NSS
Neutrosophic Sets and Systems, Vol. 49, 2022
University of New Mexico

Medical Diagnosis Problems Based on Neutrosophic Sets and Their Hybrid Structures: A Survey

Said Broumi[1,2], Mamoni Dhar[3], Abdellah Bakhouyi[4,5], Assia Bakali[6], Mohamed Talea[7]

[1] Laboratory of Information Processing, Faculty of Science Ben M'Sik, University of Hassan II, Casablanca, Morocco; broumisaid78@gmail.com

[2]Regional Center for the Professions of Education and Training, Casablanca-Settat; broumisaid78@gmail.com

[3]Laboratory of Science College, Kokrajhar Assam, India;mamonidhar@gmail.com

[4]M2S2I Laboratory, Hassan II University,

[5]National Higher School of Art and Design,Casablanca, Morocco; abdellah.bakhouyi@gmail.com

[6]Ecole Royale Navale-Boulevard Sour Jdid, B.P 16303 Casablanca, Morocco; assiabakali@yahoo.fr

[7]Laboratory of Information Processing, Faculty of Science Ben M'Sik, University of Hassan II, Casablanca, Morocco; taleamohamed@yahoo.fr

* **Correspondence: broumisaid78@gmail.com**

Abstract

The investigation of a person's symptoms can be evaluated through medical diagnosis to diagnose the diseases. To medical clinicians, a large amount of data is available for diagnosis, which comprises uncertainty, inconsistency, and indeterminacy. The field of medicine is one of the best areas of application for neutrosophic set theory. The main intention of this article is to deal with some of the applications of neutrosophic sets and their hybrid structures to solve medical diagnosis problems.

Keywords: Neutrosophic sets; interval valued neutrosophic sets, simplified neutrosophic sets; medical diagnosis problem

I. Introduction

The concept of neutrosophic set theory was first developed by Smarandache [1]. Smarandache [1-2] developed the notions of neutrosophic set (NS) and neutrosophic logic as a generalization of fuzzy sets [3], intuitionistic fuzzy sets [4]. Certain kinds of uncertainty, such as incomplete, indeterminate, and inconsistent information seen in the real world and not handled by fuzzy sets, as well as intuitionistic fuzzy sets, can be easily handled by neutrosophic sets. Three independent membership degrees characterize the concept of a neutrosophic set: truth-membership degree (T), indeterminacy-membership degree (I), and falsity-membership degree (F).

Smarandache [5] developed the concept of a single-valued neutrosophic set (SVNS), which is a subclass of neutrosophic sets in which the values of the three membership functions T, I, and F are in the unit interval [0, 1]. Smarandache [6] extended the neutrosophic set to include neutrosophic precalculus, neutrosophic calculus, neutrosophic measure, neutrosophic probability (chance that an event occurs, indeterminate-chance of occurrence of the event, and chance that the event does not occur), and neutrosophic statistic (statistics that have indeterminacy) were carried out by Smarandache [6]. Many researchers have proposed extensions to the notion of neutrosophic sets since it was first introduced.interval-valued neutrosophic sets [7], simplified neutrosophic sets [8], trapezoidal neutrosophic sets [9], single-valued neutrosophic hesitant sets [10], neutrosophic overset, underset, and offset [11], bipolar neutrosophic sets [12], interval-valued bipolar neutrosophic sets [13], single-valued neutrosophic multi-sets [14], rough neutrosophic sets [15], bipolar neutrosophic refined sets [16] and refined neutrosophic sets [17]. All of the newly presented notions have been thoroughly investigated, and attempts to apply them to multiple-attribute decision-making issues and other disciplines have been explored.[18–30] contains a lot of study in this area. In clinical medicine, medical diagnosis is critical in determining diseases based on a set of symptoms.Many academics have undertaken studies linked to medical diagnosis difficulties in fuzzy and intuitionistic fuzzy settings, according to the literature review [31-47]. Later, so many of the fuzzy models based on soft sets were quickly investigated and applied to medical diagnosis issues [48-58].The purpose of all investigations is to establish an adequate medical diagnosis method for determining whether a patient has a specific disease. The medical diagnosis is determined in relation to a specific ailment under certain assumptions. Due to the presence of indeterminacy data, the approaches employed to solve the medical diagnosis problem in fuzzy environments and intuitionistic fuzzy environments are not suitable to neutrosophic related problems.As a result, a number of methods and algorithms for dealing with the medical diagnosis problem in a neutrosophic environment have been created.The purpose of this paper is to show how the neutrosophic set and its hybrid structures can be used to solve medical diagnosis issues.

