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Optimal Solution for the Intuitionistic Fuzzy Assignment Problem via Three Methods-IFRMM, IFOAM, IFAM

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

An Assignment Problem mainly deals with allocation and scheduling. In this work Intuitionistic Fuzzy Assignment Problem (IFAP) with the Trapezoidal Intuitionistic fuzzy numbers (TIFNS) is solved by using three different methods namely Intuitionistic Fuzzy Reduced Matrix Method (IFRMM), Intuitionistic Fuzzy Ones Assignment Method (IFOAM) and Intuitionistic Fuzzy Approximation Method (IFAM). A numerical example is illustrated to explain the above methods.

Keywords: Intuitionistic Fuzzy Assignment Problem (IFAP); Trapezoidal Intuitionistic Fuzzy Numbers (TIFNS); ranking function; optimal solution.

Mathematics Subject Classification: 90C05, 90B06, 90C08, 90C10, 90C90.

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1. INTRODUCTION

In decision-making situations as to assign tasks to machines, workers to jobs, salesmen to regions, drivers to trucks, trucks to routes, requirements to suppliers etc are mainly tackled with the help of Assignment Problems. In day to day problems various calculations should be solved with uncertainty and inexactness. Variations in measurement, deviation in accuracy, errors in computation leads to uncertaininy and in exactness. In order to deal with this uncertainty we use fuzzy assignment problems instead of classical assignment problems.

If it is not possible to explain an imprecise concept by using the conventional fuzzy set the intustinistic fuzzy set can be used. The membership of an element to a fuzzy set is a single value with the degree of acceptance between zero and one. But in the case of Intuitionistic fuzzy Set it is characterized by a membership function and a non-membership function so that the sum of both values is less than one. Optimization in intuitionistic fuzzy environment was given by Angelov [1]. The idea of intuitionistic fuzzy set (IFS) introduced by Atanassov [2,3] is the generalization of Zadeh's [4] fuzzy set. Assignment problem with costs in the form of fuzzy interval number is solved by Lin and Wen [5] using labeling algorithm.

Actual problems on production and work force assignment in a housing material manufacturer and a subcontract firm was disscused by Sakawa et al. [6], Similarity measures of Intuitionistic fuzzy sets has been studied and modified by several authors, [7-11]. Ones Assignment Method that can be used for assignment problems maximizing or minimizing the objective function is developed by Basirzadeh [12]. This method is based on creating some ones in the assignment matrix, and finds an assignment in terms of the ones. Revised Ones Assignment Method was developed by Ghadle and Muley [13] by introducing a new step to Basirzadeh's Method. This method can be utilized for all types of assignment problems maximizing or minimizing the objective function.

A fuzzy version of Hungarian algorithm for the solution of intuitionistic fuzzy assignment problems involving triangular intuitionistic fuzzy numbers without converting them to classical assignment problems is explained by Prabakaran and Ganesan [14]. Various methods are proposed to find the solution of Intuitionistic Fuzzy Assignment Problem. Ranking method based on the magnitude of membership function and non-membership function of a Intuitionistic Fuzzy Number is proposed by Sagaya Roseline and Henry Amirtharaj [15].

Solution for Fuzzy Assignment Problems with circumcentre of centriods has been discused by Vimala and Krishna Prabha [16]. Mukherjee and Basu [17] introduced an algorithm to solve Intuitionistic Fuzzy Assignment Problem. Optimal Solution for Mixed Constrains Intuitionistic Fuzzy Transportation Problems and Balanced Intuitionistic Fuzzy Assignment Problems were proposed by Senthil Kumar and Jahir Hussain [18,19].

In this paper, Intuitionistic Fuzzy Assignment Problem (IFAP) with the Trapezoidal Intuitionistic fuzzy numbers (TIFNS) is solved by using three different methods namely IFRMM, IFOAM and IFAM. Simplest ranking method proposed by Stephen Dinagar and Thiripurasundari, [20] is used for converting the TIFNS into crisp values.

This paper has been arranged in the following way. In Section 2, some basic definitions on IFS, TIFN'S, TrIFN'S have been described. In Section 3 mathematical model of IFAP and Ranking method for converting TIFN'S to crisp numbers is developed. In Section 4, the three different methods namely Intuitionistic Fuzzy Reduced Matrix Method (IFRMM), Intuitionistic Fuzzy Ones Assignment Method (IFOAM) and Intuitionistic Fuzzy Approximation Method (IFAM) have been explained. A numerical example is taken and the above there methods are applied and tested numerically. Section 5 concludes the paper.

