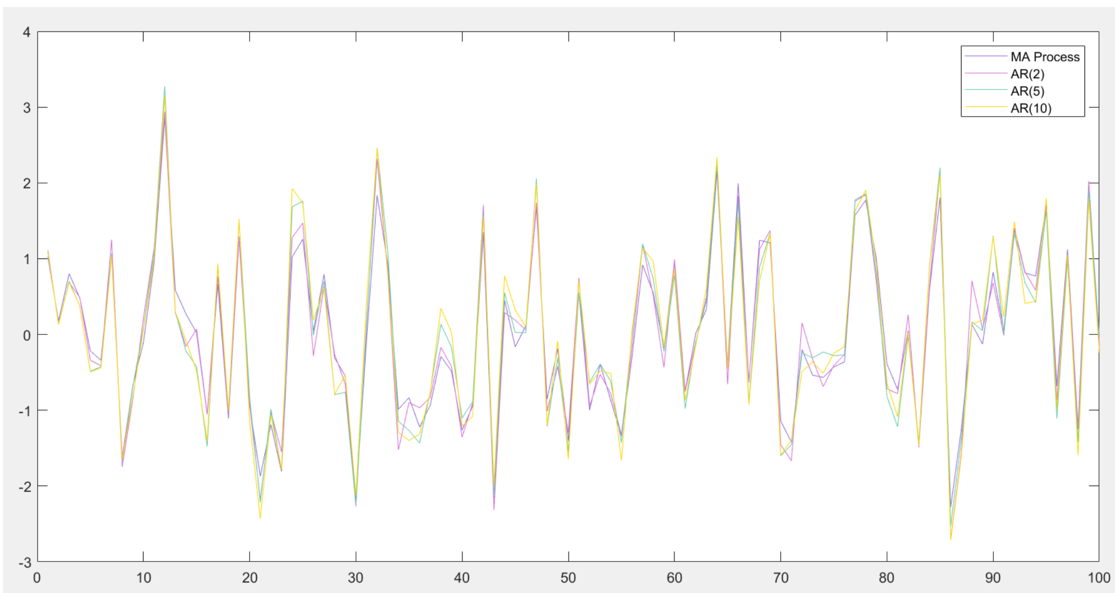
In this part first the correlation function (R_x) must be evaluated. Using equation below this R_x can be approximated:

$$r(m) = \frac{\text{۱}}{N-m}\sum_{k=\text{۰}}^{N-m-\text{۱}} x(k+m)x*(k)$$

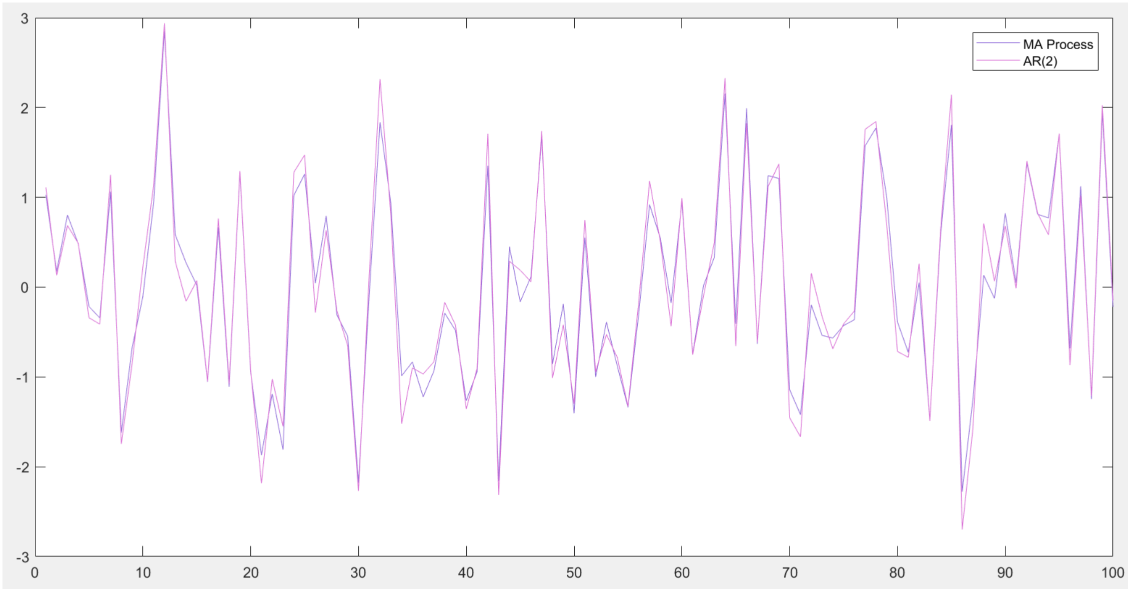
Then when the whole R_x for this process is calculated, using the equations below coefficients (w_1, w_2, ...) are calculated. Then again like part B using these coefficients the AR process is approximated.

$$R_x W = r_x \rightarrow \begin{bmatrix} r_x[0] & \cdots & r_x[M-1] \\ \vdots & \ddots & \vdots \\ r_x[-M+1] & \cdots & r_x[0] \end{bmatrix} \begin{bmatrix} w_1 \\ w_2 \\ \vdots \\ w_M \end{bmatrix} = \begin{bmatrix} r_x[-1] \\ r_x[-2] \\ \vdots \\ r_x[-M] \end{bmatrix}$$