The paper is organized as follows: Section 1 is introductory in nature. Section 2 deals with some preliminary definitions that are required in subsequent sections. Section 3 gives a literature survey of different neutrosophic models for solving a medical diagnosis problem, and Section 4 describes the conclusions.

II. Preliminaries

In this section, we mainly recall some notions related to neutrosophic sets, single valued neutrosophic sets, interval valued neutrosophic sets, refined neutrosophic sets, soft sets, bipolar neutrosophic refined sets and rough neutrosophic sets relevant to the present work. See especially [1, 2, 5, 6, 15, 17, 48] for further details and background

Definition 2.1 [1-2]. Let X be a space of points (objects) with generic elements in X denoted by x; then the neutrosophic set A (NS A) is an object having the form A = {< x: $T_A(x)$, $I_A(x)$, $F_A(x)$ >, x $\in$ X}, where the functions T, I, F: X→]$^-$0,1$^+$[define respectively the truth-membership function, an indeterminacy-membership function, and a falsity-membership function of the element x $\in$ X to the set A with the condition:

$$^-0 \le T_A(x) + I_A(x) + F_A(x) \le 3^+. \quad (1)$$

The functions $T_A(x)$, $I_A(x)$ and $F_A(x)$ are real standard or nonstandard subsets of]$^-$0,1$^+$[.

Since it is difficult to apply NSs to practical problems, Smarandache [5] introduced the concept of a SVNS, which is an instance of a NS and can be used in real scientific and engineering applications.

Definition 2.2 [5]. Let X be a space of points (objects) with generic elements in X denoted by x. A single valued neutrosophic set A (SVNS A) is characterized by truth-membership function $T_A(x)$, an indeterminacy-membership function $I_A(x)$, and a falsity-membership function $F_A(x)$. For each point x in X, $T_A(x)$, $I_A(x)$, $F_A(x) \in [0, 1]$. A SVNS A can be written as

$$A = \{< x: T_A(x), I_A(x), F_A(x) >, x \in X\} \quad (2)$$

$$0 \leq T_A(x) + I_A(x) + F_A(x) \leq 3.$$

Definition 2.3 [6]. Let X be a space of points (objects) with generic elements in X denoted by x. An interval-valued neutrosophic set A (IVNS A) is characterized by an interval truth-membership function $T_A(x) = \left[T_A^L, T_A^U\right]$, an interval indeterminacy-membership function $I_A(x) = \left[I_A^L, I_A^U\right]$, and an interval falsity-membership function $F_A(x) = \left[F_A^L, F_A^U\right]$. For each point x in X $T_A(x)$, $I_A(x)$, $F_A(x) \in [0, 1]$. An IVNS A can be written as

$$A = \{< x: T_A(x), I_A(x), F_A(x) >, x \in X\} \quad (3)$$

In some practical situations, there is the possibility of each element having different membership, indeterminacy and non-membership functions. For this purposeSmarandache [16] proposed the concept of:

Definition 2. 4 [17] (neutrosophic refined sets)

Let E be a universe, a neutrosophic refined set (NRS) A on E can be defined as follows

$$A = \left\{ \begin{matrix} < x, (T_A^1(\mathrm{x}), T_A^2(\mathrm{x}), ..., T_A^p(\mathrm{x})), (I_A^1(\mathrm{x}), I_A^2(\mathrm{x}), ..., I_A^p(\mathrm{x})), \\ (F_A^1(\mathrm{x}), F_A^2(\mathrm{x}), ..., F_A^p(\mathrm{x})) \end{matrix} \right\} \quad (4)$$

where $T_A^1(\mathrm{x}), T_A^2(\mathrm{x}), ..., T_A^p(\mathrm{x}) : \mathrm{E} \to [0, 1]$, $I_A^1(\mathrm{x}), I_A^2(\mathrm{x}), ..., I_A^p(\mathrm{x}) : \mathrm{E} \to [0, 1]$ and

$F_A^1(\mathrm{x}), F_A^2(\mathrm{x}), ..., F_A^p(\mathrm{x}) : \mathrm{E} \to [0, 1]$ such that

$0 \leq T_A^i(x) + I_A^i(x) + F_A^i(x) \leq 3$ (i=1, 2, 3,…, p)

Definition 2.5 [48] soft sets

Let U be an initial set and E be a set of parameters. Let P(U) denote the power set of U, and let A → E. A pair (F, A) is called a soft set over U, where F is a mapping given by F: A→ P(U).