2. PRELIMINARIES

In this section, some basic definitions and arithmetic operations are reviewed. The various definitions for intustinistic fuzzy sets were given by Atanassov [2,3], Sagaya Roseline and Henry Amirtharaj [15].

2.1 Intuitionistic Fuzzy Number

Let X be a classical set of objects called the universal set, where an element of X is denoted by

Definition 1: An IFS A in X is given by A $=\{\mu_A(x), \nu_A(x)/x\epsilon\, X\}$ where the functions, μ_A, ν_A:

$X \to [0, 1]$ are functions such that $0 \le \mu(x) + \nu(x) \le 1$ $\forall x \epsilon X$. For each x the numbers $\mu_A(x)$ and $\nu_A(x)$ represent the degree of membership and degree of non-membership of the element $x \in X$ to the set, this is a subset of X, respectively.

Definition 2: An IFS $A = \{\mu_A(x), \nu_A(x)/x \epsilon X\}$ is called IF- normal, if there exists at least two points $x_0, x_1 \in X$ such that $\mu_A(x_0) = 1$, $\nu_A(x_1) = 1$.

Definition 3: An IFS $A = \{x, \mu_A(x), \nu_A(x)/x \epsilon X\}$ of the real line is called IF- convex if $\forall x_1, x_2 \in$, $\forall \lambda \in [0,1]$, $\mu_A(\lambda x_1 + (1-\lambda)x_2) \ge \mu_A(x_1) \wedge \mu_A(x_2)$ and $\nu_A(\lambda x_1 + (1-\lambda)x_2) \ge \nu_A(x_1) \wedge \nu_A(x_2)$. Thus A is IF-convex if its membership function is fuzzy convex and its non membership function is fuzzy concave.

Definition 4: An IFS $A = \{x, \mu_A(x), \nu_A(x)/x \epsilon X\}$ of the real line is called an Intuitionistic Fuzzy Number (IFN) if (a) A is IF-normal, (b) A is IF-convex, (c) μ_A is upper semi continuous and ν_A is lower semi continuous, (d) $A = \{x \in X / \nu_A(x) < 1\}$ is bounded.

Definition 5: A is a Trapezoidal Intuitionistic Fuzzy Number (TIFN) with parameters $b_1 \le a_1 \le b_2 \le a_2 \le a_3 \le b_3 \le a_4 \le b_4$ and denoted by $A = (b_1, a_1, b_2, a_2, a_3, b_3, a_4, b_4)$.

In this case

$$\mu_A(x) = \begin{cases} 0 & if\ x \le a_1 \\ \frac{x-a_1}{a_2-a_1} & a_1 < x < a_2 \\ 1 & a_2 < x < a_3 \\ \frac{x-a_4}{a_3-a_4} & a_3 < x < a_4 \\ 0 & a_4 \le x \end{cases}$$

and $$(x) = \begin{cases} 0 & if\ x \le b_1 \\ \frac{x-a_1}{a_2-a_1} & b_1 < x < b_2 \\ 1 & b_2 < x < b_3 \\ \frac{x-a_4}{a_3-a_4} & b_3 < x < b_4 \\ 0 & b_4 \le x \end{cases}$$

If in a TIFN A, we let $b_2 = b_3$ (and hence $a_2 = a_3$) then it will be a Triangular Intuitionistic Fuzzy Number (TrIFN) with parameters $b_1 \le a_1 \le b_2$ $(a_2 = a_3 = b_3) \le a_4 \le b_4$ and denoted by $A = (b_1, a_1, b_2, a_4, b_4)$.

