Pricing Analytics
Jindal School of Banking and Finance
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Problem set 3

The assignment comprises of three questions. You are required to submit your answers for every question. Please find guidelines as follow,

- *Clearly specify decision variables, objective function and constraints.*
- *Provide explanation of any assumptions taken for a model.*
- *Stay consistent with the notation*
- *Excel solutions must be submitted as well wherever needed. Please combine all solutions in one excel file.*

1. You have been hired as the lead analyst at the inventory and pricing control department of a leading manufacturing firm. The firm believes the pricing techniques can only be applied once the operations related to inventory are enhanced. You have been tasked with the role of improving efficiency of inventory management at the firm. At a recent team meeting, you suggest the use of optimisation methods (like linear programming and dynamic programming) to model the decision-making process of inventory management. As a test run, your manager suggests you to develop optimisation models for the upcoming 3 months. The model must be built to schedule the monthly production levels of a certain product for the planning horizon of three months. Your manager provides the following information,

   - For a month j, the total demand of the product is denoted as d_j, where $j = 1,2,3$. The demand is evaluated by applying forecasting on historical data.
   - Each unit of the product is produced and sold at ₹c_j and ₹p_j in month j. Production capacity for month j is denoted as m_j.
   - A certain cost, referred as the "holding cost", is incurred at the end of each month for holding the left-over and unsold inventory. The inventory holding cost per unit for month j is ₹h_j.
   - The value of the parameters is provided in the following table,

p_1	7	d_1	2	c_1	2	h_1	1
p_2	8	d_2	4	c_2	3	h_2	1
p_3	8	d_3	1	c_3	4	h_3	1

   Specifically, your task is to construct optimisation models to generate a production schedule which maximizes the overall profit.

   a. Formulate the decision-making problem as a linear programming (LP) model. Consider the following assumptions while developing the LP model,

- There is no initial inventory at the beginning of the first month
- Production happens instantaneously. In other words, units schedules for production are available immediately to satisfy the demand at a given month.
- Shortages of the product is not allowed and all demand must be satisfied.
- There are no setup or fixed cost for production.

b. From the assumptions mentioned above, the manager believes the last assumption is over simplifying the problem. The last assumption is restricting the model from capturing an important aspect of dynamic decision-making problem. Thus, you decide to relax the assumption by consider a fixed set-up cost of ₹5 in every month. The value of set-up cost is independent of the number of units produced. Given the additional cost, re-formulate the model using dynamic programming (DP).

c. Compare and analyse the solutions from both LP and DP models. Report the solution from DP approach when the set-up cost is set to zero. Is it the same as LP? If yes, explain why.

2. PurpleDart, a well-known shipping service, has decided to incorporate techniques of advanced analytics to minimize delivery costs and efforts. The analytics team has built a prototype tool to find shorter routes for regional deliveries. The tool uses the shortest path algorithm and dynamically finds the best route. The general manager decides to apply the tool to route a package from city A to city F. The travel time, in hours, between possible routing stations between A and F are provided in the table below. Visualize the potential routes provided in the Table and find the shortest path between A and F.

Distance (in hours)	A	B	C	D	E	F
A	*	_	_	15	14	_
B	_	*		18	24	19
C	_	_	*	18	15	25
D	15	18	18	*	14	_
E	14	24	15	14	*	_
F	_	19	25	_	_	*

Note: A blank space, denoted by "_" means the route is not possible. For example, there is no possible route between A and B.

3. Orange Inc, an electronic giant, is planning to launch, oPad 3.0, a new generation of its electronic tablet series. At present, Orange Inc, sells two old generations of tablets, oPad 1.0 and oPad 2.0. The launch of oPad 3.0 will expand the tablet series. Although the expansion is likely to enhance the market share of Orange Inc, the firm is also worried about demand cannibalization between its different table generations. Thus, the firm wishes to carefully price the new and old versions to ensure sufficient demand for all its products. However, the firm wishes to have higher demand for the newer versions. The pricing and marketing team suggests the following options,

Multiple Options (in ₹s)	oPad 1.0	oPad 2.0	oPad 3.0
Option 1	1.5	1.9	2.5
Option 2	2	2.5	3
Option 3	1	1.5	2
Option 4	2.4	2.9	3.7

Assume the quality levels of the three generations as 5, 6 and 7 (the lowest refereeing to the quality of the oldest generation and vice versa). The maximum number of customers in the market are assumed to be 10,00,000. The firm experiences customer arrivals in a bulk value of 1,00,000. Since the customer arrivals are random, they follow a probability distribution as,

Demand (in 1,00,000s)	0	1	2	3	4	5	6	7	8	9	10
Probabilities	0.05	0.05	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

Find which pricing strategy is most suitable for Orange Inc. To support your answer, please provide the customers' choice probabilities for every generation. Also, find the probability distribution of demand for every version.