ONE'S ASSIGNMENT METHOD TO SOLVE INTUITIONISTIC FUZZY ASSIGNMENT PROBLEMS

Rajaraman.K[1], Sophia Porchelvi.R[2], Irene Hepzibah.R[3]

[1,3]Department of Mathematics, A.V.C.College of Engineering, Mayiladuthurai, Tamilnadu.
[2] PG & Research Department of Mathematics and Controller of Examinations,
A.D.M. College for Women (Autonomous), Nagapattinam, Tamilnadu.,India.
krajaleo@gmail.com

Abstract: An appointment of right person in right job is challenging because of ambiguity and vague information. However intuitionistic fuzzy assignment problem can positively solve this problem. In this paper, intuitionistic fuzzy assignment problem is solved for the selection of four staff for four designations in an organization. The problem is converted in to crisp assignment problem by magnitude ranking method and the solved by matrix one's assignment method and direct method. Results are compared for operative application of selection of right person for right job.

Keywords: *Intuitionistic fuzzy assignment problem, magnitude ranking method, MOA, Direct method.*

1. INTRODUCTION

The assignment problem (AP) is a special type of transportation (TP) and a linear zero-one programing problem it is a one of the well-studied problem in optimization problems in management science and widely applied in decision making areas. The main objective is to assign given number of persons to number of jobs on one to one basis in such a way to minimize total cost of performing the task or maximize the total profit of allocation. The assignment problem arisesbecause of the unpredictable capacity of person or machine to perform the given task (8). Application of conventional AP in solving real life problem has some limitation. Cost in many real life applications are not deterministic numbers. The intuitionistic fuzzy assignment problem (IFAP) is more realistic than AP because most real environment is uncertain. IFAP can certainly minimize these limitations. In 1965 Zadeh[9] introduced the concept of fuzzy sets to deal with vagueness in real life problems. In 1972 Bellman and Zadeh [2] proposed the concept of decision making under fuzzy environment. The intuitionistic fuzzy set were first introduced by K.Atanassov[1] the intuitionistic fuzzy set is found to be useful to deal with vagueness. Fuzzy Assigment problem have been studied by several authors including chen[4], Akpan& Abraham[3], Thakra, Chaudhri, and Dhawade [7]Fuzzy Hungarian method in intuitionisticFuzzy assignment problem deals
By Prabakaran & Ganesan[5]. In this paper, intuitionistic fuzzy assignment problem is solved or the selection of four staff for four designations in an organization. The problem is converted in to crisp one; using magnitude ranking technique [5] and then it is solved by matrix one's assignment and direct method [8].Comparison of these two methods are also provided in this paper. The rest of this paper is worked out as follows: In section 2, Fundamental definitions, arithmetic operations and ranking method on intuitionistic fuzzy numbers. In section 3, we draw intuitionistic fuzzy assignment problems and followed by illustrations

2. PRELIMINARIES

2.1 Fuzzy set

A Fuzzy set Ã is defined by Ã = {x,$\mu_A(x)$}; x∈A, $\mu_A(x)$∈[0,1]. In the pair (x, $\mu_A(x)$),the first element x belong to the classical set A,the second element $\mu_A(x)$,belong to the interval [0,1] called membership function.

2.2 Intuitionistic Fuzzy Set

An Intuitionistic fuzzy set a' assign the each element x of the universe X a membership degree $\mu_{a'}(x) \in [0,1]$ and non-membership degree $\upsilon_{a'}(x) \in [0,1]$ such that $\mu_{a'}(x)+ \upsilon_{a'}(x) \leq 1$. An IFS a' is mathematically represented as $\{x, \mu_{a'}(x), \upsilon_{a'}(x)/x \in X\}$

2.3 Intuitionistic Triangular Fuzzy Number

A triangular intuitionistic fuzzy number (TIFN) $\tilde{A}^I$ is an intuitionistic fuzzy set in R with the following membership function $\mu_{\tilde{A}^I}(x)$ and non-membership function $\nu_{\tilde{A}^I}(x)$

$$\mu_{\tilde{A}^I}(x) = \begin{cases} \frac{x-a_1}{a_2-a_1}, a_1 \leq x \leq a_2 \\ \frac{x-a_3}{a_2-a_3}, \ a_2 \leq x \leq a_3 \\ 0 \quad , otherwise \end{cases} \text{ and } \nu_{\tilde{A}^I}(x) = \begin{cases} \frac{a_2-x}{a_2-a_1'}, a_1' \leq x \leq a_2 \\ \frac{x-a_2}{a_3'-a_2}, \ a_2 \leq x \leq a_3' \\ 1 \quad , otherwise \end{cases}$$