2.2 Arithmetic Operations of TIFNs

The Arithmetic Operations between two TIFNs defined on universal set of real numbers R,

(i) Let $A = (b_1, a_1, b_2, a_2, a_3, b_3, a_4, b_4)$ and $B = (b_1', a_1', b_2', a_2', a_3', b_3', a_4', b_4')$ be two TIFN**s**, then $A \oplus B = (b_1+b_1', a_1+a_1', b_2+b_2', a_2+a_2', b_3+b_3', a_3+a_3', b_4+b_4', a_4+a_4')$

(ii) Let $A = (b_1, a_1, b_2, a_2, a_3, b_3, a_4, b_4)$ and $B = (b_1', a_1', b_2', a_2', a_3', b_3', a_4', b_4')$ be two TIFNs, then $A \ominus B = (b_1 - b_4', a_1 - a_1', b_2 - b_3', a_2 - a_3', a_3 - a_2', b_3 - b_2', a_4 - a_1', b_4 - b_1')$

(iii) Let $A = (b_1, a_1, b_2, a_2, a_3, b_3, a_4, b_4)$ be a TIFN and r be a real number then

$$rA = \begin{cases} rb_1, ra_1, rb_2, ra_2, ra_3, rb_3, ra_4, rb_4 & if\ r > 0 \\ rb_4, ra_4, rb_3, ra_3, ra_2, rb_2, ra_1, rb_1 & if\ r < 0 \end{cases}$$

(iv) Let $A = (b_1, a_1, b_2, a_2, a_3, b_3, a_4, b_4)$ and $B = (b_1', a_1', b_2', a_2', a_3', b_3', a_4', b_4')$ be two positive TIFNs, then $A \otimes B = (b_1 b_1', a_1 a_1', b_2 b_2', a_2 a_2', a_3 a_3', b_3 b_3', a_4 a_4', b_4 b_4')$

3. RANKING OF INTUITIONISTIC FUZZY NUMBERS

We define a ranking function $\Re$: F(R) → R which maps each fuzzy number in to the real line; F(R) represents the set of all intuitionistic trapezoidal fuzzy numbers. If $\Re$ be any linear ranking function, then:

$$\Re(A) = \left(\frac{b_1+a_1+b_2+a_2+a_3+b_3+a_4+b_4}{8}\right) \quad (1)$$

4. THE INTUITIONISTIC FUZZY ASSIGNMENT PROBLEM

Intuitionistic Fuzzy Assignment Problems are similar to that of Fuzzy Assignment Problems. The costs or time are Intuitionistic trapezoidal fuzzy numbers. $\tilde{c}_{ij} = [c_{ij}^1, c_{ij}^2, c_{ij}^3, c_{ij}^4, c_{ij}^5, c_{ij}^6, c_{ij}^7, c_{ij}^8]$ is the cost of assigning the i^{th} job to the j^{th} person. The cost matrix of the assisgnment problem will be similar to the cost matrix of the transportation problem with a modification that the supply at each of the sources and the demand at each of the destinations is unity. In assignment problem one source is assigned to one destination but in transportation problem one or more source can be assigned to any number of destinations.

4.1 Intuitionistic Fuzzy Ones Assignment Method (IFOAP)

Ones Assignment Method have this name because the assignments are made in terms of ones. Create some ones in the IFA matrix and find a complete assignment in terms of ones. By a complete assignment.

Step 1. Form the cost table from the given IFAP.

Step 2. Find the opportunity cost table:

(a) For each row of the matrix find the smallest/largest element in each row and then divide that from each element of that row. By this operation we get at least one ones in each rows and
(b) Locate the smallest/largest element in each column of the reduced matrix and then divide that from each element of that column. By this operation we get at least one ones in each columns and assignment are made in terms of one for IFAP.

Step 3. Cover all zeros in the IFA matrix using minimum number of horizontal and vertical lines.

4.1.1 Test for optimality

i) If the number of lines is exactly equal to *n*, then the complete assignment is obtained.
ii) If the number of lines drawn is less than *n*, then the complete assignments is not possible and proceed to step 4.

Step 4. Determine the smallest/largest entry (say d_{ij}) not covered by any line. Then divide by d_{ij} each element of the uncovered rows or columns, which d_{ij} lies on it. This operation creates some new ones to this row or column.

If still a complete optimal assignment is not achieved in this new matrix, then use step 4 and 3 iteratively. By repeating the same procedure the optimal assignment will be obtained. Priority plays an important role in this method, when we want to assign the ones.

4.1.2 Priority rule

(i) For maximization (minimization) assignment problem, assign the ones on the rows which have greatest (smallest) element on the right hand side, respectively.
(ii) To convert a non square matrix as a square matrix, we add one artificial row / column in which all elements are one. Then we solve the problem with the new matrix, by using the new method. The matrix after performing the steps reduces to a matrix which has ones in each rows and columns. So, the optimal assignment has been reached.

