NEUTROSOPHIC VAGUE DECISION MAKING MODEL SELECTION OF EDUCATIONAL STREAM FOR HIGHER EDUCATION

Abstract

The paper introduces a neutrosophic vague decision-making paradigm for selecting a course in higher education. It suggests that parents should choose a course that best meets their child's needs, considering the growing number of options available. The research develops a decision-making model using neutrosophic vague multi-attribute decision-making with interval weight information. The model's efficacy is demonstrated through a numerical example.

Keywords: Neutrosophic Vague, Higher Education.

Authors

Ancy Vershinia. S
PG Student
Department of Mathematics
Nirmala College for Women
Coimbatore.
ancyvershinia11@gmail.com

Mohana. K
Assistant Professor
Department of Mathematics
Nirmala College for Women
Coimbatore.
riyaraju1116@gmail.com

Radhika V. R
Research Scholar
Department of Mathematics
Nirmala College for Women
Coimbatore.
radhikaramakrishnan2805@gmail.com

I. INTRODUCTION

Discover the transformative power of higher education, a dynamic force that fuels personal growth and drives economic, technological, and social progress. Through the exchange of knowledge, research, and innovation, students are equipped with essential skills to navigate evolving job markets. As students embark on their post-secondary journey after completing class XII, the importance of selecting subjects wisely becomes paramount for shaping promising career paths. To alleviate confusion and ensure informed decisions for a fulfilling future, employing a suitable mathematical method for decision-making is imperative. The idea of a fuzzy set was initially suggested in 1965 by Lofti A. Zadeh [6]. The key idea behind this approach is that it establishes the uncertainty of a set via a membership function that provides values to the components of the universal set that fall between [0,1]. These metrics are referred to as membership degrees. In 1986 Atanassov [2] introduced the Intuitionistic Fuzzy Set, which expands on the Fuzzy Set concept by additionally taking into account the non-membership degree. In this case, the cardinality of a finite member is indicated by the letters. A special instance of context-dependent fuzzy sets, the theory of hazy sets was first put forth by Gau and Buehrer [3] as an extension of fuzzy set theory. By proposing the idea of a Neutrosophic set, Smarandache expanded the notion of an intuitionistic fuzzy set (NS). Smarandache originally discussed Neutrosophy in 1995, and in 2005 [4] he defined the Neutrosophic set theory, one of the most significant new mathematical techniques for dealing with issues involving erroneous, ambiguous, and inconsistent data. Many scholars go on to employ NS in both their theoretical and applied research after then.

The term "Neutrosophic vague set," which combines the terms "Neutrosophic set" and "vague set," was first introduced by Shawkat Alkhazaleh [5] in 2015. Neutrosophic vague theory is a useful method for analysing ambiguous, conflicting, and incomplete data.
Indeterminacy was divided into three categories by Smarandache [4]: unknown, contradiction, and ignorance. He also developed Five Symbol Valued Neutrosophic Logic (FSVNL).

In this work, we introduced and discussed the Neutrosophic Vague Decision Making Model Selection Of Educational Stream For Higher Education with some examples.

II. PRELIMINARIES

Definition 2.1: [1]

Let X be a nonempty set. A **Fuzzy set** A in X is given by

$$A = \{\langle x,\ \mu_A(x)\rangle / \ x \in X\}$$

Where $\mu_A(x)$: X→ [0,1] is the membership function of the Fuzzy Set A.
(i.e) , $\mu_A(x) \in [0,1]$ is the membership of $x \in X$ in A.

Definition 2.2: [2]

An **Intuitionistic Fuzzy Set (IFS),** A in X is given by $A = \{\langle x,\mu_A(x),\nu_A(x)\rangle / x \in X\}$ where μ_A: $X \to [0,1]$ and ν_A: $X \to [0,1]$ with the condition $0 \le \mu_A(x)+ \nu_A(x) \le 1, \forall x \in X$.Here $\mu_A(x)$ and $\nu_A(x) \in [0,1]$ denote the membership and non-membership functions of the Fuzzy set A.

Definition 2.3: [1]

A **vague set** is defined by a truth-membership function t_v and a false membership function f_v, where $t_v(x)$ s a lower bound on the grade of membership of x derived from the evidence for x, and f(x) is a lower bound on the negation of x derived from the evidence against x. The values of $t_v(x)$ and $f_v(x)$ are both defined on the closed interval [0, 1] with each point in a basic set X, where $t_v(x)$ + $f_v(x) \le 1$.

