

15XW43 Optimization Techniques – HW – 2 Submission date : 27/12/17

LPP Model(only Formulation)

1. SilComputers makes quarterly decisions about their product mix of two products: notebook computers and desktop computers. SilComputers would like to know how many of each product to produce in order to maximize profit for the quarter. There are a number of limits on what SilComputers can produce. The major constraints are as follows:
 - Each computer (either notebook or desktop) requires a Processing Chip. Due to tightness in the market, our supplier has allocated 10,000 such chips.
 - Each computer requires memory. Memory comes in 16MB chip sets. A notebook computer has 16MB memory installed (so needs 1 chip set) while a desktop computer has 32MB (so requires 2 chip sets). It received a great deal on chip sets, so have a stock of 15,000 chip sets to use over the next quarter.
 - Each computer requires assembly time. Due to tight tolerances, a notebook computer takes more time to assemble: 4 minutes versus 3 minutes for a desktop. There are 25,000 minutes of assembly time available in the next quarter.

Given current market conditions, material cost, and production system, each notebook computer produced generates \$750 profit, and each desktop produces \$1000 profit.

2. MegaMarketing is planning a concentrated one week advertising campaign for their new product SuperKnife. The ads have been designed and produced and now they wish to determine how much money to spend in each advertising outlet. There are two outlets: Prime-time TV, and newsmagazines. Each minute of primetime TV and page of newsmagazine advertisement reaches the following number of people (in millions):

Outlet	Boys	Women	Men	Cost
TV	5	1	3	600
Mag	2	6	3	500
Target	24	18	24	

Design the model such that the cost of purchasing the outlets is optimum.

3. The ABC Furniture Company produces tables and chairs. The production process for each is similar in that both require a certain number of hours of carpentry work and a certain number of labor hours in the painting and varnishing department. Each table takes 4 hours of carpentry and 2 hours in the painting and varnishing shop. Each chair requires 3 hours in carpentry and 1 hour in painting and varnishing. During the current production period, 240 hours of carpentry time are available and 100 hours in painting and varnishing time are available. Each table sold yields a profit of Rs.7; each chair produced is sold for a Rs.5 profit.

ABC Furniture's problem is to determine the best possible combination of tables and chairs to manufacture in order to reach the maximum profit. The firm would like this production mix situation formulated as a linear programming problem.

4. A manufacturer produces two types of models M and N. Each M model requires 4 hours of grinding and 2 hours of polishing; whereas each N model requires 2 hours of grinding and 5 hours of polishing. The manufacturer has 2 grinders and 3 polishers. Each grinder works for 40 hours a week and each polisher works for 60 hours a week.

Profit on model M is Rs.3 and model N is Rs.4. All the models produced in a week is sold in the market. How should the manufacturer allocate his production capacity to the two types of models so that he may make the maximum profit in a week?

5. A company has two grades of inspector 1 and 2, who are to be assigned for a quality control inspection. It is required that at least 2,000 pieces be inspected per 8 – hour day. Grade 1 inspector can check pieces at the rate of 40 with an accuracy of 97 %. Grade 2 inspector checks at the rate of 30 pieces per hour with an accuracy of 95 %. The wage rate of a Grade 1 inspector is Rs.5 per hour while that of a Grade 2 inspector is Rs.4 per hour. An error made by an inspector costs Rs.3 to the company. There are only nine Grade 1 inspectors and eleven Grade 2 inspectors available in the company. The company wishes to assign work to the available inspectors so as to minimize the daily inspection cost.
6. The Sky shop promotes its products from a large city to different parts in the state. The Sky shop has budgeted up to Rs.8,000 per week for local advertising. The money is to be allocated among four promotional media: TV spots, newspaper ads, and two types of radio advertisements. Sky shop's goal is to reach the largest possible high-potential audience through the various media. The following table presents the number of potential customers reached by making use of an advertisement in each of the four media. It also provides the cost per advertisement placed and the maximum number of ads that can be purchased per week.

medium	audience reached per ad	cost per ad(rs.)	maximum ads per week
TV spot (1 minute)	5,000	800	12
Daily newspaper (full-page ad)	8,500	925	5
Radio spot (30 seconds, prime time)	2,400	290	25
Radio spot (1 minute, afternoon)	2,800	380	20

Sky shop's contractual arrangements require that at least five radio spots be placed each week. To ensure a broad-scoped promotional campaign, management also insists that no more than Rs.1,800 be spent on radio advertising every week. Formulate this problem as a LPP.

