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# AN Application of Neutrosophic Vague Max-Min Composition Technique

**Mary Margaret A, Trinita Pricilla M**

***Abstract:** The theory of fuzzy set was introduced by Zadeh, has a wider scope in terms of applications than the classical set theory in solving various problems. Extensive applications of the fuzzy set theory have been found in various fields such as Computer Sciences, Artificial Intelligence, Medical Sciences, Economics, Statistics, Neural Networks, etc. In fuzzy set each element had a degree of membership. Smarandache defined the neutrosophic set theory, which was one of the most important new mathematical tools for handling problems involving imprecise, indeterminacy, and inconsistent data. The theory of vague sets was first proposed by Gau and Buehrer as an extension of fuzzy set theory and vague sets are regarded as a special case of context-dependent fuzzy sets. Shawkat Alkhazaleh introduced the concept of neutrosophic vague set as a combination of neutrosophic set and vague set. Neutrosophic vague theory is an effective tool to process incomplete, indeterminate and inconsistent information. This paper attempts to develop a new model known as neutrosophic vague max-min composition technique to examine the daily life problems. One of the major problems that everyone comes across is their children's studies. Education is a very important aspect of the lives of all people all over the world. What we learn, not just in the classroom, shapes who we are. We take our education everywhere we go. Student life is not as easier as it seems. Now a days the studies of the student is deviated due to various reasons. Here we identify those problems of students and by using neutrosophic vague max-min composition technique we analyze the problem faced by the students that affect their lack of concentration in studies.*

***Keywords:** Neutrosophic vague set, neutrosophic vague relation, max-min composition.*

## I. INTRODUCTION

Education is one of the most important aspects in society and hence should be taken with optimal seriousness. Students play a major role and many students have an absolute desire to study in various colleges. In the process of learning, there are many different problems that face students either within the Campus or outside the campus. Some of them facing memory loss, some face drowsiness, some facing adolescent problems, some facing family problems, some facing financial problems etc., all these problems have indicated that, students are at great risk of failing to complete their courses. The concept of fuzzy sets was introduced by Zadeh [12] in 1965. Using this fuzzy sets intuitionistic fuzzy sets was introduced by Atanassov [1] in 1986. The intuitionistic fuzzy relations was used in medical diagnosis by Biswas [2,3]. The theory of vague sets was first proposed and developed as an extension of fuzzy set theory by Gau and Buehrer [4]. Then,

Smarandache [11] introduces the neutrosophic elements T, I, F which represent the membership, indeterminacy, and non-membership values respectively, where $]^-0,1^+[$ is that the non-standard unit interval in 1998. Shawkat Alkhazaleh [10] in 2015 introduced and constructed the concept of neutrosophic vague set. With this neutrosophic vague set in 2017 Mary Margaret and Trinita Pricilla [5] defined a set in topology known as neutrosophic vague generalized pre closed set. In 2019, Mary Margaret et.al. [6] defined the neutrosophic vague topological spaces.

In this paper we use the neutrosophic vague relation and max-min composition technique which was known as Sanchez's approach [7,8,9], to analysis of various problems that affect the studies of the students.

## II. PRELIMINARIES

**Definition 2.1: [10]** A neutrosophic vague set $A_{NV}$ (NVS in short) on the universe of discourse $X$ written as $A_{NV} = \left\{\left\langle x; \hat{T}_{A_{NV}}(x); \hat{I}_{A_{NV}}(x); \hat{F}_{A_{NV}}(x)\right\rangle; x \in X\right\}$, whose truth membership, indeterminacy membership and false membership functions is defined as:

$$\hat{T}_{A_{NV}}(x) = \left[T^-, T^+\right],$$
$$\hat{I}_{A_{NV}}(x) = \left[I^-, I^+\right],$$
$$\hat{F}_{A_{NV}}(x) = \left[F^-, F^+\right]$$

where,

1) $T^+ = 1 - F^-$
2) $F^+ = 1 - T^-$ and
3) $^-0 \le T^- + I^- + F^- \le 2^+$.

