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Integrated Methodology for Multi – Person – Multi Objective Decision Making in Intuitionistic Fuzzy Environment

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Abstract:

In this paper, multi – person – multi objective decision making in intuitionistic fuzzy environment is discussed using integrated methodology. And this new approach is also explained with an application. Many decision making problems involve multiple decision makers and conflicting objectives. This paper refers to this kind of problems as group decision making for multi-objective problems (GDM-MOP). The task of GDM-MOP is to select final solution(s) from a set of non-dominated solutions according to the decision makers′ preferences. However, it is common that the preference could be imprecise. We study the GDM-MOP where preferences are expressed by fuzzy reference points, called as fuzzy GDMMOP (FGDM-MOP). This paper provides a decision support model to simultaneously consider two measures for FGDM-MOP: consensus measure and robustness measure. The former is used to reflect the acceptable degree of a solution by the decision making group, while the latter indicates a solution′s ability to cope with any change on preferences. A multi-objective evolutionary approach is presented to solve the problem. Finally, a modified benchmark function is studied to illustrate the proposed approach.

Keywords: Decision makers, Decision matrix, Parameter, Aggregated fuzzy weight, Hungarian method.

1. Introduction

Castello (2010) has given the notes for Hungarian algorithm. Cao (2008)[1] developed the munkres assignment algorithm. Huang (2008)[2] has integrated an entropy weight and TOPSIS technique for information system selection. Hwang et. al., (1993)[3] has given a new approach for multiple objective decisions making. Kahraman (2008)[4] has analysed the multi-criteria decision making methods and fuzzy sets. Kuhn (1955)[5] has solved the Hungarian method for the assignment problem. Munkres (1957)[6] has proposed algorithms for the assignment and transportation problems. Nauss (2003)[7] has solved the generalized assignment problem. Odior (2010)[8] has determined the feasible Solutions of multi criteria assignment problem. Oliver et. al., (1987)[9] has studied the permutation cross over operators on the traveling salesman problem. Saghafian and Hejazi (2005)[10] were modified fuzzy TOPSIS technique to solve the multi-criteria group decision making problems. Toroslu, (2003)[11] has presented the personnel assignment problem with hierarchical ordering constraints. Wang and Lee

(2007) [12]have generalized the TOPSIS method for fuzzy multiple-criteria group decision making problems.

2. Problem Procedure

- Define a problem and form a committee of decision makers. Then identify the evaluation criteria.
- Choose the appropriate linguistic variables for the importance weight of the parameter and the linguistic ratings for alternatives with respect to parameter.
- For the criterion C_j , aggregate the weight of parameter to get the aggregated fuzzy weight W_j and pool the decision maker's opinions to get the aggregated fuzzy rating $\tilde{X}_{ij}$ of the alternative Ai under criterion C_j.
- Determine the fuzzy decision matrix and the normalized fuzzy decision matrix.
- Reduce the decision matrix to three terms.
- Find out the average of each parameter.
- Solve the average matrix by Hungarian method to assigning the position of each candidate.

3. Application of Integrated Methodology in Multi Objective Decision Making Problem with Triangular Intuitionistic Fuzzy numbers

Here, the goal is to assign the candidates position for the college office. Already college committee members selected the three candidates to fill the vacancy in college office but, they have confusion to assigning a work in office. So, they were seeking an advice from the three decision authority members. Alternatives are three candidates(C_1), (C_2) and (C_3) and multi-objective are HR - Emotional steadiness(P_1), Co-Ordinator - Good communicator(P_2), Receptionist - Personality(P_3), and Accountant - Emphasizing accuracy (P_4). With respect to these multiple objectives, decision makers (D_1, D_2, D_3) will assign the suitable position for each alternative.

The three decision makers use the seven points scale linguistic variables whose values are given as triangular intuitionistic fuzzy numbers to express the importance priority to four parameters is given by

Very Good (VG)	(8,10,12;7.5,10,12.5)
Good (G)	(7,9,11;6.5,9,11.5)
Medium Good (MG)	(6,8,10;5.5,8,10.5)
Fair (F)	(5,7,9;4.5,7,9.5)
Poor (P)	(4,6,8;3.5,6,8.5)
Medium Poor (MP)	(3,5,7;2.5,5,7.5)
Very Poor (VP)	(2,4,6;1.5,4,6.5)

Table 1: Linguistic variables of triangular intuitionistic fuzzy number for criteria

	D_1	D_2	D_3
P_1	VG	P	MG
P_2	MG	G	P
P_3	G	G	F
P_4	VG	G	VG

Table 2: The importance weight of the criteria

From the table 1 and 2, the fuzzy weight of each criterion is found as

$\widetilde{W}$	Fuzzy weight
$\widetilde{W}_1$	(6,8,10;5.5,8,10.5)
$\widetilde{W}_2$	(5.7,7.7,9.7;5.2,7.7,10.2)

$\widetilde{W}_3$	(6.3,8.3,10.3;5.8,8.3,10.8)
$\widetilde{W}_4$	(7.7,9.7,11.7;7.2,9.7,12.2)

Table 3: Fuzzy weight of each criterion

The three candidates are assessed by the three decision makers on a seven point linguistic scale whose values are given as