4.1.3 Numerical example

A project consists of three major jobs for which three contractors have submitted the tenders. The tender amount quoted in dollars is given in terms of Intuitionistic fuzzy numbers which are given in the matrix below. Find the assignment that minimizes the total cost of the project. Each contractor has to be assigned only one job.

$$\begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \end{array} \begin{array}{ccc} J_1 & J_2 & J_3 \\ \end{array}$$

$$\begin{matrix} C_1 \\ C_2 \\ C_3 \end{matrix}\begin{bmatrix} [1,2,4,5,7,8,10,12] & [2,3,5,6,9,10,12,14] & [1,3,5,6,9,10,11,13] \\ [3,4,6,7,9,11,13,15] & [1,2,4,6,10,12,14,16] & [2,3,5,7,10,12,14,15] \\ [2,4,6,8,10,11,12,14] & [2,3,4.5,8,9,10,11] & [3,4,5,7,11,12,13,14] \end{bmatrix}$$

The given problem is a balanced one.

Convert the given IFAP into crisp assignment problem by using (1).

$$\begin{matrix} & J_1 & J_2 & J_3 \\ \begin{matrix} C_1 \\ C_2 \\ C_3 \end{matrix} & \left[\begin{matrix} 6.125 & 7.625 & 7.25 \\ 8.5 & 8.125 & 8.5 \\ 8.375 & 6.5 & 8.625 \end{matrix}\right. & & \left.\right] \end{matrix}$$

$$\begin{array}{c} \quad J_1 \qquad J_2 \qquad J_3 \\ \begin{matrix} C_1 \\ C_2 \\ C_3 \end{matrix}\begin{bmatrix} 6.125 & 7.625 & 7.25 \\ 8.5 & 8.125 & 8.5 \\ 8.375 & 6.5 & 8.625 \end{bmatrix} \end{array}$$

Find the minimum element of each row in the assignment matrix (say a_i), and write it on RHS as follows:

$$\begin{array}{c} \quad J_1 \qquad J_2 \qquad J_3 \\ \begin{matrix} C_1 \\ C_2 \\ C_3 \end{matrix}\begin{bmatrix} 6.125 & 7.625 & 7.25 \\ 8.5 & 8.125 & 8.5 \\ 8.375 & 6.5 & 8.625 \end{bmatrix}\begin{matrix} 6.125 \\ 8.125 \\ 6.5 \end{matrix} \end{array}$$

Then divide each element of i^{th} row of the matrix by a_i. Thus it creates ones to each row, and the matrix reduces to following matrix.

$$\begin{array}{c} \quad J_1 \qquad J_2 \qquad J_3 \\ \begin{matrix} C_1 \\ C_2 \\ C_3 \end{matrix}\begin{bmatrix} 1 & 1.245 & 1.184 \\ 1.046 & 1 & 1.046 \\ 1.288 & 1 & 1.32 \end{bmatrix} \end{array}$$

Now next to find the minimum element of each column in assignment matrix (say b_j), and write it below that column. Then divide each element of j^{th} column of the matrix by b_j.

$$\begin{array}{c} \quad J_1 \qquad J_2 \qquad J_3 \\ \begin{matrix} C_1 \\ C_2 \\ C_3 \end{matrix}\begin{bmatrix} 1 & 1.245 & 1.131 \\ 1.046 & 1 & 1 \\ 1.288 & 1 & 1.26 \end{bmatrix} \end{array}$$

$$\begin{array}{c} \quad J_1 \qquad J_2 \qquad J_3 \\ \begin{matrix} c_1 \\ c_2 \\ c_3 \end{matrix}\begin{bmatrix} (1) & 1.245 & 1.131 \\ 1.046 & 1 & (1) \\ 1.288 & (1) & 1.26 \end{bmatrix} \end{array}$$

$C_1 \rightarrow J_1$, $C_2 \rightarrow J_3$, $C_3 \rightarrow J_2$

We can assign the ones and the solution is (1,1), (2,3), (3,2) and minimum cost is

6.125+6.5+8.5 = 21.125

4.2 Intuitionistic Fuzzy Reduced Matrix Method (IFRMM)

Step1: Form the Intuitionistic fuzzy cost matrix (IFCM).

Verify if it is balanced (nxn) or unbalanced (mxn, m ≠ n):

(i) If it is a balanced then go to **step 3**.
(ii) If it is an unbalanced then go to **step 2**.