**Definition 2.2: [10]** Let $A_{NV}$ and $B_{NV}$ be two NVSs of the universe $U$. If $\forall u_i \in U$, $\hat{T}_{A_{NV}}(u_i) \le \hat{T}_{B_{NV}}(u_i)$; $\hat{I}_{A_{NV}}(u_i) \ge \hat{I}_{B_{NV}}(u_i)$, $\hat{F}_{A_{NV}}(u_i) \ge \hat{F}_{B_{NV}}(u_i)$, then the NVS $A_{NV}$ is included by $B_{NV}$, denoted by $A_{NV} \subseteq B_{NV}$, where $1 \le i \le n$.

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**Definition 2.3: [10]** The complement of NVS $A_{NV}$ is denoted by $A_{NV}^c$ and is defined by

$$\hat{T}_{A_{NV}}^c(x) = \left[1 - T^+, 1 - T^-\right],$$
$$\hat{I}_{A_{NV}}^c(x) = \left[1 - I^+, 1 - I^-\right],$$
$$\hat{F}_{A_{NV}}^c(x) = \left[1 - F^+, 1 - F^-\right].$$

**Definition 2.4: [10]** The union of two NVSs $A_{NV}$ and $B_{NV}$ is NVS $C_{NV}$, written as $C_{NV} = A_{NV} \cup B_{NV}$, whose truth-membership, indeterminacy-membership and false-membership functions are related to those of $A_{NV}$ and $B_{NV}$ given by,

$$\hat{T}_{C_{NV}}(x) = \left[\max\left(T_{A_{NV_x}}^-, T_{B_{NV_x}}^-\right), \max\left(T_{A_{NV_x}}^+, T_{B_{NV_x}}^+\right)\right]$$
$$\hat{I}_{C_{NV}}(x) = \left[\min\left(I_{A_{NV_x}}^-, I_{B_{NV_x}}^-\right), \min\left(I_{A_{NV_x}}^+, I_{B_{NV_x}}^+\right)\right]$$
$$\hat{F}_{C_{NV}}(x) = \left[\min\left(F_{A_{NV_x}}^-, F_{B_{NV_x}}^-\right), \min\left(F_{A_{NV_x}}^+, F_{B_{NV_x}}^+\right)\right].$$

**Definition 2.5: [10]** The intersection of two NVSs $A_{NV}$ and $B_{NV}$ is NVS $C_{NV}$, written as $C_{NV} = A_{NV} \cap B_{NV}$, whose truth-membership, indeterminacy-membership and false-membership functions are related to those of $A_{NV}$ and $B_{NV}$ given by,

$$\hat{T}_{C_{NV}}(x) = \left[\min\left(T_{A_{NV_x}}^-, T_{B_{NV_x}}^-\right), \min\left(T_{A_{NV_x}}^+, T_{B_{NV_x}}^+\right)\right]$$
$$\hat{I}_{C_{NV}}(x) = \left[\max\left(I_{A_{NV_x}}^-, I_{B_{NV_x}}^-\right), \max\left(I_{A_{NV_x}}^+, I_{B_{NV_x}}^+\right)\right]$$
$$\hat{F}_{C_{NV}}(x) = \left[\max\left(F_{A_{NV_x}}^-, F_{B_{NV_x}}^-\right), \max\left(F_{A_{NV_x}}^+, F_{B_{NV_x}}^+\right)\right].$$

**Definition 2.6: [10]** Let $A_{NV}$ and $B_{NV}$ be two NVSs of the universe $U$. If $\forall u_i \in U$, $\hat{T}_{A_{NV}}(u_i) = \hat{T}_{B_{NV}}(u_i)$; $\hat{I}_{A_{NV}}(u_i) = \hat{I}_{B_{NV}}(u_i)$; $\hat{F}_{A_{NV}}(u_i) = \hat{F}_{B_{NV}}(u_i)$, then the NVS $A_{NV}$ and $B_{NV}$, are called equal, where $1 \le i \le n$.