Very Poor (VP)	(0.2,0.4,0.6;0.15,0.4,0.65)
Poor (P)	(0.4,0.6,0.8;0.35,0.6,0.85)
Medium Poor (MP)	(0.3,0.5,0.7;0.25,0.5,0.75)
Fair (F)	(0.5,0.7,0.9;0.45,0.7,0.95)
Medium Good (MG)	(0.6,0.8,0.10;0.55,0.8,1.05)
Good (G)	(0.7,0.9,0.11;0.65,0.9,1.15)
Very Good (VG)	(0.8,0.10,0.12;0.75,0.10,1.25)

Table 4: Linguistic scale of triangular intuitionistic fuzzy number for alternatives

By the evaluation of the three candidates by the three decision makers under the four parameters and combining the opinion of all the three decision makers for each parameter, the fuzzy decision matrix $\tilde{F} = (\tilde{X}_{ij})$, where i = 1, 2, 3 and j = 1, 2, 3, 4 is given by

		P_1	P_2	P_3	P_4
$\widetilde{D} =$	C_1	(4,4,4; 4,4,4)	(0.7,0.9,1.1; 0.65,0.9,1.15)	(0.7,0.9,1.1; 0.65,0.9,1.15)	(0.5,0.7,0.9; 0.45,0.7,0.95)
	C_2	(5,5,5;5,5,5)	(0.77,0.97,0.17; 0.72,0.97,1.22)	(0.53,0.73,0.93: 0.48,0.73,0.98)	(0.33,0.53,0.73; 0.28,0.53,0.78)
	C_3	(7,7,7;7,7,7)	(0.57,0.77,0.97; 0.52,0.77,1.02)	(0.5,0.7,0.9; 0.45,0.7,0.95)	(0.53,0.73,0.93; 0.48,0.73,0.98)

Table 5: Fuzzy decision matrix

Then calculate the normalized decision matrix $\tilde{R} = (\tilde{r}_{ij})$ for each parameter.

	P_1	P_2	P_3	P_4
C_1	(1,1,1;1,1,1)	(0.57,0.74,0.90; 0.53,0.74,0.94)	(0.61,0.78,0.96; 0.57,0.78,1)	(0.51,0.71,0.92; 0.46,0.71,0.97)
C_2	(0.8,0.8,0.8; 0.8,0.8,0.8)	(0.63,0.79,0.14; 0.59,0.79,1)	(0.46,0.63,0.81; 0.42,0.63,0.85)	(0.34,0.54,0.74; 0.29,0.54,0.79)
C_3	(0.6,0.6,0.6; 0.6,0.6,0.6)	(0.47,0.63,0.79; 0.43,0.63,0.84)	(0.43,0.61,0.78; 0.39,0.61,0.83)	(0.54,0.74,0.95; 0.49,0.74,1)

Table 6: The normalized decision matrix

Now, calculate the normalized decision matrix $\tilde{V} = (\tilde{v}_{ij})$ for each parameter and reducing to three terms. We get,

$$\tilde{V} = (\tilde{v}_{ij}) = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \end{array} \begin{array}{c} \begin{array}{cccc} \boldsymbol{P_1} & \boldsymbol{P_2} & \boldsymbol{P_3} & \boldsymbol{P_4} \end{array} \\ \begin{bmatrix} (5.75,8,10.25) & (3,5.6.9,9.16) & (3.58,6.47,10.35) & (3.62,6.89,11.29) \\ (4.6,6.4,8.2) & (3.33,6.08,5.78) & (2.67,5.23,8.76) & (2.36,5.24,9.15) \\ (3.45,4.8,6.15) & (2.46,4.85,8.12) & (2.49,5.06,8.49) & (3.85,7.18,11.66) \end{bmatrix} \end{array}$$

Finding the average for each parameter from $\tilde{V}$ and we get the value as shown in table 7.

	P_1	P_2	P_3	P_4
C_1	8	6.51	6.8	7.27
C_2	6.39	5.06	5.55	5.58
C_3	4.8	5.14	5.35	7.56

Table 7: Average matrix

Evaluate the table 7 by Hungarian method. Here, am applying maximization type because, each candidate's quality for the position should be in maximum.

Here the problem is of Maximization type and convert it into minimization by subtracting it from maximum value 8

	P_1	P_2	P_3	P_4
C_1	0	1.49	1.2	0.73
C_2	1.61	2.94	2.45	2.42
C_3	3.2	2.86	2.65	0.44

Table 8

Here, the given problem is unbalanced so; add 1 dummy row to convert it into a balance.

	P_1	P_2	P_3	P_4
C_1	0	1.49	1.2	0.73
C_2	1.61	2.94	2.45	2.42
C_3	3.2	2.86	2.65	0.44
d_3	0	0	0	0

Table 9

The optimal solution of this problem is

	P_1	P_2	P_3	P_4
C_1	[0]	0.65	0.36	0
C_2	0	0.49	[0]	0.08
C_3	3.49	2.31	2.1	[0]
d_3	0.84	[0]	0	0.11

Table 10: Optimal assignment

Work	Job	Cost
C_1	P_1	8
C_2	P_3	5.55
C_3	P_4	7.56
d_3	P_2	0
	Total	21.11

Table 11: Optimal Solution

According to the optimal solution the three alternatives position is assigned. And need to fill the vacancy for the position P_2.

4. Conclusion

Here assignment problem with triangular intuitionistic fuzzy numbers is solved with a simple and easiest calculation is used to assign the suitable positions for each candidates. In future use we can apply this method in real life problems like choosing best and suitable persons to develop our business growth.

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