Where $a_1' \leq a_1 \leq a_2 \leq a_3 \leq a_3'$ and $\mu_{\tilde{A}^I}(x) + \nu_{\tilde{A}^I}(x) \leq 1$ or $\mu_{\tilde{A}^I}(x) = \nu_{\tilde{A}^I}(x)$, for all $x \in R$. This TIFN is denoted by $\tilde{A}^I = (a_1, a_2, a_3; a_1', a_2, a_3') = \{(a_1, a_2, a_3); (a_1', a_2, a_3')\}$

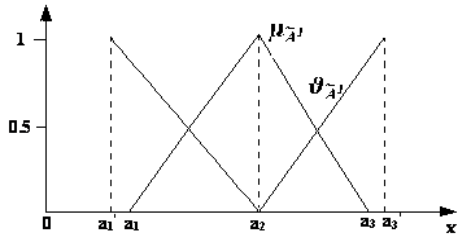

Fig 1: Membership and non-membership functions of TIFN

2.4 Positive triangular intuitionistic fuzzy number:

A positive triangular intuitionistic fuzzy number is denoted as $\{(a_1, a_2, a_3); (a_1', a_2, a_3')\}$where all a_i's and a_i''s >0 for alli=1, 2, 3.

2.5 Negative triangular intuitionistic fuzzy number:

A negative triangular intuitionistic fuzzy number is denoted as $\{(a_1, a_2, a_3); (a_1', a_2, a_3')\}$where all a_i's and a_i''s <0 for alli=1, 2, 3.

2.6 Modified operations of triangular intuitionistic fuzzy numbers using function principle:

The following are the modified operations that can be performed on triangular intuitionistic fuzzy numbers:

Let $\tilde{A}^I = \{(a_1, a_2, a_3); (a_1', a_2, a_3')\}$and $\tilde{B}^I = \{(b_1, b_2, b_3); (b_1', b_2, b_3')\}$.

Then

(i) Addition: $\tilde{A}^I + \tilde{B}^I = \{(a_1 + b_1, a_2 + b_2, a_3 + b_3); (a_1' + b_1', a_2 + b_2, a_3' + b_3')\}$

(ii) Subtraction: $\tilde{A}^I - \tilde{B}^I = \{(a_1 - b_3, a_2 - b_2, a_3 - b_1); (a_1' - b_3', a_2 - b_2, a_3' - b_1')\}$

(iii) Multiplication:

$\tilde{A}^l * \tilde{B}^l$= {(min$(a_1b_1, a_1b_3, a_3b_1, a_3b_3)$, a_2b_2, max$(a_1b_1, a_1b_3, a_3b_1, a_3b_3)$

(min $(a_1'b_1', a_1'b_3', a_3'b_1', a_3'b_3')$, a_2b_2, max$(a_1'b_1', a_1'b_3', a_3'b_1', a_3'b_3')$}

(iv) Division: $\tilde{A}^l$ / $\tilde{B}^l$= {(min$(\frac{a_1}{b_1}, \frac{a_1}{b_3}, \frac{a_3}{b_1}, \frac{a_3}{b_3})$, $\frac{a_2}{b_2}$, max $(\frac{a_1}{b_1}, \frac{a_1}{b_3}, \frac{a_3}{b_1}, \frac{a_3}{b_3})$);

(min $(\frac{a_1'}{b_1'}, \frac{a_1'}{b_3'}, \frac{a_3'}{b_1'}, \frac{a_3'}{b_3'})$, $\frac{a_2}{b_2}$, max$(\frac{a_1'}{b_1'}, \frac{a_1'}{b_3'}, \frac{a_3'}{b_1'}, \frac{a_3'}{b_3'})$)}

2.7 Ranking of TIFNAccuracy Function

Let $\tilde{A}^l = \{(a_1, a_2, a_3); (a_1', a_2, a_3')\}$ be a TIFN then we define

Mag($\tilde{A}'$) = $\left(\frac{a_1+a_1'+8a_2+a_3+a_3'}{4}\right)$an accuracy function of $\tilde{A}^l$ to defuzzify the given number.

