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NEUTROSOPHIC TRANSPORTATION PROBLEMS USING ZERO SUFFIX METHOD

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ABSTRACT--The aim of this paper is to propose a method for finding an optimal solution for Neutrosophic Fuzzy Transportation Problem (TP). Here, a new ranking approach to solve fuzzy Neutrosophic transportation problems under the approach of zero suffix method together with the scalar division of fuzzy numbers is introduced. The solution of the given problem which satisfies the conditions of optimality and feasibility by proposing the method together with scalar division and triangular ranking technique.

Keywords-Triangular fuzzy number, Triangular Neutrosophic fuzzy number, Neutrosophic Transportation problem, Fuzzy Zero suffix Algorithm.

1. INTRODUCTION

The fundamental TP was originally developed by Hitch-cock. The transportation problem in Operations Research is considering the minimum cost of transporting of commodity from a given number of sources to destinations. Zadeh [7] initiated the concept of fuzzy sets which is a best mathematical tool for representing impreciseness or vagueness. In 1986 Atanassov [2] developed the concept of Intuitionistic fuzzy sets (IFSs) which is very useful to deal with vagueness. The concept of Neutrosophy was introduced by Smarandache[8] in 1995, it deals with the certain type of uncertain information like indeterminate, incomplete and inconsistent information which exist in real time scenarios which cannot be solved with fuzzy set as well as intuitionistic fuzzy sets. In a fuzzy transportation problem cost, supply and demand are fuzzy quantities. The aim of the paper is to confirm the shipping schedule to minimize the total fuzzy transportation cost while satisfying fuzzy supply and fuzzy demand. The solution of Fuzzy Intuitionistic Transportation Problem Using Zero Suffix Algorithm was introduced by NagoorGani [12]. Many methods have been proposed the parameter is not always correct in real lifetime situation due to various reasons like diesel price, road conditions, monsoon season etc. The parameters cannot be always a real number. The expert would tell their opinion like high or low to deal such a real time situation to represent parameter as fuzzy number. Here, we propose the Neutrosophic fuzzy transportation problem using triangular ranking technique by incorporating the fuzzy zero suffix method together with the scalar division.

2. PRELIMINARIES

A. *Definition: Fuzzy set (7)*

A fuzzy set can be defined as $A = \{(x, \mu_A(x))\}$ belongs to the classical set A and $\mu_A(x)$ belongs to interval[0,1] and $\mu_A(x)$ are called membership function of x.



B. Definition: Fuzzy number

A fuzzy subset A is a fuzzy number on the real line R . If

- (1) A is an upper continuous
- (2) A is fuzzy convex
- (3) A is normal such that $\mu_A \{x_0 = 1\}$

C. Definition: Triangular fuzzy number(5)

A fuzzy number $A = (a_1, a_2, a_3)$ is called the triangular fuzzy number with membership function given by

$$\mu_A(x) = \begin{cases} \frac{x - a_1}{a_2 - a_1} & a_1 \leq x < a_2 \\ 1 & x = a_2 \\ \frac{a_3 - x}{a_3 - a_2} & a_2 < x \leq a_3 \\ 0 & \text{Otherwise} \end{cases}$$

D. Definition: Intuitionistic fuzzy set (2)

An Intuitionistic Fuzzy set A^I of X can be defined as $A^I = \{(x, \mu_{A^I}(x), \gamma_{A^I}(x)) / x \in X\}$

where $\mu_{A^I}(x)$ and $\gamma_{A^I}(x)$ are membership and non-membership functions such that

$\mu_{A^I}(x), \gamma_{A^I}(x): X \rightarrow [0,1]$ and $0 \leq \mu_{A^I}(x) + \gamma_{A^I}(x) \leq 1$ for every $x \in X$

E. Definition: Neutrosophic fuzzy set (8)

A Neutrosophic fuzzy set A^N of X can be defined as

$$A^N = \{(x, \alpha_{A^N}(x), \beta_{A^N}(x), \gamma_{A^N}(x)) / x \in X\}$$

Where $\alpha_{A^N}(x)$ is truth – membership, $\beta_{A^N}(x)$ is indeterminacy membership and $\gamma_{A^N}(x)$ is falsity- membership function such that $\alpha_{A^N}(x), \beta_{A^N}(x), \gamma_{A^N}(x): X \rightarrow [0,1]$ for all $x \in X$ and $0 \leq \alpha_{A^N}(x) + \beta_{A^N}(x) + \gamma_{A^N}(x) \leq 3$.