Step 2: Add dummy rows / columns to IFMA to make balanced.

Step 3: Subtract the minimum entry of each row from all the entries of the respective row in the IFCM.

Step 4: After completion of row reduction, subtract the minimum entry of each column from all the entries of the respective column. Each column and row now has at least one Intuitionistic fuzzy element with rank zero.

Step 5: In the modified IFA table obtained in step 4, examine for Intuitionistic fuzzy optimal assignment as follows:

a) Examine the rows successively until a row with a single Intuitionistic fuzzy element with rank zero is found. Assign this Intuitionistic fuzzy element with rank zero and cross off all other Intuitionistic fuzzy element with rank zero in its column. Continue this for all the rows.
b) Repeat the procedure for each column of reduced Intuitionistic fuzzy assignment table.
c) If a row and / or column has two or more Intuitionistic fuzzy element with rank zero then assign arbitrary any one of that and cross off all other Intuitionistic fuzzy element with rank zero of that row/column.
d) Repeat a) through c) above successively until the chain of assigning or cross ends.

Step 6: If the number of assignments is equal to n, the order of the Intuitionistic fuzzy cost matrix, Intuitionistic fuzzy optimal solution is reached. If the number of assignments is less than n, the order of the Intuitionistic fuzzy cost matrix, go to the step 7.

Step 7: Cover all Intuitionistic fuzzy zeros in the resulting matrix using a minimum number of horizontal and vertical lines.

i) Mark rows that do not have any assigned Intuitionistic fuzzy zero.
ii) Mark columns that have Intuitionistic fuzzy zeros in the marked rows.

iii) Mark rows that do have assigned Intuitionistic fuzzy zeros in the marked columns.
iv) Repeat ii) and iii) above until the chain of marking is completed.
v) Draw lines through all the unmarked rows and marked columns.

This gives the desired minimum number of lines.

Step 8: Develop the new revised reduced Intuitionistic fuzzy cost matrix as follows:

i) Find the smallest entry of the reduced Intuitionistic fuzzy cost matrix not covered by any of the lines.
ii) Subtract this entry from all the uncovered entries and add the same to all the entries lying at the intersection of any two lines.

Step 9: Repeat step 6 to step 8 until Intuitionistic fuzzy optimal solution to the given Intuitionistic fuzzy assignment problem is attained.

Let us solve the above numerical example by **Intuitionistic Fuzzy Reduced Matrix Method (IFRMM).**

Find the minimum element of each row in the assignment matrix (say a_i), and write it on RHS as follows:

$$\begin{array}{c} \\ c_1 \\ c_2 \\ c_3 \end{array} \begin{array}{c} \begin{array}{ccc} J_1 & J_2 & J_3 \end{array} \\ \begin{bmatrix} 6.125 & 7.625 & 7.25 \\ 8.5 & 8.125 & 8.5 \\ 8.375 & 6.5 & 8.625 \end{bmatrix} \end{array} \begin{array}{c} \\ 6.125 \\ 8.125 \\ 6.5 \end{array}$$

Then subtract each element of i^{th} row of the matrix by a_i. Thus it creates zeros to each row, and the matrix reduces to following matrix.

$$\begin{array}{c} \\ c_1 \\ c_2 \\ c_3 \end{array} \begin{array}{c} \begin{array}{ccc} J_1 & J_2 & J_3 \end{array} \\ \begin{bmatrix} 0 & 1.5 & 1.125 \\ 0.375 & 0 & 0.375 \\ 1.875 & 0 & 2.125 \end{bmatrix} \end{array}$$

Now next to find the minimum element of each column in assignment matrix (say b_j), and write it below that column. Then subtract each element of j^{th} column of the matrix by b_j.

$$\begin{array}{c} \\ c_1 \\ c_2 \\ c_3 \end{array} \begin{array}{c} \begin{array}{ccc} J_1 & J_2 & J_3 \end{array} \\ \begin{bmatrix} 0 & 1.5 & 0.75 \\ 0.375 & 0 & 0 \\ 1.875 & 0 & 1.75 \end{bmatrix} \end{array}$$

$$\begin{array}{c} \\ c_1 \\ c_2 \\ c_3 \end{array} \begin{array}{c} \begin{array}{ccc} J_1 & J_2 & J_3 \end{array} \\ \begin{bmatrix} (0) & 1.5 & 0.75 \\ 0.375 & 0 & (0) \\ 1.875 & (0) & 1.75 \end{bmatrix} \end{array}$$

$C_1 \rightarrow J_1$, $C_2 \rightarrow J_3$, $C_3 \rightarrow J_2$

We can assign the ones and the solution is (1,1), (2,3), (3,2) and minimum cost is 6.125+6.5+8.5 = 21.125.

