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Solving the Decision Making Problem Using Decagonal Fuzzy Number and Fuzzy Matrix

Research Article*

A.Virginraj[1] and S.Hemavathi[1]

1 Department of Mathematics, St. Joseph's College of Arts & Science, Manjakuppam, Cuddalore (Tamil Nadu), India.

Abstract: The field of decision-making are the most useful and interesting area of applications fuzzy set theory. In this paper, we use decagonal fuzzy number and decagonal fuzzy number matrix to choose the winner of the participant in a dance competition decision making model.

Keywords: Decision making, decagonal fuzzy number, decagonal fuzzy number matrix, decision maker.

1. Introduction

In 1965, L.A. Zadeh introduced Fuzzy sets. It represents data and information containing uncertainties. It provides tools to deal with imprecision intrinsic to many problem. A fuzzy set is a function with the universal set X as its domain and unit interval [0,1] as its range. Decision-making in a Fuzzy Environment is meant a decision process in which the goals and the constraints, but not necessarily the system under control are in Fuzzy nature. Fuzzy logic allows decision making under incomplete or uncertain information. In fuzzy decision model overall ranking or ordering of different fuzzy sets are determined by using comparison matrix. The maximizing decision is defined as a point in the space of alternatives at which the membership function of a fuzzy decision attains its maximum value. The paper is organized as follows:

In section 2, basic definitions of fuzzy set theory have been reviewed. In Section 3, some arithmetical operations in decagonal fuzzy number and decagonal fuzzy number matrix are used. In section 4, a procedure is proposed for fuzzy decision model using new relatively function and comparison matrix. Then illustrative examples is include to demonstrate the proposed approach. In section 5, the conclusion is given.

2. Preliminaries

Definition 2.1 (Fuzzy Set). *A fuzzy set $\tilde{A}$ in x is characterized by a membership function $\mu_{\tilde{A}}(x)$ which associates with each point X a real number in the interval [0, 1]. A fuzzy set $\tilde{A}$ of X is defined as $\tilde{A}$=$\{(x, \mu_{\tilde{A}}(x))/x\epsilon X\}$, where $\mu_{\tilde{A}}(x)$ is called the membership function which maps each element of x to value between 0 and 1.*

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Definition 2.2 (Fuzzy Number)**.** *A fuzzy set $\tilde{A}$, defined on the universal set of real number R, is said to be a fuzzy number if and only if its membership function has the following characteristics.*

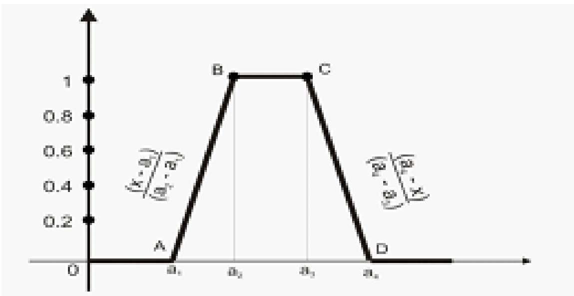
1. *$\tilde{A}$ is convex i.e., $\mu_{\tilde{A}}(\lambda x_1 + (1-\lambda)x_2) \geq \min(\mu_{\tilde{A}}(x_1), (\mu_{\tilde{A}}(x_2))$ for all $x_1, x_2 \in R, \lambda \in [0,1]$*
2. *$\tilde{A}$ is normal is there exists $x_0 \in R$ that $\mu_{\tilde{A}}(x_0) = 1$*
3. *$\mu_{\tilde{A}}$ is piecewise continuous.*

Definition 2.3 (Definition Triangular Fuzzy Number)**.** *Triangular fuzzy number (TFN) is defined as $\tilde{A}(a_1, a_2, a_3)$ where all a_1, a_2, a_3 are real numbers and its membership function. $\mu_{\tilde{A}}(x)$ given by*

$$\mu_{\tilde{A}}(x) = \begin{cases} 0, & \text{for } x \leq a; \\ \frac{(x-a)}{(b-a)}, & \text{for } a \leq x \leq b; \\ \frac{(c-x)}{(c-b)}, & \text{for } b \leq x \leq b; \\ 0, & \text{for } x \geq c. \end{cases}$$

