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A Study on Fuzzy Transportation Problems under Modified Vogel's Approximation Method

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Abstract: ***Transportation Problem is a well-known topic and is used very often in solving problems of Engineering and Management Science. In this paper, we analyze triangular fuzzy members which are considered to be more realistic in nature. The Modified Vogel's Approximation Method (MVAM) algorithm is used for solving fuzzy transportation problems.***

Keywords: Fuzzy Transportation Problems, Triangular fuzzy numbers, Initial solution, Total opportunity cost, Modified Vogel's Approximation Method.

1. Introduction

The Transportation Problem (TP) is one of the familiar applications of linear programming problems. The TP can be modified as a standard Linear Programming Problem (LPP) that can be solved by the Simplex method. We can get an initial basic feasible solution for the TP by using North-West Corner rule, Matrix Minima method and the Vogel's Approximation method. To get an optimal solution for the TP, we use the MODI method.

A Fuzzy Transportation Problem (FTP) is a transportation problem in which the transportation cost, supply and demand quantities are fuzzy quantities. The objective of the FTP is to determine the shipping schedule that minimizes the total fuzzy transportation cost while satisfying fuzzy supply and demand limits.

In this paper, we analyze the MVAM algorithm for solving fuzzy transportation problems. The balanced condition is both a necessary and sufficient condition for the existence of a feasible solution to the TP.

2. Preliminaries

Consider k origins O_i (i = 1, 2… k) and l destinations D_j (j = 1, 2… l). At each O_i, let P_i be the amount of homogeneous product that we want to transport to L destinations D_j, in order to satisfy the demand for q_j units of the product there. A penalty C_{ij} is associated with transportation of a unit of the product from origin i to destination j. The penalty could represent transportation cost, delivery time, quantity of goods delivered under-used capacity, etc. A variable y_{ij} represents the unknown quantity to be transported from origin O_i to destination D_j. However, all transportation problems are not single objective LPP.

3. Mathematical Model

Minimize $Z = \sum_{i=1}^{k}\sum_{j=1}^{l} C_{ij} y_{ij}$

Subject to $\sum_{j=1}^{l} y_{ij} = q_i$ i = 1, 2, …, k

$\sum_{i=1}^{k} y_{ij} = p_j$ j = 1, 2, …, l

$y_{ij} \geq 0$ i = 1, 2, …, k and j = 1, 2, …, l

and $\sum_{i=1}^{k} p_i = \sum_{j=1}^{l} p_j$ (balanced condition)

The balanced condition is both necessary and sufficient condition for the existence of a feasible solution to the TP.

4. Fuzzy Set

A fuzzy set is characterized by a membership function mapping element of a domain, space or universe of discourse to the unit interval [0, 1] (i.e.,) A = {X, $\mu_A(x)$; x ∈ X}. Here, $\mu_A : X \rightarrow [0\ 1]$ is a mapping called the degree of membership function of the fuzzy set A and $\mu_A(x)$ is called the membership value of x ∈ X in the fuzzy set A.

5. Triangular Fuzzy Number

For a triangular fuzzy number p(x) it can be represented by p(a_1, a_2, a_3; 1) with membership function μ(x) is given by

$$\mu(x) = \begin{cases} \dfrac{x-a_1}{a_2-a_1} & a_1 \leq x \leq a_2 \\ 1 & x = a_2 \\ \dfrac{x-a_2}{a_3-a_2} & a_2 \leq x \leq a_3 \\ 0 & otherwise \end{cases}$$

Consider the following fuzzy transportation problem.

Minimize $Z = \sum_{i=1}^{k}\sum_{j=1}^{l} \overline{C}_{ij}\, \overline{y}_{ij}$

Subject to $\sum_{j=1}^{l} \bar{y}_{ij} \leq \bar{p}_i$ for i = 1, 2, …, k

$\sum_{i=1}^{k} \bar{y}_{ij} \geq \bar{q}_j$ j = 1, 2, …, l

$\bar{y}_{ij} \geq 0$ i = 1, 2, …, k and j = 1, 2, …, l

where

$\bar{p}_i = (a_1, a_2, a_3)$, $\bar{q}_j = (b_1, b_2, b_3)$

and $\bar{C}_{ij}$ =(C_{ij} , C_{ij} , C_{ij}) representing the uncertain supply and demand for the TP.