Definition 2.6 [16] bipolar neutrosophic refined sets

Let E be a universe, A bipolar neutrosophic refined set (BNRS) A on E can be defined as follows

$$A=\left\{\begin{array}{l}< x,(T_A^{1+}(x),T_A^{2+}(x),...,T_A^{p+}(x),T_A^{1-}(x),T_A^{2-}(x),...,T_A^{p-}(x)),\\ (I_A^{1+}(x),I_A^{2+}(x),...,I_A^{p+}(x),I_A^{1-}(x),I_A^{2-}(x),...,I_A^{p-}(x)),\\ (F_A^{1+}(x),F_A^{2+}(x),...,F_A^{p+}(x),F_A^{1-}(x),F_A^{2-}(x),...,F_A^{p-}(x)) >: x\in X\end{array}\right\} \quad (5)$$

Where

$(T_A^{1+}(x),T_A^{2+}(x),...,T_A^{p+}(x),T_A^{1-}(x),T_A^{2-}(x),...,T_A^{p-}(x)) : E \rightarrow [0, 1]$,

$(I_A^{1+}(x),I_A^{2+}(x),...,I_A^{p+}(x),I_A^{1-}(x),I_A^{2-}(x),...,I_A^{p-}(x)) : E \rightarrow [0, 1]$ and

$(F_A^{1+}(x),F_A^{2+}(x),...,F_A^{p+}(x),F_A^{1-}(x),F_A^{2-}(x),...,F_A^{p-}(x)) : E \rightarrow [0, 1]$ such that $0\leq T_A^i(x)+ I_A^i(x)+ F_A^i(x)\leq 3$

(i=1,2,3,…,p)

$(T_A^{1+}(x),T_A^{2+}(x),...,T_A^{p+}(x),T_A^{1-}(x),T_A^{2-}(x),...,T_A^{p-}(x))$ (6) $(I_A^{1+}(x),I_A^{2+}(x),...,I_A^{p+}(x),I_A^{1-}(x),I_A^{2-}(x),...,I_A^{p-}(x))$

(7)

$(F_A^{1+}(x),F_A^{2+}(x),...,F_A^{p+}(x),F_A^{1-}(x),F_A^{2-}(x),...,F_A^{p-}(x))$ (8)

is the truth membership sequence, indeterminacy membership sequence and falsity membership sequence of the element, x respectively. Also, P is called the dimension of BNR-set. The set of all bipolar neutrosophic refined sets on E is denoted by BNRS(E).

Definition 2.7 [15] rough neutrosophic sets.

Let *Z* be a non-null set and *R* be an equivalence relation on *Z*. Let P be a neutrosophic set in *Z* with the membership function T_P, indeterminacy function I_P and non-membership function F_P. The lower and the upper approximations of *P* in the approximation (*Z*, *R*) denoted by $\underline{N}(P)$ and $\overline{N}(P)$ are respectively defined as follows

$$\left\langle\left\langle x, T_{\underline{N}(P)}(x), I_{\underline{N}(P)}(x), F_{\underline{N}(P)}(x)\right\rangle / z\in[x]_R, x\in Z\right\rangle$$

$$\left\langle\left\langle x, T_{\overline{N}(P)}(x), I_{\overline{N}(P)}(x), F_{\overline{N}(P)}(x)\right\rangle / z\in[x]_R, x\in Z\right\rangle \quad (9)$$

Where $T_{\underline{N}(P)}(x)=\wedge_z T_P(z)\in[x]_R$, $I_{\underline{N}(P)}(x)=\wedge_z I_P(z)\in[x]_R$, $F_{\underline{N}(P)}(x)=\wedge_z F_P(z)\in[x]_R$, $T_{\overline{N}(P)}(x)=\vee_z T_P(z)\in[x]_R$, $I_{\overline{N}(P)}(x)=\vee_z I_P(z)\in[x]_R$, $F_{\overline{N}(P)}(x)=\vee_z F_P(z)\in[x]_R$ So

