IE 375 Fall 2020 Exercise Set II

1) Problem 47, p. 117, 7th Edition (Problem 47 p 113, 6th Edition)

47. John Kittle, an independent insurance agent, uses a five-year moving average to forecast the number of claims made in a single year for one of the large insurance companies he sells for. He has just discovered that a clerk in his employ incorrectly entered the number of claims made four years ago as 1,400 when it should have been 1,200.

a. What adjustment should Mr. Kittle make in next year's forecast to take into account the corrected value of the number of claims four years ago?

b. Suppose that Mr. Kittle used simple exponential smoothing with $\alpha = .2$ instead of moving averages to determine his forecast. What adjustment is now required in next year's forecast? (Note that you do not need to know the value of the forecast for next year in order to solve this problem.)

2) Problem 48, p. 118, 7th Edition (Problem 48 p 114, 6th Edition)

A method of estimating the MAD discussed in Section 2.13 recomputes it each time a new demand is observed according to the following formula:

$$\text{MAD}_t = \alpha|e_t| + (1 - \alpha)\,\text{MAD}_{t-1}.$$

Consider the one-step-ahead forecasts for aircraft engine failures for quarters 2 through 8 obtained in Example 2.3. Assume an initial value of the MAD = 50 in period 1. Using the same value of α, what values of the MAD does this method give for periods 2 through 8? Discuss the advantages and disadvantages of this approach vis-à-vis direct computation of the MAD.

3) Problem 31, p. 163, 7th Edition. (Problem 29 p. 162, 6th Edition) **To solve parts of the below problem you need an LP solver.**

(a) Problem 36, p. 165, 7th Edition. (Problem 37 p. 165, 6th Edition)

29. An aggregate planning model is being considered for the following applications. Suggest an aggregate measure of production and discuss the difficulties of applying aggregate planning in each case.

a. Planning for the size of the faculty in a university.

b. Determining workforce requirements for a travel agency.

c. Planning workforce and production levels in a fish-processing plant that produces canned sardines, anchovies, kippers, and smoked oysters.

(b) Problem 37 p. 165, 6th Edition - for Part c. you need to reformulate the problem

4)

37. The Yeasty Brewing Company produces a popular local beer known as Iron Stomach. Beer sales are somewhat seasonal, and Yeasty is planning its production and workforce levels on March 31 for the next six months. The demand forecasts are as follows:

Month	Production Days	Forecasted Demand (in hundreds of cases)
April	11	85
May	22	93
June	20	122
July	23	176
August	16	140
September	20	63

As of March 31, Yeasty had 86 workers on the payroll. Over a period of 26 working days when there were 100 workers on the payroll, Yeasty produced 12,000 cases of beer. The cost to hire each worker is $125 and the cost of laying off each worker is $300. Holding costs amount to 75 cents per case per month.

As of March 31, Yeasty expects to have 4,500 cases of beer in stock, and it wants to maintain a minimum buffer inventory of 1,000 cases each month. It plans to start October with 3,000 cases on hand.

a. Based on this information, find the minimum constant workforce plan for Yeasty over the six months, and determine hiring, firing, and holding costs associated with that plan.

b. Suppose that it takes one month to train a new worker. How will that affect your solution?

c. Suppose that the maximum number of workers that the company can expect to be able to hire in one month is 10. How will that affect your solution to part (*a*)?

d. Determine the zero inventory plan and the cost of that plan. [You may ignore the conditions in parts (*b*) and (*c*).]

38. *a.* Formulate the problem of planning Yeasty's production levels, as described in Problem 37, as a linear program. [You may ignore the conditions in parts (*b*) and (*c*).]

b. Solve the resulting linear program. Round the appropriate variables and determine the cost of your solution.

c. Suppose Yeasty does not wish to fire any workers. What is the optimal plan subject to this constraint?

Read the problem described on p. 196 for both editions.

5)

Fisher et al. (1982) describe an application of linear programming to the problem of providing a coordinated vehicle scheduling and routing system for delivery of consumable products to customers of the Du Pont Company. The primary issue was to determine delivery routes (loops) for the trucks to the company's clients in various regions of the country. A refrigerated truck drives a weekly loop that includes several dozen customers. The largest region considered, Chicago, had 16 loops and several hundred cities, whereas the Houston region, the smallest, had 4 loops and less than 80 cities.

The basic mathematical formulation of the problem was a generalized assignment problem. (The assignment problem is discussed in Chapter 9. It is a linear programming problem in which the decision variables are restricted to be zeros and ones.) The mathematical formulation used in this study is the following:

1. Given data

$$d_{ik} = \text{Cost of including customer } i \text{ in loop } k,$$
$$a_i = \text{Demand from customer } i.$$

2. Problem variables

$$y_{ik} = \begin{cases} 1 & \text{if customer } i \text{ is assigned to loop } k, \\ 0 & \text{if customer } i \text{ is not assigned to loop } k. \end{cases}$$

3. Generalized assignment problem

$$\text{Min} \sum_{k=1}^{K} \sum_{i=1}^{n} d_{ik} y_{ik}$$

subject to

$$\sum_{k=1}^{K} y_{ik} = 1, \qquad \text{for } i = 1, \ldots, n,$$
$$\sum_{i=1}^{n} a_i y_{ik} \leq b_k, \qquad \text{for } k = 1, \ldots, K,$$
$$y_{ik} = 0 \text{ or } 1, \qquad \text{for all } i \text{ and } k,$$

where K is the total number of loops in the region and n is the number of customers.

The implementation of this model was reported to have saved Du Pont over $200 million. A more complex mathematical model solving a similar problem for Air Products Corporation was reported by Bell et al. (1983). This study won the Institute of Management Sciences Practice Award in 1983.

