



Applying Linear Program to Real World

Jingchao Wang¹(✉) and Jiaen Li²

¹ Saint James School, Hagerstown, MD 21740, USA

linda53e@163.com

² Victoria Eduhub of Singapore, Geylang 408600, Singapore

Abstract. Linear programming can apply to real-life problems. Simplex methods, one of the common methods can be used to calculate some math involved problems in daily life, providing an accurate solution that is restrained by the given information and data. In this paper, ideas of linear programming and simplex methods are presented and explained. Most importantly, the goal is to find the optimal solution using the simplex method. This paper shows the procedures of applying linear program in a real-life problem. By using simplex methods, plugging in the data into the computer, the optimal solution will appear eventually. The significance of this paper is giving out specific steps using a linear program to solve issues more accurately.

Keywords: Optimal Solution · Linear Algebra · Matrix

1 Introduction

1.1 The Background of the Research

Linear programming is a useful method to solve a lot of problems in daily life. We try to find the value of linear programming by exploring how it works. And therefore, make sure it is a valid and valuable methods [11].

1.2 Finding the Most Beneficial Function

People often need to find the best solution in order to gain the greatest profit. An optimal solution happens when a function reaches its extremity (maximum or minimum) [2]. Optimal solutions can be helpful when applies to real-life problems, for example, the least amount of costs or the best amount of gain. Linear program is one of the methods that can help people to find the most beneficial result [12].

1.3 Optimal Solutions Application

Optimal solutions are always an important factor that involves in daily life, in order to apply linear programs, people need to be familiar to linear algebra. Linear algebra is often presented in scientific studying and some engineering projects due to its ability to create models for different phenomena [4] (Fig. 1).

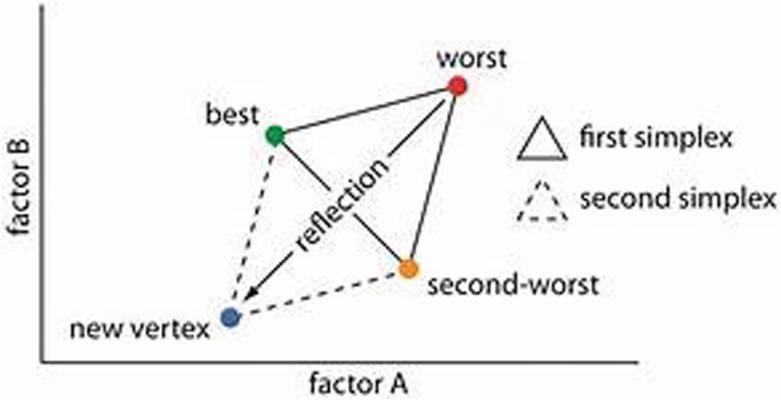


Fig. 1. Algorithm for two parameters

1.4 Matrix Functions

Matrix functions is an important part of linear algebra since it allows the operations of vectors. Matrix is a rectangular array of factors presented in rows and columns [2]. Matrix has the ability to solve systems of linear equations and show graphs in graph theory [2].

1.5 Functions of Linear Algebra in Statistics

Linear algebra is the mathematical calculation of data, it is the study of what Matrix provides [3]. Linear Algebra has a close connection with statistics, for example, data analysis strongly depending on the study of Linear Algebra [3]. While data might be large, and is necessary to find a precise result, people often input functions into computers, rather than calculating by themselves. People can apply the use of linear programs into real-world to solve many problems [5].

2 Functions of Linear Algebra

2.1 What is the Linear Algebra?

Linear algebra is a combination of linear equations. Linear equations are normally lines that are presented in a two-dimensional graph, through the x-axis and y-axis. A two-dimensional matrix is created by rows and columns, and its function is sometimes given by matrix [6].

$$A \in \mathbb{R}^{n \times n}. \tag{1}$$

This matrix means that (Fig. 2)

$$A = \text{rank } A^T = \text{dim of column } A. \tag{2}$$

$$\begin{matrix}
 & & & n \text{ columns} & & \\
 & & & & & \\
 A = & \left[\begin{array}{cccccc}
 a_{11} & a_{12} & a_{13} & \dots & a_{1n} \\
 \vdots & \vdots & \vdots & \ddots & \vdots \\
 a_{i1} & a_{i2} & a_{i3} & \dots & a_{in} \\
 \vdots & \vdots & \vdots & \ddots & \vdots \\
 a_{m1} & a_{m2} & a_{m3} & \dots & a_{mn}
 \end{array} \right] & & m \text{ rows}
 \end{matrix}$$

