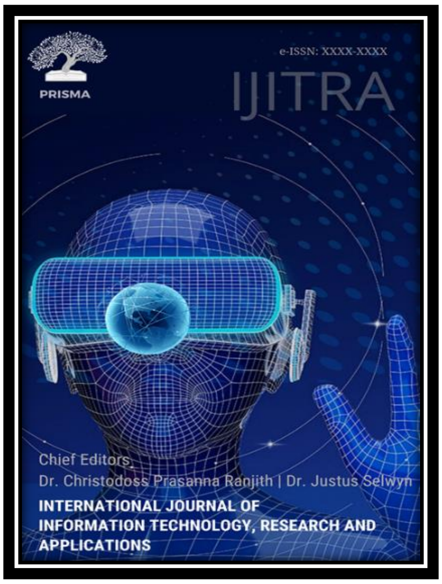

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A hybrid approach of Hungarian method to find optimal solution for solving Fuzzy Transportation Problem using Hexagonal Fuzzy numbers

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ABSTRACT

This research article explains about a hybrid approach of Hungarian method to solve Hexagonal Fuzzy Transportation Problem. Step by step algorithm is given in this article. A numerical illustration is given to verify the new hybrid algorithm. Within short duration, optimal solution is derived easily.

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1. INTRODUCTION

Transportation Problem is a branch of Linear Programming Problem which is used to find the optimal solution for transportation cost. Transportation Problem first introduced by Hitchcock (1941) and we can find brief introduction and solving methodology in [3, 4, 6, 7, 13, 17, 19]. [1, 2, 5, 10 - 16] was introduced some new algorithm to derive the direct optimal solution for transportation problem and Fuzzy Transportation Problem using different fuzzy numbers.

Fuzzy theory was introduced by LA Zadeh in 1965 and proposed a mathematical model for dealing with uncertainty concepts and every problem will have several solutions. [9] given the basic definitions for fuzzy mathematical programming problems.

2. FUZZY TRANSPORTATION PROBLEM [FTP]:

The fuzzy transportation problems in which a decision maker is uncertain about the precise values of transportation cost, availability and demand. They are categorized into two types namely, Balanced Fuzzy Transportation Problem [BFTP] and Unbalance Fuzzy Transportation Problem [UFTP]. Unbalance fuzzy transportation problem is converted into balanced fuzzy transportation problem by introducing new dummy origin or dummy destination as per requirement.

3. DEFINITION: HEXAGONAL FUZZY NUMBERS [5]

The Fuzzy Number H is a Hexagonal Fuzzy A_H is a hexagonal fuzzy number denoted $A_H(a, b, c, d, e, f; 1)$ and its membership function $\mu A_H(X)$ is given below:

$$\mu A_H(X) = \begin{cases} \dfrac{y-a}{b-a}, & a \le y \le b \\ 1, & b \le y \le c \\ \dfrac{d-y}{d-c}, & a \le y \le d \\ 0, & otherwise \\ \dfrac{y-c}{d-c}, & c \le y \le d \\ 1 & d \le y \le e \\ \dfrac{f-y}{f-c}, & e \le y \le f \\ 0, & otherwise \end{cases}$$

$$R(A) = \int_0^1 (0.5)\left(A^L_{\{H\alpha\}}, A^U_{\{H\alpha\}}\right) d_\alpha$$

Where $\left(A^L_{\{H\alpha\}}, A^U_{\{H\alpha\}}\right) = (\{(b-a)\alpha + a, d-(d-c)\alpha\}, \{(d-c)\alpha + c, f-(f-e)\alpha\})$

Numerous types of numbers are employed and created using various techniques. While [1] presented an intuitionist fuzzy number, [8] employed trapezoidal fuzzy numbers and proposed a novel technique and used alpha-cut triangular numerals.

4. HYBRID APPROACH OF HUNGARIAN ALGORITHM FOR SOLVING HEXAGON FUZZY TRANSPORTATION PROBLEM [HFTP]:

Step 1: Check the given FTP is balanced or not balanced.
Step 2: If it is balanced move to Step 4, if it is not balanced move to Step 3.
Step 3: Convert the given UFTP into BFTP by adding dummy origin or dummy destination.
Step 4: Transform the HFTP into crisp transportation problem using Range technique [CP].
Step 5: Check whether the objective function is Minimum or Maximum, If its Maximum convert into Minimum with usual process.
Step 6: Check the Transportation matrix is square, if not make it square by adding dummy row or column with zero weightages.
Step 7: Apply the Hungarian Method.
Step 8: Get the optimum solution and identify the encircled elements.
Step 9: Consider the cell containing encircled zeros and allocate the supply and demand first in the encircled cell
Step 10: Check the supply and demand are fully satisfied.
Step 11: If yes move to step 13 otherwise move to step 12.
Step 12: Use traditional method to find the optimal solution.
Step 13: Write down the optimum solution.