4.3 Intuitionistic Fuzzy Approximation Method (IFAM)

The proposed steps for Intuitionistic Fuzzy Approximation method to find a optimal assignment for IFAP is as follows.

Step1: Form the Intuitionistic fuzzy cost matrix (IFCM).

Verify if it is balanced (nxn) or unbalanced (mxn, m ≠ n):

(i) If it is a balanced then go to **step 3**.
(ii) If it is an unbalanced then go to **step 2**.

Step 2: Add dummy rows / columns to IFMA to make balanced.

Step 3: Find the minimum and the next minimum Intuitionistic fuzzy costs in each row and column of IFAP using the ranking method.

Step 4: Find the Intuitionistic fuzzy difference between the minimum and next minimum Intuitionistic fuzzy costs in each row and column and display them alongside the Intuitionistic fuzzy assignment matrix against the respective rows. Similarly compute the differences for each column.

Step 5: Select the row or column with the largest difference among all the rows and columns. If a tie occurs use arbitrary tie-breaking choice. Let the greatest difference correspond to i^{th} row and let c_{ij} be the smallest Intuitionistic fuzzy cost in the i^{th} row. Assign that Intuitionistic fuzzy entry and cross off the i^{th} row and j^{th} column.

Step 6: Recompute the column and row Intuitionistic fuzzy differences for the reduced IFAP and go to step 5. Repeat the procedure until each row and column has exactly one Intuitionistic fuzzy assignment.

Let us solve the above numerical example by **Intuitionistic Fuzzy Approximation Method.**

By applying Step3 and Step4 of the Intuitionistic fuzzy approximation Method, the following Intuitionistic fuzzy assignment matrix is obtained.

$$\begin{array}{c} \\ c_1 \\ c_2 \\ c_3 \\ \\ \end{array}\begin{array}{c} \begin{array}{ccc} J_1 & J_2 & J_3 \end{array} \\ \begin{bmatrix} 6.125 & 7.625 & 7.25 \\ 8.5 & 8.125 & 8.5 \\ 8.375 & 6.5 & 8.625 \end{bmatrix} \\ \begin{array}{ccc} 2.245 & 1.125 & 1.25 \end{array} \end{array}\begin{array}{c} \\ 1.125 \\ 0.375 \\ 1.875 \\ \\ \end{array}$$

Now using the Step 5 of the Intuitionistic fuzzy approximation Method, the following Intuitionistic fuzzy matrix is obtained. The largest difference among all rows and columns is 2.245 and the minimum cost in the column is 6.125. We cross the first row and first column.

Similarly proceeding like this with step 6, the largest difference in the next iteration is 1.625 and the smallest cost is 6.5. Cross the second column and third row. Proceeding by step 6 the final assignment is given bellow.

$$\begin{array}{c} \\ c_1 \\ c_2 \\ c_3 \end{array}\begin{array}{c} \begin{array}{ccc} J_1 & J_2 & J_3 \end{array} \\ \begin{bmatrix} (6.125) & 7.625 & 7.25 \\ 8.5 & 8.125 & (8.5) \\ 8.375 & (6.5) & 8.625 \end{bmatrix} \end{array}$$

$C_1 \rightarrow J_1$, $C_2 \rightarrow J_3$, $C_3 \rightarrow J_2$

We can assign the ones and the solution is (1, 1), (2, 3), (3, 2) and minimum cost is 6.125+6.5+8.5 = 21.125.

5. CONCLUSION

Various methods like Intuitionistic Fuzzy Hungarian Method, Intuitionistic Fuzzy Approximation Method and Intuitionistic Fuzzy Ones Assignment Method are explained in this paper with a numerical example. Maximize as well as minimize objective functions of Assignment problem can be solved by these methods. For a particular problem we have similar optimal assignments for the three methods. The results reveal that the proposed methodologies can effectively solve the IFAP. These methods can be applied in job scheduling, to assign fleets of aircrafts, or assigning school buses to routes, or networking computers etc.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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