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Finding the Maximization to Intuitionistic Triangular Fuzzy Transportation Problem Using Ranking Method

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Abstract:

In this research study, a new approach was introduced to determine Intuitionistic triangular fuzzy transportation problems with an objective function of the type of maximization which are used to reach the largest required profit. A utilization of this new approach was experimented in terms of the type of results obtained when it was used to solve many fuzzy transportation problems in life, and some of the illustrations have highlighted in this paper. After that, the solutions have compared with the proposed techniques like NWCM, LCM & VAM.

Keywords: Operations Research, Optimization Problems, Transportation Model, Maximization of Transportation Problems, IBFS, VAM, Intuitionistic Triangular Fuzzy Transportation Problem.

1. Introduction

In this Current scenario the need for commodities increases day by day. Accordingly, the importance of transportation plays a vital role in society. The profits and opportunities of firms that move goods from one place to another has determined by transportation. The transportation problem is one of the well-known technique in operations research that is focused with finding the number of commodities have transferred from a group of distributors to a group of warehouses through the road way so that the demand in the warehouses is met, but with the largest possible profit or the lowest possible cost depending on the type of problem.

TP was first proposed by Frank L. Hitchcock (1875-1957) in 1941 in his paper "The distribution of a product from several sources to numerous localities". In 1947, Tjalling C.Koopmans presented his paper titled "Optimum utilization of the transportation system". The above mentioned studies are the main motto in developing various approaches to solving transportation problems. Transportation problem focused mainly on the optimal solution that reach the maximum profit or the lowest cost according to the type of problem with which the homogeneous goods are to be transported from many factories (sources) to many warehouses (destinations).

The concept of Intuitionistic fuzzy sets (IFSs) proposed by Atanassov in 1986 is found to be highly useful to deal with vagueness. The important advantages of IFS over fuzzy set is that IFSs Separate the degree of membership (belongingness) and the degree of non-membership of an element in the set. In this paper, we find basic solution for an IFTP using zero suffix method where the supply and demand are Intuitionistic triangular fuzzy numbers.

After illustrating the new approach proposed in this paper it may be used to solve many transportation problems in real life, its utilization had been proven by giving the required results that are better or equal to the results obtained by

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using the three well-known existing methods. For examples, to find the optimal solution of nonlinear systems and optimization problems we used the trust region techniques conjugate gradient techniques line search techniques and projection technique, and some article in reliability, but in this work we introduce a new technique to find the maximization to transportation problems. D. Santhosh Kumar and G. Charles Rabinson have introduced Profit Maximization of Balanced Fuzzy Transportation Problem Using Ranking Method (2018). G.Charles Rabinson and R.Chandrasekaran have worked on A Method for Solving a Pentagonal Fuzzy Transportation Problem via Ranking Technique and ATM (2019). K. Nandhini and G. Charles Rabinson have given about Socratic Technique to Solve the Bulk Hexadecagonal Fuzzy transportation Problem Using Ranking Method (2021). M Pachamuthu, G Charles Rabinson have put their contribution on Neutrosophic Fuzzy Transportation Problem for finding optimal solution Using Nanogonal Number (2021).

1.1: Definition: Transportation problem:

The classical transportation problem concerns minimizing the cost of transporting a single item from sources to destinations. The total number of items produced at each origin, the total number of items required at each destination and the cost to transport one unit from each source to each destination are the basic inputs. The objective which has to minimize the total cost of transporting the items produced at sources to reach the demands at destinations.

1.2: Maximization Transportation Model

There are various types of transportation problems which have the objective function to be maximized instead of being minimized. This kind of problems can be solved by converting the maximization case into a minimization case. Transportation which means transfer of products from different sources to different destinations. Suppose that a firm has production units at $S_1, S_2, \dots, S_m$ The demand to produce merchandise is at n various centers $D_1, D_2, \dots, D_n$. The firm problem is to transport merchandise from m different production units to n different demand centers with minimum cost. Consider the cost of shipping from production unit S_i to the demand center D_j is C_{ij} , and X_{ij} unit is shipped from S_i to D_j , then the cost is $C_{ij}X_{ij}$. Therefore, the total shipping cost is

Max z = $\sum_{i=1}^{m}\sum_{j=1}^{n} C_{ij}x_{ij}$

The matrix $(C_{ij})_{m\times n}$ is called the unit cost matrix. The products are transported from the source ito the demand j. We wish to find $X_{ij} \geq 0$ which satisfy the m + n -1constraints. Then, we have

$\sum_{j=1}^{n} x_{ij} = a_i$ & $\sum_{i=1}^{m} x_{ij} = b_j$

$X_{ij} \geq 0$

Where a &b are total supply and total demand.

