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Assorted Perspectives and Application Domains of Linear Programming

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Abstract

Optimization is the way of life. We all have finite resources and time and we want to make the most of them. From using your time productively to solving supply chain problems for your company – everything uses optimization. It's a especially interesting and relevant topic in data science. It is also a very interesting topic – it starts with simple problems, but can get very complex. For example, sharing a chocolate between siblings is a simple optimization problem. On the other hand devising inventory and warehousing strategy for an e-tailer can be very complex. For some reason, LP doesn't get as much attention as it deserves while learning data science.

Keywords: Linear Programming, Applications of Linear Programming

Linear Programming

Linear programming (LP) is one of the simplest ways to perform optimization. It helps you solve some very complex optimization problems by making a few simplifying assumptions. As an analyst you are bound to come across applications and problems to be solved by Linear Programming.

Process to formulate a Linear Programming problem

1. Identify the decision variables
2. Write the objective function
3. Mention the constraints
4. Explicitly state the non-negativity restriction

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For a problem to be a linear programming problem, the decision variables, objective function and constraints all have to be linear functions. If the all the three conditions are satisfied, it is called a Linear Programming Problem.

Using linear programming requires defining variables, finding constraints and finding the objective function, or what needs to be maximized. In some cases, linear programming is instead used for minimization, or the smallest possible objective function value. Linear programming requires the creation of inequalities and then graphing those to solve problems. While some linear programming can be done manually, quite often the variables and calculations become too complex and require the use of computational software.

Applications of Linear Programming

Farmers apply linear programming techniques to their work. By determining what crops they should grow, the quantity of it and how to use it efficiently, farmers can increase their revenue

In nutrition, linear programming provides a powerful tool to aid in planning for dietary needs. In order to provide healthy, low-cost food baskets for needy families, nutritionists can use linear programming. Constraints may include dietary guidelines, nutrient guidance, cultural acceptability or some combination thereof. Mathematical modeling provides assistance to calculate the foods needed to provide nutrition at low cost, in order to prevent noncommunicable disease. Unprocessed food data and prices are needed for such calculations, all while respecting the cultural aspects of the food types. The objective function is the total cost of the food basket. Linear programming also allows time variations for the frequency of making such food baskets.

Engineers also use linear programming to help solve design and manufacturing problems. For example, in airfoil meshes, engineers seek aerodynamic shape optimization. This allows for the reduction of the drag coefficient of the airfoil. Constraints may include lift coefficient, relative maximum thickness, nose radius and trailing edge angle. Shape optimization seeks to make a shock-free airfoil with a feasible shape. Linear programming therefore provides engineers with an essential tool in shape optimization.

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Transportation systems rely upon linear programming for cost and time efficiency. Bus and train routes must factor in scheduling, travel time and passengers. Airlines use linear programming to optimize their profits according to different seat prices and customer demand. Airlines also use linear programming for pilot scheduling and routes. Optimization via linear programming increases airlines' efficiency and decreases expenses.

Manufacturing requires transforming raw materials into products that maximize company revenue. Each step of the manufacturing process must work efficiently to reach that goal. For example, raw materials must past through various machines for set amounts of time in an assembly line. To maximize profit, a company can use a linear expression of how much raw material to use. Constraints include the time spent on each machine. Any machines creating bottlenecks must be addressed. The amount of products made may be affected, in order to maximize profit based on the raw materials and the time needed.

Modern energy grid systems incorporate not only traditional electrical systems, but also renewables such as wind and solar photovoltaics. In order to optimize the electric load requirements, generators, transmission and distribution lines, and storage must be taken into account. At the same time, costs must remain sustainable for profits. Linear programming provides a method to optimize the electric power system design. It allows for matching the electric load in the shortest total distance between generation of the electricity and its demand over time. Linear programming can be used to optimize load-matching or to optimize cost, providing a valuable tool to the energy industry.

LP is applied for determining the optimal allocation of such resources as materials, machines, manpower, etc. by a firm. It is used to determine the optimal product- mix of the firm to maximize its revenue. It is also used for product smoothing and assembly line balancing.

LP technique enables the personnel manager to solve problems relating to recruitment, selection, training, and deployment of manpower to different departments of the firm. It is also

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used to determine the minimum number of employees required in various shifts to meet production schedule within a time schedule.

A firm is faced with the problem of inventory management of raw materials and finished products. The objective function in inventory management is to minimise inventory cost and the constraints are space and demand for the product. LP technique is used to solve this problem.

LP technique enables the marketing manager in analysing the audience coverage of advertising based on the available media, given the advertising budget as the constraint. It also helps the sales executive of a firm in finding the shortest route for his tour. With its use, the marketing manager determines the optimal distribution schedule for transporting the product from different warehouses to various market locations in such a manner that the total transport cost is the minimum.

The financial manager of a firm, mutual fund, insurance company, bank, etc. uses the LP technique for the selection of investment portfolio of shares, bonds, etc. so as to maximise return on investment.

LP technique is also applicable to blending problem when a final product is produced by mixing a variety of raw materials. The blending problems arise in animal feed, diet problems, petroleum products, chemical products, etc. In all such cases, with raw materials and other inputs as constraints, the objective function is to minimise the cost of final product.

Linear programming (LP) can be defined as a statistical model that is employed in various practical fields to maximize output of a given process using given inputs. It was invented during World War II for the purposes of determining how to maximize the efficiency of available resources by optimizing the value of certain objectives which are subjected to particular constraints. It was of paramount importance to manage costs during the war to ensure that the right decisions were made for the purposes of winning (Christos, and Neal 649). Besides, linear programming has many real life applications that have the objective of maximizing profit or

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minimizing costs that includes but not limited to freight carriages to determine distribution, in agriculture to determine production, in telecommunications in building capacity, and in microchips optimum layout development (Taha 12).

Hence, linear programming models enable production of optima solution within the context of limited resources by formulating the problem variables and solving the problem using standard techniques to find non-negative outcomes which satisfies the constraints (Taylor 17). This paper seeks to apply the linear programming tools and techniques learnt as well as incorporating some experience, interests, and career business/management goals and ambitions in solving real life situations.

Conclusion

It can be concluded that linear programming is useful in many areas and can be applied to increase the certainty of decisions made. Understanding how the models are employed around the existing constraints plays a critical role in ensuring that resources are effectively allocated without bias or through guess work. Although linear programming approaches seems complicated, understanding them and their application in real life scenarios saves time, costs and resources since the decisions made are informed and guided by the analysis of the available information. In the power supply challenges facing Light-Connect Company, it is erroneous to think that distributing the electricity in any possible way is feasible but it could lead to losses and increased cost of distribution. However, by employing the LP model it was possible to determine an optimal approach to the issue in a way that saves the available resources and maximizes outcomes.

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