$0\leq \sup T_{\underline{N}(P)}(x)+\sup I_{\underline{N}(P)}(x)+\sup F_{\underline{N}(P)}(x)\leq 3$ and $0\leq \sup T_{\overline{N}(P)}(x)+\sup I_{\overline{N}(P)}(x)+\sup F_{\overline{N}(P)}(x)\leq 3$

And $\wedge$ and $\vee$ denote "min" and "max" operators respectively, $T_P(z)$, $I_P(z)$ and $F_P(z)$ are the membership, indeterminacy and non-membership of Z with respect to P.

Thus NS mapping $\underline{N}$, $\overline{N}$: $N(Z) \to N(Z)$ are, respectively, referred to as the lower and upper rough neutrosophic approximation operators, and the pair ($\underline{N}(P)$, $\overline{N}(P)$) is called the rough neutrosophic set in Z.

III. REVIEW OF LITTERATURE

In this section, medical diagnosis under different neutrosophic hybrid environments is discussed since the medical field seems to be the most suitable for its applicability. Researchers concerned with neutrosophic sets have found that they needed to be developed for solving complex problems that occur most often in medical diagnosis. Some methods are as below:

3.1 Medical diagnosis using the single valued neutrosophic environment.

To achieve better results, Ansari et al. [59-60] introduced neutrosophic logic into the medical arena. Kharal [61] expanded Sanchez's method of medical diagnosis to neutrosophic sets. The proposed approach of diagnosis allows the decision maker to attribute ambiguous notions to degrees of satisfiability, non-satisfiability, and indeterminacy of symptoms. Shahzadi et al.[84] developed two algorithms for medical diagnosis based on distance and similarity measures in a neutrosophic environment, and discovered that the results achieved using the suggested technique are identical to those obtained using normalized Hamming and normalized Euclidean distance. Kharal [62] suggested a multi-criteria decision-making system based on further extensions of neutrosophic sets (MCDM).The mathematical aspects of the approach, as well as the vis neut-MCDM algorithm, are investigated. The algorithm of viz. neut-MCDM is provided, along with some noteworthy mathematical aspects of the method. The suggested method provides the MCDM community with the principles of neutrosophic set theory. With the use of the neutrosophic membership values of truth, indeterminacy, and falseness, De and Mishra [63] proposed a novel technique of decision making. The major goal was to come to a reasonable conclusion about the illness of a patient who was suffering from a condition utilizing neutrosophic notions. Sanchez's approach of medical diagnostics in the arena of fuzzy neutrosophic composition relations was examined by Jenny and Arockiarani [64]. The steps of proposed algorithm are as follows

Step 1: Determination of symptoms of the patients .i.e. the relation Q(R $\to$ S) between the patients and symptoms are noted.

Step 2: The medical knowledge relating the symptoms with the set of diseases under consideration are noted in table II i.e. the relation of symptoms and diseases R(S $\to$ D) are given.

Step 3: Compute the composition relation of patients and diseases T (P $\to$ D). Using the membership function given by

$$\mu_T(p_i,d) = \vee_{s\in S}\left[\mu_Q(p_i,s)\wedge\mu_R(s,d)\right], \quad (10)$$

the indeterminacy membership function given by $\nu_T(p_i,d) = \vee_{s\in S}\left[\nu_Q(p_i,s)\wedge\nu_R(s,d)\right]$

(11)

and non- membership function given by

$$\omega_T(p_i,d)=\underset{s\in S}{\wedge}\left[\omega_Q(p_i,s)\vee\omega_R(s,d)\right] \quad (12)$$

and noted in Table III.

Step 4: Compute the value function using the

$$V(A)=\mu_A+(1-\nu_A)-\omega_A \quad (13)$$

for Table III and is given in Table IV.

Step 5: Compute the score function for the table III using the

$$S_2=\mu_i-\nu_i\omega_i \quad (14)$$

and it is given in Table V.

Step 6: The higher the score, higher is the possibility of the patient affected with the respective disease.

