Journal of Advanced Zoology

ISSN: 0253-7214

Volume ***44*** *Issue* ***S-1*** ***Year 2023*** *Page* ***15:24***

Medical Diagnosis via Refined Neutrosophic Fuzzy Logic: Detection of Illness using Neutrosophic Sets

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Article History

Received: 06 June 2023
Revised: 15 August 2023
Accepted:21August 2023

Abstract

The objective of the paper is to implement and validate diagnosis in the medical field via refined neutrosophic fuzzy logic (RNFL). As such, we have proposed a Max-Min composition (MMC) method in RNFL. This method deals with the diagnosis under certain constraints like uncertainty and indeterminacy. Further, we have considered the diagnosis problems to validate the sensitivity analysis of the novel multi attribute decision-making technique. Finally, we gave the graphical representations and compared the obtained results with other existing measures in refined neutrosophic fuzzy sets.

Keywords: *Fuzzy set, Multi Fuzzy set, Refined Neutrosophic Fuzzy set, Max-Min composition.*

1. Introduction

Several authors established many concepts of decision-making in fuzzy sets. Fuzzy set theory is very successful in handling uncertainties arising from the vagueness of an element in a set. As such, the concept of interval-valued fuzzy sets came into force to capture uncertain situations in 1975, (L.A, Zadeh 1965). Generalization of the fuzzy set which is known as intuitionistic fuzzy sets (IFs) was made by (K. Atanassov, 1986). In IFs, instead of one membership grade, there is also a non-membership grade attached to each element. The conception of IFs can be viewed as an alternative approach in case where available information is not sufficient to define the impreciseness by the single value fuzzy set. From a philosophical standpoint, (F. Smarandache, 2002; F. Smarandache, 2005) proposed the neutrosophic set (NS) to deal with imprecise uncertain, inconsistent and partial information that exists in reality. This theory is very important in many applications areas since indeterminacy is quantified explicitly. Later, (F.Smarandache, 2013) introduced n-valued neutrosophic logic. More on Fuzzy Neutrosophic sets and Fuzzy Neutrosophic Topological spaces are discussed by (Arockiarani et al., 2014; S. Sabu & Ramakrishnan, 2011; S. Sabu & Ramakrishnan, 2010), discussed about Multi fuzzy topology. Modeling diffusion transport mechanisms by utilizing the polynomials is proposed by (Rao & Chakraverty, 2018). Further, I.Deli et.al. (2015), proposed neutrosophic multisets and their application in medical diagnosis. Fuzzy Decision-Making Using Max-Min Method and Minimization of Regret Method given by Muhammad Siddique (2009). M.Z. Ragab & Emam (1995), also discussed the min-max composition of fuzzy matrices, fuzzy sets and systems. Fuzzy Max-Min Composition Technique in Medical Diagnosis analyzed by Edward Samuel & M. Balamurugan (2012). Wang et al. (2010), analyzed various aspects related to single valued neutrosophic sets. Entropy-based grey relational analysis method for multi-attribute decision making under single valued neutrosophic assessments given by Biswas et al. (2014). Further, Zeshui (2010) proposed method based on distance measure for interval-valued intuitionistic fuzzy group decision-making. Multiple-attribute decision-making method under a single-valued neutrosophic hesitant fuzzy environment is given by (Ye J, 2015; Broumi et al., 2022) discussed about the medical diagnosis problems based on neutrosophic sets and their hybrid structures. This article has five sections the first section deals with the introductory part and the next with the preliminaries then the third section gives a brief report on Max-Min Composition in Refined Neutrosophic fuzzy Sets, the fourth will discuss about the diagnosis problems of the proposed concept. Further, the fifth section gives the validation and sensitivity analysis and the final section will deliver the conclusion of this study.

Preliminaries

Refined Neutrosophic fuzzy relation in different product space can be combined with each other by the operation called “composition”. They are many composition methods in use, e.g., max – product method, max- average method and max-min method and distance measures used in decision-making problems. But the max-min composition method is best known in refined neutrosophic fuzzy logic applications. Before illustrating the max min composition method in refined neutrosophic fuzzy sets. Here we give some basic definitions of fuzzy, multi-fuzzy, neutrosophic fuzzy and refined neutrosophic fuzzy sets. Generally fuzzy sets handling the concept of partial truth- truth values between complete truth and complete false whereas neutrosophic set is an extension of the intuitionistic fuzzy set which includes indeterminacy.