## III. ANALYSIS OF VARIOUS PROBLEMS THAT AFFECT THE STUDIES OF THE STUDENTS

**Definition 3.1:** A neutrosophic vague relation is defined as a neutrosophic vague subsets of $X \times Y$, having the form $A_{NV} = \left\{\left\langle (x,y); \hat{T}_{A_{NV}}(x,y); \hat{I}_{A_{NV}}(x,y); \hat{F}_{A_{NV}}(x,y)\right\rangle; x \in X, y \in Y\right\}$, whose truth membership, indeterminacy membership and false membership functions is defined as:

$$\hat{T}_{A_{NV}}(x,y) = \left[T^-(x,y), T^+(x,y)\right],$$
$$\hat{I}_{A_{NV}}(x,y) = \left[I^-(x,y), I^+(x,y)\right],$$
$$\hat{F}_{A_{NV}}(x,y) = \left[F^-(x,y), F^+(x,y)\right]$$

where,

1) $T^+ = 1 - F^-$
2) $F^+ = 1 - T^-$ and
3) $^-0 \le T^- + I^- + F^- \le 2^+$.

**Definition 3.2:** Let $B_{NV}(X \to Y)$ and $A_{NV}(Y \to Z)$ be two neutrosophic vague relations. The max-min composition is the neutrosophic vague relation on $(X \to Z)$, which is denoted by $A_{NV} \circ B_{NV}$, whose truth membership, indeterminacy membership and false membership functions is defined as:

$$A_{NV} \circ B_{NV} = \left\{\left\langle (x,z); \hat{T}_{A\circ B}(x,z); \hat{I}_{A\circ B}(x,z); \hat{F}_{A\circ B}(x,z)\right\rangle; x \in X, z \in Z\right\}$$

where

$$\hat{T}_{A\circ B}(x,z) = \underset{y\in Y}{Max}\left\{\underset{x\in X}{Min}\left[T_B^-(x,y), T_A^-(y,z)\right]\right\}, \underset{y\in Y}{Max}\left\{\underset{x\in X}{Min}\left[T_B^+(x,y), T_A^+(y,z)\right]\right\}$$

$$\hat{I}_{A\circ B}(x,z) = \underset{y\in Y}{Min}\left\{\underset{x\in X}{Max}\left[I_B^-(x,y), I_A^-(y,z)\right]\right\}, \underset{y\in Y}{Min}\left\{\underset{x\in X}{Max}\left[I_B^+(x,y), I_A^+(y,z)\right]\right\}$$

$$\hat{F}_{A\circ B}(x,z) = \underset{y\in Y}{Min}\left\{\underset{x\in X}{Max}\left[F_B^-(x,y), F_A^-(y,z)\right]\right\}, \underset{y\in Y}{Min}\left\{\underset{x\in X}{Max}\left[F_B^+(x,y), F_A^+(y,z)\right]\right\}$$

## IV. ALGORITHM OF THE PROBLEM

**Step 1:** Compute $C_{NV} = A_{NV} \circ B_{NV}$ where

$$C_{NV} = A_{NV} \circ B_{NV} = \left\{\left\langle (x,z); \hat{T}_{A\circ B}(x,z); \hat{I}_{A\circ B}(x,z); \hat{F}_{A\circ B}(x,z)\right\rangle; x \in X, z \in Z\right\}$$

**Step 2:** Calculate $D$ where

$$D = \left\{\left\langle (x,z); T_D(x,z); I_D(x,z); F_D(x,z)\right\rangle; x \in X, z \in Z\right\}$$

where

$$T_D(x,z) = \left\{\frac{\underset{y\in Y}{Max}\left\{\underset{x\in X}{Min}\left[T_B^-(x,y), T_A^-(y,z)\right]\right\}, \underset{y\in Y}{Max}\left\{\underset{x\in X}{Min}\left[T_B^+(x,y), T_A^+(y,z)\right]\right\}}{2}\right\},$$

$$I_D(x,z) = \left\{\frac{\underset{y\in Y}{Min}\left\{\underset{x\in X}{Max}\left[I_B^-(x,y), I_A^-(y,z)\right]\right\}, \underset{y\in Y}{Min}\left\{\underset{x\in X}{Max}\left[I_B^+(x,y), I_A^+(y,z)\right]\right\}}{2}\right\},$$

$$F_D(x,z) = \left\{\frac{\underset{y\in Y}{Min}\left\{\underset{x\in X}{Max}\left[F_B^-(x,y), F_A^-(y,z)\right]\right\}, \underset{y\in Y}{Min}\left\{\underset{x\in X}{Max}\left[F_B^+(x,y), F_A^+(y,z)\right]\right\}}{2}\right\}.$$