Ye [65] later produced the tangent function-based similarity measure for SVNSs and the weighted tangent similarity measure for SVNSs, which were introduced by first assessing the relevance of each element and then investigating their features.

The author developed a multi medical diagnosis technique based on the proposed similarity measure and weighted aggregation of multi-period data.

The diagnosis steps are given as follows:

Step1: Compute the similarity measure between a patients P_s and the considered Diseases $D_i\,(i=1,2,...,\mathrm{n})$ in each period $t_k\,(k=1,2,...,q)$ by the following formula:

$$T_{w_i}(P_S,\mathrm{t}_k)=$$

$$1-\sum_{j=1}^{m}\left\{w_j\tan\left[\frac{\pi}{12}\left(\left|T_j(w_i)-T_{ij}\right|+\left|I_j(w_i)-I_{ij}\right|+\left|F_j(w_i)-F_{ij}\right|\right)\right]\right\} \quad (15)$$

Steps 2: Obtain the weighted aggregation values of $M_{T_i}(\mathrm{P}_S)=\sum_{k=1}^{q}T_{w_i}(\mathrm{P}_S,t_k)\,\omega(t_k)$

(16)

Steps 3: Obtain a proper diagnosis for the patient P_s according to the maximum weighted aggregation value.

Step 4: Last step.

According to [69], the multi-period medical diagnosis method is superior to the single-period medical diagnosis method because the latter can be difficult to give a proper diagnosis of a specific patient with a specific disease in some situations, whereas the former must examine the patient over multiple periods and take into account the weighted information aggregation of multiple periods in order to reach a proper conclusion for the patient.

The concept of fuzzy ontology was expanded to neutrosophic ontology by Bhutani and Aggarwal [66].On the appendicitis dataset, the authors used Fuzzy Ontology and Neutosophic Ontology.

Furthermore, the authors determined that categorization using neutrosophic ontology, as opposed to fuzzy ontology, produces more practical findings because it divides data into appendicitis, nonappendicitis, and uncertainty classes.

Prem Kumar Singh [67] has recently explored how the features of the three-way fuzzy idea lattice and neutrosophic graph presented by Broumi et al [28] can be used to analyze uncertainty and ambiguity in medical data sets. Using the vertices and edges of a neutrosophic graph, this study gave a precise description of medical diagnosis difficulties. Furthermore, using neutrosophic graphs and component-wise Godelresiduated lattice to enrich the knowledge, three-way fuzzy concept creation and hierarchical order visualization in the idea lattice are provided. The proposed method is also used to examine the multi-criteria decision-making process in one application.

3.2 Medical diagnosis under the interval neutrosophic environment.

The notion of interval neutrosophic linguistic numbers (INLNs) was developed by Ma et al. [68], and certain related properties were examined.The authors selected medical therapies based on interval neutrosophic linguistic information using interval neutrosophic linguistic prioritized harmonic.

In addition, the authors conclude that interval neutrosophic linguistic numbers can be utilized to analyze information more successfully than fuzzy sets during the medical treatment selection process.

3.3 Medical diagnosis under the simplified neutrosophic environment.

Ye [69] proposed an improved cosine similarity measure of simplified neutrosophic sets (SNSs) based on the cosine function, including single-valued neutrosophic cosine similarity measures and interval neutrosophic cosine similarity measures, to overcome some of the shortcomings of existing cosine similarity measures of SNSs.

The author then presented a medical diagnosis approach for solving medical diagnosis problems utilizing simplified neutrosophic information based on improved cosine similarity measurements.

To demonstrate the efficacy and rationale of the increased cosine similarity measures-based diagnosis technique, two medical diagnosis challenges were supplied.

3.4. Medical diagnosis under the neutrosophic refined environment.

Broumi and Smarandache [70] examined some of the basic properties of a new distance measure between neutrosophic refined sets based on the extended Hausdorff distance of a neutrosophic set.

A medical diagnosis problem is solved using the extended Hausdorff distance or similarity measurements.

Broumi and Smarandache [71] extended the enhanced cosine similarity measure of single-valued neutrosophic sets provided by Ye [21] to neutrosophic refined sets, and investigated some of their basic features.

