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A Comparison of Proposed Ranking Method for Fuzzy Transportation Problem with the Existing Method

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Abstract:

In this paper, we proposed two ranking methods to solve the transportation problems. Here we introduced new methods for problem solving. In this article, we proposed two ranking functions called ῡ_μ (Value Ranking) and Ā_μ(Ambiguity Ranking) to solve the transportation problems. This work's main aim is to compare the suggested ranking function with the existing ranking method (Roubast Ranking). We have compared it with an example and justified it..

Keywords: Trapezoidal fuzzy numbers, Fuzzy Transportation Problem, Roubast Ranking Method, Value Ranking, Ambiguity Ranking.

1. Introduction

Transportation models can be widely utilized in supply chain and logistics to minimize costs when there is accurate knowledge of the demand and supply quantities, as well as the cost coefficients. In these situations, efficient algorithms for solving the transportation problem have been developed. An Optimal Algorithm for a FTP (Fuzzy Transportation Problem) was studied in [1]. Randomness and imprecision are inevitable in the real world due to unanticipated events. They put forth a novel strategy in [2,3] to address the transportation issues with fuzzy numbers. In certain situations, uncontrollable factors may lead to uncertainty in the cost coefficients and demand & supply quantities of a transportation problem. Finding the schedule of shipping which reduces overall fuzzy transportation costs while meeting demand limits & fuzzy supply is the aim of the fuzzy transportation problem. We proposed a similarity measure in [4,5,6] using vector length for a TrIFNs, sign distance, and value ambiguity indices. Various ranking procedures are used to propose the measures. In this work, we addressed more practical issues, such as the fuzzy cost $\tilde{c}_{ij}$ transportation problem. The objective function is also regarded as a FN since the goal is to maximize total profit or minimize total cost, subject to certain fuzzy constraints. To find the best option, the objective function’s fuzzy objective values are ranked according to value using the ambiguity ranking approach for numbers. The FTP has been transformed using the α cut solution. The concept involves converting a fuzzy parameter problem into an LPP and using the Vogel Approximation Method to solve it.

2. Objectives

Definition:2.1

A FN $\tilde{A}$ has to be generalized TrFNs (Trapezoidal Fuzzy Number) having a parameter $\leq a_1 \leq a_2 \leq a_3 \leq a_4$ and represented by

$$\tilde{A} = (a_1, a_2, a_3, a_4)$$

and its membership functions are followed below.

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

Definition: 2.2

Tough ranking algorithm that yields results consistent with human intuition while meeting linearity, additivity, and compensation requirements. If ã then the Robust Ranking which has been defined by $\mathrm{R}(\tilde{a}) = \int_0^1 (0.5)(a_\alpha^L a_\alpha^U) d\alpha$ where $(a_\alpha^L a_\alpha^U)$ is the α level cut of the FN ã we use this approach for objective values ranking. The R(ã) provides the representative value of FN ã.

2.3 Arithmetic operations on Generalized Trapezoidal Fuzzy Numbers

Let $\tilde{A}$= (a_1, a_2, a_3, a_4) and

$\tilde{B}$ = (b_1, b_2, b_3, b_4) be 2 generalized TrFNs & λ be a real number. Then

1. $\tilde{A}$+$\tilde{B}$ = $(a_1 + b_1$, $a_2 + b_2$, $a_3 + b_3$, $a_4 + b_4)$

2. $\tilde{A}$-$\tilde{B}$ = $(a_1 - b_4$, $a_2 - b_3$, $a_3 - b_2$, $a_4 - b_1)$

3. $\boldsymbol{\lambda}\tilde{A}$ = ($\boldsymbol{\lambda} a_1$, $\boldsymbol{\lambda} a_2$, $\boldsymbol{\lambda} a_3$, $\boldsymbol{\lambda} a_4$); if $\boldsymbol{\lambda}$ > 0