3. Mathematical Formulation of intuitionistic fuzzy Assignment problem

The objective is to minimize the total cost of intuitionistic fuzzy assignment. If job I is assigned to operator 1, the cost is ($\tilde{C}'_{11}\tilde{X}'_{11}$). Similarly, for job 1, operator 2 the cost is (($\tilde{C}'_{12}\tilde{X}'_{12}$). The objective function is:

Minimize = $\sum_{i=1}^{n} \sum_{j=1}^{n} (\tilde{C}'_{ij} \tilde{X}'_{ij}$

Since one job 1 can be assigned to any one of the operators, we have following constraint set:

$\sum_{i=1}^{n} \tilde{X}'_{ij} \approx \tilde{1}$; for all j;j = 1, 2, ... n

Similarly for each operator, there may be only one assignment of job. For this, the constraint set is:

$\sum_{i=1}^{n} \tilde{X}'_{ij} \approx \tilde{1}$; for all i;i = 1, 2, ... n

The non-negativity constraint is:

$\tilde{X}'_{ij} \approx \tilde{1}$ *or* $\tilde{0}$ for all i and all j.

4. NUMERICAL EXAMPLES

4.1 Example:1

In this problem,four applicants A_1, A_2, A_3, A_4 and four vocations namely Administrativeofficer(AO),Development officer(DO),Sales executive(SE),Junior assistant(JS) in a company are taken for placement by intuitionistic fuzzy assignment problem. As every applicant has varying capability and skills, the task here is to place a right candidate for right job in order to develop the performance of the organization based on the scored by them. So here we have maximal assignment problem where each entry in the matrix is scoregained by the employee for different vocations and our objective is to find out an optimal assignment for placement of right person in right place

Intuitionistic fuzzy assignment matrix for above placement is as shown below

	SE	**DO**	**AO**	**JS**
A_1	(12,13,14;10,13,16)	(9,10,11;7,10,13)	(10,11,12;8,11,14)	(9,10,11;7,10,13)
A_2	(11,12,13;9,12,15)	(12,13,14;10,13,16)	(10,11,12;8,11,14)	(11,12,13;9,12,15)
A_3	(7,8,9;5,8,11)	(9,10,11;7,10,13)	(9,10,11;7,10,13)	(10,11,12;8,11,14)
A_4	(10,11,12;8,11,14)	(8,9,10;6,9,12)	(10,11,12;8,11,14)	(7,8,9;5,8,11)

The problem can be stated as linear programming problem as follows:

Maximize=mag(12,13,14;10,13,16)$\tilde{X}'_{11}$+mag(9,10,11;7,10,13)$\tilde{X}'_{12}$+mag(10,11,12;8,11,14)$\tilde{X}'_{13}$+mag(9,10,11;7,10,13)$\tilde{X}'_{14}$+mag(11,12,13;9,12,15)$\tilde{X}'_{21}$+mag(12,13,14;10,13,16)$\tilde{X}'_{22}$+mag(10,11,12;8,11,14)$\tilde{X}'_{23}$+mag(11,12,13;9,12,15)13)$\tilde{X}'_{24}$+mag(7,8,9;5,8,11)$\tilde{X}'_{31}$+mag(9,10,11;7,10,13)$\tilde{X}'_{32}$+mag(9,10,11;7,10,13)$\tilde{X}'_{33}$+mag(10,11,12;8,11,14)$\tilde{X}'_{34}$+mag(10,11,12;8,11,14)$\tilde{X}'_{41}$+mag(8,9,10;6,9,12)$\tilde{X}'_{42}$+mag(10,11,12;8,11,14)$\tilde{X}'_{43}$+mag(7,8,9;5,8,11)$\tilde{X}'_{44}$

Subject to constraints

$$\sum_{i,j=1}^{4} \tilde{X}'_{ij} = 1$$

Where $\tilde{X}'_{ij} \in [0,1]$

Ranking method

We useranking method proposed for converting above intuitionistic fuzzy assignment problem in to crisp assignment problem.we calculate first Magnitude of (12,13,14;10,13,16)

We getMag(x_{11}) = $\left(\frac{12+14+8(13)+10+16}{4}\right)$

Similarlymag(12,13,14;10,13,16)=39,mag(9,10,11;7,10,13)=30,mag(10,11,12;8,11,14)=33,
mag(11,12,13;9,12,15)=36,mag(7,8,9;5,8,11)=24,mag(8,9,10;6,9,12)=27

The crisp assignment problem of above intuitionistic assignment problem by using above ranking

	SE	**DO**	**AO**	**JS**
A_1	39	30	33	30
A_2	36	39	33	36
A_3	24	30	30	33
A_4	33	27	33	24

a) Solution of IFAP by MOA Method

This section presents MOA method i.e. Matrix One's Assignment method given by [8] whose algorithm is stated as follows:

Step1: In a minimization (maximization) problem, find the minimum (maximum) element of each row(say a_i) and write it on the right hand side of the matrix. Then divide each element of the i^{th} row of the matrix by a_i which will result in creation of at least one ones in each rows. In terms of ones for each row and column doassignment, otherwise go to step 2.

