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Study on Decision Making Problem Using Octadecagonal Fuzzy Number

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Abstract: *The aim of this article is to address the fuzzy decision making problem (FDMP) utilizing the Octadecagonal fuzzy number. We initiate the evaluation of the Payoff matrix through the Octadecagonal fuzzy number. We transform the fuzzy decision making problem into a crisp valued decision making problem by employing a ranking method for the payoff. The crisp valued decision making problem can be effectively formulated using the savage mini max regret criterion.*

Keywords: Fuzzy decision making problem (FDMP), Octadecagonal fuzzy number, membership function, Pay off matrix

I. INTRODUCTION

Fuzzy decision making has been introduced by Bellman and Zadeh [1]. In the decision making problem the alternatives from which the conclusion has to be taken must be determined. There are different types in decision making. Decision making in a particular issue may vary between person to person. A single person is accountable for taking decisions are individual decision making. Several persons are meeting and transforming practiced knowledge from various persons are utilized to make decisions are Multi person decision making. Proper informations are to be collected for making better decision. Decision making is an activity which includes the steps to be taken for choosing a suitable alternative from those that needs for realizing a certain plan. Jain [2] was the first to propose method of ranking fuzzy numbers for decision making in fuzzy related situation. V.Raju and Jayagopal [3] was the first to introduce the Octadecagonal fuzzy number. Many decisions are taken based on the collection of data. Decision makers are applying Octadecagonal fuzzy numbers rather than real numbers to express their judgments. Collections of facts are important to conclude the decision. Solving problems and making decisions are indispensable skills for business and life. Problem solving shows the importance of decision making. Decision making is very important for management and leadership. In current circumstances there are many procedure and techniques to get better the decision making and the value of decision making.

In this article, we have used decision making problem in which imprecise values are Octadecagonal fuzzy number. We have performed it with converting to crisp valued decision making problem using ranking technique. We have expounded fuzzy decision making problem using Octadecagonal fuzzy number with examples

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

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Definition 2.3 *An α-cut of fuzzy set A is classical set defined as* $^{\alpha}[A] = \{x \in X | \mu_A(x) \geq \alpha\}$
Definition 2.4 *A fuzzy set A is a convex fuzzy set iff each of its α-cut* $^{\alpha}A$ *is a convex set.*

2.5 Ranking of Octadecagonal fuzzy number:

Let I be a normal Enneadecagonal fuzzy number. The value $M\ (I)$, called as measure of I is calculated as

$$M(I) = \frac{e_1 + e_2 + e_3 + e_4 + e_5 + e_6 + e_7 + e_8 + e_9 + e_{10} + e_{11} + e_{12} + e_{13} + e_{14} + e_{15} + e_{16} + e_{17} + e_{18}}{18}$$

$$where\ \ 0 \leq k_1 \leq k_2 \leq k_3 \leq k_4 \leq 1$$

III. MATHEMATICAL FORMULATION OF FUZZY DECISION MAKING PROBLEM

Consider a fuzzy decision making problem in which all the entries of the payoff matrix are Octadecagonal fuzzy numbers. Let us obtain the problem R has m strategies and problem S has n strategies. Then the payoff matrix m x n is

$$A = \begin{pmatrix} r_{11} & r_{12} & . & r_{1n} \\ r_{21} & r_{22} & . & r_{2n} \\ . & . & . & . \\ r_{m1} & r_{m2} & . & r_{mn} \end{pmatrix}$$

3.1 Procedures for solving Savage Minimax Regret Criterion:

Step 1: Construct a regret (opportunity loss) table of each alternative for every state of nature from the given pay off matrix

Step 2: Pick out the maximum pay off in each column and subtract all the elements in that column from this maximum value

Step 3: For each decision alternative (row) , pick out the maximum row value and enter this in the last decision column

Step 4: Choose the decision alternative with the smallest value in the decision column