Definition 2.4 (Trapezoidal fuzzy number)**.** *For a trapezoidal number $\tilde{A}(x)$, it can be represented by $\tilde{A} = (a_1, a_2, a_3, a_4)$ with membership function $\mu_{\tilde{A}}(x)$ given by*

$$\mu_{\tilde{A}}(x) = \begin{cases} 0 & \text{for } a \leq x \leq b; \\ \frac{(x-a)}{(b-a)} & \text{for } ; \\ 1 & \text{for } b \leq x \leq c; \\ \frac{(d-x)}{(d-c)} & \text{for } c \leq x \leq d; \\ 0 & \text{for } x > d; \end{cases}$$



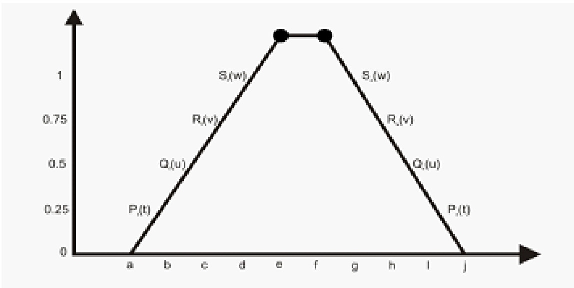
Graphical representation of trapezoidal fuzzy number

Definition 2.5 (Pentagonal Fuzzy Number)**.** *A Pentagonal Fuzzy Number (PFN) of a fuzzy set $\tilde{A}$ is defined as $\tilde{A}_P = \{a, b, c, d, e\}$, and its membership function is given by,*

$$\mu_{\tilde{A}P}(x) = \begin{cases} 0 & \text{for } x < a; \\ \frac{(x-a)}{(b-a)} & \text{for } a \leq x \leq b; \\ \frac{(c-x)}{(c-b)} & \text{for } b \leq x \leq c; \\ 1 & \text{for } x = c; \\ \frac{(d-x)}{(d-c)} & \text{for } c \leq x \leq d; \\ \frac{(e-x)}{(e-d)} & \text{for } d \leq x \leq e; \\ 0 & \text{for } x > e; \end{cases}$$

Definition 2.6 (Decagonal Fuzzy Number (DFN)). *Decagonal Fuzzy Number $\tilde{D}$ can be defined as $(a, b, c, d, e, f, g, h, i, j)$ and the membership function is defined as*

$$\mu_{\tilde{D}}(x) = \begin{cases} \frac{1}{4}\frac{(x-a)}{(b-a)}, & a = x = b \\ \frac{1}{4} + \frac{1}{4}\frac{(x-b)}{(c-b)}, & b = x = c \\ \frac{1}{2} + \frac{1}{4}\frac{(x-c)}{(d-c)}, & c = x = d \\ \frac{3}{4} + \frac{1}{4}\frac{(x-d)}{(e-d)}, & d = x = e \\ 1, & e = x = f \\ 1 - \frac{1}{4}\frac{(x-f)}{(g-f)}, & f = x = g \\ \frac{3}{4} - \frac{1}{4}\frac{(x-g)}{(h-g)}, & g = x = h \\ \frac{1}{2} - \frac{1}{4}\frac{(x-h)}{(i-h)}, & h = x = i \\ \frac{1}{4}\frac{(j-x)}{(j-i)}, & i = x = j \\ 0 & \end{cases}$$



Decagonal Fuzzy Number

3. Some Arithmetical Operations

Definition 3.1 (Operations of Decagonal fuzzy numbers). *In general, Let $A = (a_{ij})_{n\times n}$ and $B = (b_{ij})_{n\times n}$ are two decagonal fuzzy number matrices of a same order matrix $n \times n$.*

(1) Addition: $A(+)B = (a_{ij} + b_{ij})_{n\times n}$, where $a_{ij} + b_{ij} = a_{ij}L + b_{ij}L, a_{ij}M + b_{ij}M, a_{ij}M + b_{ij}M, a_{ij}M + b_{ij}M, a_{ij}M + b_{ij}M, a_{ij}N + b_{ij}N, a_{ij}N + b_{ij}N, a_{ij}N + b_{ij}N, a_{ij}N + b_{ij}N, a_{ij}U + b_{ij}U)$ is ij^{th} element of $A(+)B$.