Step 2: Find the minimum (maximum) element of each column in the assignment matrix (say b_j) and write it below jth column of the matrix. Then divide each element of the j^{th} column of the matrix by b_j which will result in creation of at least one ones in each column. In terms of ones make the assignment. If no feasible assignment can be achieved from step 1 and step 2 then go to step 3.

Note: In a maximization case, at the end of the step 2 we have fuzzy matrix whose all elements belong to [0,1] and the greatest element is one.

Step 3: Draw the minimum number of lines to cover all the ones of the matrix. If the number of drawn lines is exactly equal to n, then the complete assignment is obtained else the complete assignment is not possible and then go to step 4.

Step 4: Select the smallest (largest) element (say d_{ij}) which do not lie on any of the lines in the above matrix and divide each element of the uncovered rows or columns by d_{ij}. This will result in creating some new ones to this row or column. If still a complete optimal assignment is not achieved in the new matrix, then use step 4 and step 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. Priority rule: for maximization (minimization) assignment problem assign the ones on the rows which have greatest (small) element on the right hand side, respectively. We solve assignment problem converting after ranking method by this matrix ones assignment method Assignment can be done through the followings steps

	SE	**DO**	**AO**	**JS**	
A_1	39	30	33	30	39
A_2	36	39	33	36	39
A_3	24	30	30	33	33
A_4	33	27	33	24	33

	SE	DO	AO	JS
A_1	1	0.77	0.85	0.77
A_2	0.92	1	0.82	0.92
A_3	0.72	0.91	0.91	1
A_4	1	0.82	1	0.72

	SE	**DO**	**AO**	**JS**
A_1	1	0.77	0.85	0.77
A_2	0.92	1	0.82	0.92
A_3	0.72	0.91	0.91	1
A_4	1	0.82	1	0.72

	SE	DO	AO	JS
A_1	**(1)**	0.77	0.85	0.77
A_2	0.92	**(1)**	0.82	0.92
A_3	0.72	0.91	0.91	**(1)**
A_4	~~1~~	0.82	**(1)**	0.72

So fuzzy optimal assignment by matrix ones assignment method is as follows$A_1 \rightarrow$SE, $A_2 \rightarrow$DO, $A_3 \rightarrow$AO, $A_4 \rightarrow$JS.

b) Solution of IFAP by Direct method

Direct method of solving maximal assignment problem [8] whose

Algorithm is given as:

Step 1: Construct a balanced assignment problem where persons are taken along the rows and jobs along the columns. If the problem is unbalanced then turn it to balanced one by adding dummy row or column.

Step 2: Now create a new matrix by subtracting each row from maximum element of that row.

Step 3: Locate the zero position of $(i,j)^{th}$ entry for the column of the matrix. Make allocation wherezero has unique position and delete the corresponding row and column. Continue the process till all the persons are assigned.

Step 4: If some rows have the same column then find the value of next successor of zero and make theallocation to the row where there is maximum value of successor. If tie is found for the maximum value then find value of next to next successor of zero and make the allocation to maximum value.
Step 5: In reduced matrix after allocation, each row must have at least one zero, if not then
Subtract theminimum element of each row from every element of that row.
Step 6: Repeat all the steps from step 3 to step 5 until all the rows are assigned and calculate theoptimal solution.
We solve maximal assignment problem by these method as follows..

	SE	**DO**	**AO**	**JS**
A_1	0	9	6	9
A_2	3	0	6	3
A_3	9	3	3	0
A_4	0	6	0	1

Locate the position of zeros

Rows	**Columns**	**Successor of zeros**
A_1	SE	6
A_2	DO	3
A_3	JS	3
A_4	SE,AO	0

Assign A_1 to SE and delete the corresponding row and column.

	DO	**AO**	**JS**
A_2	0	6	3
A_3	3	3	0
A_4	6	0	1

Locate the position of zeros.

Rows	Columns	Successor of zeros
A_2	DO	3
A_3	JS	3
A_4	AO	1

Assign A_2 to DO and delete the corresponding row and column.