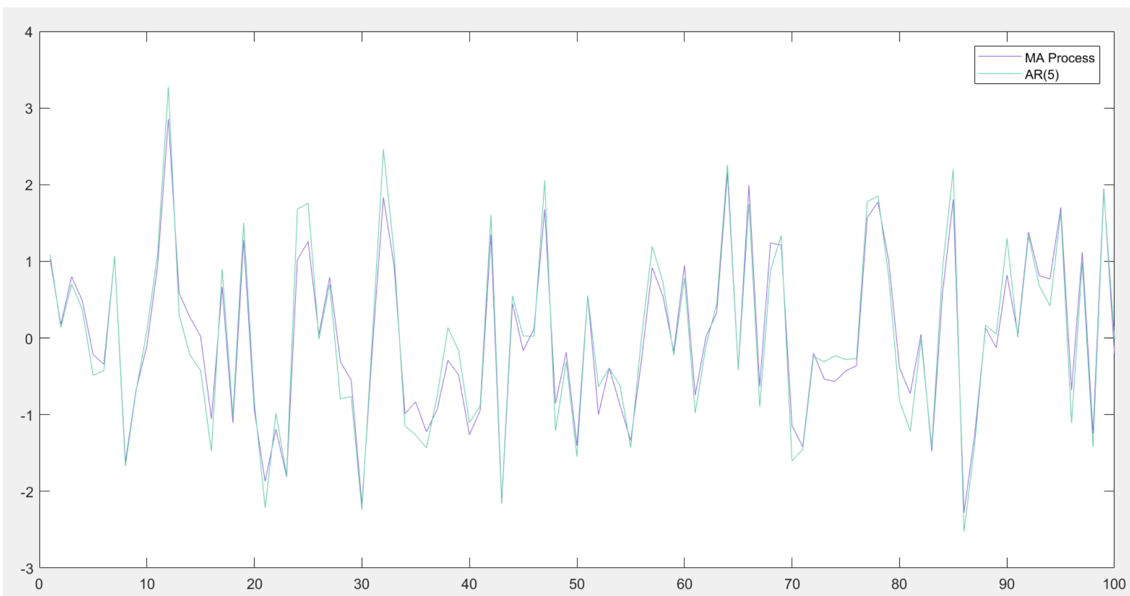
If these process be plotted it can be seen that like part B and C as M increases MSE between MA and AR process decreasing and they act somehow the same. This statement can be shown with computing MSE too. (which can be found in codes). But what is different form the last 2 parts is that since R_x was calculated using an approximation, the approximation of MA with AR is not as accurate as the last 2 parts. It can easily be seen by the plots and also the MSEs.



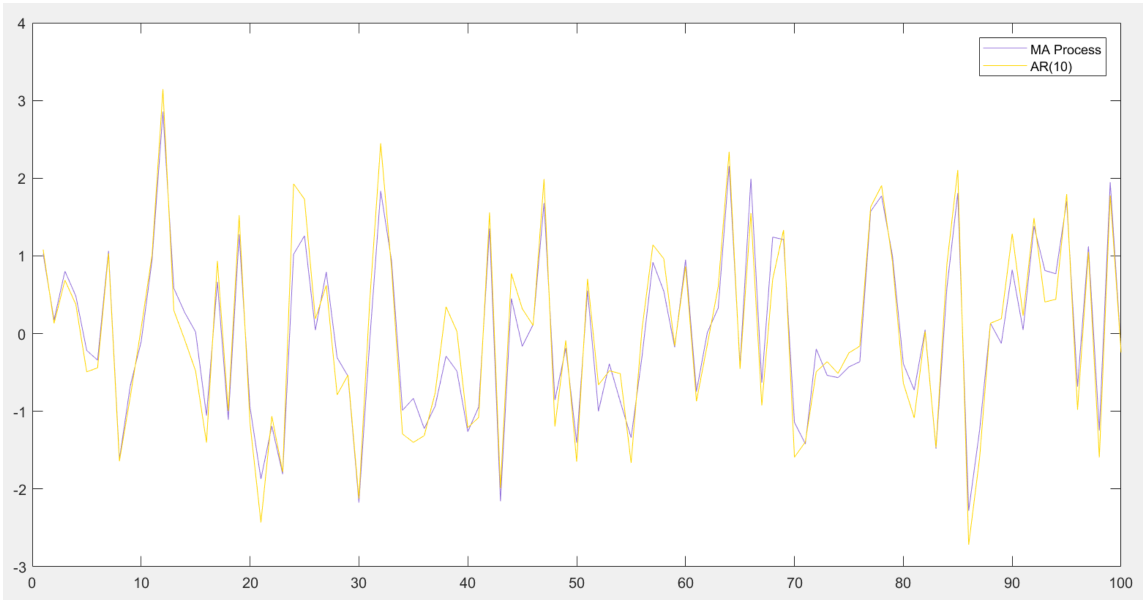
Plot5.



Plot6.



Plot7.



Plot8.

And errors are : err_ar10 = 0.0828, err_ar5 = 0.0255, err_ar2 = 0.0372

Simulation for 1000 iterations are made too and had the same results. (can be found in codes.)