(2) Subtraction: $A(-)B = (a_{ij} - b_{ij})_{n\times n}$, where $a_{ij} - b_{ij} = (a_{ij}L - b_{ij}U, a_{ij}M - b_{ij}N, a_{ij}M - b_{ij}N, a_{ij}M - b_{ij}N, a_{ij}M - b_{ij}N, a_{ij}N - b_{ij}M, a_{ij}N - b_{ij}M, a_{ij}N - b_{ij}M, a_{ij}N - b_{ij}M, a_{ij}U - b_{ij}L)$ is ij^{th} element of $A(-)B$.

(3)Multiplication: The two fuzzy decagonal number matrix are $A = (a_{ij})_{m\times p}$ and $B = (b_{ij})_{p\times n}$ defined by $A(\cdot)B = (c_{ij})_{m\times n}$, where $(c_{ij}) = \sum_{k=1}^{P} a_{ik}.b_{kj}$ for $i = 1, 2, \ldots, m$ and for $j = 1, 2, \ldots, n$

Definition 3.2 (Maximum operation on decagonal fuzzy number). *The two decagonal fuzzy number matrices are $A = (a_{ij})_{n\times n}$, where $a_{ij} = (a_{ij}L, a_{ij}M, a_{ij}M, a_{ij}M, a_{ij}M, a_{ij}N, a_{ij}N, a_{ij}N, a_{ij}N, a_{ij}U)$ $B = (b_{ij})_{n\times n}$ where $b_{ij} = (b_{ij}L, b_{ij}M, b_{ij}M, b_{ij}M, b_{ij}M, b_{ij}N, b_{ij}N, b_{ij}N, b_{ij}N, b_{ij}U)$ in a some order $n \times n$. Then the maximum operation is given by $\max(A, B) = (\sup\{a_{ij}, b_{ij}\})$, where sup $\{a_{ij}, b_{ij}\} = \sup(a_{ij}L, b_{ij}L)$, $\sup(a_{ij}M, b_{ij}M)$, $\sup(a_{ij}M, b_{ij}M)$, $\sup(a_{ij}M, b_{ij}M)$, $\sup(a_{ij}M, b_{ij}M)$, $\sup(a_{ij}N, b_{ij}N)$, $\sup(a_{ij}N, b_{ij}N)$, $\sup(a_{ij}N, b_{ij}N)$, $\sup(a_{ij}N, b_{ij}N)$, $\sup(a_{ij}U, b_{ij}U)$ is ij^{th} element of $\max(A, B)$.*

Definition 3.3 (Arithmetic Mean for decagonal fuzzy number (AM)). *Let $A = (a, b, c, d, e, f, g, h, i, j)$ be a decagonal fuzzy number. Then $AM(A) = \frac{a+b+c+d+e+f+g+h+i+j}{10}$. The same condition hold for decagonal fuzzy membership number.*

Definition 3.4 (Decagonal fuzzy number matrix). *The elements of decagonal fuzzy number matrix are defined as* $A = (a_{ij})_{m\times n}$, *where* $a_{ij} = (a_{ij}L,\ a_{ij}M,\ a_{ij}M,\ a_{ij}M, a_{ij}M, a_{ij}N,\ a_{ij}N,\ a_{ij}N, a_{ij}N,\ a_{ij}U))$ *is the* ij^{th} *element of decagonal fuzzy number matrix of A. Then*

$$0 \le a_{ij}L \le a_{ij}M \le a_{ij}M \le a_{ij}M \le a_{ij}M \le a_{ij}N \le a_{ij}N \le a_{ij}N \le a_{ij}N \le a_{ij}U \le 20 \tag{1}$$

where $a_{ij}L$ *is the lower bound,* $a_{ij}M,\ a_{ij}N$ *is the moderate value, and* $a_{ij}U$ *is the upper bound.*

Example: $A = (2, 4, 6, 6, 10, 12, 14, 16, 18, 18)$

Answer: $0 \le 2 \le 4 \le 6 \le 6 \le 10 \le 12 \le 14 \le 16 \le 18 \le 18 \le 20$