	AO	**JS**
A_3	3	0
A_4	0	1

Locate the positions of zeros

Rows	columns	successor of zeros
A_3	JS	3
A_4	AO	1

Assign A_3 to JS and A_4 to AO.
So fuzzy optimal assignment by matrix ones assignment method is as follows$A_1 \rightarrow$SE, $A_2 \rightarrow$DO, $A_3 \rightarrow$AO, $A_4 \rightarrow$JS.

4.2 Example: 2

Suppose that a company decide to appoint system administrative engineers, after initial selection process three candidates C_1, C2, C3, C4 remain for further evaluation. A committee of three decision-makers, D1, D2 and D_3 has been formed to conduct the interview and select the most suitable candidate for four quality criteria are considered:

1. Emotional steadiness (Q_1),
2. Oral communication skill (Q_2),
3. Personality (Q_3),
4. Self-confidence (Q_4).

Weightage of linguistic variable

Linguistic variable	Weight
Very Good(VG)	(18,20,22;19,20,21)
Good(G)	(17,19,21;18,19,20)
Medium Good(MG)	(16,18,20;15,17,19)
Fair(F)	(9,11,13;10,11,12)
Nearly Fair(NF)	(12,14,16;13,14,15)
Poor(P)	(8,10,12;9,10,11)
Medium Poor(MP)	(7,9,11;8,9,10)
Very Poor(VP)	(6,8,10;7,8,9)

Linguistic decision matrix corresponding to decision makers is

	Q_1	Q_2	Q_3	Q_4
C_1	P	MP	F	P
C_2	G	P	P	F
C_3	NF	P	VP	NF
C_4	MG	VG	MP	G

Intuitionistic fuzzy assignment matrix for above decision matrix is as shown below

	Q_1	Q_2	Q_3	Q_4
C_1	(8,10,12;9,10,11)	(7,9,11;8,9,10)	(9,11,13;10,11,12)	(8,10,12;9,10,11)
C_2	(17,19,21;18,19,20)	(8,10,12;9,10,11)	(8,10,12;9,10,11)	(9,11,13;10,11,12)
C_3	(12,14,16;13,14,15)	(8,10,12;9,10,11)	(6,8,10;7,8,9)	(12,14,16;13,14,15)
C_4	(16,18,20;15,17,19)	(18,20,22;19,20,21)	(7,9,11;8,9,10)	(17,19,21;18,19,20)

Magnitude of (8,10,12;9,10,11)

We get$Mag(\tilde{X}'_{11}) = \left(\frac{8+9+8(10)+11+12}{4}\right)$

Similarly$mag(8,10,12;9,10,11)=30$,$mag(7,9,11;8,9,10)=33.75$, $mag(9,11,13;10,11,12)=33$ $mag(17,19,21;18,19,20)=57$,$mag(12,14,16;13,14,15)=42$, $mag(6,8,10;7,8,9)=24$,$mag(16,18,20;15,18,19)=53.5$,$mag(18,20,22;19,20,21)=60$.

The crisp assignment problem of above intuitionistic assignment problem by using above ranking

	Q_1	Q_2	Q_3	Q_4
C_1	30	33.75	33	30
C_2	57	30	30	33
C_3	42	30	24	42
C_4	53.5	60	33.5	57

a) Solution of IFAP by MOA Method

Assignment can be done through the following steps

	Q_1	Q_2	Q_3	Q_4	
C_1	30	33.75	33	30	33.75
C_2	57	30	30	33	57
C_3	42	30	24	42	42
C_4	53.5	60	33.5	57	60

	Q_1	Q_2	Q_3	Q_4
C_1	0.89	1	0.98	0.89
C_2	1	0.53	0.53	0.58
C_3	1	0.71	0.57	1
C_4	0.89	1	0.55	0.95

	Q_1	Q_2	Q_3	Q_4
C_1	0.89	~~1~~	**(1)**	0.89
C_2	**(1)**	0.53	0.54	0.58
C_3	~~1~~	0.71	0.58	**(1)**
C_4	0.89	**(1)**	0.56	0.95

So fuzzy optimal assignment by matrix ones assignment method is as follows $C_1 \rightarrow Q_3$, $C_2 \rightarrow Q_1$, $C_3 \rightarrow Q_4$, $C_4 \rightarrow Q_2$

b) Solution of IFAP by Direct method

We solve maximal assignment problem by these method as follows.