Fig. 2. Matrix

When matrix $A \in R^{n \times n}$ appears, the equation $Ax = b$ only has one result, which is the rank of $A = n$. When matrix

$$A \in R^{n \times m} \tag{3}$$

happens, the equation $Ax = b$ will have 3 possible outputs. The equation will have some possible solutions when $b \in \text{Column } A$ which means the rank of $A = \text{rank of } (A, b)$; it will have infinite solutions when $b \in \text{Column } A$; and it will have no solution when rank of $a = \text{rank of } (A, b)$. A three-dimensional matrix happens when a two-dimensional matrix combined, when created a stereoscopic function, which will create objects instead of shapes [1].

2.2 How Does the Linear Programming Working?

Linear programming is the way that people can use it when they are trying to find the optimized solution for mathematical problems [1]. Some common terms that are used in Linear programming are decision variable, objective function, constraints, non-negativity constraints, feasible solution, and optimal solution [7]. Decision variable refers to numbers that are controlled by the decision-maker and will affect the solution of the problem. Objective function refers to the desire of the solution, maximum or minimum [10]. Constraints are the basic limits to the problem while non-negativity constraints are limits that are required to be non-negative [7]. Feasible solution refers to all of the possible solution that meets the requirements while optimal solution (best solution) refers to the maximum or minimum result of the problem [7]. The procedure of figuring out the optimal solution is, first, identify the decision variables; second, write out the objective function; then, find the constraints and/or the non-negativity constraints [8]. Simplex method is one of the most popular ways to find the optimal solution. It has a basic formulation (formula of simplex method 1) (Fig. 3)

$$\begin{aligned}
 & \text{minimize } c^T x \\
 & \text{subject to } Ax \geq b, \\
 & x \geq 0
 \end{aligned}$$

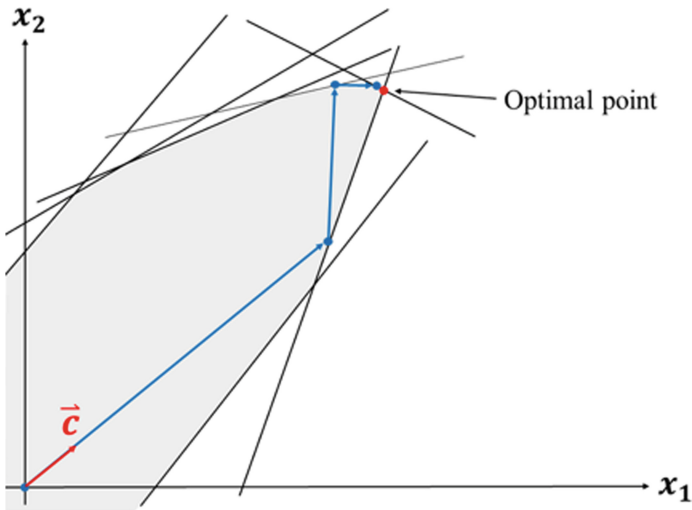


Fig. 3. Simplex method for SNAR (artificial-free simplex algorithm based on the non-acute constraint relaxation)

3 Discussion

3.1 Functions of Simplex Method

It is created in order to find the optimal solution from extreme points. Simplex method can be used not only with professional mathematical questions but can also be used in daily life. Here is a project that provides an example in real life [13].

3.2 Real Life Example

In the project, the goal was to minimize the cost with enough nutrient intake. Economist George J. Stigler created a document called “The Cost of Subsistence” in the 1940s, trying to solve this diet problem. Since the document was written and calculated in the 1940s, the calculation methods were limited. Simplex method was used in this project in order to find a more precise solution for the problem. First of all, decision variables were identified, using the formulation for simplex method above. A refers to the nutrient that every object contains per dollar, using a matrix of 77 or 80 objects and 9 nutrients); b refers to the minimum nutrient that a person is needed (matrix of 9 containing 9 nutrients); and c^T refers to the cost of the objects. Matrix A was founded on Stigler’s paper, mentioning the nutrient value of foods in 1939 and 1944. I matrix was introduced in order to get the canonical form of the linear program. After having all of the numbers for each symbol in the matrix, we can start the final step to calculate the optimal solution for the minimum nutrient that a person need. The final process was to plug all the data and functions into the computer and receive a final result. Overall, the solution has shown a cheaper need in finance to absorb enough nutrients for a male adult per day. Compared to the calculation in the 1940s, this method provides a more efficient and convenient way

for people to calculate the specific data that they need. There were some disadvantages to this problem for certain. For example, the disunity of nutrients needed for everyone and the limitation of food. The calculation only presents an extreme situation that was given by restrictive backgrounds [9].