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IV. NUMERICAL EXAMPLE

Let us consider the Matrix

$$
\begin{bmatrix}
\begin{pmatrix} -4,-3,-2,-1, \\ 0,1,2,3,4,5,6, \\ 7,8,9,10,11, \\ 12,13,14 \end{pmatrix} & \begin{pmatrix} -3,-2,-1,0, \\ 1,2,3,4,5,6, \\ 7,8,9,10,11, \\ 12,13,14,15 \end{pmatrix} & \begin{pmatrix} 1,2,3,4,5,6 \\ 7,8,9,10,11 \\ 12,13,14,15 \\ 16,17,18, \end{pmatrix} \\
\begin{pmatrix} -3,-2,-1,0, \\ 1,2,3,4,5,6, \\ 7,8,9,10,11, \\ 12,13,14,15 \end{pmatrix} & \begin{pmatrix} -2,-1,0,1,2, \\ 3,4,5,6,7,8, \\ 9,10,11,12, \\ 13,14,15,16 \end{pmatrix} & \begin{pmatrix} 0,1,2,4,5,6 \\ 7,8,9,10,11, \\ 12,13,14,16, \\ 18,20,22,24 \end{pmatrix} \\
\begin{pmatrix} 0,1,2,3,4,5, \\ 6,7,9,10,11, \\ 13,14,15,17, \\ 19,21,22,25 \end{pmatrix} & \begin{pmatrix} 1,2,3,6,8,9,10, \\ 12,13,15,16,17 \\ 19,20,22,23, \\ 25,28,30 \end{pmatrix} & \begin{pmatrix} -3,-2,-1,0, \\ 1,2,3,4,5,6, \\ 7,8,9,10,11, \\ 12,13,14,15 \end{pmatrix}
\end{bmatrix}
$$

This problem is solved by taking the values *for* $k_1 = \frac{1}{5}, k_2 = \frac{2}{5}, k_3 = \frac{3}{5}, k_4 = \frac{4}{5}$. We obtain the values of Measure of matrix A and is denoted by $\mu_{EDC}(a_{ij})$

a_{11}	-4,-3,-2,-1,0,1,2,3,4,5,6,7,8,9,10,11,12,13,14	$\mu_{EDC}(a_{11}) = 5$
a_{12}	-3,-2,-1,0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15	$\mu_{EDC}(a_{12}) = 6$
a_{13}	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19	$\mu_{EDC}(a_{13}) = 10$
a_{21}	-3,-2,-1,0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15	$\mu_{EDC}(a_{21}) = 6$
a_{22}	-2,-1,0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16	$\mu_{EDC}(a_{22}) = 7$
a_{23}	0,1,2,4,5,6,7,8,9,10,11,12,13,14,16,18,20,22,24	$\mu_{EDC}(a_{23}) = 10.63$
a_{31}	0,1,2,3,4,5,6,7,9,10,11,13,14,15,17,19,21,22,25	$\mu_{EDC}(a_{31}) = 10.68$
a_{32}	1,2,3,6,8,9,10,12,13,15,16,17,19,20,22,23,25,28,30	$\mu_{EDC}(a_{32}) = 14.16$
a_{33}	-3,-2,-1,0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15	$\mu_{EDC}(a_{33}) = 6$

Step 2: The given fuzzy decision making problem is reduced to the following payoff profit matrix

Alternatives	Expected level of Sale (in Rupees)		
	I	II	III
Lemon	5	6	10
Orange	6	7	10.63
Apple	10.68	14.16	6

Step 3: The opportunity loss table for each alternative with the states of nature is depicted below

Alternatives	Expected level of Sale (in Rupees)		
	I	II	III
Lemon	5.68	8.16	0.63
Orange	4.68	7.16	0
Apple	0	0	4.63
Column Maximum	10.68	14.16	10.63

Step 4: The opportunity loss table and the maximum loss in each row is entered and shown in the below table

Alternatives	Expected level of Sale (in Rupees)			Decision Column
	I	II	III	(Maximum Loss)
Lemon	5.68	8.16	0.63	8.16
orange	4.68	7.16	0	7.16
Apple	0	0	4.63	4.63

Result: Since the minimum of maximum loss is in alternative Sugar = 4.63 rupees, this alternative must be selected.

V. CONCLUSION

In this article, we have outlined and addressed the fuzzy decision-making problem along with its payoff matrix, which consists of Enneadecagonal fuzzy numbers. We have demonstrated the process of selecting alternatives for the fuzzy-valued decision-making problem by transforming it into a crisp-valued decision-making problem through the application of ranking techniques. The crisp-valued decision-making problem is resolved using the Savage minimax regret criterion.

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