Linear Programming:

Linear programming is a way of solving problems involving two variables with certain constraints. Usually, linear programming problems will ask us to find the minimum or maximum of a certain output dependent on the two variables.

Linear programming uses Prescriptive Analytics where the end solution/answer will be able to guide the user regarding which actions need to be taken and which not to. (Prescriptive Analytics – It's a mix of descriptive and predictive analytics which ultimately helps the users to make more informed decisions regarding the future).

Linear Programming problems are word problems, so one needs to be very good at reading and understanding the situation based on real-life parameters. Mostly the objective would be to maximize or minimize a variable subject to various constraints.

Linear Programming helps a firm to take the right course of action based on the end solution. For example: If the objective is to maximize profits by manufacturing 2 different products with some constraints subject to the cost ($), time(hrs./mins) and labour. We will be able to identify at the end which approach would be best suitable to maximize the profits.

How do we benefit from learning LP?

- It provides a methodology to optimize operations with certain constraints.
- It helps in making processes more efficient and less cost-effective.

Many existing mathematical models do indeed provide us with the right course of action to solve a business problem, few of them which are widely used by most statisticians/economists/analysts/scientists are as follows:

Variance – Variance is a measure of variability which helps a firm understand to what extent an investor can take the risk and whether will that be profitable or not.

Covariance helps determine the relationship between two random variables and how they change together.

For ex: X and Y are two unique variables, if X tends to increase when Y increases or X tends to decrease when Y decreases then we can state that the covariance is Positive, On the other hand, if X tends to decrease upon Y's increase or displays an opposite behaviour then we state that the covariance is Negative.

Correlation – It is a statistical measure that helps us understand to what extent two or more variables fluctuate together. It is usually measured between -1 and +1. -1 -> Perfect Negative Correlation, 0 -> No Correlation, +1 -> Perfect Positive Correlation.

Regression – This is another statistical measure which helps in determining the strength of the relationship between one dependent variable (usually denoted by Y) and the independent variable (usually denoted by X).

Normal Distribution – This helps us define the probability distribution of various factors such as rainfall, height, weight, manufacturing error etc... All normal distribution curves should satisfy the Law of Empirical Rule -> 68-95-99.7%.

Although each of these measures has its implications in the real world, they come with their **disadvantages**, following are the disadvantages:

Variance – The process is quite lengthy and any problems within the process can cause significant deficiencies during variance analysis. Squaring the numbers can often skew the data and it is not easily interpreted.

Covariance – It helps us in understanding the relationship between 2 assets but it fails in depicting the strength between these variables, so it isn't that workable when compared to other mathematical measures.

Correlation – It assumes or follows a linear association with variables which indicates that any linear transformation or scale transformation among any variable X, Y or both will not affect the correlation coefficient.

Regression – We only consider the linear relationships, in regression analysis, there are other variables other than X which may influence the resultant value but we don't consider it, thereby causing a blotch in the value obtained.

Every mathematical model has its own merits and demerits, it depends on the problems and situations, which ultimately leaves us an option to choose from one of these mathematical operators because every situation/problem has its objective, variables and constraints.

Although there are many mathematical operators in use, other than the mentioned operators above. Linear Programming is one such model which has taken the fleet off the air, it is most widely used in every field these days. Especially, the field of business is most widely reliant on the LP.

Most companies do want to maximize their profits or minimize their cost, Linear Programming helps in providing the best solution for tackling these situations and arriving at a better solution.

So, why do most companies use linear programming comparatively at a higher scale when compared to other models?

1. **Easily Computable** – Most linear programming problems have an objective, few constraints and variables, which can be easily calculated by focusing on the end objective.
2. **Multiple ways of approach** – A single linear programming can be solved in many ways, most importantly they all give us the same answers, a few of them are:
    a. Graphical Method
    b. Simplex Method
    c. Using R
3. **Numerous Alternatives** – There are numerous alternatives to apply the end solution that focuses on the objective, it's up to the business manager which one he would like to choose and opt for basis the availability of resources.
4. **Real-Life** Problem Solver- Most of the LPPs are based on real-life situations and counting the above merits to the linear programming problems, it is most widely used by all the sectors to come to an end conclusion basing the primary objective of the firm.

These can be counted as the primary factors/reasons for companies choosing linear programming as one of their major analysis to solve real-world business problems.

There are a lot of factors and things which should be considered while working with linear programming problems, so a question arises does LPP fit the **real-life world** aptly and clearly?

First and foremost, we need to understand one thing i.e., linear programming models are only effective if and only if it reflects the real world. There are many

assumptions that one makes while solving a problem, but if these assumptions don't reflect or tally with the real world then we can't use linear programming as a mathematical model for solving business problems.

So, shall we count that LPP fit the real-life world better when compared to other models?

No, when it comes to the application of the LP model to a problem, we encounter certain limitations i.e., Inflexible and Reality.

Reality – Most of the models rely on assumptions and in most cases, these models will not be considered in getting the right solution to the business problem. [1] An assumption i.e., tripling production will triple sales, but in reality, it saturates the market. Linear equations sometimes give results that don't correlate with the end objective, another situation wherein the end solution is indicating that we should contract to build 23.75 battleships for the Navy to maximize profits. But in reality, how will we deal with manufacturing the .75 in practical terms?

Inflexibility – [1] Some situations have too many possibilities to fit into a linear programming formula. A medical practice could use linear programming to determine the optimum radiation treatments for cancer patients, but medical conditions are so diverse, that doctors inevitably find some that don't fit any linear model.

Although there are a few limitations that lead to a benefit of the doubt while applying the linear programming model, but they eventually prove to be the best considerate model in real-world situations, why?

- LPPs are one of the most efficient models to convert verbal description and numeric data into a mathematical expression, further helping us to solve the expression and arrive at a conclusion.
- It's the best operator to capture the relevant relationship among the deciding factors.

There might be slight variations in the resultant values when compared to real-world situations but this might be due to the term real-world itself. In general, the real world refers to the life around us and in LPP when we try to solve a real-life situation using mathematical points and statements then there are chances of wrong assumptions and wrong framing of variables & constraints which eventually leads to miscalculations when compared to reality. So, this is why understanding the variables and later framing objectives and constraints is very much important in LPP.

"All in All, Linear programming has proven to be an extremely powerful tool to solve real-world problems and as a widely applicable mathematical theory. Linear programming theory is also considered an important part of business and economics, but may also be used to solve certain engineering problems" [4]. (A Real-Life Application of Linear Programming - Win Win Myo - Dagon University Research Journal 2012, Vol. 4).

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