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Intuitionistic Fuzzy Transportation Problem: Solving in a New Perspective Way

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ABSTRACT

Fuzzy Transportation problem plays an important role in the decision making process. Such problem is studied with the help of fuzzy numbers. This paper describes the methodology for transportation problem in an intuitionistic fuzzy environment where cost are represented by octagonal intuitionistic fuzzy numbers. We have extended our problem to fully intuitionistic fuzzy transportation problem instead of fully fuzzy transportation problem. The problem is then solved by accuracy function for octagonal intuitionistic fuzzy numbers. The basic feasible solution is obtained by Russell's method. Finally the approach is verified by giving an illustrative example.

Keywords: Intuitionistic Fuzzy Transportation Problem, Octagonal Intuitionistic Fuzzy Numbers, Russell's Method.

I.INTRODUCTION

The transportation problem is one of the major and widely used area of Operational Research. The transportation problem was originally introduced by Hitchcock in 1941. The finished goods from different sources are transported to different destinations so as to minimize the total transported cost.While solving the transportation problem with the precise data, there are uncertain parameters due to uncontrollable factors (data) which are known as fuzzy data. So, the concept of fuzziness came into existence. It was first introduced by Zadeh (1965) [1] which was further extended to intuitionistic fuzzy sets (IFS) by Atanassov [2] in 1986. The major advantage of IFS is that degree of membership function or acceptance and degree of non-membership function or rejection are defined simultaneously such that their sum is less than one but greater than zero. From the past few decades, many researchers have used the method of ranking in solving the intuitionistic fuzzy transportation problem.

Shiang-Tai Liu and Chiang Kao [3],Chanas et al. [4], Chanas and Kuchta [5], presented a new method for solving fuzzy transportation problem. Nagoor Gani and Abdul Rezak [6] obtained a fuzzy solution for a two stage cost minimizing fuzzy transportation problem. Pandian et al. [7], proposed a zero point method to find a fuzzy optimal solution for a fuzzy transportation problem where all parameters are trapezoidal fuzzy numbers. A

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new method for solving fuzzy transportation problem by assuming that a decision maker is uncertain about the precise values of the transportation cost, availability and demand of the product was proposed by Amarpreet Kaur [8].

In fuzzy problems, the data are represented in terms of fuzzy numbers. So to change the fuzzy number into crisp form, ranking method is used. The method for ranking was first given by Jain [9].

Further references can be found in [10-11, 12-13]. Ranking function can be used in different areas of fuzzy optimization. Two new methods for solving the fuzzy transportation problems are proposed by Kumar andKaur [14] to overcome the shortcomings and limitations of the existing methods. They suggested to use the proposed methods as compared to the existing methods for solving some fuzzy transportation problems. Kumar and Murugesan (2012) [15] obtained an optimal solution for fuzzy transportation with triangular membership functions.

In this paper, a new method to solve the intuitionistic fuzzy transportation problem is developed. The ranking method is used so as to simplify the calculations and then solution is obtained by using the new method. This paper is organized as follows: with introduction in this section, next Section presents some basic definitions and also describes the new method and the final section presents the conclusions.

II.PRELIMINARIES

1.1. Intuitionistic fuzzy transportation problem:

Let $\overline{A}$ be an intuitionistic fuzzy set with $\mu_{\bar{A}}(x)$ and $\nu_{\bar{A}}(x)$ as membership and non-membership function respectively, then the intuitionistic fuzzy set is defined as:

$\bar{A}^I = \{<x, \mu_{\bar{A}}(x), \nu_{\bar{A}}(x) > x \in X\}$

And the membership and non-membership function is as follows:

$$\mu_{\bar{A}}(x) = \begin{cases} f_1(x), & x \in [m-\alpha_1, m) \\ 1 & x = m \\ h_1(x) & x \in (m, m+\beta_1] \\ 0 & otherwise \end{cases}$$

And

$$\nu_{\bar{A}}(x) = \begin{cases} 1 & x = (-\infty, m-\alpha_2) \\ f_2(x) & x \in [m-\alpha_2, m) \\ 0 & x = m, x \in (m+\beta_2, \infty] \\ h_2(x) & x \in (m, m+\beta_2] \end{cases}$$

Where the functions $\mu_{\bar{A}}(x) : \to [0,1]$ and $\nu_{\bar{A}}(x) : \to [0,1]$ and $0 \leq \mu_{\bar{A}}(x) + \nu_{\bar{A}}(x) \leq 1$, for every $x \in X$.