7. A pharmaceutical company produces two products : A and B. Production of both products requires the same process, I and II. The production of B results also in a by-product C at no extra cost. The product A can be sold at a profit of Rs.3 per unit and B at a profit of Rs.8 per unit. Some of this by-product can be sold at a unit profit of Rs.2, the remainder has to be destroyed and the destruction cost is Rs.1 per unit. Forecasts show that only up to 5 units of C can be sold. The company gets 3 units of C for each unit of B produced. The manufacturing times are 3 hours per unit for A on process I and II, respectively, and 4 hours and 5 hours per unit for B on process I and II, respectively. Because the product C results from producing B, no time is used in producing C. The available times are 18 and 21 hours of process I and II, respectively. Formulate this problem as an LP model to determine the quantity of A and B which should be produced, keeping C in mind, to make the highest total profit to the company.

8. A company, engaged in producing tinned food, has 300 trained employees on the rolls, each of whom can produce one can of food in a week. Due to the developing taste of the public for this kind of food, the company plans to add to the existing labor force by employing 150 people, in a phased manner, over the next five weeks. The newcomers would have to undergo a two-week training programme before being put to the work. The training is to be given by employees from among the existing ones and it is known that one employee can train three trainees. Assume that there would be no production from the trainers and the trainees during training period as the training is off-the-job. However, the trainees would be remunerated at the rate of Rs.300 per week, same rate as for the trainers. The company has booked the following orders to supply during the next five weeks :

Week	:	1	2	3	4	5
No. of Cans	:	280	298	305	360	400

Assume that the production in any week would not be more than the number of cans ordered for so that every delivery of the food would be 'fresh'.

Formulate this problem as an LP model to develop a training schedule that minimizes the labour cost over the five-week period.

9. Pantaloon Industries, a nationally known manufacturer of menswear, produces four varieties of ties. One is an expensive, all-silk tie, one is an all-polyester tie, and two are blends of polyester and cotton. The following table illustrates the cost and availability (per monthly production planning period) of the three materials used in the production process:

MATERIAL	COST PER	MATERIAL AVAILABLE PER
Silk	21	800
Polyester	6	3,000
Cotton	9	1,600

The firm has fixed contracts with several major department store chains to supply ties. The contracts require that Pantaloon supply a minimum quantity of each tie but allow for a larger demand if Pantaloon chooses to meet that demand. (Most of the ties are not shipped with the name Pantaloon on their label, incidentally, but with "private stock" labels supplied by the stores.) Table 1.2 summarizes the contract demand for each of the four styles of ties, the selling price per tie, and the fabric requirements of each variety.

TABLE 1.2 Data for Pantaloon

variety of tie	selling price per tie (Rs.)	monthly contract minimum	monthly demand	material required per tie (yards)	material requirements
All silk	6.70	6,000	7,000	0.125	100% silk
All polyester	3.55	10,000	14,000	0.08	100% polyester
Poly-cotton	4.31	13,000	16,000	0.10	50% polyester-50%
Poly-cotton	4.81	6,000	8,500	0.10	30% polyester-70%

Pantaloon's goal is to maximize its monthly profit. Formulate the policy for product mix by a LP.

10. The International City Trust (ICT) invests in short-term trade credits, corporate bonds, gold stocks, and construction loans. To encourage a diversified portfolio, the board of directors has placed limits on the amount that can be committed to any one type of investment. ICT has Rs.5 million available for immediate investment and wishes to do two things: (1) maximize the interest earned on the investments made over the next six months, and (2) satisfy the diversification requirements as set by the board of directors. The specifics of the investment possibilities are as follows:

investment	interest earned (%)	maximum investment (rs. millions)
Trade credit	7	1.0
Corporate bonds	11	2.5
Gold stocks	19	1.5
Construction loans	15	1.8

In addition, the board specifies that at least 55% of the funds invested must be in gold stocks and construction loans, and that no less than 15% be invested in trade credit. Formulate as LPP.

11. A candy manufacturer has 130 pounds of chocolate-covered cherries and 170 pounds of chocolate-covered mints in stock. He decides to sell them in the form of two different mixtures. One mixture will contain half cherries and half mints by weight and will sell for \$2.00 per pound. The other mixture will contain one-third cherries and two-thirds mints by weight and will sell for \$1.25 per pound. How many pounds of each mixture should the candy manufacturer prepare in order to maximize his sales revenue?

