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A Novel Approach to Sequencing Problems via Intuitionistic Fuzzy Sets

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Abstract: In this paper sequencing problem is solved in intuitionistic fuzzy environment. IFS is considered as generalization of fuzzy set. In fuzzy set only membership functions are taken into consideration, but in IFS both membership function and non-membership function is taken and sum of both is less than one. In this paper new method is proposed to solve sequencing problem in which processing times are taken as intuitionistic fuzzy number.

Keywords: Intuitionistic fuzzy number, optimal sequence, arithmetic operations of intuitionistic fuzzy number.

I. INTRODUCTION

In job sequencing problems sequence of jobs is planned to complete the given task in minimum possible time. Sequencing problem consists of processing times of different jobs under different machines. While measuring processing time some errors are committed and to resolve this problem in 1965 Zadeh gave the concept of fuzzy theory. After some time Atanassov [1,2] introduced intuitionistic fuzzy set which has some advantages over fuzzy sets. Intuitionistic fuzzy set deals more effectively with Vagueness. By using this concept Li et al. [3,4] developed value and ambiguity based ranking method for triangular intuitionistic fuzzy numbers and solved multiattribute decision making problems. Mahapatra and Roy [5] gave arithmetic operations for triangular and trapezoidal intuitionistic fuzzy number. Kumar and Kaur [6] proposed new ranking method after studying the limitations of existing method. Shabani and Jamkhaneh[7] worked with generalized intuitionistic fuzzy number and defined their properties. Roseline and Amirtharaj[8] solved assignment problem with the help of trapezoidal intuitionistic fuzzy number by using ranking method based on magnitude of membership and non-membership function. Zhang et al. [9] used normal intuitionistic fuzzy numbers in multi-criteria group decision making. Jia and Zhang [10] solved fuzzy decision-making problems with Interval-valued intuitionistic fuzzy numbers. Yogashanthi et al. [11] proposed centroid based ranking for generalized intuitionistic fuzzy numbers and used result for flow shop scheduling problem. Apart from this Das et al. [12] defined robust ranking for intuitionistic trapezoidal fuzzy number and used it in decision making problems. After studying all these papers in this job sequencing problem is solved with trapezoidal intuitionistic fuzzy number.

II. PRELIMINARIES

Definition 2.1:
For universal set $X = \{x_1, x_2, \dots \dots, x_n\}$, an intuitionistic fuzzy set is defined as $A = \{\langle x, \mu_A(x), \theta_A(x)\rangle : x \epsilon X\}$ in which functions $\mu_A(x): X \to [0,1]$ and $\theta_A(x): X \to [0,1]$ called membership function and non-membership function respectively and for every $x \epsilon X, 0 \leq \mu_A(x) + \theta_A(x) \leq 1$ always holds.

Definition 2.2:
The degree of hesitancy or uncertainty of an element x in A is defined as

$$\pi_A(x) = 1 - \mu_A(x) - \theta_A(x)$$

It is also called intuitionistic fuzzy index. For every , $0 \leq \pi_A(x) \leq 1$.

Definition 2.3:
An intuitionistic fuzzy normal is an intuitionistic fuzzy set in which there exists at least two points $a, b \epsilon X$ which satisfies $\mu_A(a) = 1$ and $\theta_A(b) = 1$.

Definition 2.4:
An intuitionistic fuzzy number is an intuitionistic fuzzy set which satisfies following conditions.
i) It is fuzzy normal.
ii) Membership function is convex i.e.

$\mu_A(\lambda a + (1-\lambda)b) \geq min\big(\mu_A(a), \mu_A(b)\big)$ for all $a, b \epsilon R, \lambda \epsilon [0,1]$

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iii) Non-Membership function is concave i.e.

$\theta_A(\lambda a + (1-\lambda)b) \leq max(\theta_A(a), \theta_A(b))$ for all $a, b \epsilon R, \lambda \epsilon [0,1]$

III. ARITHMETIC OPERATIONS ON INTUITIONISTIC FUZZY NUMBER

Let $\tilde{A} = (\mu, \gamma)$ and $\tilde{B} = [\mu', \gamma']$ are two intuitionistic fuzzy numbers

i) $\tilde{A} + \tilde{B} = [\mu + \gamma; \mu' + \gamma']$

ii) $\tilde{A} - \tilde{B} = [\mu - \gamma; \mu' - \gamma']$

iii) $\lambda\tilde{A} = \begin{cases} (\lambda\mu, \lambda\gamma), & if\ \lambda \geq 0 \\ (\lambda\mu, \lambda\gamma), & if \lambda > 0 \end{cases}$

IV. ALGORITHM

The sequencing problem is defined as:

Jobs→ Machines↓	J_1	J_2	.....	J_n
M_1	t_{11}	t_{12}	.....	t_{1n}
M_2	t_{21}	t_{22}	.....	t_{2n}

Here t_{ij} is intuitionistic fuzzy number which denotes time duration taken by i^{th} job on j^{th} machine.

The following algorithm is given to solve the sequencing problem.

Step 1:

Take processing times as intuitionistic fuzzy number.

Step 2:

Using Johnson's algorithm Find optimal sequence for given sequencing problem.

V. NUMERICAL ILLUSTRATION

Example:

Five jobs are to be processed through two machines and processing time of each job which is taken as intuitionistic fuzzy number is presented in following table. Find optimal sequence of jobs and total elapsed time.

Jobs→ Machines↓	A	B	C	D	E
M_1	(0.8,0.1)	(0.7,0.2)	(0.9,0.1)	(0.6,0.3)	(0.1,0.8)
M_2	(0.5,03)	(0.5,0.4)	(0.7,0.1)	(0.4,0.3)	(0.6,0.2)

Solution:

Step 1: Using Johnson's algorithm optimal sequence is calculated. Among all processing times minimum time is (0.1,0.8) which is corresponding to job
E on first machine, so this job is placed first.

E	-	-	-	-

Leaving job E, for remaining jobs the shortest time is(0.4,0.3) which is for job D on second machine, so this would be placed at last position.

E	-	-	-	D

Leaving both jobs E and D, for remaining jobs the shortest time is (0.5,03)which is for job A for the second machine, so it would be placed at second last position.

E	-	-	A	D

Leaving these jobs from remaining jobs minimum time is(0.5,0.4) which is for job B on second machine, so put that job in third position.

E	-	B	A	D

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Final sequence is

E	C	B	A	D

VI. CONCLUSION

In this Job sequencing problem is solved with intuitionistic fuzzy numbers by using proposed methods and arithmetic operations of these fuzzy numbers. Finally, the optimal sequence of jobs is calculated.

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