International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 12 Dec 2021, pp: 952-954 www.ijaem.net ISSN: 2395-5252

Applications of Optimization for Transceiver Transport System

Nguyen Minh Cuong[1], Nguyen Thi Xuan Mai[2]
[1,2]*Thai Nguyen University of Technology, Vietnam*
Corresponding Author: Nguyen Thi Xuan Mai

Submitted: 01-12-2021 Revised: 12-12-2021 Accepted: 15-12-2021

ABSTRACT: In recent years, optimization methods have been widely and effectively applied in economics, engineering, transportation, information technology, and many other scientific disciplines. This article will systematize a real-life model that needs the help of Mathematics to solve production cost problems in business to clarify the relationship between Mathematics and practice.

KEYWORDS: Optimization, Optimal, mathematical model.

I. INTRODUCTION

Currently, the direction of scientific research to serve practice and solve problems arising in practice is of great interest. One of the most interested directions is the field of mathematical optimization [1-21].When planning production and design based on optimization principles, it will save costs in terms of capital, raw materials, time and labor while increasing efficiency, productivity and quality of work. Therefore, the problem is to model real-world problems into optimization problems. Then, the results of the optimization problem will give us the most reasonable production plan in practice.

II. INTOPTIMIZATION PROBLEM

The general optimization problem is stated as follows:

Maximum (minimum) the function $f(x)$ with conditions:

$$g_i(x) \le b_i,\ i = \overline{1,m} \qquad (1)$$

$$x \in X \subset R^n. \qquad (2)$$

Inequalities in the system (1) can be replaced by equality or inequality in the opposite direction.

Then, the function $f(x)$ is called the objective function, the functions $g_i(x)$ are called the binding function. Each inequality (or equality) in the system (1) is called a binding.

Domain D = $\{x \in X \mid g_i(x) \le b_i, i = \overline{1,m}\}$ is called the bound domain (or acceptable domain). Each $x \in D$ is called an alternative (or an acceptable solution). An option $x^* \in D$ is the maximum (or minimum) of the objective function, it means:

$$f(x^*) \ge f(x), \forall x \in D$$

(with the problem of maximization)

$$f(x^*) \le f(x), \forall x \in D$$

(with the problem of minimization)

is called the optimal solution. Then the value of $f(x^*)$ is called the optimal value of the problem. Solving an optimization problem is finding the optimal solution x^*.

Optimization problems (are known as mathematical programming) are divided into several categories: Linear programming (the objective function and the constraint functions are linear), nonlinear programming (the objective function and the constraint functions, at least one function is nonlinear), dynamical programming (Objects are considered as multi-stage processes) …. Optimization theory has given many methods to find the optimal solution depending on each problem. However, Linear programming is a problem that is fully studied in both theory and practice because: simple linear model to be able to apply, many other programming problems (original programming, nonlinear programming) can be approximated with high accuracy by a series of linear programming problems.

III. MODEL OF OPTIMIZATION FOR TRANSCEIVER BALANCE TRANSPORT

The modeling process of a real-world system consists of four steps:

Step 1: Build a qualitative model for the problem. In this step, we often state the model in words, in diagrams and give the conditions to be satisfied and the goals to be achieved.

Step 2: Describe the qualitative model through mathematical language. Specifically, it is necessary to determine the objective function (the most important) and express the conditions and constraints in the form of equations and inequalities.

Step 3: Use appropriate mathematical tools to solve the problem given in step 2. Sometimes, the actual problems are large, so when solving, it is necessary to program the algorithm in an appropriate programming language. appropriate, let the computer run and output the results.

Step 4: Analyse and verify the results in step 3, then consider whether to apply the results of the model in practice.

In reality, we need to solve the problem of distribution of goods from some supply locations (are called the source locations) to some consumption locations (are called destination locations) so that the total cost is minimal, the shipping distance is the shortest, total profit is the largest. For simplicity, let's consider the problem: the total quantity supplied from the source locations is equal to the total consumption at the destination locations (called the transceiver balanced transport problem).

The actual problem is as follows: There are m locations $A_1, A_2, ..., A_m$ that produce the same product with corresponding quantities of $a_1, a_2, ..., a_m$. There are n places of consumption $B_1, B_2, ..., B_n$ with the corresponding requirements are $b_1, b_2, ..., b_n$. For convenience, put A_i is the ith transmitting station , B_j is the jth receiving station.

Assuming that:

+ Goods can be transferred from any transmitting station A_i to any receiving station B_j.

+ The cost of transporting goods from the ith transmitter to the jth receiver is c_{ij} , $c_{ij} \geq 0$.

+ The total amount of goods available at m transmitters is equal to the total quantity required at n receivers (transceiver equilibrium condition), it means $\sum_{i=1}^{m} a_i = \sum_{j=1}^{n} b_j$.