12. The Osgood County refuse department runs two recycling centers. Center 1 costs \$40 to run for an eight hour day. In a typical day 140 pounds of glass and 60 pounds of aluminum are deposited at Center 1. Center 2 costs \$50 for an eight-hour day, with 100 pounds of glass and 180 pounds of aluminum deposited per day. The county has a commitment to deliver at least 1540 pounds of glass and 1440 pounds of aluminum per week to encourage a recycler to open up a plant in town. How many days per week should the county open each center to minimize its cost and still meet the recycler's needs?

13. A cargo plane has three compartments for storing cargo: front, centre and rear. These compartments have the following limits on both weight and space:

Compartment	Weight capacity (tonnes)	Space capacity (cubic metres)
Front	10	6800
Centre	16	8700
Rear	8	5300

Furthermore, the weight of the cargo in the respective compartments must be the same proportion of that compartment's weight capacity to maintain the balance of the plane.

The following four cargoes are available for shipment on the next flight:

Cargo	Weight (tonnes)	Volume (cubic metres/tonne)	Profit (£/tonne)
C1	18	480	310
C2	15	650	380
C3	23	580	350
C4	12	390	285

Any proportion of these cargoes can be accepted. The objective is to determine *how much* (if any) of each cargo C1, C2, C3 and C4 should be accepted and *how to distribute* each among the compartments so that the total profit for the flight is maximised. Formulate the above problem as a linear program.

14. A canning company operates two canning plants. The growers are willing to supply fresh fruits in the following amounts:

S1: 200 tonnes at £11/tonne

S2: 310 tonnes at £10/tonne

S3: 420 tonnes at £9/tonne

Shipping costs in £ per tonne are:

	To: Plant A	Plant B
From: S1	3	3.5
S2	2	2.5
S3	6	4

Plant capacities and labour costs are:

	Plant A	Plant B
Capacity	460 tonnes	560 tonnes
Labour cost	£26/tonne	£21/tonne

The canned fruits are sold at £50/tonne to the distributors. The company can sell at this price all they can produce. The objective is to find the best mixture of the quantities supplied by the three growers to the two plants so that the company maximises its profits. Formulate the problem as a linear program.

15. A garment manufacturer has a production line making two styles of shirts. Style I requires 200 grams of cotton thread, 300 grams of dacron thread, and 300 grams of linen thread. Style II requires 200 grams of cotton thread, 200 grams of dacron thread and 100 grams of linen thread. The manufacturer makes a net profit of Rs. 19.50 on Style 1, Rs. 15.90 on Style II. He has in hand an inventory of 24 kg of cotton thread, 26 kg of dacron thread and 22 kg of linen thread. His immediate problem is to determine a production schedule, given the current inventory to make a maximum profit. Formulate the LPP model.

16. The ABC manufacturing company can make two products P_1 and P_2 . Each of the products requires time on a cutting machine and a finishing machine. Relevant data are:

	Product	
	P_1	P_2
Cutting Hours (per unit)	2	1
Finishing Hours (per unit)	3	3
Profit (Rs. per unit)	6	4
Maximum sales (unit per week)		200

The number of cutting hours available per week is 390 and the number of finishing hours available per week is 810. How much should be produced of each product in order to achieve maximum profit for the company?