F. Definition: Neutrosophic Triangular fuzzy number

A Neutrosophic Triangular fuzzy number is defined by $A^N =$

$$\{x, (\alpha_{a_1^N}(x), \alpha_{a_2^N}(x), \alpha_{a_3^N}(x)), (\beta_{a_1^N}(x), \beta_{a_2^N}(x), \beta_{a_3^N}(x)), (\gamma_{a_1^N}(x), \gamma_{a_2^N}(x), \gamma_{a_3^N}(x)) / x \in X\}$$

where $(\alpha_{a_1^N}(x), \alpha_{a_2^N}(x), \alpha_{a_3^N}(x)): X \rightarrow [0,1]$ is truth membership value, $(\beta_{a_1^N}(x), \beta_{a_2^N}(x), \beta_{a_3^N}(x)): X \rightarrow [0,1]$ is indeterminacy membership value and $(\gamma_{a_1^N}(x), \gamma_{a_2^N}(x), \gamma_{a_3^N}(x)): X \rightarrow [0,1]$ is falsity membership value of x in A^N for every $x \in X$.

G. Arithmetic Operations on Neutrosophic Triangular fuzzy numbers

Let $A_1^N = \langle (a_1, b_1, c_1), (e_1, f_1, g_1), (r_1, s_1, t_1) \rangle$ and $A_2^N = \langle (a_2, b_2, c_2), (e_2, f_2, g_2), (r_2, s_2, t_2) \rangle$ be two TFNVs are as follows:

$$\begin{aligned}
 \text{(i)} \quad A_1^N + A_2^N &= \langle (a_1 + a_2 - a_1 a_2, b_1 + b_2 - b_1 b_2, c_1 + c_2 - c_1 c_2), \\
 &\quad (e_1 e_2, f_1 f_2, g_1 g_2), (r_1 r_2, s_1 s_2, t_1 t_2) \rangle \\
 \text{(ii)} \quad A_1^N * A_2^N &= \langle (a_1 a_2, b_1 b_2, c_1 c_2), (e_1 + e_2 - e_1 e_2, f_1 + f_2 - f_1 f_2, g_1 + g_2 - g_1 g_2) \rangle \\
 &\quad (r_1 + r_2 - r_1 r_2, s_1 + s_2 - s_1 s_2, t_1 + t_2 - t_1 t_2) \\
 \text{(iii)} \quad \lambda A^N &= \langle (1 - (1 - a_1)^\lambda, 1 - (1 - b_1)^\lambda, 1 - (1 - c_1)^\lambda), \\
 &\quad (e_1^\lambda, f_1^\lambda, g_1^\lambda), (r_1^\lambda, s_1^\lambda, t_1^\lambda) \rangle
 \end{aligned}$$

Where $\lambda > 0$.

3. Distance Ranking Method of Triangular fuzzy number

Let $A = (a, b, c)$ be the α -cut of A is $A(\alpha) = [A_L(\alpha), A_U(\alpha)]$, $\alpha \in [0, 1]$ where $A_L(\alpha) = a + (b - a)\alpha$ and $A_U(\alpha) = c + (c - b)\alpha$. The distance of \bar{A} to origin 0 is $d(\bar{A}, 0) = \frac{1}{4}(a + 2b + c)$

4. Algorithm

Zero Suffix Method

Step 1: Select the minimum value of each row and subtract it from each row

Step 2: Select the minimum value of each column and subtract it from each column

Step 3: we are getting atleast one zero in each row and column of the reduced cost matrix, then find the suffix value S which is equal to the addition of nearest adjacent sides of fuzzy zero

Step 4: Find the maximum of S , if it has one maximum value then, we first supply to that corresponding demand cell. If it has more equal values then select $\{a_i, b_j\}$ and supply to that demand maximum possible.