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1.2. Octagonal Fuzzy Numbers(OFN):

$$\mu_{\bar{A}}(x)=\begin{cases} 0 & x < a_1 \\ k\left(\frac{x-a_1}{a_2-a_1}\right) & a_1 \le x \le a_2 \\ k & a_2 \le x \le a_3 \\ k+(1-k)\left(\frac{x-a_3}{a_4-a_3}\right) & a_3 \le x \le a_4 \\ 1 & a_4 \le x \le a_5 \\ k+(1-k)\left(\frac{a_6-x}{a_6-a_5}\right) & a_5 \le x \le a_6 \\ k & a_6 \le x \le a_7 \\ k\left(\frac{a_8-x}{a_8-a_7}\right) & a_7 \le x \le a_8 \\ 0 & otherwise \end{cases}$$

1.3. Octagonal Intuitionistic Fuzzy Numbers [TrIFNs]

Let us consider an octagonal intuitionistic fuzzy number (say) $\overline{A}$ =$(a_1, a_2, a_3, a_4, a_5, a_6, a_7, a_8)$ with membership functions as follows:

$$\mu_{\bar{A}}(x)=\begin{cases} 0 & x < a_1 \\ k\left(\frac{x-a_1}{a_2-a_1}\right) & a_1 \le x \le a_2 \\ k & a_2 \le x \le a_3 \\ k+(1-k)\left(\frac{x-a_3}{a_4-a_3}\right) & a_3 \le x \le a_4 \\ 1 & a_4 \le x \le a_5 \\ k+(1-k)\left(\frac{a_6-x}{a_6-a_5}\right) & a_5 \le x \le a_6 \\ k & a_6 \le x \le a_7 \\ k\left(\frac{a_8-x}{a_8-a_7}\right) & a_7 \le x \le a_8 \\ 0 & otherwise \end{cases}$$

And

$$\nu_{\bar{A}}(x)=\begin{cases} 1 & \acute{a}_1 < x \\ k+(1-k)\left(\frac{\acute{a}_2-x}{\acute{a}_2-\acute{a}_1}\right) & \acute{a}_1 \le x \le \acute{a}_2 \\ k & \acute{a}_2 \le x \le \acute{a}_3 \\ k\left(\frac{a_4-x}{a_4-\acute{a}_3}\right) & \acute{a}_3 \le x \le a_4 \\ 0 & a_4 \le x \le a_5 \\ k\left(\frac{x-a_5}{\acute{a}_6-a_5}\right) & a_5 \le x \le \acute{a}_6 \\ k & \acute{a}_6 \le x \le \acute{a}_7 \\ k+(1-k)\left(\frac{x-\acute{a}_7}{\acute{a}_8-\acute{a}_7}\right) & \acute{a}_7 \le x \le \acute{a}_8 \\ 1 & x > \acute{a}_8 \end{cases}$$

1.4. Ranking method:

Let$\bar{A}_i$=$(a_1, a_2, a_3, a_4, a_5, a_6, a_7, a_8)$

$(\acute{a}_1, \acute{a}_2, \acute{a}_3, a_4, a_5, \acute{a}_6, \acute{a}_7, \acute{a}_8)$ where I =1, 2, 3, ….. k, then the ranking function is defined as-

$R(\bar{A}_i)=\frac{(\acute{a}_1+a_1+\acute{a}_2+a_2+\acute{a}_3+a_3+a_4+a_5+a_6+\acute{a}_6+a_7+\acute{a}_7+a_8+\acute{a}_8)}{8}$ where w=min (i=1, 2, 34……….k)

1.5. **Algorithm of Fuzzy Russell's Approximation Method (FRAM):**

The proposed method(FRAM)[16] is proposed to obtain the IFBFS. Russell's approximation method provides an excellent criterion that is quick to implement on a computer.The algorithm of this method for the FTP when all the cost coefficients are fuzzy numbers and all demands and supply are crisp numbers are follows:

Step1**:** Let $\bar{u}_i$represents the largest fuzzy unit transportation cost c_{ij} .Calculate $\bar{u}_i$= max c_{ij} in row i.