Definition 2.4: [4]

Let U be a universe. A **Neutrosophic set** A on X can be defined as follows:
$A = \{\langle x,T_A(x),I_A(x),F_A(x)\rangle : x \in X\}$ where T,I,F: $X \to [0,1]$ and $0 \le T_A(x)+I_A(x)+F_A(x) \le 3$. Here $T_A(x)$ is the degree of membership, (x) is the degree of indeterminacy and (x) is the degree of non-membership.

Definition 2.5: [5]

A **Neutrosophic vague set** A_{NV} (NVS) on X written as

$A = \{\langle x; \hat{T}_A(x); \hat{I}_A(x); \hat{F}_A(x)\rangle; x \in X\}$, , whose truth membership, indeterminacy membership and false membership functions is defined as:

$\hat{T}_A(x) = [T^-, T^+]$, $\hat{I}_A(x)[I^-, I^+]$, $\hat{F}_A(x)$=$[F^-, F^+]$,
Where, (1) $T^+ = 1 - F^-$ (2) $F^+ = 1 - T^-$ and (3) $0 \le T^- + I^- + F^- \le 2^+$ when X is continuous, a NVS A can be written as

$$A = \int \langle x; \hat{T}_A(x); \hat{I}_A(x); \hat{F}_A(x)\rangle \, /x, x \in X$$

When X is discrete, a NVS A can be written as

$$A = \sum_{i=1}^{n} \langle x; \hat{T}_A(x); \hat{I}_A(x); \hat{F}_A(x)\rangle / x_i, \qquad x_i \in X$$

III. SINGLE VALUED NEUTROSOPHIC VAGUE MULTIPLE ATTRIBUTE DECISION MAKING PROBLEMS BASED ON GRA WITH INTERVAL WEIGHT INFORMATION

Here, a multi-criteria decision-making issue with m choices and n qualities is examined. Let $Q_1, Q_2, \ldots, Q_n$ be the set of criteria and $K_1, K_2, \ldots, K_m$ a discrete set of options. The options are ranked by the decision-makers. The ranking displays how alternatives K_i fare in relation to Q_j criteria. The decision matrix that follows (see Table 1) displays the values corresponding to the possibilities for the MADM issue.

Table 1: Decision Matrix

D=$\langle\delta_{ij}\rangle_{m*n}$ =

	Q_1	Q_2	....	Q_n
K_1	δ_{11}	δ_{12}	....	δ_{1n}
K_2	δ_{21}	δ_{22}	....	δ_{2n}
.	...	...	....	...
.	...	...	....	...
K_m	δ_{m1}	δ_{m2}	....	δ_{mn}

The weight $\omega_j \in [0,1](j = 1,2,\dots,n)$ represent the relative importance of criteria $Q_j(j = 1,2,..,m)$ to the decision-making process such that $\sum_{j=1}^{n}\omega_j = 1$.

The steps of neutrosophic vague multiple attribute decision making based on GRA under Neutrosophic Vague environment can be presented as follows.

Step 1: Construction of the decision matrix with Neutrosophic Vague Environment

Examine the attribute choice making issue. After pre-processing the data, the general from decision matrix as displayed in Table 1 may be shown. In this case, NV is the ranking of alternatives K_i $(i = 1,2,\dots,m)$ in relation to qualities Q_j $(j = 1,2,\dots,n)$. The following decision matrix (see Table 2) can be used to describe the neutrosophic values associated with the option for MADM situations.

Table 2: Decision Matrix with N

$\delta_s = \langle\hat{T}_{ij},\hat{I}_{ij},\hat{F}_{ij}\rangle_{m*n}$ =

	Q_1	Q_2	...	Q_n
K_1	$\langle\hat{T}_{11},\hat{I}_{11},\hat{F}_{11}\rangle$	$\langle\hat{T}_{12},\hat{I}_{12},\hat{F}_{12}\rangle$	...	$\langle\hat{T}_{1n},\hat{I}_{1n},\hat{F}_{1n}\rangle$
K_2	$\langle\hat{T}_{21},\hat{I}_{21},\hat{F}_{21}\rangle$	$\langle\hat{T}_{21},\hat{I}_{21},\hat{F}_{21}\rangle$	...	$\langle\hat{T}_{2n},\hat{I}_{2n},\hat{F}_{2n}\rangle$
.				
.				
K_m	$\langle\hat{T}_{m1},\hat{I}_{m1},\hat{F}_{m1}\rangle$	$\langle\hat{T}_{m2},\hat{I}_{m2},\hat{F}_{m2}\rangle$	...	$\langle\hat{T}_{mn},\hat{I}_{mn},\hat{F}_{mn}\rangle$