2.1: Definition: Fuzzy set: A fuzzy set is characterized by a membership function mapping element of a domain, space or universe of discourse X to the unit interval [0, 1]. i.e. Á = {(x, μÁ (x); x ∈ X}, Here μÁ: X →[0,1] is a mapping called the degree of membership function of the fuzzy set Á and μÁ (x) is called the membership value of x ∈ X in the fuzzy set Á. These membership values are frequently represented by real numbers represent from [0,1].

2.2: Definition: Fuzzy Balanced Transportation Problem:

The balanced fuzzy transportation problem, in which a decision maker is uncertain about the precise values of transportation cost, availability and demand, may be formulated as LPP as follows

Minimize $\Sigma\Sigma cij * xij$

Subject to

$\Sigma xij=ai$, i=1,2,….p, $\Sigma xij=bj$, j=1,2,….q

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$\Sigma ai = \Sigma bj$

Here xij is a non negative triangular fuzzy number, where

p = total number of sources

q = total number of destinations

ai = the fuzzy capacity of the product at i^{th} origin

bj = the fizzy requirement of the product at j^{th} destination

cij = the fuzzy transportation cost for unit quantity of the product from ith source to jth destination

xij = the fuzzy quantity if the product that should be transported from ith source to jth destination to minimize the total fuzzy transportation cost ,

Σai = total fuzzy availability of the product,

Σbj= total fuzzy demand of the product,

$\Sigma\Sigma cij * xij$ = total fuzzy transportation cost.

2.3: Definition: Intuitionistic Fuzzy Set: An Intuitionistic fuzzy set (IFS) A_I in X is given by a set of ordered triples: A_I= {x, μA_I (x), νA_I (x) /x ∈ X}, where μA_I , νA_I: X → [0, 1] are functions such that 0 ≤ μA_I (x) + νA_I (x) ≤ 1 for all x ∈ X. For each x the numbers μA_I (x) and νA_I (x) represent the degree of membership and degree of non-membership of the element x ∈ X to A_I ⊂ X, respectively.

2.4: Definition: Intuitionistic Fuzzy Number: An Intuitionistic fuzzy subset A_I= {x, μA_I (x), νA_I (x) /x ∈ X}, of the real line R is called an Intuitionistic Fuzzy Number (IFN) if the following holds:

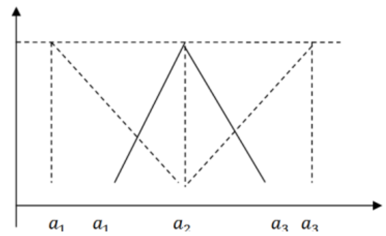
(i) There exist $\bar{x}$ ∈ R, μA_I ($\bar{x}$) = 1 and νA_I ($\bar{x}$) = 0, ($\bar{x}$ is called the mean value of A_I).

(ii) μ$A_I$is a continuous mapping from R to the closed interval [0, 1] and ∀ x ∈ R,

the relation 0 ≤ μA_I (x) + νA_I (x) ≤ 1 holds.

2.5: Definition: Intuitionistic Triangular Fuzzy Number: A Triangular Intuitionistic Fuzzy Number

(p,q,r: u,v,w) A_I is an Intuitionistic fuzzy set in R with the following membership function μA_I(x) and non membership function νA_I(x) :



Membership and non membership functions of TrIFN

$$\mu A_I(x) = \begin{cases} \frac{x-p}{q-p}, & p \le x \le q \\ \frac{r-x}{r-q}, & q \le x \le r \\ 0, & Otherwise \end{cases}$$

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$$\nu A_I(\mathrm{x}) = \begin{cases} \frac{v-x}{u-v}, & \mathrm{u} \leq \mathrm{x} \leq \mathrm{v} \\ \frac{x-v}{w-v}, & \mathrm{v} \leq \mathrm{x} \leq \mathrm{w} \\ 0, & Otherwise \end{cases}$$

This TIFN is denoted by A_I Tr IF N = (p,q,r; u,q,w).