Fuzzy Set

Let X is an Universe of discourse and A be a fuzzy set defined on X[1]. A fuzzy set can be defined by $A=\{(x,\mu_A(x))/x\in X,\mu_A(x)\in[0,1]\}$

Ex: Let $X=\{1,2,3,4,5\}$ and $A=\{(1,0.1),(2,0.2),(3,0.3),(4,0.4),(5,0.5)\}$.

Multi Fuzzy Set

A multi $fuzzy$ set A in X is defined by way of a sequence of well-ordered set[6,7]

$$A=\{(x,\mu_{A_1}(x),\mu_{A_2}(x),....\mu_{A_n}(x))/x\in X,\mu_{A_i}(x)\in[0,1]\}\ where\ i=1\ to\ n$$

Ex: Let $X=(a,b,c)$ then $A=\{(a,0.1,0.2,0.5),(b,0.2,0.2,0.3),(c,0.2,0.3,0.4)\}$.

Properties

Let us consider two multi $fuzzy$ sets A and B in X[6,7]

Then we have for each $i=1\ to\ n$ where n is a positive integer

$$A\subseteq B\ if\ and\ only\ if\ \mu_{A_i}(x)\le\mu_{B_i}(x)$$

$$A=B\ if\ and\ only\ if\ \mu_{A_i}(x)=\mu_{B_i}(x)$$

$$A\cup B=\{x,\max(\mu_{A_i}(x),\mu_{B_i}(x))\}$$

$$A \cap B = \left\{ x, \min\left(\mu_{A_i}(x), \mu_{B_i}(x)\right) \right\}$$

$$C(A) = \left\{ (x, C\mu_{A_i}(x)), C\mu_{A_i}(x) = 1 - \mu_{A_i}(x) \right\}$$

Neutrosophic Fuzzy set

Consider a neutrosophic $fuzzy$ set[3,4] $\mathcal{N}$ in X(nonempty)is normally characterized by three proposes namely T_N, I_N, F_N. Then neutrosophic fuzzy set is defined by

$$N = \left\{ < x, T_N(x), I_N(x), F_N(x) >: x \in X, T_N(x), I_N(x), F_N(x) \in [0,1] \right\}$$

$$0^- \le T_N(x) + I_N(x) + F_N(x) \le 3^+$$

T_N = Truth membership function

I_N = Indeterminacy membership function

F_N = Falsity membership function

The n-Numerical Valued Refined Neutrosophic Fuzzy Logic

In general [18] T_N can be split many types of truths like $T_N^1, T_N^2, \ldots T_N^p$, I_N can be split many types of indeterminacies like $I_N^1, I_N^2, \ldots I_N^r$ and F_N can be split many types of falsities like $F_N^1, F_N^2, \ldots F_N^s$. All subcomponents T_N^i, I_N^j, F_N^k are subsets of [0,1], for all $i \in \{1,2,\ldots p\}, j \in \{1,2,\ldots r\} \, and \, k \in \{1,2,\ldots s\}$. Then it can be defined X as follows

$$N = \left\{ < x, \left(T_N^1(x), T_N^2(x), \ldots T_N^p(x)\right), \left(I_N^1(x), I_N^2(x), \ldots I_N^r(x)\right), \left(F_N^1(x), F_N^2(x), \ldots F_N^s(x)\right) > x \in X \right\}$$

If all sources of information that separately provide neutrosophic values for a specific subcomponent are independent sources, then in the general case we consider that each of the subcomponents T_N^i, I_N^j, F_N^k is independent with respect to the others and it is in the non-standard set $\left]^-0, 1^+\right[$.

$${}^-0 \le \sum_{i=1}^{p} T_N^i + \sum_{j=1}^{r} I_N^j + \sum_{k=1}^{s} F_N^k \le n^+ \quad \text{where } n = p + r + s.$$