	Q_1	Q_2	Q_3	Q_4
C_1	3.75	0	25.75	3.75
C_2	0	27	27	24
C_3	0	12	15	0
C_4	6.5	0	26.5	3

Locate the position of zeros

Rows	Columns	Successor of zeros
C_1	Q_2	3.75
C_2	Q_1	24
C_3	Q_1,Q_4	0
C_4	Q_2	3

Assign C_2 to Q_1 and delete the corresponding row and column.

	Q_2	Q_3	Q_4
C_1	0	25.75	3.75
C_3	12	15	0
C_4	0	26.5	3

Locate the position of zeros.

Rows	Columns	Successor of zeros
C_1	Q_2	3.75
C_3	Q_4	12
C_4	Q_2	3

Assign C_3 to Q_4 and delete the corresponding row and column.

	Q_2	Q_3
C_1	0	25.75
C_4	0	26.5

Locate the positions of zeros

Rows	columns	successor of zeros
C_1	Q_2	25.75
C_4	Q_2	26.5

Assign C_4 to Q_2 then C_1 to Q_3.

So fuzzy optimal assignment by matrix ones assignment method is as follows $C_1 \rightarrow Q_3$, $C_2 \rightarrow Q_1$, $C_3 \rightarrow Q_4$, $C_4 \rightarrow Q_2$.

5. RESULTS AND DISCUSSION

Intuitionistic Fuzzy assignment problem of the assignment matrix for the placement of four candidate for four quality criteria is converted to crisp assignment problem by using magnitude ranking method. Further it is solved by Matrix One's assignment method and direct method. In first example Applicant A_1 is placed to post of sales executive, applicant A_2 is placed to post of Development Officer, applicant A_3 to post of Administrative Officer and applicant A_4 to post of Development Officer. And in second example the given maximal assignment problem is solved in 3 iterations where first candidate C_1 is placed for Personality, candidate C_2 is placed for Emotional steadiness, candidate C_3 is placed for Self-confidence and candidate C_4 is placed for Oral communication skill.Similarly Assignment result in direct method also.It is found that placements of the candidates are same as those method. It seems that intuitionistic fuzzy assignment problem can be used efficiently for placement policy to place a right person at suitable job.

6. CONCLUSION

In this paper, maximum intuitionistic fuzzy assignment problem for the placement of four candidates for four different posts is solved successfully. Magnitude ranking method is used to convert intuitionistic fuzzy assignment problem into crisp assignment problem and further the Matrix Ones Assignment method and direct method are used to find out the optimal assignment. It is observed that optimal solution by two methods is same and also observed that each candidate is placed to right posts as per capacity of the candidate. Results are confirmed as per the opinion of the experts in this field. The solution of the intuitionistic fuzzy assignment problem is more relevant as it considers vague information and gives effective solution to place a right person at suitable job.

REFERENCES

[1]Atanassov K.T.,(1986). Intuitionistic fuzzy sets,fuzzy sets and systems,20(1) 87-96.

[2] Bellman R.E and zadah.L.A,(1970),Decision making in fuzzyenvironment,managementscience,17,141-164. [3] Akpan N. P., & Abraham, U. P. (2016). A Critique of the Hungarian Method of Solving Assignment Problem to the Alternate Method of Assignment Problem by Mansi. IJSBAR,8 43-56.

[4]ChenM.S,On a fuzzy Assignment problem,(1985) Tamkang.journal of mathematics,22,407-411.

[5] Prabakaran,K.,Ganesan K.(2015). Fuzzy Hungarian method for solving intuitionistic Fuzzy assignmentproblem.International Journal of Scientific and Engineering Research,5(3),11-17.

[6] Rajaraman.K , Sophia Porchelvi.R and Irene Hepzibah.R.(2018).Mathematical model for consensus in group decision making under linguistic assessment using triangular intuitionistic fuzzy numbers. International Journal of Advance Research in Science and. Engineering, ISSN 2319-8354 Volume 7, Number 6,100-107.

[7] Thakra, T.A., Chaudhri,O.K.,Dhawade,N.R.(2018).Placement of staff in LIC using fuzzy assignmentproblem.International Journal of Mathematics Trends and Technology,53(4),259-266.

[8] S Vimala, S. K. (2016). Assignment Problems with fuzzy costs using Ones Assignment Method. IOSR Journal of Mathematics, 12 (5), 85-89.

[9] Zadeh,L.A., (1965), Fuzzy sets, Information and Control, Vol.8, 338-353.

[10] Zimmermann H.J.,(1998) Fuzzy set theory and its applications, fourth edition,Kluwer acadicmic publishers.