**Step 3:** Find $\min\left(T_D(x,z); I_D(x,z); F_D(x,z)\right)$.

**Step 4:** Find $\max\left(\min\left(T_D(x,z); I_D(x,z); F_D(x,z)\right)\right)$.

## V. CASE STUDY

Here we consider some of the most common problems faced by students which affect their studies. Let us consider five students, and denoted by set S = {$S_1$, $S_2$, $S_3$, $S_4$, $S_5$} and the set of marks is denoted by M = {$M_1$, $M_2$, $M_3$, $M_4$, $M_5$}.

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The neutrosophic vague relation $B(X \rightarrow Y)$ is given in Table 1. Let the set of problems be P = {Memory Loss, Drowsiness, Adolescent Problem, Family Problem, Financial Problem}. The neutrosophic vague relation $A(Y \rightarrow Z)$ is given in Table 2.

**Table 1: Neutrosophic vague relation $B_{NV}(S \rightarrow M)$**

| B | $M_1$ | $M_2$ | $M_3$ | $M_4$ | $M_5$ |
|---|---|---|---|---|---|
| $S_1$ | {[0.1,0.3]; [0.4, 0.5]; [0.7,0.9]} | {[0,0.2]; [0.3, 0.6]; [0.8,1]} | {[0.4,0.7]; [0.3, 0.6]; [0.3,0.6]} | {[0.2,0.8]; [0.1, 0.5]; [0.2,0.8]} | {[0.2,0.3]; [0.5, 0.7]; [0.7,0.8]} |
| $S_2$ | {[0,0.1]; [0.5, 0.6]; [0,1]} | {[0.5,0.6]; [0.5, 0.6]; [0.4,0.5]} | {[0.2,0.3]; [0.2, 0.4]; [0.7,0.8]} | {[0.1,0.2]; [0.4, 0.5]; [0.8,0.9]} | {[0,0.3]; [0.4, 0.6]; [0.7,1]} |
| $S_3$ | {[0.3,0.5]; [0.2, 0.4]; [0.5,0.7]} | {[0.1,0.4]; [0.3, 0.5]; [0.6,0.9]} | {[0.2,0.6]; [0.1, 0.3]; [0.4,0.8]} | {[0.6,0.7]; [0.3, 0.5]; [0.3,0.4]} | {[0.3,0.6]; [0.2, 0.4]; [0.4,0.7]} |
| $S_4$ | {[0.3,0.4]; [0.4, 0.6]; [0.6,0.7]} | {[0,0.3]; [0.5, 0.7]; [0.7,0.1]} | {[0.1,0.4]; [0.3, 0.5]; [0.6,0.9]} | {[0.5,0.6]; [0.3, 0.6]; [0.4,0.5]} | {[0.3,0.4]; [0.1, 0.4]; [0.6,0.7]} |
| $S_5$ | {[0.2,0.5]; [0.4, 0.5]; [0.5,0.8]} | {[0.4,0.5]; [0.1, 0.2]; [0.5,0.6]} | {[0.3,0.5]; [0.4, 0.7]; [0.5,0.7]} | {[0.1,0.4]; [0.3, 0.6]; [0.6,0.9]} | {[0.4,0.6]; [0.3, 0.7]; [0.4,0.6]} |