4 Conclusion

By plugging in information into the computer with simplex method, the optimal solution will show up with precise data. Linear programming can be applied to a lot of areas such as financial management, simple income and expenditure. Moreover, it can be used for a bigger image, for example, business investment and forecast, in order to help companies obtaining higher profits under cost comparisons and rationalities. Linear programming can also play an important role in scientific research. Before a project starts, it can be used to create related models, which provide more information and help people become more familiar with the contents in advance. Overall, it is significance and helpful to apply linear programming in real life issues. In conclusion, the linear programming is beneficial to the many fields. The paper try to verify it is feasible and valid by studying its fundamental process. Show how does it work and after working what positive impact will he have. The result of linear may be easily to find after we input code to computer but sometimes there are some difference between the data and real life. So we will find the influence factors which lead to a difference result in next step.

References

1. Attaway S Dimensional matrix—an overview | Science direct topics. Dimensional matrix. www.sciencedirect.com/topics/computer-science/dimensional-matrix. Accessed 20 May 2021
2. Boundless. Introduction to matrices | Boundless algebra. Lumen. courses.lumenlearning.com/boundless-algebra/chapter/introduction-to-matrices. Accessed 10 June 2021
3. Brownlee J A gentle introduction to linear algebra. Machine learning mastery, 9 Aug. 2019, machinelearningmastery.com/gentle-introduction-linear-algebra
4. Dotson JD Five areas of application for linear programming techniques. Sciencing, 21 May, 2018. <https://sciencing.com/five-application-linear-programming-techniques-7789072.html>. Accessed 11 Aug 2021
5. Linear Algebra-in a Nutshell. <http://pi.math.cornell.edu/~mec/Winter2009/RalucaRemus/Lecture1/lecture1.html>. Accessed 25 Sept
6. Linear programming and its uses. Digital Vidya. https://www.digitalvidya.com/blog/linear-programming-and-its-uses/#ouibounce_modal. Accessed 18 Sept 2021
7. Linear Programming Terminology. Universal teacher publications. www.universalteacherpublications.com/univ/ebooks/or/Ch2/bscterm.htm. Accessed 15 July 2021
8. Pant R Linear Programming Problems. Atma Ram Sanatan Dharma Colege. <https://www.arsdcollege.ac.in/wp-content/uploads/2020/03/LPP-Business-Mathematics-1.pdf>. Accessed 10 Aug 2021
9. Research Gate https://www.researchgate.net/figure/Simplex-method-for-SNAR-artificial-free-simplex-algorithm-based-on-the-non-acute_fig1_339755442. Accessed 26 Sept

10. Sekhon R, Bloom R Introduction to linear programming applications in business, finance, medicine, and social science. LibreTexts, 5 September, 2021. [https://math.libretexts.org/Bookshelves/Applied_Mathematics/Applied_Finite_Mathematics_\(Sekhon_and_Bloom\)/04%3A_Linear_Programming_The_Simplex_Method/4.01%3A_Introduction_to_Linear_Programming_Applications_in_Business_Finance_Medicine_and_Social_Science](https://math.libretexts.org/Bookshelves/Applied_Mathematics/Applied_Finite_Mathematics_(Sekhon_and_Bloom)/04%3A_Linear_Programming_The_Simplex_Method/4.01%3A_Introduction_to_Linear_Programming_Applications_in_Business_Finance_Medicine_and_Social_Science). Accessed 20 Sept 2021
11. Thota AV Applying linear programming to solve real-life problems in R language. Linked in <https://www.linkedin.com/pulse/applying-linear-programming-solve-real-life-problems-r-thota>. Accessed 20 Sept 2021
12. Sherry T Simplex method. <http://sherrytowers.com/2014/07/14/simplex-method/>. Accessed 25 Sept 2021
13. Vidhya A introductory guide on linear programming for (aspiring) data scientists. Analytics Vidhya, 1 Apr. 2020. www.analyticsvidhya.com/blog/2017/02/introductory-guide-on-linear-programming-explained-in-simple-english

Open Access This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