(1)

In the matrix $d_s = \langle\hat{T}_{ij},\hat{I}_{ij},\hat{F}_{ij}\rangle_{m*n}$ $\hat{T}_{ij}$ $\hat{I}_{ij}$ and $\hat{F}_{ij}$ indicate, with regard to attribute Q_j, the degrees of truth membership, degree of indeterminacy, and degree of falsity membership of the alternative K_i. The following qualities are met by these three NV components.

$$1.\ 0 \le \hat{T}_{ij} \le 1, 0 \le \hat{I}_{ij} \le 1, 0 \le \hat{F}_{ij} \le 1 \quad (2)$$

$$2.\ 0 \le \hat{T}_{ij} + \hat{I}_{ij} + \hat{F}_{ij} \le 3 \quad (3)$$

Step 2: Determination of the ideal neutrosophic vague estimate reliability solution (INVERS)

For a given neutrosophic vague decision matrix, be used to establish the ideal neutrosophic vague estimate reliability solution (INVERS)

Step 3: Calculation of the neutrosophic vague grey relational coefficient

Grey relational coefficient of each alternative from INVERS can be defined as follows

$$S_{ij}^{+} = \min_i \min_j \Delta_{ij}^{+} + \frac{\rho \max_i \max_j \Delta_{ij}^{+}}{\Delta_{ij}^{+} + \rho \max_i \max_j \Delta_{ij}^{+}} \quad (4)$$

Where $\Delta_{ij}^{+}= d\left(r_{ij}, r_j^{+}\right),\ i = 1,2, \dots m \text{ and } j = 1,2, \dots n.$

$\rho \in [0,1]$ is also known as the identifying or distinguishing coefficient. A smaller differentiating coefficient value indicates a wider range of grey relationship coefficients. Generally, $\rho = 0.5$ is set for decision making situation.

Step 4: Calculation of the neutrosophic vague grey relational coefficient (NVGRC)

Each alternative from the Indeterminacy Truthfullness Falsity Positive Ideal Solution (ITFPIS) has a degree of neutrosophic vague grey relational coefficient that is determined using the following relation:

$$S_i^{+} = \sum_{j=1}^{n} w_j S_{ij}^{+} \quad (5)$$

Step 5: Neutrosophic vague decision-making model Selection of Educational stream for higher Education

A model enabling parents to choose their child's educational stream is being developed using the field research as the basis, and domain experts have identified five key criteria for this process. Here are the specifics as they are displayed:

- **Availability of courses:** It includes the course details in that college which a student can choose.

- **Facility of transportation:** It includes the cost of transportation facility availed by the student provided by college administration from student's house to the college.

- **Cost:** It includes reasonable admission fees and other fees stipulated by the college administration

- **Staff and curriculums:** The degree of capability of the college administration in providing good competent staff, teaching and coaching, and extra-curricular activities.
- **Placement programs:** It includes the placement availability provided by the college for the student's good career path.

Following an initial screening process, the three institutions below were identified as alternatives, and an effort was made to create a model that would allow the best candidate to be chosen using the aforementioned criteria.

Table 3: Decision Matrix with NV

	Q_1	Q_2	Q_3	Q_4	Q_5
K_1	[0.3,0.5]; [0.2,0.5]; [0.5,0.7]	[0.6,0.7]; [0.2,0.4]; [0.3,0.4]	[0.3,0.8]; [0.2,0.5]; [0.2,0.7]	[0.6,0.3]; [0.7,0.8]; [0.7,0.4]	[0.5,0.6]; [0.2,0.3]; [0.4,0.5]
K_2	[0.4,0.6]; [0.3,0.6]; [0.4,0.6]	[0.3,0.4]; [0.3,0.5]; [0.6,0.7]	[0.2,0.5]; [0.2,0.5]; [0.5,0.8]	[0.2,0.4]; [0.4,0.6]; [0.6,0.8]	[0.4,0.5]; [0.1,0.2]; [0.5,0.6]
K_3	[0.1,0.6]; [0.1,0.3]; [0.4,0.9]	[0.2,0.8]; [0.1,0.5]; [0.2,0.8]	[0.5,0.7]; [0.5,0.6]; [0.3,0.5]	[0.8,0.2]; [0.5,0.9]; [0.8,0.2]	[0.2,0.4]; [0.3,0.5]; [0.6,0.8]

The following details are known regarding the attribute weights:
$w = 0.20, 0.15, 0.25, 0.35, 0.05$

We then apply the strategy created to obtain the preferred option or options.