Furthermore, using the formulas below, the concept of similarity is applied to medical diagnosis problems:

$$C_{NRS}(A,B)=\frac{1}{p}\sum_{j=1}^{p}\left\{\frac{1}{n}\sum_{i=1}^{n}\cos\left[\frac{\pi\left(\left|T_A^j(x_i)-T_B^j(x_i)\right|+\left|I_A^j(x_i)-I_B^j(x_i)\right|+\left|F_A^j(x_i)-F_B^j(x_i)\right|\right)}{6}\right]\right\} \quad (17)$$

Mondal and Pramanik [73] suggested a tangent similarity measure for the neutrosophic refined set, and some of the features of tangent similarity measures were investigated. A tangent similarity measure of single-valued neutrosophic refined sets is a variant of the tangent similarity measure of single-valued neutrosophic sets. The proposed refined tangent similarity measure of single-valued neutrosophic sets is applied to solve a problem in medical diagnosis.

The notion of neutrosophic refined sets (NRS) has been used in medical diagnostics by Deli et al. [14]. The symptoms of each disease can be used to determine the distance and similarity of each patient to that disease.The suggested technique is unusual in that it takes into account multi-membership, indeterminacy, and non-membership.There may be some inaccuracies in diagnosis if you only do a one-time inspection.As a result, in the multi-time inspection procedure, obtaining samples from the same patient at different periods yields the most accurate diagnosis.

3.5 Medical diagnosis under the bipolar neutrosophic refined environment

Deli and ubaş [16] proposed the concept of a bipolar neutrosophic refined set, and further research was conducted into some of the basic properties of this bipolar neutrosophic refined set that generalize the fuzzy set, fuzzy multiset, bipolar fuzzy set, intuitionistic fuzzy multiset, and neutrosophic multisets. Two bipolar neutrosophic refined sets are compared using the score certainty and accuracy functions.Using bipolar neutrosophic refined sets, a new algorithm for solving a medical diagnosis problem was developed.

Ngan et al.[94] established a new distance measure based on the H-max distance measure of intuitionistic fuzzy sets and single valued neutrosophic sets, and then used the H-max distance measure of bipolar neutrosophic sets to introduce a technique of medical diagnosis.

3.6 Medical diagnosis under the single valued neutrosophicmultisets environment.

As a generalization of intuitionistic fuzzy multisets (IFM), Ye et al. [74] proposed a new theory of single-valued neutrosophic multisets (SVNMS), combining the concepts of single-valued neutrosophic sets with the theory of multisets. Then the dice similarity measure between SVNMs is discussed, and then the same measure is applied to medical diagnosis problems.

A generalized distance measure and similarity measures between single-valued neutrosophic multisets (SVNMs) were proposed by Ye et al. [75]. Then the similarity measures obtained in the process are applied to a medical diagnosis problem with incomplete, indeterminate, and inconsistent information. The diagnosis method deals with the diagnosis problem with indeterminate and inconsistent information, which cannot be handled by the diagnosis method based on intuitionistic fuzzy multisets (IFMs).

The notion of SVNMS is redefined by Chatterjee et al. [14] and several set theoretic and algebraic operations on SVNMS are also discussed. Distance and similarity measures between two single-valued neutrosophic multisets were introduced, and single-valued neutrosophic multisets were used to solve medical diagnosis problems.

Samuel et al. [85] used cosine logarithmic distance among single-valued neutrosophic sets to investigate relationships between sets of symptoms found in patients and sets of diseases affecting patients.

In another work, Samuel et al. [86] provided a new approach called the tangent inverse similarity measure by using single-valued neutrosophic sets and applied this newly introduced technique to diagnose which patient is suffering from which disease.

3.7 Medical diagnosis under the rough neutrosophic set environment.

Medical diagnosis necessitates a great deal of data from modern medical technologies, and this data is sometimes partial and inconclusive due to the complexities and ambiguity of disease symptoms.

A rough neutrosophic set has been shown to be effective in dealing with medical diagnosis, which often comprises of imperfect and partial information.

Pramanik and Mondal [76] defined a rough cosine similarity measure between two rough neutrosophic sets and investigated some of their basic features.