Definition 3.5 (Decagonal fuzzy number matrix into membership Function). *Let Membership function of*

$$a_{ij} = (a_{ij}L,\ a_{ij}M,\ a_{ij}M,\ a_{ij}M, a_{ij}M, a_{ij}N,\ a_{ij}N,\ a_{ij}N,\ a_{ij}N, a_{ij}U)$$

is defined as $\frac{a_{ij}L}{20}, \frac{a_{ij}M}{20}, \frac{a_{ij}M}{20}, \frac{a_{ij}M}{20}, \frac{a_{ij}M}{20}, \frac{a_{ij}N}{20}, \frac{a_{ij}N}{20}, \frac{a_{ij}N}{20}, \frac{a_{ij}N}{20}, \frac{a_{ij}U}{20}$ *if* $0 \le a_{ij}L \le a_{ij}M \le a_{ij}N \le a_{ij}U \le 20$, *where*

$$0 \le \frac{a_{ij}L}{20} \le \frac{a_{ij}M}{20} \le \frac{a_{ij}M}{20} \le \frac{a_{ij}M}{20} \le \frac{a_{ij}M}{20} \le \frac{a_{ij}N}{20} \le \frac{a_{ij}N}{20} \le \frac{a_{ij}N}{20} \le \frac{a_{ij}N}{20} \le \frac{a_{ij}U}{20} \le 1 \tag{2}$$

is called a decagonal fuzzy number matrix into its membership function.

Example: $A = (2, 4, 6, 8, 10, 12, 12, 14, 16, 18)$

Answer: $0 \le 2 \le 4 \le 6 \le 8 \le 10 \le 12 \le 12 \le 14 \le 16 \le 18 \le 20$; $\frac{0}{20} \le \frac{2}{20} \le \frac{4}{20} \le \frac{6}{20} \le \frac{8}{20} \le \frac{10}{20} \le \frac{12}{20} \le \frac{12}{20} \le \frac{14}{20} \le \frac{16}{20} \le \frac{18}{20} \le \frac{20}{20}$; $0 \le 0.1 \le 0.2 \le 0.3 \le 0.4 \le 0.5 \le 0.6 \le 0.6 \le 0.7 \le 0.8 \le 0.9 \le 1$.

4. Decision Making Under Fuzzy Environment

Definition 4.1. *A problem exists when there is a gap between what you except to happen and what actually happens.*

- *Problems must be resolved for organization to function properly.*

Definition 4.2. *Decision making is selecting a course of action from among available alternatives.*

- *Process of analyzing critical data to determine the best decision.*
- *We do not always select the best choice when faced with alternatives.*
- *Organization has limited resources. (i.e., number of employed, time, money, etc.)*

This form of non-transitive ranking can be accommodated by means of relativity function which is defined as a membership value of choosing one variable over the other.

Definition 4.3 (Relativity function). *Let x and y be variables defined on a universal set* $\times$. *The relativity function is denoted as* $f(x/y)$ *and is defined as*

$$f\,(x/y) = \frac{\mu_y\,(x)\,(-)\,\mu_x(y)}{\max\{\mu_y\,(x)\,, \mu_x\,(y)\}} \tag{3}$$

Where $\mu_y\,(x)$ *is the membership function of x with respect to y for decagonal fuzzy number and* $\mu_x(y)$ *is the membership function of y with respect to x for decagonal fuzzy number. Here* $\mu_y\,(x) - \mu_x\,(y)$ *is calculated using subtraction operation and max* $\{\mu_y\,(x) - \mu_x\,(y)\}$ *is calculated using maximum operation on decagonal fuzzy number.*

Definition 4.4 (Comparison Matrix)**.** *Let $A = \{x_1, x_2, \ldots, x_{i-1}, x_i, x_{i+1}, \ldots, x_n\}$ be a set of n variables defined on $\times$. Then form a matrix of relativity values $f\left(\frac{x_i}{x_j}\right)$, where x_i's for $i = 1$ to n, are n variables defined on an universe $\times$. The matrix $C = (C_{ij})$ is a square matrix of order n is called the comparison matrix. (or) C-matrix, with*

$$AM(f(x_i/x_j)) = \frac{AM(\mu_{xj}\,(x_i)\,(-)\,\mu_{xi}\,(x_j))}{AM(max\{\mu_{xj}\,(x_i)\,,\mu_{xi}\,(x_j)\}}$$

Where AM denote the Arithmetic Mean. The elements of C-matrix $\in [-1, 1]$ then $C'i = \min\{f\left(\frac{x_i}{\times}\right), i = 1$ to $n\}$.

Definition 4.5 (Procedure For A Decision Making Problem)**.** *Let A be a dance competition "a, b and c" be the participant in the dance competition. We have evaluated the date of which are fuzzy (such as the potential of the participant and his role in the dance competition) and depending on that we have found the winner of the participant in the competition.*

Procedure

Step 1: For the problem, consider the necessary imprecise estimation in the form of decagonal fuzzy number matrix using equation (1)

Step 2: Calculate the decagonal membership matrix form equation (2)

Step 3: We shall calculate all the relativity values $f\left(\frac{x_i}{x_j}\right)$ by 3.