Note: q=v

2.6: Ranking of Triangular Intuitionistic Fuzzy Numbers:

[13,15] The Ranking of a triangular Intuitionistic fuzzy number is completely defined by its membership and non- membership as follows: Let A_I = (p,q,r:u,q,w)

$$R[\mu A_I(x)] = \left[\frac{(p+2q+r)+(u+2q+w)}{8}\right]$$

2.7: Definition: Intuitionistic Fuzzy Transportation Problem:

Consider a transportation with m Intuitionistic Fuzzy (IF) origins and n IF destination. Let Cij (i = 1, 2, · · · , m & j = 1, 2, · · · , n) be the cost of transporting one item of the product form i-th origin to j-th destination. Let aii (i = 1, 2, · · · ,m) be the quantity of commodity availableat IF origin i . Let bij(j = 1, 2, · · · , n) be the quantity of commodity needed of IF destination j. Let Xij (i = 1, 2, · · · , m, j = 1, 2, · · · , n) is quantity transported from i-th IF origin to j-th IF destination.

3. The Steps of the New Approach

The following solution steps are specific to the technique suggested in this paper:

Step1: Building TP schedule.

Step 2: Transform the problem from maximum into minimum by subtracting every value from the highest value in Transportation Problem.

Step3: Convert the unbalanced TP to balanced TP.

Step 4: At every row define the two minimum values and output the difference between these two values (called the penalty). And at every column define the two maximum values and output the difference between these two values (called the penalty).

Step5: Determine which row or column corresponds to the largest difference obtained in Step 4.

Step 6: Assign the largest possible amount of demand and supply units to the cell with the lowest value in the specific row or column chosen in Step 5. If the highest differences are repeated, then the cell with the lowest value in the row or column corresponding to the largest difference is chosen. When there is a redundancy in the minimum cells, the cell that takes the maximum possible amount of allocation is chosen. If a repeat occurs in the maximum allotted quantity in the minimum cells, the cell corresponding to the largest is chosen from among the demand or supply.

Step7: After allocating the maximum possible quantity for the selected cell, the row (or column) in which the supply (or demand) was consumed is removed.

Step8: Repeat the process until all supply and all demand have been exhausted.

Step9: Put the values of the decision variables x_{ij} into the TP schedule in Step 1.

Step10: Apply the objective function to find the solution to the problem.

4. Numerical Example:

Consider the 5× 5 Intuionistic Fuzzy Transportation Problem

	IS1	IS2	IS3	IS4	IS5	IF supply
IO1	(2,4,5; 1,4,6)	(2,5,7; 1,5,8)	(4,6,8; 3,6,9)	(4,7,8; 3,7,9)	(11,12,13; 10,12,14)	(9,11,10; 8,11,11)
IO2	(4,6,8; 3, 6, 9)	(3,7,12; 2,7,13)	(10,15,20; 8,15,22)	(11,12,13; 10,12,14)	(2,4,5; 1,4,6)	(7,11,11; 10,11,12)
IO3	(3,4,6; 1,4,8)	(8,10,13; 5,10,16)	(2,3,5; 1,3,6)	(6,10,14; 5,10,15)	(3,4,6; 1,4,8)	(8,11,12; 9,11,12)
IO4	(2,4,6; 1,4,7)	(3,9,10; 2,9,12)	(3,6,10; 2,6,12)	(3,4,5; 2,4,8)	(4,6,8; 3,6,9)	(11,12,14; 7,12,13)
IO5	(3,4,5; 2,4,8)	(2,3,5; 1,3,6)	(11,12,13; 10,12,14)	(2,3,5; 1,3,6)	(3,7,12; 2,7,13)	(15,16,16; 11,16,17)
IF demand	(15,16,16; 11,16,17)	(7,10,12; 8,10,11)	(7,8,9; 9,8,9)	(6,11,10; 7,11,11)	(15,16,16; 10,16,17)	

Solution:

Step1: We should convert IF Supply & IF demand into Crisp number using Average method.

