



Membership and Non Membership Function of Pentagonal Fuzzy Number

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Abstract- *Transportation models play an important role in logistics and supply chain management for reducing cost and improving service. In this paper, we proposed a new membership and non-membership function according to the Ranking function. This paper develops a procedure to derive the feasible solution of the fuzzy transportation problem, in that the cost coefficients and the supply and demand quantities are fuzzy numbers. Two different types of the fuzzy transportation problem are discussed: one with membership ranking function and the other non-membership ranking function. It is found that the membership ranking function show a profit from the fuzzy transportation problem.*

Keywords- *Membership Function, Non-Membership Function, Ranking Function, fuzzy transportation problem, Pentagonal Fuzzy Numbers.*

Mathematical Classification : 90B06, 90B60

1. Introduction

Transportation problems have been widely studied in Computer Science and Operations Research. It is one of the fundamental problems of network flow problem which is usually use to minimize the transportation cost for industries with number of sources and number of destination while satisfying the supply limit and demand requirement.

The basic transportation problem was developed by Hitchcock. Fuzzy set theory introduced by Zadeh [9] in 1965 opened a new horizon to deal with imprecise information while making decisions. The idea of fuzzy set was first proposed by Bellman and Zadeh [1] as a mean of handling uncertainty that is due to imprecision rather than randomness. Zimmermann's [10] fuzzy linear programming has developed into several fuzzy optimization methods for solving the transportation problems. Chanas and Kuchta [2] proposed A concept of optimal solution of the transportation with fuzzy cost coefficient, Uthraet. al [8] solved ranking generalized Intuitionistic Pentagonal Fuzzy Number by centroidal approach. Helen and Uma [5] proposed a new operation and ranking on pentagon fuzzy numbers. Ponnivalavan and Pathinathan [6] obtained Intuitionistic Pentagonal fuzzy number. Sujatha and Elizabeth [7] introduced Fuzzy one point method for finding the fuzzy optimal solution for FTP and FUAP, Chanas and Kuchta proposed a concept of the optimal solution of the transportation problem with fuzzy cost coefficients. Dhurai and karpagam [3] proposed to obtain initial basic feasible solution physical distribution problems. Dhurai and karpagam [4] proposed new ranking function on octagonal fuzzy number for solving fuzzy transportation problem.

This paper is structured as follows: In section 2, we have reviewed the preliminary concepts of fuzzy set theory. In section 3, we have proposed new membership function, Non-membership function according as Ranking Function. Through illustrative examples, the optimal solution obtained in this paper is compared with the membership ranking function and non-membership ranking function. Section 4, concludes the paper.

II. Preliminaries

2.1. The characteristic function μ_A of a crisp set $A \subset X$ assigns a value either 0 or 1 to each individual in the universal set X . This function can be generalized to a function μ_A such that the value assigned to the element of the universal set X fall within a specified range i.e. $\mu_A : X \rightarrow [0,1]$. The assigned value indicates the membership function and the set $\tilde{A} = \{(x, \mu_A(x)); x \in X\}$ defined by $\mu_A(x)$ for $x \in X$ is called fuzzy set.

2.2. An fuzzy set $A = \{x, \mu_{\tilde{A}}(x), \gamma_{\tilde{A}}(x); x \in X\}$ of the real line R is called an fuzzy number if

- A is convex for the membership function $\mu_{\tilde{A}}(x)$.
- A is concave for the non-membership function $\gamma_{\tilde{A}}(x)$.
- A is normal, that is there is some $x_0 \in R$ such that $\mu_{\tilde{A}}(x_0) = 1, \gamma_{\tilde{A}}(x_0) = 0$.

2.3. Mathematical formulation of a fuzzy Transportation problem

The general form of Transportation problem

Minimize (Total cost) $Z = \sum_{i=1}^m \sum_{j=1}^n c_{ij} x_{ij}$

Subject to the constraints $\sum_{j=1}^n x_{ij} = a_i, \quad i=1,2,3,\dots,m$

$$\sum_{i=1}^m x_{ij} = b_j, \quad j=1,2,3,\dots,n$$

$x_{ij} \geq 0$ for all i and j .

III. Proposed method

3.1 Membership and Non- Membership function

A fuzzy number $\tilde{A}_p$ is a pentagonal fuzzy number denoted by $\tilde{A}_p = (a_1, a_2, a_3, a_4, a_5)$ where $(a_1, a_2, a_3, a_4, a_5)$ are real numbers and its membership function $\mu_{\tilde{A}_p}(x)$ and non- membership function $\gamma_{\tilde{A}_p}(x)$ is given below

$$\mu_{\tilde{A}_p}(x) = \begin{cases} 0 & x < a_1 \\ \frac{x - a_1}{a_2 - a_1} & a_1 \leq x \leq a_2 \\ 1 - \frac{1}{4} \left(\frac{x - a_2}{a_3 - a_2} \right) & a_2 \leq x \leq a_3 \\ \frac{3}{4} - \frac{1}{2} \left(\frac{x - a_3}{a_4 - a_3} \right) & a_3 \leq x \leq a_4 \\ \frac{1}{4} - \frac{1}{4} \left(\frac{x - a_4}{a_5 - a_4} \right) & a_4 \leq x \leq a_5 \\ 0 & x > a_5 \end{cases}$$

$$\gamma_{\tilde{A}_p}(x) = \begin{cases} 0 & x < b_1 \\ 1 - \frac{x - b_1}{b_2 - b_1} & b_1 \leq x \leq b_2 \\ \frac{1}{4} \left(\frac{x - b_2}{b_3 - b_2} \right) & b_2 \leq x \leq b_3 \\ \frac{1}{4} + \frac{1}{2} \left(\frac{x - b_3}{b_4 - b_3} \right) & b_3 \leq x \leq b_4 \\ \frac{3}{4} + \frac{1}{4} \left(\frac{x - b_4}{b_5 - b_4} \right) & b_4 \leq x \leq b_5 \\ 0 & x > b_5 \end{cases}$$