Step 5: Finally, The resultant matrix must possess at least one zero in each row and each column.

5. Numerical example

Let us take the Neutrosophic fuzzy transportation problem whose payoffs are represented as triangular fuzzy number. Here, we find the fuzzy minimum transportation cost

	<i>Destination 1</i>	<i>Destination 2</i>	<i>Destination 3</i>	
Supply				
<i>Source 1</i>	$(-2, 1, 4)(0, 2, 4)(-1, 3, 7)$	$(1, 2, 3)(-1, 3, 7)(2, 4, 6)$	$(-5, 1, 7)(-4, 2, 8)(3, 4, 9)$	$(0, 3, 6)$
<i>Source 2</i>	$(-24, 6)(2, 4, 6)(2, 5, 8)$	$(-5, 2, 9)(-2, 3, 8)(0, 6, 12)$	$(1, 3, 5)(1, 4, 7)(-1, 8, 9)$	$(2, 5, 8)$
<i>Source 3</i>	$(-1, 1, 3)(-1, 2, 5)(0, 4, 8)$	$(-2, 2, 6)(2, 3, 4)(4, 5, 6)$	$(2, 3, 8)(4, 5, 6)(2, 7, 8)$	$(2, 4, 7)$
Demand	$(1, 3, 6)$	$(2, 4, 8)$	$(1, 5, 7)$	

By applying triangular ranking method

Using this formula $A = \left(\frac{a + 2b + c}{4}\right)$

We get

Destination 1 Destination 2 Destination 3 Supply

$$\begin{array}{l}
 \text{Source 1} \\
 \text{Source 2} \\
 \text{Source 3} \\
 \text{Demand}
 \end{array}
 \begin{array}{ccc}
 \begin{bmatrix} (1,2,3) \\ (3,4,5) \\ (1,2,4) \end{bmatrix} & \begin{bmatrix} (2,3,4) \\ (2,3,6) \\ (2,3,5) \end{bmatrix} & \begin{bmatrix} (1,2,5) \\ (3,4,6) \\ (4,5,6) \end{bmatrix} \\
 (0,3,6) & (2,5,8) & (2,4,7)
 \end{array}$$

Here, Total Supply = Total Demand

Therefore it is a balanced fuzzy transportation problem.

$$\begin{array}{l}
 \text{Source 1} \\
 \text{Source 2} \\
 \text{Source 3}
 \end{array}
 \begin{array}{ccc}
 \text{Destination 1} & \text{Destination 2} & \text{Destination 3} \\
 \begin{bmatrix} (1,2,3) \\ (3,4,5) \\ (1,2,4) \end{bmatrix} & \begin{bmatrix} (2,3,4) \\ (2,3,6) \\ (2,3,5) \end{bmatrix} & \begin{bmatrix} (1,2,5) \\ (3,4,6) \\ (4,5,6) \end{bmatrix}
 \end{array}$$

Select the least fuzzy number in each row and subtract it from the other elements in the corresponding row. Similarly do the same for the columns also. We noted that the reduced matrix has at least one fuzzy zero in each row and each column. The reduced matrix is given below

$$\begin{array}{l}
 \text{Source 1} \\
 \text{Source 2} \\
 \text{Source 3}
 \end{array}
 \begin{array}{ccc}
 \text{Destination 1} & \text{Destination 2} & \text{Destination 3} \\
 \begin{bmatrix} (-5,0,5) \\ (-6,1,6) \\ (-6,0,6) \end{bmatrix} & \begin{bmatrix} (-5,1,7) \\ (-8,0,8) \\ (-6,1,8) \end{bmatrix} & \begin{bmatrix} (-6,-1,7) \\ (-7,0,7) \\ (-4,2,8) \end{bmatrix}
 \end{array}$$