Step 4: In the comparison matrix, the upper triangular part and lower triangular part are same with opposite sign.

Step 5: The minimum value from each row is taken and among them the worker corresponding to the maximum value is the winner of the participant.

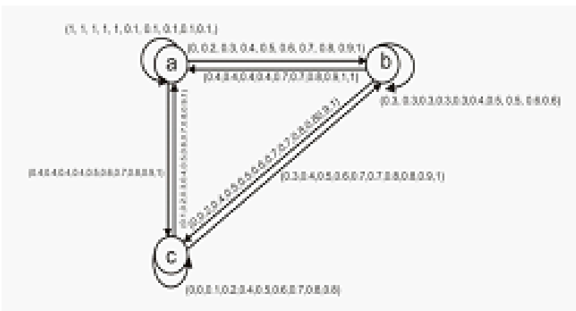
Step 6: The required solution in decision making problem.

Example 4.6. *Let A be a dance competition, let 'a' be a participant (esther), let 'b' be a participant (rani) and 'c' be a participant (kanish). Let us find out the winner of the participant in a dance competition by comparing three participant $(a, b\&c)$, which their characteristics are expressive, energetic, dance standard, creativity, time keeping, sincerity, Stamina, costume, discipline and creative steps in a dance.*

Step 1: The form of decagonal fuzzy number matrix

$$A = \begin{array}{c} \\ a \\ b \\ c \end{array}\begin{array}{c} \begin{array}{ccc} a & b & c \end{array} \\ \begin{bmatrix} (20,20,20,20,20,2,2,2,2,2) & (0,4,6,8,12,12,14,16,18,20) & (8,8,8,8,10,12,14,16,18,20) \\ (8,8,8,8,14,14,16,18,20,20) & (6,6,6,6,6,8,10,10,12,12) & (0,4,8,10,10,12,12,14,18,20) \\ (2,4,6,8,10,12,14,16,18,20) & (6,8,10,12,14,14,16,16,18,20) & (0,0,2,4,8,10,12,14,16,16) \end{bmatrix} \end{array}$$

This can be represented in the form of a graph (network) as follows:



Graphical Representation Decagonal Fuzzy Number

Step 2:

$$(A)_{mem} = \begin{array}{c} \\ a \\ b \\ c \end{array} \begin{array}{ccc} a & b & c \\ \left[(1,1,1,1,1,0.1,0.1,0.1,0.1,0.1) \right. & (0,0.2,0.3,0.4,0.6,0.6,0.7,0.8,0.9,1) & (0.4,0.4,0.4,0.4,0.5,0.6,0.7,0.8,0.9,1) \\ (0.4,0.4,0.4,0.4,0.7,0.7,0.8,0.9,1,1) & (0.3,0.3,0.3,0.3,0.3,0.4,0.5,0.5,0.6,0.6) & (0,0.2,0.4,0.5,0.5,0.6,0.6,0.7,0.9,1) \\ (0.1,0.2,0.3,0.4,0.5,0.6,0.7,0.8,0.9,1) & (0.3,0.4,0.5,0.6,0.7,0.7,0.8,0.8,0.9,1) & \left. (0,0,0.1,0.2,0.4,0.5,0.6,0.7,0.8,0.8) \right] \end{array}$$

$$\mu_a(a) = (1,1,1,1,1,0.1,0.1,0.1,0.1,0.1),$$

$$\mu_a(b) = (0.4,0.4,0.4,0.4,0.7,0.7,0.8,0.9,1,1),$$

$$\mu_a(c) = (0.1,0.2,0.3,0.4,0.5,0.6,0.7,0.8,0.9,1),$$

$$\mu_b(a) = (0,0.2,0.3,0.4,0.6,0.6,0.7,0.8,0.9,1),$$

$$\mu_b(b) = (0.3,0.3,0.3,0.3,0.3,0.4,0.5,0.5,0.6,0.6)$$

$$\mu_b(c) = (0.3,0.4,0.5,0.6,0.7,0.7,0.8,0.8,0.9,1)$$

$$\mu_c(a) = (0.4,0.4,0.4,0.4,0.5,0.6,0.7,0.8,0.9,1)$$

$$\mu_c(b) = (0,0.2,0.4,0.5,0.5,0.6,0.6,0.7,0.9,1)$$

$$\mu_c(c) = (0,0,0.1,0.2,0.4,0.5,0.6,0.7,0.8,0.8)$$

Step 3:

$$f\left(\frac{a}{a}\right) = \frac{\mu_a(a)\,(-)\,\mu_a(a)}{\max\{\mu_a(a)\ ,\mu_a(a)\}}$$

$$= \frac{(1,1,1,1,1,0.1,0.1,0.1,0.1,0.1)\,(-)\,(1,1,1,1,1,0.1,0.1,0.1,0.1,0.1)}{\max\{(1,1,1,1,1,0.1,0.1,0.1,0.1,0.1),\ (1,1,1,1,1,0.1,0.1,0.1,0.1,0.1)\}}$$

$$= \frac{(0,0,0,0,0,0,0,0,0,0)}{(1,1,1,1,1,0.1,0.1,0.1,0.1,0.1)} = \frac{0}{0.5}$$

$$\boldsymbol{AM\,(f\,(a/a)) = \frac{0}{0.5} = 0}$$

$$f\left(\frac{a}{b}\right) = \frac{\mu_b(a)\,(-)\,\mu_a(b)}{\max\{\mu_b(a)\ ,\mu_a(b)\}}$$

$$= \frac{(0,0.2,0.3,0.4,0.6,0.6,0.7,0.8,0.9,1)\,(-)\,(0.4,0.4,0.4,0.4,0.7,0.7,0.8,0.9,1,1)}{\max\{((0,0.2,0.3,0.4,0.6,0.6,0.7,0.8,0.9,1)),\ (0.4,0.4,0.4,0.4,0.7,0.7,0.8,0.9,1,1)\}}$$

$$= \frac{(-1,-0.8,-0.6,-0.4,-0.1,-0.1,0.3,0.4,0.5,0.6)}{(0.4,0.4,0.4,0.4,0.7,0.7,0.8,0.9,1,1)}$$

$$\boldsymbol{AM\left(f\left(\frac{a}{b}\right)\right) = \frac{-0.12}{0.67} = -0.179}$$

$$f\left(\frac{a}{c}\right) = \frac{(0.4,0.4,0.4,0.4,0.5,0.6,0.7,0.8,0.9,1)\,(-)\,(0.1,0.2,0.3,0.4,0.5,0.6,0.7,0.8,0.9,1)}{\max\{((0.4,0.4,0.4,0.4,0.5,0.6,0.7,0.8,0.9,1)),\ (0.1,0.2,0.3,0.4,0.5,0.6,0.7,0.8,0.9,1)\}}$$

$$= \frac{(-0.6,-0.5,-0.4,-0.3,-0.1,0.1,0.3,0.5,0.7,0.9)}{(0.4,0.4,0.4,0.4,0.5,0.6,0.7,0.8,0.9,1)}$$

$$\boldsymbol{AM\left(f\left(\frac{a}{c}\right)\right) = \frac{0.6/10}{6.1/10} = 0.188}$$

$$f\left(\frac{b}{a}\right) = \frac{\mu_a(b)\,(-)\,\mu_b(a)}{\max\{\mu_a(b)\ ,\mu_b(a)\}}$$

$$= \frac{(0.4,0.4,\ 0.4,\ 0.4,0.7,0.7,0.8,0.9,1,1) - (0,0.2,0.3,0.4,0.6,0.6,0.7,0.8,0.9,1)}{(0.4,0.4,\ 0.4,\ 0.4,0.7,0.7,0.8,0.9,1,1)}$$