Properties

Let A and B are two n-numerical valued refined neutrosophic fuzzy **sets** in X and x be the generic element in X then the following properties hold :

$$A \subseteq B \text{ if and only if } T_A^i(x) \le T_B^i(x), I_A^j(x) \ge I_B^j(x), F_A^k(x) \ge F_B^k(x)$$

$$A = B \text{ if and only if } T_A^i(x) = T_B^i(x), I_A^j(x) = I_B^j(x), F_A^k(x) = F_B^k(x)$$

$$A \cup B = \left\{ x, \max\left(T_A^i(x), T_B^i(x)\right), \min\left(I_A^j(x), I_B^j(x)\right), \min\left(F_A^k(x), F_B^k(x)\right) \right\}$$

$$A \cap B = \left\{ x, \min\left(T_A^i(x), T_B^i(x)\right), \max\left(I_A^j(x), I_B^j(x)\right), \max\left(F_A^k(x), F_B^k(x)\right) \right\}$$

Max-Min Composition in refined neutrosophic Fuzzy Sets

Many authors developed uncertain problems in decision making by using max min composition method in fuzzy sets (Muhammad, 2009; M.Z. Ragab & E.G. Emam, 1995; A. Edward Samuel & M. Balamurugan, 2012). But this method has some limitations when the data includes indeterminacy. Since the fuzzy set takes only one value between 0 and 1. This may affect the decision drawn from the information. Using the max-min method on a single set of data may not give accurate results. As such, we get the minimum error by collecting the data two or more times to apply the max min method. To overcome these situations, we are proposing max min method in the refined neutrosophic fuzzy set, where we can see the data includes indeterminacy and information also includes multi fuzzy. The indeterminacy function does not exist in fuzzy sets, implicitly exist in intuitionistic fuzzy sets and explicitly exist in neutrosophic fuzzy sets. Here, we present the max-min composition method to handle uncertainty in multiple constraints and plays a vital role to handling multiple data sets.

Let X be the universe of discourse and A and B are two refined neutrosophic fuzzy set defined on X. Then the data set in A and B can be represented in the form of matrices say Z and Y is given by:

$Z=[a_{lm}]_{LxM}$ where $a_{lm}=\left(T_A^i(x_l/y_m), I_A^j(x_l/y_m), F_A^k(x_l/y_m)\right)$, $l=1 to L, m=1 to M$.

$Y=[b_{mn}]_{MxN}$ where $b_{mn}=\left(T_B^i(y_m/z_n), I_B^j(y_m/z_n), F_B^k(y_m/z_n)\right)$, $m=1 to M, n=1 to N$.

Then the Max-Min composition of the two matrices Z and Y is defined by: $Z\,o\,Y=C=\left[c_{\ln}\right]_{LxN}$ where:

$$c_{l\text{n}}=\begin{pmatrix}\max\left(\max_l\left(\min_m\left(T_A^i(x_l/y_m), T_B^i(y_m/z_n)\right)\right)\right), \min\left(\min_l\left(\max_m\left(I_A^j(x_l/y_m), I_B^j(y_m/z_n)\right)\right)\right), \\ \min\left(\min_l\left(\max_m\left(F_A^k(x_l/y_m), F_B^k(y_m/z_n)\right)\right)\right)\end{pmatrix}$$

For better result get the data for the proposed method via refined neutrosophic fuzzy sets at two or more different intervals.

Propositions of Max-Min composition

Max min method can exhibit various useful properties, a few of which are given here for effectiveness and efficiency of the proposed method.

Let Z,Y,D are three refined neutrosophic fuzzy matrices defined on X then $maxmin$ composition on Z,Y is denoted by Z o Y and it is easily verify the following algebraic properties.

3.1.1 Associative

Z o (Y o D) = (Z o Y) o D   for all Z, Y, D

3.1.2 Commutative

Z o Y = Y o Z for all Z, Y

3.1.3 Transitive

Z o Y = Y o D then Z o D for all Z, Y, D

Algorithm

Making choices between future, and uncertain possibilities is defined as decision making. It is a choice between numerous methods for achieving a goal. In business, finance, and economics, as well as engineering, social, physical, and medical sciences, decision-making is critical. It should be highlighted that all decisions are made with the future in mind. There can be no decision-making when there are no choices. Due to issues such as insufficient and imprecise information, vagueness, and the uncertainty of the situation, it is a tough process. These characteristics demonstrate that judgments are made in a fuzzy logic environment. The act of making a decision is characterized by the selection of an option from a set of options. Stipulated goals must be met while keeping obstacles in mind during this procedure. Consider a simple goal-and-constraints decision-making paradigm.

