University at Buffalo
Department of Industrial and Systems Engineering
IE 500/459: Supply Chain Engineering
Homework #1.
Due Date: 6:00 PM Feb 21, 2020

Academic Integrity Rules (Please read carefully)

- You are responsible to complete and return your solutions on time. Failure to submit a homework will result in a grade of 0% on that component. Late assignments will not be accepted.
- If you received some help to obtain the solution of a problem, you should acknowledge the source. In particular, for each question I would like you to cite, if applicable, any book you consulted, any website you searched, or any individual you cooperated with (other than the instructor or the TA). This information will not be used to reduce your homework score, provided that help is limited to a reasonable portion of the homework. However, failing to report any assistance you may have received will be considered dishonest.
- Remember, it is acceptable to ask your classmates for hints if you feel "stuck" on a problem. However, by no means you should share complete/almost-complete solutions, codes, formulations, mathematical proofs, or any other material that represents a substantial portion of the problem being solved. Any computational code must be done by each student individually.
- If the question requires you to perform some calculations using MS Excel/R, you must upload the files to UB Learns.

Question 1 (a) The monthly sales data for the year 2011 for Datastream, Inc., which produces network routers for small companies, are given in Table 2.18. The sales manager wants a forecast of sales for the first quarter of year 2012 (months 13). Compute the forecasts using the following four methods: (1) Last value method (2) Averaging method (3) Three-month moving average method (4) Exponential smoothing with $\alpha = 0.25$.

TABLE 2.18

Sales Data for Exercise 2.6

Month	Sales
1	34
2	33
3	42
4	34
5	36
6	43
7	34
8	33
9	43
10	31
11	35
12	41

(b) We discussed four different accuracy measures such as MAD, MSE, STD, MAPE. Now, please find your prediction results from Month 4 to 12 using same methods in Q1(a). What is prediction accuracy of four models based on different measures?

	MAD	MSE	STD	MAPE
Last value				
Averaging				
Three-month Avg				
Exp. S				

(c) Based on your answer Q1(b), which method do you think is the best to this scenario?

Question 2.

ABC company is experimenting with two forecasting methods for its product. Table 2.20 gives the actual sales and the forecasts obtained by the two methods during the past 6 months.

(a) Calculate MAD, MSE, and BIAS for the two methods.
(b) Are the methods under-forecasting or over-forecasting? Which method would you recommend for forecasting future sales and why?

TABLE 2.20

Sales and Forecast Data for Exercise 2.9

Month	Actual Sales	Forecast—1	Forecast—2
1	558	532	521
2	490	541	538
3	576	520	546
4	632	550	542
5	515	575	555
6	610	590	575

Question 3.

Jill Smith, who has joined recently as the forecasting manager for ABC company, is interested in developing quarterly forecasts for one of the company's key products. She has collected data on quarterly sales for this product for the past 5 years and they are given in Table 2.22. Jill decides to use seasonality prediction methods. She also decides to use the first 4 years of data and predict the estimates in 2011 first.

(a) Using only the data for the years 2007–2010, prepare the initial estimates of the seasonal factors for each quarter.

(b) Using seasonality method, predict four quarters sales in 2011. Please assume that initial estimation is 780 and α is 0.3.

(c) Using the 2011 actual demand data, validate these forecasts. Use BIAS, STD.

TABLE 2.22

Quarterly Sales Data for 2007–2011 (Exercise 2.15)

Quarter	2007	2008	2009	2010	2011
1	800	1700	2100	2400	3600
2	750	1100	2200	3060	3900
3	600	680	1300	1800	1500
4	1500	2000	3100	4000	3320

Question 4 (ARMA model: Theory).

(a) Please write down the equation of three models: $AR(p), MA(q), ARMA(p,q)$.

(b) Let X_{10} and X_{13} be random variables which follow $MA(1)$. What is the covariance of X_{10}, X_{13}.

$$Cov\ (X_{10}, X_{13})$$

Hint: $Cov\ (X,Y) = E[XY] - E[X]E[Y]$

(c) X_t is a random variable from the model $MA(q)$. Lee argues that $E[X_t]$ remains 0 for all time periods t, regardless the value of q. If you agree with him, please show your argument. Otherwise, please give the counter example.

Question 5 (ARMA model: Practice).

(a) In the "AR_model" sheet in the MS-excel file, two hundred number of random variables are in column B. By using these random variables and $Norm.inv$ built-in function, please generate two hundred number of Gaussian white noises ($\sigma^2 = 2$) and place them in column C.

(b) Produce AR(2) with $\phi_1 = 0.6, \phi_2 = 0.1$ and place your data in column D. Plot these data over time. Please assume that first two demands are zero.

(c) Produce AR(2) with $\phi_1 = 0.2,\ \phi_2 = 0.05$ and place your data in column E. Plot these data over time. Please assume that first two demands are zero.

(d) Produce AR(2) with $\phi_1 = 0.8, \phi_2 = 0.3$ and place your data in column F. Plot these data over time. Please assume that first two demands are zero.

(e) Please compare three patterns in (b), (c), and (d). What can you observe? Why do you think these differences are observed?

(f) In the "Prediction" sheet in the MS-excel file, three hundred number of Gaussian white noises $GN(0, \sigma_W^2)$ are in column A. What do you think will be the value of σ_W^2? Which estimator will you use?

(g) Two prediction models (MA(1) with $\theta_1 = 0.5$ and MA(1) with $\theta_1 = 0.2$) are given in columns C and D in the "Prediction" sheet. The real demand data is shown in the column E. Which model do you think is better? Is your judgment changing based on different accuracy measures as MAD or MSE? Please give me your reasoning.