5. NUMERICAL ILLUSTRATIONS [5]

Example Problem: Let us consider a fuzzy transportation problem with rows representing 6 persons A, B, C, D, E, F columns and representing 6 jobs like job1, job2, job3, job4, job5, job6.The cost matrix $[a_{ij}]$ is given whose elements are hexagonal fuzzy numbers. The problem is to find the optimal transportation cost so that the total cost of job become minimum.

	D1	**D2**	**D3**	**D4**	**Supply**
O1	(14, 16, 18; 12, 16, 20)	(0, 1, 2; -1, 1, 3)	(7, 8, 9; 6, 8, 10)	(11, 13, 15; 10, 13, 16)	(2,4, 6; 1, 4, 7)
O2	(8,11,14; 7,11,15)	(3,4,5; 2,4,6)	(5,7,9; 4,7,10)	(8,10,12; 6,10,14)	(5,6,7; 4,6,8)
O3	(6,8,10; 5,8,11)	(13,15,17; 12,15,18)	(7,9,11; 6,9,12)	(1,2,3; 0,2,4)	(7,8,9; 5,8,11)
Demand	(3,4,5; 2,4,6)	(3,5,7; 1,5,9)	(10,12,14; 8,12,16)	(6,7,8; 5,7,9)	

	D1	D2	D3	D4	Supply
O1	(14, 16, 18; 12, 16, 20)	(0, 1, 2; -1, 1, 3)	(7, 8, 9; 6, 8, 10)	(11, 13, 15; 10, 13, 16)	(2,4, 6; 1, 4, 7)
O2	(8,11,14; 7,11,15)	(3,4,5; 2,4,6)	(5,7,9; 4,7,10)	(8,10,12; 6,10,14)	(5,6,7; 4,6,8)
O3	(6,8,10; 5,8,11)	(13,15,17; 12,15,18)	(7,9,11; 6,9,12)	(1,2,3; 0,2,4)	(7,8,9; 5,8,11)
O4	(0,0,0; 0,0,0)	(0,0,0; 0,0,0)	(0,0,0; 0,0,0)	(0,0,0; 0,0,0)	(8,10,12; 6,10,14)
Demand	(3,4,5; 2,4,6)	(3,5,7; 1,5,9)	(10,12,14; 8,12,16)	(6,7,8; 5,7,9)	

	D1	D2	D3	D4	Supply
O1	31.5	2.75	15.75	25.75	7.75
O2	21.75	7.75	13.75	19.5	11.75
O3	15.75	29.75	17.75	3.75	15.5
O4	0	0	0	0	19.5
Demand	7.75	9.5	23.5	13.75	

	D1	D2	D3	D4	Supply
O1	31.5	2.75 (7.75)	15.75	25.75	7.75
O2	21.75	7.75	13.75 (11.75)	19.5	11.75
O3	15.75	29.75	17.75 (1.75)	3.75 (13.75)	15.5
O4	0 (7.75)	0 (1.75)	0 (10.75)	0	19.5
Demand	7.75	9.5	23.5	13.75	

The Transportation cost $Z = (2.75 \times 7.75) + (13.75 \times 11.75) + (3.75 \times 13.75) + (17.75 \times 1.75) = 265.5$

Comparison with Existing Methods: The proposed method is compared with literature method [5] in the table below, and it is clear that the proposed method produces the best results.

Methods	Optimal Solution
	Example 1
Method used in [5]	299.49
Proposed Method	**265.5**

6. CONCLUSION

In this article, the author introduced new hybrid approach of Hungarian method for finding optimal solution for FTP by using Hexagonal Fuzzy numbers. Numerical example problem is taken from the literature and solved the same problem using proposed method. A comparison is also made between proposed and literature method, it revels that the proposed method got the better optimal solution. Within short duration, one can get the optimum solution by using this proposed method.

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