   ($\boldsymbol{\lambda} a_4$, $\boldsymbol{\lambda} a_3$, $\boldsymbol{\lambda} a_2$, $\boldsymbol{\lambda} a_1$) if $\boldsymbol{\lambda}$ > 0

4.Let $R(\tilde{B})$ = $\frac{b_1+b_2+b_3+b_4}{4}$

   $\tilde{A} \times \tilde{B}$= $(a_1 R(\tilde{B})$, $a_2 R(\tilde{B})$, $a_3 R(\tilde{B})$, $a_4 R(\tilde{B}))$

5. Let $R(\tilde{B})$ = $\frac{b_1+b_2+b_3+b_4}{4}$

   $\tilde{A} \div \tilde{B}$ = $\left(\frac{a_1}{R(\tilde{B})}, \frac{a_2}{R(\tilde{B})}, \frac{a_3}{R(\tilde{B})}, \frac{a_4}{R(\tilde{B})} \right)$

3. Methods

(i) Vague ranking function

$$\bar{\upsilon}_{ij}(x) = \int_0^1 (L_{\tilde{A}^i}(\alpha) + R_{\tilde{A}^i}(\alpha)) f(\alpha) d\alpha$$

$$\bar{\upsilon}_{ij}(x) = \int_0^1 [a_1 + \alpha(a_2 - a_1) + a_4 - \alpha(a_4 - a_3)]\alpha\, d\alpha$$

After simplification, we get

$$\bar{\upsilon}_{ij}(x) = \frac{a_1 + 2a_2 + 2a_3 + a_4}{6}$$

The vague ranking function of TrFN is defined as $\bar{\upsilon}_{\mu}(x) = \frac{a_1+2a_2+2a_3+a_4}{6}$

(ii) Ambiguity ranking function

$$\bar{A}_{ij}(x) = \int_0^1 (R_{\tilde{A}^i}(\alpha) - L_{\tilde{A}^i}(\alpha)) f(\alpha) d\alpha$$

$$\tilde{A}_{ij}(x) = \int_0^1 [a_4 - \alpha(a_4 - a_3) - a_1 + \alpha(a_2 - a_1)]\alpha\, d\alpha$$

After simplification, we get

$$\bar{A}_{\mu}(x) = \frac{-a_1 - 2a_2 + 2a_3 + a_4}{6}$$

The ambiguity ranking function of TrFN is defined as

$$\bar{A}_{\mu}(x) = \frac{-a_1 - 2a_2 + 2a_3 + a_4}{6}$$

4. Results

Transportation Problem Using Proposed Ranking Function

The company has four sources, denoted as s_1, s_2, s_3, and s_4, and four destinations, also denoted as s_1, s_2, s_3, and s_4. The fuzzy transportation cost for transferring one unit of the product from the ith source to the jth destination is determined by the given formula.

$$C_{ij} = \begin{pmatrix} (1,2,3,4)(1,3,5,6)(9,11,12,14)(5,7,8,11) \\ (0,1,2,4)(-1,0,1,2)(5,6,7,8)(0,1,2,3) \\ (3,5,6,8)(5,8,9,12)(12,15,16,19)(7,9,10,12) \end{pmatrix}$$

The availability of the sources are ((1,6,7,12), (0,1,2,3), (5,10,12,17)) and the product's fuzzy demand at destinations are ((5,7,8,10), (1,5,6,10), (1,3,4,6) (1,2,3,4)) correspondingly.

Then the problem becomes as

	f_{D_1}	f_{D_2}	f_{D_3}	f_{D_4}	Supply
f_{S_1}	(1,2,3,4)	(1,3,4,6)	(9,11,12,14)	(5,7,8,11)	(1,6,7,12)
f_{S_2}	(0,1,2,4)	(-1,0,1,2)	(5,6,7,8)	(0,1,2,3)	(0,1,2,3)
f_{S_3}	(3,5,6,8)	(5,8,9,12)	(12,15,16,19)	(7,9,10,12)	(5,10,12,17)
Demand	(5,7,8,10)	(1,5,6,10)	(1,3,4,6)	(1,2,3,4)	

Table:1

Solution: The following mathematical programming form can be used to formulate the fuzzy transportation problem.