Let X be a Universal set and A be the refined neutrosophic fuzzy sets, Consider $x_1, x_2, ...x_m$ be the set of m elements and $y_1, y_2, ...y_n$ be the set of n elements then we have the following algorithm for the max min composition method in refined neutrosophic fuzzy sets. Based on this algorithm we can draw a decision for the given data.

Algorithm for the proposed method

Step 1: Let $x_1, x_2, ...x_L$ be the symptoms characterstics of every patient. The data must include percentage of truth values indeterminacy values and falsity values (T, I, F). The data may be quantitative or qualitative in nature.

Step 2: Observe the symptoms at different times.

Step 3: Convert data obtained in Step 2 into membership values by using triangular membership function and form a matrix Z of order LxM.

Step 4: Next collect the data of symptoms characteristics for the diagnosis from expert which we compare with the patient symptoms. The data must include truth values indeterminacy values and falsity values (T, I, F). The data may be quantitative or qualitative in nature. This data is already existed and standard data in nature.

Step 5: Convert the data obtained in Step 4 into membership values by using triangular membership function and form a matrix Y of order MxN.

Step 6: Apply max min composition between A and B by using the formula

$$C_{l\,n} = \left(\begin{array}{l} \max\left(\max_l \left(\min_m \left(T_A^i\left(x_l / y_m\right), T_B^i\left(y_m / z_n\right)\right)\right)\right), \min\left(\min_l \left(\max_m \left(I_A^j\left(x_l / y_m\right), I_B^j\left(y_m / z_n\right)\right)\right)\right), \\ \qquad \min\left(\min_l \left(\max_m \left(F_A^k\left(x_l / y_m\right), F_B^k\left(y_m / z_n\right)\right)\right)\right) \end{array} \right)$$

Step 7: The highest value of T in the entries of the matrix C gives the decision.

Step 8: If T is same then look into Falsity value in the relation matrix C. The least value of F in the matrix C gives the decision provided that Indeterminacy value is less than or equal to Falsity membership value. If indeterminacy membership value is greater than the Falsity value then conclusion cannot be drawn and information is bias.

Diagnosis problems by proposed method

Diagnosis problem 1:

When a person is affected by a particular disease that a person will have a more than one symptom such as Temperature, cough, throat infection, headache, sneezing etc. Also, each viral disease will have more than one symptom. For instance, malaria, typhoid, chicken gunya will have various symptoms like temperature, body pain, cough etc. A person who is affected by corona virus also will have the symptoms of temperature, cough, sneezing, body pain etc. Now to find out the core symptom of corona virus we will use max min composition via refined neutrosophic multi fuzzy sets. We can find the maximum value in T can conclude the kind of sickness affecting the patient suffering from.

Let us take 8 patients for our study i.e $P = \{P_1, P_2, P_3, P_4, P_5, P_6, P_7, P_8\}$. Each patient is experiencing more than one symptom say S = {Temperature, Headache, body pain, cough, sneezing}. Now using the neutrosophic data we want to find out the kind of disease affecting the person from the common prevalent diseases, say d = {Viral fever, malaria, typhoid, chicken gunya, corona virus}.

The data given in the form of matrix Z, Y.