**Table 2: Neutrosophic vague relation $A_{NV}(M \rightarrow P)$**

| A | Memory Loss | Drowsiness | Adolescent Problem | Family Problem | Financial Problem |
|---|---|---|---|---|---|
| $M_1$ | {[0.5,0.7]; [0.5, 0.6]; [0.3,0.5]} | {[0.2,0.5]; [0.1, 0.6]; [0.5,0.8]} | {[0.4,0.5]; [0.1, 0.2]; [0.5,0.6]} | {[0.3,0.4]; [0.1, 0.2]; [0.6,0.7]} | {[0.2,0.5]; [0.1,0.2]; [0.5,0.8]} |
| $M_2$ | {[0.2,0.8]; [0.1, 0.5]; [0.2,0.8]} | {[0.1,0.6]; [0.1, 0.3]; [0.4,0.9]} | {[0.2,0.6]; [0.3, 0.5]; [0.4,0.8]} | {[0.1,0.3]; [0.3, 0.5]; [0.7,0.9]} | {[0.1,0.2]; [0.5,0.6]; [0.8,0.9]} |
| $M_3$ | {[0.1,0.3]; [0.3, 0.5]; [0.7,0.9]} | {[0.2,0.3]; [0.2, 0.4]; [0.7,0.8]} | {[0.2,0.4]; [0.3,0.5]; [0.6,0.8]} | {[0,0.4]; [0.1, 0.2]; [0.6,1]} | {[0.3,0.6]; [0.1,0.2]; [0.4,0.7]} |
| $M_4$ | {[0,0.3]; [0.2,0.6]; [0.7,1]} | {[0.6,0.7]; [0.3, 0.5]; [0.3,0.4]} | {[0.3,0.5]; [0.2,0.3]; [0.5,0.7]} | {[0.2,0.3]; [0.1, 0.2]; [0.7,0.8]} | {[0.6,0.8]; [0.2, 0.4]; [0.2,0.4]} |
| $M_5$ | {[0.4,0.5]; [0.1,0.6]; [0.5,0.6]} | {[0,0.3]; [0.2, 0.4]; [0.7,1]} | {[0.4,0.6]; [0.5, 0.7]; [0.4,0.6]} | {[0.1,0.4]; [0.5, 0.6]; [0.6,0.9]} | {[0.5,0.6]; [0.2,0.3]; [0.4,0.5]} |

**Table 3: Max-Min composition $C_{NV} = A_{NV} \circ B_{NV}(S \rightarrow P)$**

| C | Memory Loss | Drowsiness | Adolescent Problem | Family Problem | Financial Problem |
|---|---|---|---|---|---|
| $S_1$ | {[0.2,0.3]; [0.2,0.6]; [0.7,0.8]} | {[0.2,0.7]; [0.4, 0.5]; [0.3,0.8]} | {[0.2,0.5]; [0.2, 0.5]; [0.5,0.8]} | {[0.2,0.4]; [0.1, 0.5]; [0.6,0.8]} | {[0.3,0.8]; [0.2, 0.5]; [0.2,0.7]} |
| $S_2$ | {[0.2,0.7]; [0.3,0.5]; [0.3,0.8]} | {[0.2,0.6]; [0.2, 0.4]; [0.4,0.8]} | {[0.2,0.6]; [0.3, 0.5]; [0.4,0.8]} | {[0.1,0.4]; [0.2, 0.4]; [0.6,0.9]} | {[0.2,0.5]; [0.2, 0.4]; [0.5,0.8]} |
| $S_3$ | {[0.3,0.5]; [0.2,0.5]; [0.5,0.7]} | {[0.6,0.7]; [0.2, 0.4]; [0.3,0.4]} | {[0.3,0.6]; [0.2, 0.4]; [0.4,0.7]} | {[0.3,0.4]; [0.1, 0.3]; [0.6,0.7]} | {[0.6,0.7]; [0.1, 0.3]; [0.3,0.4]} |
| $S_4$ | {[0.3,0.4]; [0.1,0.5]; [0.6,0.7]} | {[0.5,0.6]; [0.2, 0.4]; [0.4,0.5]} | {[0.3,0.5]; [0.3, 0.5]; [0.5,0.7]} | {[0.3,0.4]; [0.3, 0.5]; [0.6,0.7]} | {[0.5,0.6]; [0.2, 0.4]; [0.4,0.5]} |
| $S_5$ | {[0.4,0.5]; [0.1,0.5]; [0.5,0.6]} | {[0.2,0.5]; [0.1, 0.3]; [0.5,0.8]} | {[0.4,0.6]; [0.3, 0.5]; [0.4,0.6]} | {[0.2,0.4]; [0.3, 0.5]; [0.6,0.8]} | {[0.4,0.6]; [0.3, 0.6]; [0.4,0.6]} |