We conclude that membership function + Non membership function = 1

3.2 Ranking Function

An effective approach for ordering the elements of $F(R)$ is also to define a ranking function $\Re : F(R) \rightarrow R$ which maps each fuzzy number into the real line, where a natural order exists. We define orders on $F(R)$ by:

$\tilde{a} \geq \tilde{b}$ if and only if $R(\tilde{a}) \geq R(\tilde{b})$

$\tilde{a} > \tilde{b}$ if and only if $R(\tilde{a}) > R(\tilde{b})$

$\tilde{a} = \tilde{b}$ if and only if $R(\tilde{a}) = R(\tilde{b})$

Ranking Function of Membership and Non- Membership Function is given below

$$\Re_1(A) = \frac{a_1 + a_2 + 0.75a_3 + 0.25a_4 + a_5}{4} \quad (3.2.1)$$

$$\Re_2(A) = \frac{a_1 + a_2 + 0.25a_3 + 0.75a_4 + a_5}{4} \quad (3.2.2)$$

Example 3.3

Consider the following fuzzy transportation problem. The aim of the decision maker is to minimize the total fuzzy transportation cost.

	K_1	K_2	K_3	K_4	FS
M_1	(2,4,6,8,10)	(3,5,7,9,11)	(4,7,9,12,14)	(1,3,4,6,8)	(10,11,12,13,14)
M_2	(5,7,8,9,10)	(1,3,6,9,11)	(1,3,5,7,9)	(0,2,5,8,10)	(11,13,15,17,19)
M_3	(1,2,3,4,5)	(0,1,5,3,4,5,5,5)	(1,2,2,8,4,5)	(0,1,5,2,8,4,5,5,5)	(12,14,16,18,20)
M_4	(1,5,2,2,5,3,3,5)	(1,2,1,8,2,4,3,3,6)	(2,1,2,5,3,2,3,8,4,3)	(3,2,3,8,4,2,4,7,5,2)	(11,12,13,14,15)
FD	(17,19,21,23,25)	(8,9,10,11,12)	(9,10,11,12,13)	(10,12,14,16,18)	

	K_1	K_2	K_3	K_4	S
M_1	5.6	6.6	8.6	4.1	11.8
M_2	7.5	5.4	4.6	4.4	14.6
M_3	2.8	2.5	2.7	13.6	15.6
M_4	2.4	2.2	3.0	4.1	12.8
D	20.6	9.8	10.8	13.6	54.8

Solution:

The procedure for first stage of fuzzy transportation problem using the membership ranking function (3.2.1) converted to crisp value.

Check whether the given Tp is a balanced one. If not, convert into balanced Tp by introducing the dummy column or dummy row with cost entry one.

To obtain the initial basic feasible solution using least cost method or Dhu-Kar method or VAM method or any other methods.

11.8	5.6	6.6	8.6	4.1	11.8
5.8	7.5	5.4	8.8	4.6	4.4
2.8	2.5	2	2.7	13.6	2.5
3	2.4	9.8	2.2	3.0	4.1
20.6	9.8	10.8	13.6	54.8	

The minimum transportation cost associated with this solution is

$$\text{Min } Z_1 = 11.8 \times 5.6 + 5.8 \times 7.5 + 8.8 \times 4.6 + 2 \times 2.7 + 13.6 \times 2.5 + 3 \times 2.4 + 9.8 \times 2.2 = 218.22$$

The same procedure by applying the non- membership ranking function (3.2.2) converted to crisp value and obtained the minimum transportation cost as follows

11.9	5.8	6.8	9.0	4.3	11.9
3.9	7.6	5.8	10.9	4.8	4.8
2	2.9	2.7	2.9	13.8	2.7
3	2.4	9.9	2.3	3.1	4.1
20.8	9.9	10.9	13.8	55.4	

$$\text{Min } Z_2 = 11.9 \times 5.8 + 3.9 \times 7.6 + 10.9 \times 4.8 + 2 \times 2.9 + 13.8 \times 2.7 + 3 \times 2.4 + 9.9 \times 2.3 = 223.99$$

Sl.No	Membership ranking function	Non- Membership ranking function
1	218.22	223.99
2	193.38	202.37
3	338.40	350.08
4	363.02	371.91
5	358.23	366.52
6	154.65	159.87
7	98.27	103.85
8	189.67	164.21
9	157.98	162.84
10	289.54	295.38

Table 3.3.1 Comparison Results between MRF and NMRF

IV. Conclusion

In today's highly competitive market, various organizations want to deliver products to the customers in a cost effective way, so that the transportation model provides a powerful framework to determine the best ways to deliver goods to the customers. In this paper, we conclude that the membership ranking function are the minimum transportation cost compared with the non- membership ranking function. Ranking function is reasonable and effective for calculating the pentagonal fuzzy number.

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