(i) Vague ranking function

$$\bar{\upsilon}_{ij}(x) = \frac{a_1 + 2a_2 + 2a_3 + a_4}{6}$$

By substituting the values, we get

$\bar{\upsilon}_{11}(x)$ = 2.5; $\bar{\upsilon}_{12}(x)$ = 3.5; $\bar{\upsilon}_{13}(x)$ = 11.5; $\bar{\upsilon}_{14}(x)$ = 7.7

$\bar{\upsilon}_{21}(x)$ = 1.7; $\bar{\upsilon}_{22}(x)$ = 0.5; $\bar{\upsilon}_{23}(x)$ = 6.5; $\bar{\upsilon}_{24}(x)$ = 1.5

$\bar{\upsilon}_{31}(x)$ = 5.5; $\bar{\upsilon}_{32}(x)$ = 8.5; $\bar{\upsilon}_{33}(x)$ = 15.5; $\bar{\upsilon}_{34}(x)$ = 9.5

Supply

$\bar{\upsilon}\left(f_{S_1}\right)$ = 6.5; $\bar{\upsilon}\left(f_{S_2}\right)$ = 1.5; $\bar{\upsilon}\left(f_{S_3}\right)$ = 11

Demand

$\bar{\upsilon}\left(f_{D_1}\right)$ = 7.5; $\bar{\upsilon}\left(f_{D_2}\right)$ = 5.5; $\bar{\upsilon}\left(f_{D_3}\right)$ = 3.5; $\bar{\upsilon}\left(f_{D_4}\right)$ = 2.5

After using the value ranking function the table is

	f_{D_1}	f_{D_2}	f_{D_3}	f_{D_4}	Supply
f_{S_1}	2.5	3.5	11.5	7.7	6.5
f_{S_2}	1.7	0.5	6.5	1.5	1.5
f_{S_3}	5.5	8.5	15.5	9.5	11
Demand	7.5	5.5	3.5	2.5	

Table:2

By using the Vogel approximation method we get

2.5 $\boxed{1}$	3.5 $\boxed{1.5}$	11.5	7.7
1.7	0.5	6.5	1.5 $\boxed{1.5}$
5.5 $\boxed{6.5}$	8.5	15.5 $\boxed{3.5}$	9.5 $\boxed{1}$

Table:3

The transportation cost is

= (2.5)(1.0)+(3.5)(5.5)+(1.5)(1.5)+(5.5)(6.5)+(15.5.5)(3.5)+(9.5)(1.0)

= 123.5

(ii) Ambiguity ranking function

$$\bar{A}_{\mu}(x) = \frac{-a_1 - 2a_2 + 2a_3 + a_4}{6}$$

By the ambiguity ranking function also we get the same table value as in the value ranking function.

After using VAM we get

2.5 $\boxed{1}$	3.5 $\boxed{1.5}$	11.5	7.7
1.7	0.5	6.5	1.5 $\boxed{1.5}$
5.5 $\boxed{6.5}$	8.5	15.5 $\boxed{3.5}$	9.5 $\boxed{1}$

Table:4

The transportation cost is = 123.5.

5. Discussion and Conclusion

In [7] they used the "Roubast Ranking" to solve the transportation. Then we proposed two ranking functions and we compared them in the below table

Roubast Ranking	Value Ranking	Ambiguity Ranking
123.5	123.5	123.5

Table:5

In this article, we proposed two new ranking functions called " Value Ranking and Ambiguity Ranking" in an imprecise, vague area. Then we implemented this in the same transportation problem and we got the same cost as in Robust Ranking. To overcome the drawbacks of the existing method we newly defined the ranking function and we justified it by comparing them.

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