

- 0.8 2. (1+1+2 points) Consider the following past demand data.

| Month  | 1  | 2  | 3  | 4  | 5  |
|--------|----|----|----|----|----|
| Demand | 25 | 33 | 20 | 22 | 28 |

- a. Use the moving average method with  $N = 3$  to make one-step-ahead forecasts at the end of Month 3 and at the end of Month 4.

$$f_3 = \frac{20 + 22 + 28}{3} = 23.3$$

$$f_4 = \frac{22 + 28 + 20}{3} = 23.3$$

- b. Suppose that your previous one-step-ahead forecast for Month 3 was  $F_3 = 27$ . Use the simple exponential smoothing with  $\alpha = 0.2$  to make one-step-ahead forecasts at the end of Month 3 and at the end of Month 4.

$$e_3 = f_3 - D_3 = 27 - 20 = 7$$

$$e_4 = f_4 - D_4 = 7 - 22 = -15$$

- c. From your answers to (a) and (b) above, compare one-step-ahead forecast for Months 4 and 5 using MAPE? Which one does show a better performance?

$$\frac{\sum |e_t|}{\sum D_t} \times 100$$

- 1.5 3. (1+1+1 points) Consider a regression method for the following demand data.

| Week   | 1  | 2  | 3  |
|--------|----|----|----|
| Demand | 37 | 50 | 57 |

- a. What is  $S_{xy}$ ?

$$3(1 \cdot 37) + (2 \cdot 50) + (3 \cdot 57) - \frac{3(61)}{2} = 918$$

- b. What is  $S_{xx}$ ?

$$S_x = \frac{3(2+1)}{2} - \frac{3^2(3+1)}{4} = 6$$

- c. What is the slope and the intercept of the regression line?

$$\text{slope } \hat{b} = \frac{S_{xy}}{S_{xx}}$$

$$\text{intercept } \hat{a} = \bar{D} - \frac{n+1}{2} \hat{b}$$

$$\hat{a} = -20.8$$

$$\frac{37 + 50 + 57}{3} = 48$$

$$\hat{b} = \frac{3 \cdot 5 \cdot 918}{3 \cdot 6} = 153$$

5. (3+3 points) A startup company produces a product that has the following demand forecast for next 4 quarters. The company currently has no workers and no inventory. It is estimated that each worker can produce 50 units per quarter. The company does not want to have a shortage at any quarter.

| Quarter | 1    | 2    | 3    | 4    |
|---------|------|------|------|------|
| Demand  | 1200 | 1500 | 1000 | 1400 |

$$\frac{50}{41} = 12.5$$

Relevant costs are as follows:

Salary per worker per year = \$26,000  
 Cost when hiring one worker = \$800  
 Cost when laying off one worker = \$1,400  
 Holding cost per unit per year = \$60

- a. If the *Level Strategy* is used, what is the number workers to be hired or fired at the beginning of Quarter 1?

| Demand | Cumulative | Unit Per | Cum  | Hire | Fire | Wor Kas |  |
|--------|------------|----------|------|------|------|---------|--|
| 1200   | 1200       | 12.5     | 12.5 | 96   |      | 2       |  |

Use cumulative → choose max. (27)

need to hire 2 = 96

- b. Assume that each worker stays on the job for at least one quarter. Write a linear programming model to minimize the total cost over the next four quarters.

no ans.

IP

$$\begin{aligned} w_1 &= 1200 + 1 \\ w_2 &= 1500 + 2 \\ w_3 &= 1000 + 3 \\ w_4 &= 1400 + 4 \end{aligned}$$

(-3)

6. (2 points) Recall that forecasts can be compared by performance measures (MAD, MSE, and MAPE). In our class, we used an example with two different sets of forecasts, where one set gives a smaller MAD while the other set gives a smaller MSE. Design a similar (but simpler) example with two sets of forecasts that display this type of inconsistent conclusion when MAD and MAPE are used. That is, write a set of demands, and two sets of forecasts for those demands, where one set of forecasts results in a smaller MAD while the other set of forecasts gives a smaller MAPE.

$$\text{MAD} = \frac{\sum e_i}{n}$$

$$\frac{20}{1} = 20$$

$$\frac{41.25}{2} = 20.625$$

$$\text{MAPE} = \frac{\sum |e_i|}{n} \times 100\%$$

$$\frac{70}{2} = 35\%$$

~~MAPE~~ NO CAR'S  
 (2)



- 5 1. (3 points). Identify whether each of the following statements is 'True' or 'False'. (Grading: each correct answer = 0.5 point, each incorrect answer = 0 point, each no answer = 0.25 point). *Please read the statement carefully.* No need to show your work for these problems.

a. Jury of Executive Opinion is a subjective forecasting method that allows personal interaction between participants.

True

False

No Answer

b. MAD is calculated as the average of forecasting errors.

True

False

No Answer

c. In the regression method, the intercept and the slope are obtained so that they minimize the sum of squared errors.

True

False

No Answer

d. In exponential smoothing, using a larger value of the smoothing constant results in that a larger weight is given to the most recently observed demand in the forecast.

True

~~False~~

No Answer

e. In aggregate planning, the level strategy tries to keep zero inventory.

True

False

No Answer

f. The level strategy allows hiring or firing workers only once at the beginning of the planning horizon.

True

False

No Answer

4. (1+1+2+2+1 points) Consider the following sales data (in thousands).

| Year   | Summer Season | Winter Season |
|--------|---------------|---------------|
| Year 1 | 11            | 15            |
| Year 2 | 13            | 19            |

Use the Winters method to provide your answers.

- a. Compute  $V_1$  and  $V_2$ ?

15 - 10

no ans (-1)

- b. Compute the initial estimates on the level and the slope (i.e.,  $S_0$  and  $G_0$ ).

no ans (-1)

- c. Following the initialization of the seasonal factors discussed in the class, you found  $c_0 = 1.119$ . What is  $c_1$ ?

1.215 "g"

no ans (-1.5)

- d. Suppose that the sales during the summer season in Year 3 was 14. Using  $\alpha = \beta = 0.2$  and  $\gamma = 0.1$ , compute  $S_2$ ,  $G_2$ , and  $c_1$ .

no ans (-2)

- e. Compute  $F_{1,3}$ .

no ans (-1)