The problem is solved by the following steps:

Step 1: Determination of the ideal neutrosophic vague estimate reliability solution

From the provided decision matrix (see Table 3), the optimal neutrosophic vague estimate reliability solution (INVERS) may be derived as follows.

$R_S^+ = |r_{s_1}^+, r_{s_2}^+, r_{s_3}^+, r_{s_4}^+, r_{s_5}^+| =$

$$\begin{bmatrix} \langle \max_i\{T_{i1}^-\};\ \min_i\{I_{i1}^-\};\ \min_i\{F_{i1}^-\}\rangle \\ \langle \min_i\{T_{i1}^+\};\ \max_i\{I_{i1}^+\};\ \max_i\{F_{i1}^+\}\rangle \\ \langle \max_i\{T_{i2}^-\};\ \min_i\{I_{i2}^-\};\ \min_i\{F_{i2}^-\}\rangle \\ \langle \min_i\{T_{i2}^+\};\ \max_i\{I_{i2}^+\};\ \max_i\{F_{i2}^+\}\rangle \\ \langle \max_i\{T_{i3}^-\};\ \min_i\{I_{i3}^-\};\ \min_i\{F_{i3}^-\}\rangle \\ \langle \min_i\{T_{i3}^+\};\ \max_i\{I_{i3}^+\};\ \max_i\{F_{i3}^+\}\rangle \\ \langle \max_i\{T_{i4}^-\};\ \min_i\{I_{i4}^-\};\ \min_i\{F_{i4}^-\}\rangle \\ \langle \min_i\{T_{i4}^+\};\ \max_i\{I_{i4}^+\};\ \max_i\{F_{i4}^+\}\rangle \\ \langle \max_i\{T_{i5}^-\};\ \min_i\{I_{i5}^-\};\ \max_i\{F_{i5}^-\}\rangle \\ \langle \min_i\{T_{i5}^+\};\ \max_i\{I_{i5}^+\};\ \max_i\{F_{i5}^+\}\rangle \end{bmatrix}$$

$$\begin{pmatrix} \langle 0.4,0.1,0.4\rangle & \langle 0.5,0.6,0.9\rangle \\ \langle 0.6,0.1,0.2\rangle & \langle 0.4,0.5,0.8\rangle \\ \langle 0.5,0.2,0.2\rangle & \langle 0.5,0.6,0.8\rangle \\ \langle 0.8,0.4,0.6\rangle & \langle 0.2,0.9,0.8\rangle \\ \langle 0.5,0.1,0.4\rangle & \langle 0.4,0.5,0.8\rangle \end{pmatrix}$$

Step 3: Calculation of the neutrosophic vague grey relational coefficient of each alternative from INVERS

The neutrosophic vague grey relational coefficient of every choice from INVERS may be found using equation (4) in the following way:

$$\langle S_{ij}^+\rangle_{3*5} = \begin{pmatrix} 0.4597 & 0.4376 & 0.3729 & 0.3947 & 0.3178 \\ 0.6872 & 0.5431 & 0.6972 & 0.5941 & 0.3012 \\ 0.6989 & 0.6958 & 0.7698 & 0.7981 & 0.7998 \end{pmatrix}$$

Step 4: Determination of the degree of neutrosophic Vague grey relational co-efficient (NVGRC) of each alternative from INVERS

The required neutrosophic vague grey relational coefficient of each alternative from INVERS is determined using equation (5).

$S_1 = 0.40484; S_2 = 0.61617; S_3 = 0.75593$

Step 5: Ranking of the alternatives

From we observe that $S_3 > S_2 > S_1$ i.e

IV. CONCLUSION

In conclusion, the paper effectively showcased the practical implementation of a neutrosophic vague decision-making model in selecting an educational stream for higher education. By combining grey system theory and neutrosophic vague set, five criteria were applied to tackle school choice issues within a neutrosophic vague setting. The model's ability to easily integrate new criteria enhances its adaptability for decision-making processes. This innovative approach offers valuable guidance for individuals navigating complex grey and neutrosophic vague environments. Moreover, the concept's scalability allows for seamless extension even with incomplete weight information, demonstrating its potential for diverse real-life problem-solving scenarios.

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