Step2: Let $\bar{v}_i$ represents the largest fuzzy unit transportation cost c_{ij}. Calculate $\bar{v}_i$= max c_{ij} in column j

Step3: Now, calculate the value of each Δ_{ij} obtained from the formula:-

$\Delta_{ij} = c_{ij} - \bar{u}_i - \bar{v}_i$

$Step4$: From the above step 3, we select x_{ij} that has the largest negative value ofΔ_{ij} . Compute for each row and each column under consideration.

In case the maximum Δ_{ij} is not unique (i.e., more than one is same), then select the variable x_{ij} where maximum allocation can be made.

Step5: Eliminate the rows and columns where there is no supply and demand.

Step6: If all supply and demand requirements have not been satisfied, then go to step1 and recalculate newΔ_{ij} ,otherwise the initial fuzzy solution has been obtained.

In this study, a new algorithm called Fuzzy Russell's Approximation Method (FRAM) has been proposed to obtain the Initial Fuzzy Basic Feasible Solution (IFBFS) of a Fuzzy Transportation Problem (FTP) which would be a new attempt in solving the transportation problem in fuzzy environment.

1.6. Advantages of FRAM:

The proposed method, FRAM has the following advantages:

1. It is a systematic procedure to obtain the solution.
2. It is easy to understand and to apply in real life transportation problem.
3 The initial fuzzy basic feasible solution obtained from this method is the same as the optimum solution or it is very close to it.
4 This approach can be extended to solve other fuzzy transportation problem.
5 It simplifies the overall computer code to program it.

An Illustrative Example:

Let us consider 5*5 table matrix in which the products are supplied to the destinations describing the supply and demand at the origins and the destinations respectively.

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Table1:

	D_1	D_2	D_3	a_i
S_1	(0,1,2,3,4,5,8,9)(3,4,5,6,7,8,9,14)	(8,9,10,11,12,13,15,18)(0,4,7,9,10,11,12,14)	(4,5,6,7,8,9,12,13)(4,5,8,9,10,11,12,13)	40
S_2	(2,4,7,8,10,12,14,15)(1,2,3,4,5,6,7,8,12)	(8,9,10,13,14,16,20,30)(0,1,2,3,4,6,7,9)	(0,1,2,3,4,5,8,9)(4,7,9,10,11,12,13,14)	25
S_3	(2,3,4,7,9,12,13,14)(2,3,7,8,9,10,12,13)	(3,6,7,8,9,11,13,15)(2,4,5,7,10,11,12,13)	(2,4,5,6,7,9,15,16)(1,2,3,4,5,7,8,10)	30
b_j	15	35	45	

Since

$\sum_{i=1}^{3} a_i = \sum_{j=1}^{3} b_j$ =95, therefore the given transportation problem is balanced.

Now by using the ranking function, we get the reduced table as:

Table2:

	D_1	D_2	D_3	a_i
S_1	11	22	17	40
S_2	15	19	14	25
S_3	16	17	13	30
b_j	15	35	45	

Applying the FRAM, we can obtain the initial feasible basic values:

x_{12}=35;

x_{11}=5;

x_{23}=25;

x_{33}=20;

x_{31}=10

Hence, the minimum transportation cost is given by:

$\sum c_{ij} x_{ij}$ = 22*35+11*5+14*25+13*20+16*10

=770+55+350+260+160=1595

III.CONCLUSION

In this paper, a new proposed method is applied on the octagonal intuitionistic fuzzy transportation problem where the costs are represented by the generalized octagonal intuitionistic fuzzy numbers. Also the new method is proposed to compute the IBFS which is simple and easy to understand and can be used by the decision maker to solve the real life transportation problem.

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