The following matrix represents the patient's vs symptoms.

$$Z = \begin{bmatrix} ((0.6,0.7),(0.3,0.2),(0.3,0.1)) & ((0.5,0.4),(0.2,0.1),(0.4,0.3)) & ((0.3,0.5),(0.5,0.4),(0.2,0.1)) & ((0.4,0.3),(0.4,0.2),(0.4,0.2)) & ((0.3,0.5),(0.4,0.3),(0.5,0.4)) \\ ((0.1,0.2),(0.6,0.7),(0.4,0.3)) & ((0.4,0.3),(0.6,0.5),(0.3,0.2)) & ((0.3,0.2),(0.5,0.5),(0.4,0.4)) & ((0.3,0.3),(0.5,0.4),(0.4,0.4)) & ((0.3,0.2),(0.6,0.7),(0.7,0.5)) \\ ((0.6,0.4),(0.3,0.2),(0.4,0.2)) & ((0.6,0.6),(0.2,0.1),(0.4,0.3)) & ((0.4,0.4),(0.5,0.5),(0.5,0.4)) & ((0.2,0.2),(0.5,0.3),(0.5,0.3)) & ((0.2,0.2),(0.4,0.2),(0.3,0.3)) \\ ((0.4,0.3),(0.3,0.2),(0.2,0.2)) & ((0.4,0.4),(0.4,0.4),(0.4,0.3)) & ((0.2,0.1),(0.4,0.4),(0.5,0.4)) & ((0.5,0.4),(0.2,0.1),(0.4,0.2)) & ((0.4,0.3),(0.3,0.3),(0.4,0.3)) \\ ((0.2,0.1),(0.4,0.3),(0.6,0.5)) & ((0.2,0.1),(0.4,0.4),(0.0,0.0)) & ((0.7,0.6),(0.6,0.5),(0.1,0.1)) & ((0.2,0.1),(0.4,0.4),(0.7,0.6)) & ((0.3,0.2),(0.2,0.1),(0.7,0.5)) \\ ((0.3,0.3),(0.4,0.2),(0.5,0.4)) & ((0.6,0.4),(0.4,0.3),(0.3,0.1)) & ((0.6,0.6),(0.3,0.3),(0.1,0.0)) & ((0.5,0.5),(0.4,0.3),(0.7,0.5)) & ((0.5,0.4),(0.4,0.3),(0.6,0.7)) \\ ((0.4,0.7),(0.5,0.4),(0.3,0.2)) & ((0.6,0.5),(0.5,0.5),(0.1,0.1)) & ((0.5,0.5),(0.4,0.4),(0.4,0.3)) & ((0.5,0.4),(0.3,0.2),(0.4,0.3)) & ((0.4,0.4),(0.5,0.5),(0.4,0.3)) \\ ((0.6,0.6),(0.3,0.3),(0.7,0.6)) & ((0.6,0.4),(0.2,0.2),(0.3,0.2)) & ((0.6,0.6),(0.3,0.3),(0.6,0.6)) & ((0.4,0.3),(0.3,0.2),(0.4,0.2)) & ((0.7,0.7),(0.1,0.0),(0.2,0.2)) \end{bmatrix}$$

For each patient the type of symptoms usually found, so that we can obtain symptom disease relation. The following matrix represents the symptoms vs diseases.

$$Y = \begin{bmatrix} (0.6,0.3,0.3) & (0.2,0.5,0.3) & (0.2,0.6,0.4) & (0.1,0.6,0.6) & (0.1,0.6,0.4) \\ (0.4,0.5,0.3) & (0.2,0.6,0.4) & (0.1,0.5,0.4) & (0.2,0.4,0.6) & (0.1,0.6,0.4) \\ (0.1,0.6,0.3) & (0.0,0.6,0.4) & (0.2,0.5,0.5) & (0.8,0.2,0.2) & (0.1,0.7,0.1) \\ (0.4,0.4,0.4) & (0.4,0.1,0.5) & (0.2,0.5,0.5) & (0.1,0.7,0.4) & (0.4,0.5,0.4) \\ (0.1,0.7,0.4) & (0.1,0.6,0.3) & (0.1,0.6,0.4) & (0.1,0.7,0.4) & (0.8,0.2,0.2) \end{bmatrix}$$

The resultant matrix is patient's vs diseases.