6. Modified Vogel's Approximation Method

VAM was improved by using Total Opportunity Cost (TOC) matrix by considering alternative allocation costs. The TOC matrix is obtained by adding row opportunity cost matrix and the column opportunity cost matrix.

7. Procedure of MVAM

Step 1: Balance the given TP
Step 2: Obtain the TOC matrix
Step 3: Determine the penalty cost for each row and column by subtracting the lowest cell cost in the row or column from the next lowest cell cost in the same row or column
Step 4: Select the rows or columns with the highest three penalty cost.
Step 5: Compute three transportation costs for selected three rows or columns in Step 4 by allocating as much as possible to the feasible cell with the lowest transportation cost.
Step 6: Select minimum transportation cost of three allocations in Step 5
Step 7: Repeat Steps 3 – 6 until all requirements have been met.
Step 8: Compute total transportation cost for the feasible allocations using the original balanced transportation cost matrix

8. Remarks

8.1 Row Opportunity Cost Matrix

For each row, the smallest cost of that row is subtracted from each element of the same row.

8.2 Column Opportunity Cost Matrix

For each column of the original transportation cost matrix, the smallest cost of that column is subtracted from each element of the same column.

9. Conclusion

This study is focused on obtaining the solution of Fuzzy Transportation Problem by using well known Modified Vogel's Approximation Method. This model determines fast optimal solutions under VAM. In addition to this, main concept of this model is to observe the behaviour of opportunity cost matrix which is a smallest cost of that column is subtracted from the each element of the same column. From this observation, we conclude that the VAM algorithm and opportunity cost matrix have significant role to obtain the optimal solution.

10. Future Scope

The further scope of this research in solving Fuzzy Transportation Problem by using Modified Vogel's Approximation Method is the possibility of reducing the transportation cost.

References

[1] A.Charnes, W.W.Cooper and A.Henderson, "An Introduction to Linear Programming", Wiley, New York,1953.
[2] G.B.Dantzig, "Linear Programming and Extensions",Princeton University Press, Princeton, N J, 1963.
[3] P. K. De and Bharti Yadav "Approach to Defuzzify the Trapezoidal Fuzzy Number in Transportation Problem" International Journal of Cognition (http://www.ijcc.us), Vol. 8, NO. 4, December 2010.
[4] Edward Samuel and M. Venkatachalapathy, "Modified Vogel's Approximation Method for Fuzzy Transportation Problems", Applied Mathematical Sciences, 5, 1367-1372, 2011.
[5] Hadi Basirzadeh"An Approach for Solving Fuzzy Transportation Problem",Applied Mathematical Sciences, Vol. 5, 2011, 1549- 1566.
[6] F.L.Hitchcock, "The distribution of a product from several sources tonumerous localities", J.Math.Phys.20,224-230,1941.
[7] Kasana.H.S and Kumar.K.D., "Introductory Operations Research Theory and Applications", Springer International Edition, New Delhi,2005.
[8] A.Kaufmann, "Introduction to the Theory of Fuzzy Sets", Vol.I , Academic Press, New York,1976.
[9] Nuran Güzel "Fuzzy Transportation Problem with the Fuzzy Amounts and the Fuzzy Costs" World Applied Sciences Journal 8 (5): 543-549, 2010
[10] J.L.Riggs and M.S.Inoue, "Introduction to Operation Research and Management Science", McGraw-Hill, New York,1975.
[11] P. Senthilkumar and S. Vengataasalam "A note on the solution of fuzzy transportation problem using fuzzy linear system" Available online at www.ispacs.com/jfsva Volume 2013, Year 2013 Article ID jfsva-00138, 9 Pages
[12] Serdar Korukoglu and Serkan Balli, "An Improved Vogel's Approximation Method for the Transportation Problem", Mathematical and Computational Applications, Article in Press, 2010.
[13] M. Shanmugasundari and K. Ganesan " A Novel Approach for the fuzzy optimal solution of Fuzzy Transportation Problem" International Journal of Engineering Research and Applications (IJERA) Vol. 3, Issue 1, January -February 2013, pp.1416-1424.

[14] Shugani Poonam, S.H. Abbas, and K. Gupta, "Fuzzy Transportation Problem of Triangular Numbers with α-Cut and Ranking Technique", IOSR Journal of Engineering, 2(5), 2012, 1162-1164.
[15] H.J.Zimmermann, "Fuzzy Programming and Linear Programming with several objective functions", Fuzzy Sets and Systems, 1, 45-55, 1978.

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