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Sequencing Problem in Icosikaitetragonal Fuzzy Number

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Abstract: *In this paper, we introduce a new fuzzy number called Icosikaitetragonal fuzzy number and its Membership function and propose a method of handling it. We have devised a solution to solve the fuzzy sequencing problem where the processing time is represented by Icosikaitetragonal fuzzy numbers. Fuzzy sequencing problems can be transformed into crisp valued sequencing problems, which can be demonstrated by a numerical example..*

Keywords: Icosikaitetragonal Fuzzy number, Membership function, Fuzzy sequencing problem

I. INTRODUCTION

The fuzzy set was introduced by Zadeh [1]. In our everyday lives, we encounter numerous decision-making scenarios. Each scenario is noteworthy. We make decisions in each situation, which may be either clear or ambiguous. Sequencing provides an initiative regarding the order in which events occur or are anticipated. In this context, we engage in decision-making related to job sequencing, game theory, and other areas. The job sequencing problem is a critical issue within the field of computing. It represents one of the most significant applications of optimization techniques. The primary objective of the sequencing problem is to determine the optimal order of jobs on machines to minimize the total time required to complete all tasks. Raju and Jayagopal [2] introduced the Icosagonal fuzzy number. They also developed the Icosikaitetragonal fuzzy number [3]. In this paper, we investigate the sequencing problem utilizing the Icosikaitetragonal fuzzy number. We have employed the Icosikaitetragonal fuzzy number along with its membership function. By applying Pascal's triangular Graded Mean, the fuzzy sequencing problem can be converted into a crisp-valued problem, which is illustrated with suitable examples. The processing time is regarded as an Icosikaitetragonal fuzzy number. By resolving the crisp sequencing problem, we can determine the optimal order, idle time, and total elapsed time for each machine.

II. PRELIMINARIES

In this section, we give the preliminaries that are required for this study.

Definition 2.1. *A fuzzy set A is defined by $A = \{(x, \mu_A(x)) : x \in A, \mu_A(x) \in [0,1]\}$. Here x is crisp set A and $\mu_A(x)$ is membership function in the interval $[0,1]$.*

Definition 2.2. *The fuzzy number A is a fuzzy set whose membership function must satisfy the following conditions.*

(i) A fuzzy set A of the universe of discourse X is convex

(ii) A fuzzy set A of the universe of discourse X is a normal fuzzy set if $x_i \in X$ exists

(iii) $\mu_A(x)$ is piecewise continuous

2.3 Ranking of Icosikaitetragonal fuzzy number:

Let N be a normal Icosikaitetragonal fuzzy number. The value $V(M)$, called as measure of M is calculated as

$$M(P) = \frac{1}{2}\int_{1}^{k_1}(J_1 + J_2)dJ + \frac{1}{2}\int_{k_1}^{k_2}(A_1 + A_2)dA + \int_{k_2}^{k_3}(S_1 + S_2)dS + \int_{k3}^{k_4}(T_1 + T_2)dT + \int_{k4}^{k_5}(I_1 + I_2)dI + \int_{k5}^{k_6}(N_1 + N_2)dN + \int_{k6}^{k_1}(R_1 + R_2)dR$$

$$where \quad 0 \le k_1 \le k_2 \le k_3 \le k_4 \le 1$$

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$$M(P)=\frac{1}{4}\begin{bmatrix}(r_1+r_2+r_{27}+r_{28})k_1+(r_3+r_4+r_{25}+r_{26})(k_2-k_1)+(r_5+r_6+r_{23}+r_{24})(k_3-k_2)+\\(r_7+r_8+r_{21}+r_{22})(k_4-k_3)+(r_9+r_{10}+r_{19}+r_{20})(k_5-k_4)+(r_{11}+r_{12}+r_{17}+r_{18})(k_6-k_5)\\+(r_{13}+r_{14}+r_{15}+r_{16})(1-k_6)\end{bmatrix}$$

where $0\le k_1\le k_2\le k_3\le k_4\le k_5\le k_6\le 1$

we take the values for $k_1=\frac{1}{7},k_2=\frac{2}{7},k_3=\frac{3}{7},k_4=\frac{4}{7},k_5=\frac{5}{7},k_6=\frac{6}{7}$

III. Definition [3] A fuzzy number A = $(a_1,a_2,a_3,a_4,a_5,a_6,a_7,a_8,a_9,a_{10},.....a_{24})$ is Icosikaitetragonal fuzzy number and its membership function is given by