$$C = \begin{bmatrix} (0.6,0.3,0.3) & (0.3,0.2,0.3) & (0.2,0.5,0.4) & (0.5,0.4,0.2) & (0.3,0.3,0.1) \\ (0.4,0.4,0.3) & (0.3,0.4,0.3) & (0.2,0.5,0.4) & (0.2,0.5,0.4) & (0.3,0.5,0.4) \\ (0.6,0.3,0.3) & (0.2,0.3,0.3) & (0.2,0.5,0.4) & (0.4,0.4,0.4) & (0.2,0.2,0.3) \\ (0.4,0.3,0.3) & (0.4,0.1,0.3) & (0.2,0.4,0.4) & (0.2,0.4,0.4) & (0.4,0.3,0.3) \\ (0.2,0.3,0.3) & (0.2,0.4,0.4) & (0.2,0.5,0.4) & (0.7,0.4,0.2) & (0.3,0.2,0.1) \\ (0.4,0.4,0.3) & (0.4,0.3,0.4) & (0.2,0.5,0.4) & (0.6,0.3,0.2) & (0.5,0.3,0.1) \\ (0.6,0.4,0.3) & (0.4,0.2,0.3) & (0.2,0.5,0.4) & (0.5,0.4,0.3) & (0.4,0.5,0.3) \\ (0.6,0.3,0.3) & (0.4,0.2,0.3) & (0.2,0.5,0.4) & (0.6,0.3,0.4) & (0.7,0.2,0.2) \end{bmatrix}$$

We can conclude that P_1, P_2, P_3, P_7 suffers with Viral fever, P_4 suffers with Malaria, P_5, P_6 suffers with Chicken gunya, P_8 suffers with Corona virus.

Diagnosis Problem 2:

Three patients came with symptoms of three viruses namely Herpes simplex, Hepatitis, Influenza. Doctor suggested three tests to three patients namely Elisa test, Blood test and Viral culture.

Let $P=\{P_1, P_2, P_3\}$ be the universal set where P_1, P_2, P_3 represents the set of patients. $V=\{V_1, V_2, V_3\}$ be the set of viruses and $T=\{T_1, T_2, T_3\}$ be the set of tests. They have taken two samples and the report has given in terms of the relation matrix. The following matrix is the relation matrix of patients and their tested values (The matrices A and B given in this paper are directly converted raw data into membership values)

$$A=\begin{array}{c} \\ P_1 \\ P_2 \\ P_3 \end{array}\begin{array}{c} \begin{array}{ccc} T_1 & T_2 & T_3 \end{array} \\ \begin{bmatrix} ((0.6,0.5),(0.2,0.2),(0.2,0.2)) & ((0.8,0.8),(0.1,0.1),(0.1,0.1)) & ((0.4,0.3),(0.2,0.2),(0.4,0.5)) \\ ((0.8,0.7),(0.1,0.2),(0.1,0.1)) & ((0.4,0.3),(0.2,0.3),(0.4,0.4)) & ((0.6,0.5),(0.2,0.1),(0.3,0.3)) \\ ((0.4,0.4),((0.1,0.1),(0.5,0.5)) & ((0.3,0.3),(0.1,0.2),(0.6,0.5)) & ((0.8,0.8),(0.1,0.1),(0.1,0.1)) \end{bmatrix} \end{array}$$

Doctor is having some standard values for the tests based on the viruses. These values may help for the junior doctor for the better treatment. The following matrix is the relation matrix of test values based on viruses.

The relation matrix B is given by

$$B=\begin{array}{c} \\ T_1 \\ T_2 \\ T_3 \end{array}\begin{array}{c} \begin{array}{ccc} V_1 & V_2 & V_3 \end{array} \\ \begin{bmatrix} ((0.8,0.8),(0.1,0.1),(0.1,0.1)) & ((0.5,0.5),(0.1,0.1),(0.4,0.4)) & ((0.4,0.4),(0.1,0.1),(0.5,0.5)) \\ ((0.4,0.4),(0.1,0.1),(0.5,0.5)) & ((0.8,0.8),(0.1,0.1),(0.1,0.1)) & ((0.4,0.4),(0.1,0.1),(0.5,0.5)) \\ ((0.5,0.5),(0.1,0.1),(0.4,0.4)) & ((0.4,0.4),(0.1,0.1),(0.5,0.5)) & ((0.8,0.8),(0.1,0.1),(0.1,0.1)) \end{bmatrix} \end{array}$$

