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Decision Making Problem in Hexagonal Fuzzy Number

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Abstract:
In this paper, we start with the fuzzy decision making problem (FDMP) with Hexagonal fuzzy numbers to evaluate the Payoff matrix using Hexagonal fuzzy numbers, use a ranking method for the payoffs to turn the FDMP into a crisp valued FDMP problem, and apply the savage mini max regret criterion to formulate the crisp valued FDMP problem.

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

1. Introduction

Bellman and Zadeh [1] introduced fuzzy decision making.Finding the alternatives from which a conclusion must be made is crucial when making decisions. Different kinds of decision making exist. Individuals may take different approaches to making decisions on particular issues. Individual decision making is the term used when one person is in charge of making decisions. On the other hand, multiperson decision making occurs when several people get together and pool their knowledge to create decisions.Accurate information collection is essential for improving decisionmaking.The process of choosing a suitable option from those required to carry out a particular plan is referred to as decision making. The strategy for ranking fuzzy numbers in fuzziness-related decision-making scenarios was first proposed by Jain [2]. The idea of the Hexadecagonal fuzzy number was first introduced by V. Raju and Jayagopal [3]. Many choices are made.according to data collecting.Hexagonal fuzzy numbers are frequently used by decision makers to express their opinions rather than actual numbers. The gathering of information is essential to making a choice. Decision making and problem solving skills are critical in both personal and professional life.Solving problems emphasizes how important making decisions is.Making wise decisions is essential for leadership and management. There are several methods and strategies accessible in the modern world to improve decision-making and its overall worth.Hexagonal fuzzy numbers are used to represent imprecise values in a decisionmakingproblem that we have discussed in this article.We have done this by using a ranking technique to transform it into a clear valued decision making challenge.Additionally, with the help of example we have expanded on the fuzzy decision making problem using hexagonal fuzzy numbers.

2. 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

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 Hexagonl fuzzy number:

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

$$M(I) = \frac{e_1 + e_2 + e_3 + e_4 + e_5 + e_6}{6}$$

Definition 2.6 [2]

A fuzzy number A = $(a_1, a_2, a_3, a_4, a_5, a_6)$is Hexagonl fuzzy number and its membership function is given by

$$\mu_E(x) = \begin{cases} 0, \ for\ x < e_1 \\ \frac{1}{2}\left(\frac{x - e_1}{e_2 - e_1}\right), for\ e_1 \leq x \leq e_2 \\ \frac{1}{2} + \frac{1}{2}\left(\frac{x - e_2}{e_3 - e_2}\right), for\ e_2 \leq x \leq e_3 \\ 1, \ for\ e_3 \leq x \leq e_4 \\ 1 - \frac{1}{2}\left(\frac{x - e_4}{e_5 - e_4}\right), for\ e_4 \leq x \leq e_5 \\ \frac{1}{2}\left(\frac{e_6 - x}{e_6 - e_5}\right), for\ e_5 \leq x \leq e_6 \\ 0\ , \ for\ x > e_6 \end{cases}$$

3.1 Mathematical formulation of Fuzzy Decision making problem:

Consider a fuzzy decision making problem in which all the entries of the payoff matrix are Hexadecagonl 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

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

3.2 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

4. Numerical example:

Let us consider the Matrix

a_{11}	- 2,-1,0,1,2 ,3	$\mu_{EDC}(a_{11})$ = 0.5
a_{12}	- 1,0,1,2,3, 4	$\mu_{EDC}(a_{12})$ = 1.5
a_{13}	1,2,3,4,5,6	$\mu_{EDC}(a_{13})$ = 3.5
a_{21}	- 3,-2,-1,0,3,7	$\mu_{EDC}(a_{21})$ = 0.67
a_{22}	- 2,-1,0,1,2 ,3	$\mu_{EDC}(a_{22})$ = 0.5
a_{23}	0,1,2,4,5,6	$\mu_{EDC}(a_{23})$ = 3

a_{31}	3,4,5,6,7,9	$\mu_{EDC}(a_{31}) = 5.67$
a_{32}	6,8,9,10,12,13	$\mu_{EDC}(a_{32}) = 9.67$
a_{33}	- 3,-2,-1,0,3,7	$\mu_{EDC}(a_{33}) = 0.67$

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

Step 1: The given fuzzy decision making problem is reduced to the following payoff profit matrix

Alternatives	Expected level of Sale (in Rupees)		
	I	II	III
Maze	0.5	1.5	3.5
Wheat	0.67	0.5	3
Sugar	5.67	9.67	0.67

Step 2: 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
Maze	5.17	8.17	0
Wheat	5	9.17	0.5
Sugar	0	0	2.83
Column Maximum	5.67	9.67	3.5

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 (Maximum Loss)
	I	II	III	
Maze	5.17	8.17	0	8.17
Wheat	5	9.17	0.5	9.17
Sugar	0	0	2.83	2.83

Result: Since the minimum of maximum loss is in alternative Sugar = 2.83 rupees, this alternative must be selected.

5. Conclusion

The fuzzy decision-making issue and its payout matrix, which is made up of hexagonal fuzzy numbers, have been described and discussed in this article. By using ranking techniques to transform the fuzzy-valued decision-making problem into a crisp-valued decision-making problem, we have illustrated the process of choosing alternatives. The Savage minimax regret criteria is used to address the crisp-valued decision-making problem.

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