	IS1	IS2	IS3	IS4	IS5	IF supply
IO1	3.75	4.75	6.00	6.50	12.00	10.25
IO2	6.00	7.25	15.00	12.00	3.75	10.50
IO3	4.25	10.25	3.25	10.00	4.25	17.00
IO4	4.00	7.86	6.38	4.25	6.00	11.63
IO5	4.25	3.25	12.00	3.25	7.25	15.38
IF demand	15.38	9.75	8.25	9.75	15.25	

Step2: Total supply is not equal to total demand so we have to convert unbalanced TP

Into balanced TP. Introduce a dummy column is called ID

	IS1	IS2	IS3	IS4	IS5	ID	IF supply
IO1	3.75	4.75	6.00	6.50	12.00	0	10.25
IO2	6.00	7.25	**15.00**	12.00	3.75	0	10.50
IO3	4.25	10.25	3.25	10.00	4.25	0	17.00

IO4	4.00	7.86	6.38	4.25	6.00	0	11.63
IO5	4.25	3.25	12.00	3.25	7.25	0	15.38
IF demand	15.38	9.75	8.25	9.75	15.25	6.38	

Step3: Select the largest value from the system then subtract with other elements

	IS1	**IS2**	**IS3**	**IS4**	**IS5**	**ID**	**IF supply**
IO1	11.25	10.25	9	8.50	3	15	10.25
IO2	9	7.75	0	3	11.25	15	10.50
IO3	10.75	4.75	11.75	5	10.75	15	17.00
IO4	11	7.14	8.62	10.75	9	15	11.63
IO5	10.75	11.75	3	11.75	7.75	15	15.38
IF demand	15.38	9.75	8.25	9.75	15.25	6.38	

Step 4: Select the two minimum values from each row and the largest values from each column find the penalty

	IS1	**IS2**	**IS3**	**IS4**	**IS5**	**ID**	**IF supply**	**Penalty**							
IO1	11.25	10.25	9	8.50	3 **10.25**	15	10.25	**5.5**	-	-	-	-	-	-	-
IO2	9 **0.75**	7.75	0	3 **9.75**	11.25	15	10.50	3	3	**4.75**	1.25	1.25	**6**	-	-
IO3	10.75 **2.25**	4.75 **9.75**	11.75	5	10.75 **5**	15	17.00	0.25	0.25	0.25	**6**	**4.25**	4.25	4.25	-
IO4	11 **5.25**	7.14	8.62	10.75	9	15 **6.38**	11.63	1.48	1.48	1.86	1.86	2	4	**4**	4
IO5	10.75 **7.13**	11.75	3 **8.25**	11.75	7.75	15	15.38	4.75	**4.75**	3	3	3	4.25	4.25	**4.25**
IF demand	15.38	9.75	8.25	9.75	15.25	6.38									
Penalty	0.25	1.5	2.75	1	0.5	0									
	0.25	4	3.13	1	0.5	0									
	0.25	4	-	1	0.5	0									
	0.25	4	-	-	0.5	0									
	0.25	-	-	-	0.5	0									
	0.25	-	-	-	-	0									
	0.25	-	-	-	-	0									
	0.25	-	-	-	-	0									

Cost z = $(0.75 \times 6)+(2.25 \times 4.25)+(5.25 \times 4)+(7.13 \times 4.25)+(9.75 \times 10.25)+(8.25 \times 12)$

$+(9.75 \times 12)+(10.25 \times 2)+(5 \times 4.25)+(6.38 \times 0)$

$= 525.55$

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Conclusion:

In this work, a new technique is proposed to find a solution to the TP with an objective function of maximization. By comparing the results of the new technique with the results of the three classic methods (NWCM, LCM, and VAM). The new technique gives better results or equal to the results of the other three methods.. It can be concluded that the new technique gives favorable and appropriate results and has easy solution steps in terms of understanding and application and thus a lot of time and effort is saved to obtain the optimal solution or near of it.

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