The resultant matrix

$$D=\begin{array}{c} \\ P_1 \\ P_2 \\ P_3 \end{array}\begin{array}{c} \begin{array}{ccc} V_1 & V_2 & V_3 \end{array} \\ \begin{bmatrix} (0.6,0.1,0.2) & (0.8,0.1,0.1) & (0.4,0.1,0.5) \\ (0.8,0.1,0.1) & (0.5,0.1,0.4) & (0.6,0.1,0.3) \\ (0.5,0.1,0.4) & (0.4,0.1,0.5) & (0.8,0.1,0.1) \end{bmatrix} \end{array}$$

From the resultant matrix it is easily observe that P_1 has highest truth membership value at V_2, P_2 has highest truth membership value at V_1 and P_3 has highest truth membership value at V_3 .We conclude that P_1 suffers with V_2, P_2 suffers with V_1 and P_3 suffers with V_3.

Validation and Sensitivity Analysis

Validity and Sensitivity analysis of the proposed methodology regarding max-min composition of RNFS is done with various distance measures like Normalized Hamming distance measure, Normalized Euclidean distance measure, Hausdroff metric for the same data and the comparison results are shown in the below tables and graphs. As such, various distance measures are listed below (Tongjuan, 2021).

(a) Normalized Hamming distance measure

$$D_{Ham}^{N}(A,B)=\frac{1}{3n}\sum_{i=1}^{n}\left(\left|T_A(x_i)-T_B(x_i)\right|+\left|I_A(x_i)-I_B(x_i)\right|+\left|F_A(x_i)-F_B(x_i)\right|\right)$$

(b) Normalized Euclidean distance measure

$$D_{Euc}^{N}(A,B)=\sqrt{\frac{1}{3n}\sum_{i=1}^{n}\left(\left(T_A(x_i)-T_B(x_i)\right)^2+\left(I_A(x_i)-I_B(x_i)\right)^2+\left(F_A(x_i)-F_B(x_i)\right)^2\right)}$$

(c) Hausdroff measure

$$D_{Haus}^{N}(A,B)=\frac{1}{n}\sum_{i=1}^{n}\max\left(\left|T_A(x_i)-T_B(x_i)\right|,\left|I_A(x_i)-I_B(x_i)\right|,\left|F_A(x_i)-F_B(x_i)\right|\right)$$

Due to large calculations, I compared proposed method with the distance measures by taking diagnosis problem 2.

	MMC	NHDM	NEDM	HM
(P1, V1)	(0.6,0.1,0.2)	0.15	0.1353	0.25
(P1, V2)	(0.8,0.1,0.1)	0.2	0.2449	0.3
(P1, V3)	(0.4.0.1,0.5)	0.0667	0.0818	0.1
(P2, V1)	(0.8,0.1,0.1)	0.2667	0.3109	0.4
(P2, V2)	(0.5,0.1,0.4)	0.3	0.3266	0.45
(P2, V3)	(0.6,0.1,0.3)	0.1333	0.1526	0.2
(P3, V1)	(0.5,0.1,0.4)	0.0667	0.0816	0.1
(P3, V2)	(0.4,0.1,0.5)	0.0667	0.0816	0.1
(P3, V3)	(0.8,0.1,0.1)	0	0	0

The following figure shows that the graphical representation between proposed method and distance measures.