$$= 0.12/0.67$$

$$\boldsymbol{AM\left(f\left(\frac{b}{a}\right)\right) = 0.179}$$

$$f\left(\frac{b}{b}\right) = \frac{\mu_b\left(b\right)\left(-\right)\mu_b\left(b\right)}{\max\left\{\mu_b(b)\ ,\mu_b(b)\right\}}$$
$$= \frac{(0.3,0.3,0.3,0.3,0.3,0.4,0.5,0.5,0.6,0.6)\left(-\right)(0.3,0.3,0.3,0.3,0.3,0.4,0.5,0.5,0.6,0.6)}{(0.3,0.3,0.3,0.3,0.3,0.4,0.5,0.5,0.6,0.6)}$$
$$= \frac{0/10}{4.1/10} = 0$$
$$\boldsymbol{AM\left(f\left(\frac{b}{b}\right)\right) = 0}$$
$$f\left(\frac{b}{c}\right) = \frac{\mu_c\left(b\right)\left(-\right)\mu_b\left(c\right)}{\max\left\{\mu_c(b)\ ,\mu_b(c)\right\}}$$
$$= \frac{(0,0.2,0.4,0.5,0.5,0.6,0.6,0.7,0.9,1)\ (-)(0.3,0.4,0.5,0.6,0.7,0.7,0.8,0.8,0.9,1)}{(0.3,0.4,0.5,0.6,0.7,0.7,0.8,0.8,0.9,1)}$$
$$= \frac{-1.3/10}{6.7/10} = \frac{-0.13}{0.67}$$
$$\boldsymbol{AM\left(f\left(\frac{b}{c}\right)\right) = -0.19}$$
$$f\left(\frac{c}{a}\right) = \frac{\mu_a\left(c\right)\left(-\right)\mu_c(a)}{\max\left\{\mu_a(c)\ ,\mu_c(a)\right\}}$$
$$= \frac{(0.1,0.2,0.3,0.4,0.5,0.6,0.7,0.8,0.9,1)\left(-\right)(0.4,0.4,0.4,0.4,0.5,0.6,0.7,0.8,0.9,1)}{(0.4,0.4,0.4,0.4,0.5,0.6,0.7,0.8,0.9,1)}$$
$$= \frac{-\frac{0.6}{10}}{\frac{6.1}{10}} = -\frac{0.06}{0.61}$$
$$\boldsymbol{AM\left(f\left(\frac{c}{a}\right)\right) = -0.188}$$
$$f\left(\frac{c}{b}\right) = \frac{\mu_b\left(c\right)\left(-\right)\mu_c\left(b\right)}{\max\left\{\mu_b(c)\ ,\mu_c(b)\right\}}$$
$$= \frac{(0.3,0.4,0.5,0.6,\ 0.7,\ 0.7,0.8,0.8,0.9,1)\left(-\right)(0,0.2,0.4,0.5,0.5,0.6,0.6,0.7,0.9,1)}{(0.3,0.4,0.5,0.6,0.7,0.7,0.8,0.8,0.9,1)}$$
$$= \frac{1.3/10}{\frac{6.7}{10}} = \frac{0.13}{0.67}$$
$$\boldsymbol{AM\left(f\left(\frac{c}{b}\right)\right) = 0.194}$$
$$f\left(\frac{c}{c}\right) = \frac{\mu_c\left(c\right)\left(-\right)\mu_c\left(c\right)}{\max\left\{\mu_c(c)\ ,\mu_c(c)\right\}}$$
$$= \frac{(0,0,0.1,0.2,0.4,0.5,0.6,0.7,0.8,0.8)\left(-\right)(0,0,0.1,0.2,0.4,0.5,0.6,0.7,0.8,0.8)}{(0,0,0.1,0.2,0.4,0.5,0.6,0.7,0.8,0.8)}$$
$$= \left(\frac{0}{0.41}\right)$$
$$\boldsymbol{AM\left(f\left(\frac{c}{c}\right)\right)} = 0$$

Step 4 : The comparison matrix $C = (c_{ij}) = AM\left(\boldsymbol{f}\left(\frac{\boldsymbol{x_i}}{\boldsymbol{x_j}}\right)\right)$ is given by

$$A = \begin{array}{c} \\ a \\ b \\ c \end{array}\begin{array}{c} \begin{array}{ccc} a & b & c \end{array} \\ \begin{bmatrix} 0 & -0.179 & 0.188 \\ 0.179 & 0 & -0.194 \\ -0.188 & 0.194 & 0 \end{bmatrix} \end{array}$$

Step 5: C'i=minimum of i^{th} row

$$a = -0.179$$

$$b = -0.194$$

$$C = -0.188$$

Hence the maximum value is a = -0.179

Step 6: For this problem the ranking is a, b and c. Hence, 'a' (ester) is the winner of the participant in a dance competition by decision making problem.

5. Conclusion

As fuzzy decision-making is a most important scientific, social and economic endeavour, there exist several major approaches within the theories of fuzzy decision making. In this paper we have used decagonal fuzzy number matrix to solve the decision making problem. Hence, we have compared three participant in a dance competition and found the winner of participant in a dance competition.

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