$$\mu_A(x)=\begin{cases}0, & for \quad x<a_1\\ k_1\left(\frac{x-a_1}{a_2-a_1}\right), & for \quad a_1\le x\le a_2\\ k_1, & for \quad a_2\le x\le a_3\\ k_1+(k_2-k_1)\left(\frac{x-a_3}{a_4-a_3}\right), & for \quad a_3\le x\le a_4\\ k_2, & for \quad a_4\le x\le a_5\\ k_2+(k_3-k_2)\left(\frac{x-a_5}{a_6-a_5}\right), & for \quad a_5\le x\le a_6\\ k_3, & a_6\le x\le a_7\\ k_3+(k_4-k_3)\left(\frac{x-a_7}{a_8-a_7}\right), & for \quad a_7\le x\le a_{8/}\\ k_4, & for \quad a_8\le x\le a_9\\ k_4+(k_5-k_4)\left(\frac{x-a_9}{a_{10}-a_9}\right), & for \quad a_9\le x\le a_{10}\\ k_5, & for \quad a_{10}\le x\le a_{11}\\ k_5+(1-k_5)\left(\frac{x-a_{11}}{a_{12}-a_{11}}\right), & for \quad a_{11}\le x\le a_{12}\\ 1, & for \quad a_{12}\le x\le a_{13}\\ k_5+(1-k_5)\left(\frac{a_{14}-x}{a_{14}-a_{13}}\right), & for \quad a_{13}\le x\le a_{14}\\ k_5, & for \quad a_{14}\le x\le a_{15}\\ k_4+(k_5-k_4)\left(\frac{a_{16}-x}{a_{16}-a_{15}}\right), & for \quad a_{15}\le x\le a_{16}\\ k_4, & for \quad a_{16}\le x\le a_{17}\\ k_3+(k_4-k_3)\left(\frac{a_{18}-x}{a_{18}-a_{17}}\right), & for \quad a_{17}\le x\le a_{18}\\ k_3, & for \quad a_{18}\le x\le a_{19}\\ k_2+(k_3-k_2)\left(\frac{a_{20}-x}{a_{20}-a_{19}}\right), & for \quad a_{19}\le x\le a_{20}\\ k_2, & for \quad a_{20}\le x\le a_{21}\\ k_1+(k_2-k_1)\left(\frac{a_{22}-x}{a_{22}-a_{21}}\right), & for \quad a_{21}\le x\le a_{22}\\ k_1, & for \quad a_{22}\le x\le a_{23}\\ k_1\left(\frac{a_{24}-x}{a_{24}-a_{23}}\right), & for \quad a_{23}\le x\le a_{24}\\ 0, & for \quad x>a_{24}\end{cases}$$

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IV. PROCESSING OF 'N' JOBS THROUGH '2' MACHINES

Let 'n' jobs A_1, A_2, …..,A_n be processing through 2 machines that is M_1 , M_2 respectively. Let R_{ij} be the fuzzy processing time taken by i^{th} job to be done by j^{th} machine. Using Johnson method, we can find optimal sequence, total elapsed time and idle time on machines.

Jobs	Machine I	Machine II
A_1	Low	Good
A_2	Medium	Very Good
A_3	Very Good	Medium
A_4	Good	Low

Here fuzzy times are taken as Icosikaitetragonal fuzzy number.

Jobs	Machine M I	Machine M II
A_1	R_{11}	R_{12}
A_2	R_{21}	R_{22}
A_3	R_{31}	R_{32}
A_4	R_{41}	R_{42}

V. PROCEDURE FOR SOLVING FUZZY SEQUENCING PROBLEM.

Step 1: Using Pascal graded mean, fuzzy sequencing problem is converted to a crisp valued problem.
Step 2: The optimal sequence for the crisp sequence problem is determined using crisp sequencing problem.
Step 3: After finding the optimal sequence. Determine the total elapsed fuzzy time and also the fuzzy ideal time on machines

VI. NUMERICAL EXAMPLE:

We are taking into account the fuzzy sequence problem. Let us take the processing time of 4 jobs are given in which all the elements are fuzzy quantifiers which signalize the linguistic variables that are taking the place of Icosikaitetragonal fuzzy numbers.

These qualitative datas are transformed into quantitative datas and which is shown in the below table. The processing time is between 1 to 108 and the minimum value is considered as 1 and maximum value is considered as 108 and is shown in the following table

Low	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
Medium	29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52
Good	57,58,59,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80
Very Good	85,86,87,88,89,90,91,92,93,94,95,96,97,98,99,100.101,102,103,104,105,106,107,108

The problem is shown in the table

Jobs	Machine I	Machine II
A_1	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16, 17,18,19,20,21,22,23,24	57,58,59,60,61,62,63,64,65,66,67,68,69,70, 71,72,73,74,75,76,77,78,79,80
A_2	29,30,31,32,33,34,35,36,37,38,39,40,41,42, 43,44,45,46,47,48,49,50,51,52	85,86,87,88,89,90,91,92,93,94,95,96,97,98, 99,100,101,102,103,104,105,106,107,108
A_3	85,86,87,88,89,90,91,92,93,94,95,96,97,98, 99,100,101,102,103,104,105,106,107,108	29,30,31,32,33,34,35,36,37,38,39,40,41,42, 43,44,45,46,47,48,49,50,51,52
A_4	57,58,59,60,61,62,63,64,65,66,67,68,69,70, 71,72,73,74,75,76,77,78,79,80	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16, 17,18,19,20,21,22,23,24

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Apply Pascal's triangular graded mean for Icosikaitetragonal fuzzy number, the fuzzy valued time connected to respective valued time

R_{11}= 12.5	R_{12}= 68.5
R_{21}= 40.5	R_{22}= 96.5
R_{31}= 96.5	R_{32}= 40.5
R_{41}= 68.5	R_{42}= 12.5

A_1	A_2	A_3	A_4

The Optimum sequence is

Total elapsed time and idle time

Jobs	Machine I		Machine II	
	Time in	Time out	Time in	Time out
A_1	0	12.5	12.5	81
A_2	12.5	53	81	177.5
A_3	53	149.5	177.5	218
A_4	149.5	218	218	230.5

Total Elapsed time = 230.5 Hrs
Idle time on Machine I = 12.5 Hrs
Idle time on Machine II = 12.5 Hrs

VII. CONCLUSION

In this paper, we have addressed the fuzzy sequencing problem through the application of Icosikaitetragonal fuzzy numbers. The fuzzy sequencing issue involving Icosikaitetragonal fuzzy numbers has been converted into a crisp sequencing problem utilizing Pascal's Graded mean formula. Through this approach, we derived the optimal sequence, total elapsed time, and idle time for each machine.

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