The Fuzzy zeros are in position (1, 1), (2, 2), (2, 3) and (3, 1) of the reduced matrix. If it take the fuzzy zero in the (1, 1), the adjacent values (-6, 1, 6) and (-5, 1, 7) which are greater than fuzzy zero. So the fuzzy suffix value for that position (1, 1) is given by $\frac{(-6.1.6)+(-5.1.7)}{(2,2,2)} = (-5.5, 1, 6.5)$,

Where the fuzzy number (2, 2, 2) is the fuzzy value of the number of adjacent values which are greater than fuzzy zero added. Similarly find the fuzzy suffix value for all other fuzzy zeros. The values given below are in the position (2, 2) is (-6, 1, 8), for the position of (2, 3) is (-6, 1, 7), for the position of (3, 1) is (-6, 1, 7). Out of all these fuzzy suffix value, the fuzzy suffix value of fuzzy zero in the position (1,1) is maximum. Therefore allocate the corresponding fuzzy supply or fuzzy demand whichever is less to that (1, 1) position. From the problem it is noted that in that position the corresponding fuzzy supply (0, 3, 6) is minimum. So allocate the corresponding fuzzy supply (0, 3, 6) to that position and delete the corresponding row. This is given as follows.

$$\begin{array}{l}
 \text{Source 1} \\
 \text{Source 2} \\
 \text{Source 3} \\
 \text{Demand}
 \end{array}
 \begin{array}{ccc}
 \text{Destination 1} & \text{Destination 2} & \text{Destination 3} \\
 \begin{bmatrix} (1,2,3)^{(0,3,6)} \\ (3,4,5) \\ (1,2,4) \end{bmatrix} & \begin{bmatrix} (2,3,4) \\ (2,3,6) \\ (2,3,5) \end{bmatrix} & \begin{bmatrix} (1,2,5) \\ (3,4,6) \\ (4,5,6) \end{bmatrix} \\
 (0,3,6) & (2,5,8) & (2,4,7)
 \end{array}$$

After deleting the first row the matrix is given as follows

$$\begin{array}{ccc}
 \text{Destination 1} & \text{Destination 2} & \text{Destination 3}
 \end{array}$$

$$\begin{array}{l} \text{Source 2} \\ \text{Source 3} \end{array} \begin{bmatrix} (3,4,5) & (2,3,6) & (3,4,6) \\ (1,2,4) & (2,3,5) & (4,5,6) \end{bmatrix}$$

Applying the above mentioned procedure again and again we get the optimal table which is given as follows.

$$\begin{array}{l} \text{Source 1} \\ \text{Source 2} \\ \text{Source 3} \\ \text{Demand} \end{array} \begin{array}{l} \text{Destination 1} \\ \text{Destination 2} \\ \text{Destination 3} \\ \text{Supply} \end{array} \begin{bmatrix} (1,2,3)^{(0,3,6)} & (2,3,4) & (1,2,5) \\ (3,4,5) & (2,3,6)^{(2,4,8)} & (3,4,6)^{(-6,1,6)} \\ (1,2,4)^{(-5,0,6)} & (2,3,5) & (4,5,6)^{(-5,4,13)} \\ (1,3,6) & (2,4,8) & (1,5,7) \end{bmatrix} \begin{array}{l} (0,3,6) \\ (2,5,8) \\ (2,4,7) \end{array}$$

$$\text{Fuzzy T.C} = (1, 2, 3) * (0, 3, 6) + (1, 2, 4) * (-5, 0, 6) + (2, 3, 6) * (2, 4, 8) + (3, 4, 6) * (-6, 1, 6) + (4, 5, 6) * (-5, 4, 13)$$

$$= (-39, 42, 204)$$

$$= \frac{249}{4}$$

$$\text{Fuzzy T.C} = 62.25$$

6. CONCLUSION

In this paper, we proposed a new technique called as Neutrosophic method to find the IBFS using ranking method with Neutrosophic fuzzy transportation problem whose transportation cost are taken as triangular fuzzy numbers. For future research we propose generalized triangular Neutrosophic fuzzy numbers to deal problems in Neutrosophic fuzzy environment

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