Linear programming (or, more generally, mathematical programming) has been an important tool for logistics planning for a wide variety of operations management problems. Today, Microsoft bundles Solver, a general purpose mathematical programming Excel add-in, with its office software, thus making linear programming accessible to a much wider audience.

Read the problem 57 and Section 2.11 fo both editions- You are expected to understand the logic of method proposed.

6)

57. Trigg and Leach (1967) suggest the following adaptive response-rate exponential smoothing method. Along with smoothing the original series, also smooth the error e_t and the absolute error $|e_t|$ according to the equations

$$E_t = \beta e_t + (1 - \beta)E_{t-1},$$
$$M_t = \beta|e_t| + (1 - \beta)M_{t-1}$$

and define the smoothing constant to be used in forecasting the series in period t as

$$\alpha_t = \left|\frac{E_t}{M_t}\right|.$$

The forecast made in period t for period $t + 1$ is obtained by the usual exponential smoothing equation, using α_t as the smoothing constant. That is,

$$F_{t+1} = \alpha_t D_t + (1 - \alpha_t)F_t.$$

The idea behind the approach is that when E_t is close in magnitude to M_t, it suggests that the forecasts are biased. In that case, a larger value of the smoothing constant results that makes the exponential smoothing more responsive to sudden changes in the series.

a. Apply the Trigg-Leach method to the data in Problem 22. Using the MAD, compare the accuracy of these forecasts with the simple exponential smoothing forecasts obtained in Problem 22. Assume that $E_1 = e_1$ (the observed error in January) and $M_1 = |e_1|$. Use $\beta = .1$.

b. For what types of time series will the Trigg-Leach adaptive response rate give more accurate forecasts, and under what circumstances will it give less accurate forecasts? Comment on the advisability of using such a method for situations in which forecasts are not closely monitored.

7) Coca Cola İçecek (CCİ) is planning for the production of its soft drinks in Turkey for the next 6 months. The demand in two regions are given below (in million liters)

Region	*M1*	*M2*	*M3*	*M4*	*M5*	*M6*
	9	9	14	12	12	13
Central and Eastern	7	7	8	9	9	10

There are two plants in Turkey: one in Ankara and another in Istanbul. The plant in Ankara is primarily responsible for meeting the customer demand in Central and Eastern Turkey, while the plant in Istanbul is responsible for meeting customer demand in Western Turkey.

The soft drinks are only sold in 1 lt or 2 lt bottles. Traditionally, 60% of demand is for 2 lt bottles and 40% is for 1 lt bottles in all markets. The production is done at two steps. The first step is the bottling stage and it is completely automated. Each plant have a single bottling system which can bottle either 1 lt or 2 lt bottles at a time. If they only process 2 lt bottles, Ankara plant can bottle 6,000 bottles and Istanbul plant can bottle 9,000 bottles per hour. If they process only 1 lt bottles, Ankara plant can bottle 10,000 bottles and Istanbul plant can bottle 15,000 bottles per hour. Bottling systems work for 24 hours a day and 30 days a month. There is no setup time or cost for switching from 1 lt bottles to 2 lt bottles or vice versa.

The second step is the packaging and it is completely manual. Current workforce level for packaging is 60 employees in Ankara and 100 employees in Istanbul. Each employee can package up to 100,000 liters of soft drink per month. Monthly wages are 1,200 TL per month. Hiring cost and cost of lay-off are 1,500 TL and 2,000 TL per employee, respectively.

The company also has the option to produce in Ankara and ship to Western Turkey, or produce in Istanbul and ship to Central and Eastern Turkey. Moving soft drinks from Istanbul to Central and Eastern Turkey or from Ankara to Western Turkey costs an additional 0.1 TL per liter. Inventory is carried only in the packaged form. However inventory cannot be carried for more than 1 month due to perishability of the product. Inventory holding costs are 0.05 TL per liter per month for both plants. Initial inventories are 0 at both plants. Backlogging is not allowed. CCI aims to minimize its inventory holding, transportation, workforce, hiring and laying-off costs subject to the constraints discussed above. Formulate the problem as a mathematical program. Define the variables, constraints, and the objective function explicitly and show your work clearly.

8) Problem 33, p. 164, 7th Edition (Problem 32 and Problem 35 pp. 163-164), 6th Edition)

32. The Paris Paint Company is in the process of planning labor force requirements and production levels for the next four quarters. The marketing department has provided production with the following forecasts of demand for Paris Paint over the next year:

Quarter	Demand Forecast (in thousands of gallons)
1	380
2	630

Assume that Paris currently has 80,000 gallons of paint in inventory and would like to end the year with an inventory of at least 20,000 gallons.

a. Determine the minimum constant workforce plan for Paris Paint and the cost of the plan. Assume that stock-outs are not allowed.

b. Determine the zero inventory plan that hires and fires workers each quarter to match demand as closely as possible and the cost of that plan.

c. If Paris were able to back-order excess demand at a cost of $2 per gallon per quarter, determine a minimum constant workforce plan that holds less inventory than the plan you found in part (*a*), but incurs stock-outs in quarter 2. Determine the cost of the new plan.

33. Consider the problem of Paris Paint presented in Problem 32. Suppose that the plant has the capacity to employ a maximum of 370 workers. Suppose that regular-time employee costs are $12.50 per hour. Assume seven-hour days, five-day weeks, and four-week months. Overtime is paid on a time-and-a-half basis. Subcontracting is available at a cost of $7 per gallon of paint produced. Overtime is limited to three hours per employee per day, and no more than 100,000 gallons can be subcontracted in any quarter. Determine a policy that meets the demand, and the cost of that policy. (Assume stock-outs are not allowed.)

35. *a.* Formulate Problem 33 as a linear program.

b. Solve the linear program. Round the variables and determine the cost of the resulting plan.