**Table 4:**

$$D = \{\langle (x,z); T_D(x,z); I_D(x,z); F_D(x,z) \rangle; x \in X, z \in Z\}$$

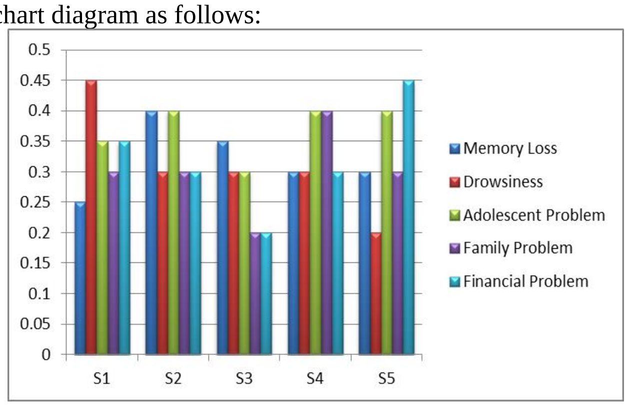
| D | Memory Loss | Drowsiness | Adolescent Problem | Family Problem | Financial Problem |
|---|---|---|---|---|---|
| $S_1$ | 0.25, 0.4, 0.75 | 0.45, 0.45, 0.55 | 0.35, 0.35, 0.65 | 0.3, 0.3, 0.7 | 0.55, 0.35, 0.45 |
| $S_2$ | 0.45, 0.4, 0.55 | 0.4, 0.3, 0.6 | 0.4, 0.4, 0.6 | 0.25, 0.3, 0.75 | 0.35, 0.3, 0.65 |
| $S_3$ | 0.4, 0.35, 0.6 | 0.65, 0.3, 0.35 | 0.45, 0.3, 0.55 | 0.35, 0.2, 0.65 | 0.65, 0.2, 0.35 |
| $S_4$ | 0.35, 0.3, 0.65 | 0.55, 0.3, 0.45 | 0.4, 0.4, 0.6 | 0.35, 0.4, 0.65 | 0.55, 0.3, 0.45 |
| $S_5$ | 0.45, 0.3, 0.55 | 0.35, 0.2, 0.65 | 0.5, 0.4, 0.5 | 0.3, 0.4, 0.7 | 0.5, 0.45, 0.5 |

**Table 5:** $\max(\min(T_D(x,z); I_D(x,z); F_D(x,z)))$

| D | Memory Loss | Drowsiness | Adolescent Problem | Family Problem | Financial Problem |
|---|---|---|---|---|---|
| $S_1$ | 0.25 | **0.45** | 0.35 | 0.3 | 0.35 |
| $S_2$ | **0.4** | 0.3 | **0.4** | 0.3 | 0.3 |
| $S_3$ | **0.35** | 0.3 | 0.3 | 0.2 | 0.2 |
| $S_4$ | 0.3 | 0.3 | **0.4** | **0.4** | 0.3 |
| $S_5$ | 0.3 | 0.2 | 0.4 | 0.3 | **0.45** |

## VI. CONCLUSION

Hence $\max(\min(T_D(x,z); I_D(x,z); F_D(x,z)))$ gives the final result of the students problems that affects their studies in the table 5, we see that the maximum value of $S_1$ is 0.45, this concludes that $S_1$ is affected by drowsiness. Then maximum value of $S_2$ is 0.4, this concludes that $S_2$ is affected by memory loss and adolescent problem. The maximum value of $S_3$ is 0.35, this concludes that $S_3$ is affected by memory loss. The maximum value of $S_4$ is 0.4, this concludes that $S_4$ is affected by adolescent problem and family problem. The maximum value of $S_5$ is 0.45, this concludes that $S_5$ is affected by financial problem. This is represented by the chart diagram as follows:



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