The graphical representation between proposed method and other measure

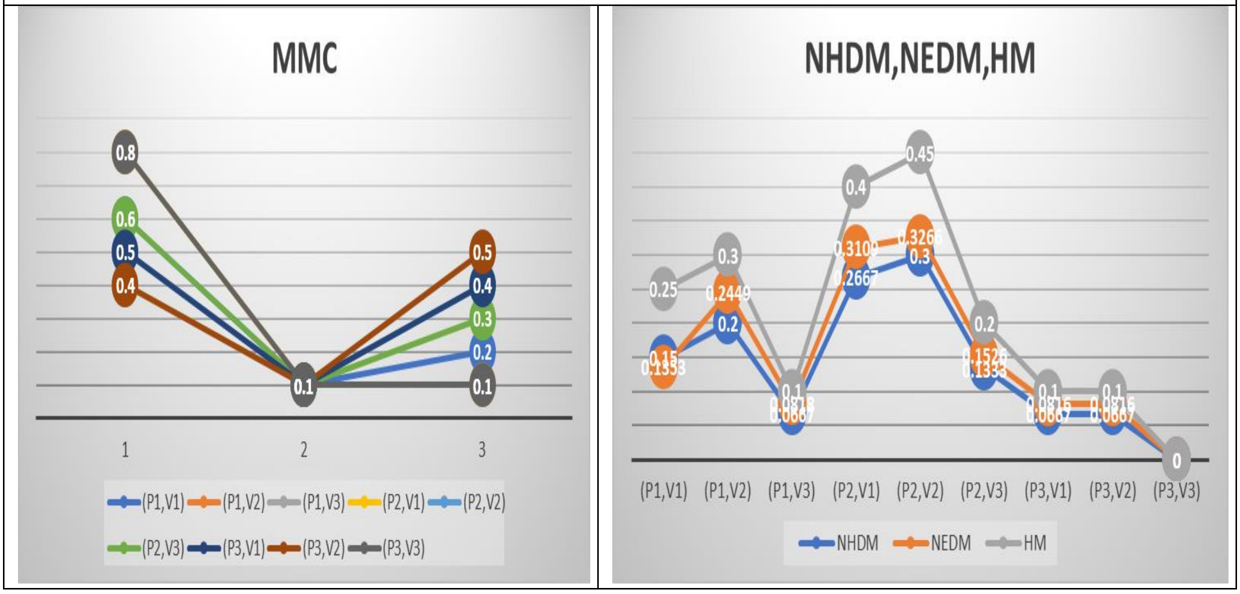

Figure (1): Graph of MMC with NHDM, NEDM & HM

Table 1 depicts the comparison values between the proposed method other method for the considered problem 2. In distance methods usually, the minimum value gives the decision. When you collect the neutrosophic data these methods fail. This we can see in the table 1. Whereas our proposed method gives the correct decision. In Fig.1, we can easily observe that the graph of proposed method shows the three values such as Truth membership value, Falsity membership values and Inderminacy value whereas the graph of other measures like NHDM, NEDM & HM shows only a single crisp value.

2. Conclusion

The discussion in this paper is related to the analysis and validation of the Max-Min Composition method. In this method the decision is based on truth membership value. Further, the decision depends on the indeterminacy membership value ($F < I$ & $F > I$). As such, in this paper, Max-Min composition method is developed and implemented to examine its feasibility for selecting a diagnosis problem. The main concluding remarks of the proposed method are accurate decision by taking into account of truth membership value (T), indeterminacy membership values (I) and falsity membership values (F). We compared this method with various measures where the decision depends on the crisp set. In these measures the authors merged all three membership values into a crisp set. In the first illustration, the proposed method and measuring methods exhibit the same result but in the second

Illustration the proposed method has given the correct decision whereas the existing methods do not. In the realm of medical diagnosis, the utilisation of neutrosophic tests presents an innovative and alternative method for detecting paten illnesses. This study explores the application of neutrosophic sets as an unconventional approach to healthcare diagnosis aiming to enhance the accuracy and reliability of disease detection. By incorporating the concept of neutrosophy, which deals with indeterminacy, uncertainty, and vagueness, this research offers a fresh perspective on how medical professionals can make informed decisions when faced with complex and ambiguous clinical data. Through the examination of real-world case studies and the development of novel algorithms, this study investigates the potential benefits of neutrosophic sets in improving patient care and medical decision making. The findings shed light on the feasibility and effectiveness of this alternative methodology in the context of diagnosing various medical conditions, ultimately contributing to the ongoing evolution of healthcare practices.

Neutrosophic set based diagnosis heavily relies on data. Incomplete, inaccurate or biased data can lead to erroneous results, limited access to high quality medical data may restrict the effectiveness of this approach. The use of unconventional diagnostic methods like neutrosophic sets may raise ethical and legal questions, particularly in case of misdiagnosis or patient harm. Neutrosophic sets should not replace the expertise of healthcare professionals. They should be considered as complementary tools rather than standalone diagnostic methods.

Conflict of interest:
The authors declare no conflict of interest.

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