Make a plan to transport the goods so that transmitting stations will be out of goods, the receiving stations will collect enough goods and the total shipping cost is minimal.

To build a mathematical model for the problem, we call x_{ij} is the amount of goods carried from transmitter i to receiver j, $x_{ij} \geq 0$ with everyone i, j.

Then, the condition for the transmitting stations to run out of goods is: $\sum_{j=1}^{n} x_{ij} = a_i$ (station i has sold out)

The condition for the collection stations to collect enough goods is: $\sum_{i=1}^{m} x_{ij} = b_j$ (station j has received enough goods).

Total shipping cost is

$$f(X) = \sum_{j=1}^{n}\sum_{i=1}^{m} c_{ij}x_{ij} = \sum_{i=1}^{m}\sum_{j=1}^{n} c_{ij}x_{ij} .$$

So the mathematical model of the problem becomes:

Find the matrix X = $(x_{ij})_{m\times n}$ so that:

$$f(X) = \sum_{j=1}^{n}\sum_{i=1}^{m} c_{ij}x_{ij} \to \min$$

with conditions:

$$\begin{cases} \sum_{j=1}^{n} x_{ij} = a_i, \forall i \\ \sum_{i=1}^{m} x_{ij} = b_j, \forall j . \\ x_{ij} \geq 0, \forall i, j \end{cases}$$

Solve the above optimization problem, we can determine the optimal solution is the matrix X = $(x_{ij})_{m\times n}$. It is also the optimal transportation plan for the quantity of goods to be transported from the transmitting station i to the receiving station j so that the total transportation cost is minimized.

IV. CONCLUSIONS

The paper presents a method application of the optimization problem for transceiver balance transport problem. This further elucidates the two-way intimate relationship between mathematics and practice and the important role of mathematics in practice. In the future, the author's follow-up studies will carry out research on optimization for the processes occurring in the engineering process.

ACKNOWLEDGEMENT

This work is supported by Thai Nguyen University of Technology, Vietnam

REFERENCES

[1]. Antoniou, A., & Lu, W. S. (2007). Practical optimization: algorithms and engineering applications (Vol. 19, p. 669). New York: Springer.

[2]. Törn, A., & Zilinskas, A. (1989). Global optimization.
[3]. Gosavi, A. (2015). Simulation-based optimization. Berlin: Springer.
[4]. Hooker, J. N. (2012). Integrated methods for optimization (Vol. 170). New York:: Springer.
[5]. Tsompanakis, Y., Lagaros, N. D., & Papadrakakis, M. (Eds.). (2008). Structural Design Optimization Considering Uncertainties: Structures & Infrastructures Book, Vol. 1, Series, Series Editor: Dan M. Frangopol. CRC Press.
[6]. Sokolowski, J., & Zolésio, J. P. (1992). Introduction to shape optimization. In Introduction to shape optimization (pp. 5-12). Springer, Berlin, Heidelberg.
[7]. Kirsch, U. (2012). Structural optimization: fundamentals and applications. Springer Science & Business Media.
[8]. Bertsekas, D. (2015). Convex optimization algorithms. Athena Scientific.
[9]. Ziegel, E. (2002). Genetic algorithms and engineering optimization.
[10]. Yang, X. S., & Koziel, S. (Eds.). (2011). Computational optimization and applications in engineering and industry (Vol. 359). Springer Science & Business Media.
[11]. Arora, R. K. (2019). Optimization: algorithms and applications. Chapman and Hall/CRC.
[12]. Kelley, C. T. (1999). Iterative methods for optimization. Society for Industrial and Applied Mathematics.
[13]. Liberti, L., & Maculan, N. (Eds.). (2006). Global optimization: from theory to implementation (Vol. 84). Springer Science & Business Media.
[14]. Palomar, D. P., & Eldar, Y. C. (Eds.). (2010). Convex optimization in signal processing and communications. Cambridge university press.
[15]. Lazinica, A. (Ed.). (2009). Particle swarm optimization. BoD–Books on Demand.
[16]. Adby, P. (2013). Introduction to optimization methods. Springer Science & Business Media.
[17]. Floudas, C. A., & Pardalos, P. M. (2014). Recent advances in global optimization. princeton University press.
[18]. Sioshansi, R., & Conejo, A. J. (2017). Optimization in Engineering. Cham: Springer International Publishing, 120.
[19]. Nicholson, T. A. J. (2017). Optimization in Industry: Volume 1, Optimization Techniques. Routledge.
[20]. Chan, F., & Tiwari, M. (Eds.). (2007). Swarm Intelligence: focus on ant and particle swarm optimization. BoD–Books on Demand.
[21]. Bhatti, M. A. (2012). Practical Optimization Methods: With Mathematica® Applications. Springer Science & Business Media.