17. A company makes two kinds of leather belts. Belt A is a high quality belt, and belt B is of lower quality. The respective profits are Re. 0.40 and Re. 0.30 per belt. Each belt of type A requires twice as much time as a belt of type B, and if all belts were of type B, the company could make 1,000 per day. The supply of leather is sufficient for only 800 belts per day (both A and B combined). Belt A requires a fancy buckle, and only 400 per day are available. There are only 700 buckles a day available for belt B. What should be the daily production of each type of belt? Formulate the linear programming problem.
18. Mr. Christ, the marketing manager of ABC Typewriter Company is trying to decide on how to allocate his salesmen to the Company's three primary markets. Market-1 is an urban area and the salesmen can sell, on an average 40 typewriters a week. Salesmen in the other two markets can sell, on an average, 36 and 25 typewriters per week, respectively. For the coming week, 3 of the salesmen will be on vacation, leaving only 12 men available for duty. Also because of the lack of company cars, maximum of 5 salesmen can be allocated to market area 1. The selling expenses per week per salesman in each area are Rs. 800 per week for area 1, Rs. 700 per week for area 2, and Rs. 500 per week for area 3. The budget for the next week is Rs. 7500. The profit margin per typewriter is Rs. 150.
Formulate a linear programming model to determine how many salesmen should be assigned to each area in order to maximise profits.
19. An animal feed company must produce 200 kg of a mixture consisting of ingredients X_1 , and X_2 daily. X_1 cost Rs. 3 per kg and X_2 Rs. 8 per kg. Not more than 80 kg of X_1 can be used, and at least 60 kg of X_2 must be used. Find how much of each ingredient should be used if the company wants to minimise cost.
20. The ABC Printing Company is facing a tight financial squeeze and is attempting to cut costs wherever possible. At present it has only one printing contract and, luckily, the book is selling well in both the hardcover and paperback editions. It has just received a request to print more copies of this book in either the hardcover or paperback form. Printing cost for hardcover books is Rs. 600 per 100 while printing cost for paperback is only Rs. 500 per 100. Although the company is attempting to economise, it does not wish to lay off any employees. Therefore, it feels obliged to run its two printing presses at least 80 and 60 hours per week, respectively. Press 1 can produce 100 hardcover books in 2 hours or 100 paperback books in 1 hours. Press II can produce 100 hardcover books in 1 hours or 100 paperback books in 2 hours. Determine how many books of each type should be printed in order to minimise cost.
21. A medical scientist claims to have found a cure for the common cold that consists of three drugs called K, S and H. His results indicate that the minimum daily adult dosage for effective treatment is 10 mg. of drug K, 6 mg. of drug S, and 8 mg. of drug H. Two substances are readily available for preparing pills or drugs. Each unit of substance A contains 6 mg., 1 mg. and 2 mg. of drugs K, S and H respectively, and each unit of substance B contains 2 mg, 3 mg, and 2 mg., of the same drugs. Substance A costs Rs. 3 per unit and substance B costs Rs. 5 per unit.

Find the least-cost combination of the two substances that will yield a pill designed to contain the minimum daily recommended adult dosage.

22. A publisher of textbooks is in the process of presenting a new book to the market. The book may be bound by either cloth or hard paper. Each cloth bound book sold contributes Rs. 24, and each paper-bound book contributes Rs. 23. It takes 10 minutes to bind a cloth cover, and 9 minutes to bind a paperback. The total available time for binding is 800 hours. After considerable market survey, it is predicted that the cloth-cover sales will exceed at least 10,000 copies, but the paperback sales will be not more than 6,000 copies. Formulate the problem as a LP problem
23. A timber company cuts raw timber-oak and pine logs into wooden boards. Two steps are required to produce boards from logs. The first step involves removing the bark from the logs. Two hours are required to remove bark from 1,000 feet of oak logs and three hours per 1,000 feet of pine logs. After the logs have been debarked, they must be cut into boards. It takes 2.4 hours for cutting 1,000 feet of oak logs into boards and 1.2 hours for 1,000 feet of pine logs. The bark removing machines can operate up to 60 hours per week, while the cutting machine are limited to 48 hours per week. The company can buy a maximum of 18,000 feet of raw oak logs and 12,000 feet of raw pine logs each week. The profit per 1,000 feet of processed logs is Rs. 1,800 and Rs. 1,200 for oak and pine logs, respectively. Solve the problem to determine how many feet of each type of log should be processed each week in order to maximise profit.
24. Upon completing the construction of his house, Mr. John discovers that 100 square feet of plywood scrap and 80 square feet of white pine scrap are in usable form for the construction of tables and book cases. It takes 16 square feet of plywood and 16 square feet of white pine to construct a book case. It takes 20 square feet of plywood and 20 square feet of white pine to construct a table. By selling the finished products to a local furniture store, Mr. John can realise a profit of Rs. 25 on each table and Rs. 20 on each book-case. How can he most profitably use the left-over wood?
25. A rubber company is engaged in producing three different kinds of tyres A, B and C. These three different tyres are produced at the company's two different plants with different production capacities. In a normal 8 hours working day, Plant 1 produces 50, 100 and 100 tyres of type A, B and C, respectively. Plant 2, produces 60, 60 and 200 tyres of type A, B and C, respectively. The monthly demand for type A, B and C is 2,500, 3,000 and 7,000 units, respectively. The daily cost of operation of Plant 1 and Plant 2 is Rs. 2,500 and Rs. 3,500, respectively. Form LP Model to determine the minimum number of days of operation per month at two different plants to minimise the total cost while meeting the demand.