

IE 222 - Tutorial

Last Tutorial before Midterm Exam 2

A parts supplier has a contract with an OEM to supply 1550 units of some component C for the next 6 months. Table 2.10 gives the OEM's monthly requirements during the contract period.

The supplier has 20 workers and 50 units of C on hand now. Each worker can produce 10 units of C per month. The company can recruit from the local labor market, but the recruits have to be trained for 1 month by a worker before they can be used in production. Each worker can train at most five recruits during a month. A worker is paid \$3000 per month, when used in production or training. A worker can be laid off at a cost of \$2000 per month. Firing a worker costs \$5000. Each recruit is paid \$1500 during training.

Production ahead of schedule incurs an inventory holding cost of \$50 per unit per month. Each unit of C not delivered on schedule involves a penalty cost of \$75 per month until delivery is completed. However, all deliveries must be completed in 6 months. The supplier requires a final labor force of 30 workers and 50 units of C at the end of the 6th month.

The aggregate planning problem is to decide what hiring, firing, producing, storing, and shortage policy the supplier should follow in order to minimize the total costs during the contract period. Formulate this problem as an LP model and solve. Discuss the production plan.

Demand Table

Month (t)	Demand (D_t)
1	100
2	200
3	300
4	400
5	300
6	250

Decision variables: The decision variables of the LP model for month t ($t = 1, 2, \dots, 6$) are defined as follows:

W_t	Total workers at the beginning of month t , <i>before firing</i>
P_t	Workers assigned to production in month t
T_t	Workers assigned to training in month t
L_t	Laid off workers in month t
F_t	Workers fired at the <i>beginning</i> of month t
R_t	Total recruits hired at the <i>beginning</i> of month t
I_t	Cumulative inventory at the <i>end</i> of month t
S_t	Cumulative shortages (backlogs) at the <i>end</i> of month t
X_t	Number of units of C produced during month t

1- Worker balance

a- Total Workforce

b- Assignment of workforce

c- Training Needs

2- Demand/Inventory Constraints

3- Production Capacity

$$1- \quad a- \quad W_t = W_{t-1} + R_{t-1} - F_{t-1} \quad \forall \quad t=2, \dots, 6$$

$$W_1 = 20$$

$$W_6 + R_6 - F_6 = 30$$

$$b- \quad W_t = P_t + T_t + L_t + F_t \quad \forall \quad t=1, \dots, 6$$

$$c- \quad R_t \leq 5T_t \quad \forall t=1, \dots, 6$$

2-

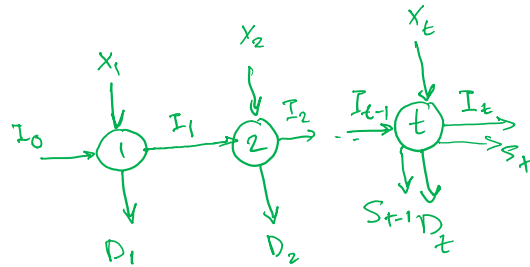
$$X_t + I_{t-1} = P_t + I_t + S_{t-1} - S_t$$

$$I_0 = 50$$

$$I_6 = 50$$

$$S_6 = 0$$

$$\forall t=1, \dots, 6$$



$$3- \quad X_t \leq 10P_t$$

$$\forall t=1, \dots, 6$$

non-negativity:

$$P_t, T_t, L_t, F_t, R_t, I_t, S_t, X_t \geq 0 \quad \forall t=1, \dots, 6$$

obj function:
$$\min z = 3000 \sum_{t=1}^6 P_t + 3000 \sum_{t=1}^6 T_t + 2000 \sum_{t=1}^6 L_t$$

$$+ 5000 \sum_{t=1}^6 F_t + 1500 \sum_{t=1}^6 R_t$$

$$+ 50 \sum_{t=1}^6 I_t + 75 \sum_{t=1}^6 S_t$$