The following formula was used to apply these notions to a medical diagnosis problem:

$$C_{RNS}(A,B) = \frac{1}{n}\sum_{i=1}^{n}\frac{\delta T_A(x_i)\delta T_B(x_i)+\delta I_A(x_i)\delta I_B(x_i)+\delta F_A(x_i)\delta F_B(x_i)}{\sqrt{(\delta T_A(x_i))^2+(\delta I_A(x_i))^2+(\delta F_A(x_i))^2}\sqrt{(\delta T_B(x_i))^2+(\delta I_B(x_i))^2+(\delta F_B(x_i))^2}} \quad (18)$$

Where $\delta T_A(x_i)=\left(\frac{\underline{T}_A(x_i)+\bar{T}_A(x_i)}{2}\right)$, $\delta I_A(x_i)=\left(\frac{\underline{I}_A(x_i)+\bar{I}_A(x_i)}{2}\right)$,

$\delta F_A(x_i)=\left(\frac{\underline{F}_A(x_i)+\bar{F}_A(x_i)}{2}\right)$

Pramanik and Mondal [77] established a rough cotangent similarity measure between two rough neutrosophic sets. In 3D-vector space, the concept of a rough neutrosophic set is used as a vector representation.The upper and lower approximation operators, as well as the pair of neutrosophic sets, are used to represent the rating of all elements in a rough neutrosophic set, which are characterized by truth-membership degree, indeterminacy-membership degree, and falsity-membership degree.

Cotangent similarity was used to solve a medical diagnosis challenge by the author. Pramanik and Mondal [78] introduced more rough dice and Jaccard similarity measures for rough neutrosophic sets, as well as some of their basic features.

The following notions were then applied to a medical diagnosis problem, and an algorithm was created to analyze the situation as follows:

Step1: Determination the relation between patients and symptoms

Step 2: Determination of the relation between Symptoms) and Diseases.

Step 3: Determination the relation between patients and Diseases

$$DIC_{RNS}(A,B) = \frac{1}{n}\sum_{i=1}^{n}\frac{2\{\delta T_A(x_i)\delta T_B(x_i)+\delta I_A(x_i)\delta I_B(x_i)+\delta F_A(x_i)\delta F_B(x_i)\}}{\left\{\left[(\delta T_A(x_i))^2+(\delta I_A(x_i))^2+(\delta F_A(x_i))^2\right]+\left[(\delta T_B(x_i))^2+(\delta I_B(x_i))^2+(\delta F_B(x_i))^2\right]\right\}} \quad (19)$$

$$JAC_{RNS}(A,B) = \frac{1}{n}\sum_{i=1}^{n}\frac{\{\delta T_A(x_i)\delta T_B(x_i)+\delta I_A(x_i)\delta I_B(x_i)+\delta F_A(x_i)\delta F_B(x_i)\}}{\left\{\begin{array}{l}\left[(\delta T_A(x_i))^2+(\delta I_A(x_i))^2+(\delta F_A(x_i))^2\right]+\\ \left[(\delta T_B(x_i))^2+(\delta I_B(x_i))^2+(\delta F_B(x_i))^2\right]-\\ \left[\delta T_A(x_i)\delta T_B(x_i)+\delta I_A(x_i)\delta I_B(x_i)+\delta F_A(x_i)\delta F_B(x_i)\right]\end{array}\right\}} \quad (20)$$

Step 4: Ranking the alternative

The major feature of these proposed approaches is that they take a single time inspection to diagnose the truth, indeterminate, and false membership of each element between two approximations of neutrosophic sets.

The order function of rough neutrosophic sets is proposed in [87], and this method is then applied in the field of medical diagnosis to determine the sickness affecting the patient in question.

In [88] the authors proposes and discusses tangent logarithmic distance and cosecant similarity metrics between rough neutrosophic sets, as well as some of their features.

Following then, the use of this technology in medical diagnostics was discussed.Alias et al. [90] proposed a distance-based similarity measure for approximate neutrosophic sets as a means of medical diagnostics.

In [91], Olgun et al. presented 2-additive choquet similarity measures for multi-period medical diagnosis in single-valued neutrosophic set settings.

Ye et al. [92] introduced a generalized distance measure and similarity measures between single-valued neutrosophic multisets. This method of distance-based similarity measure of single-valued neutrosophic multisets is then applied in medical diagnosis to find which patient is suffering from which type of disease.

Habib et al. [93] presented a single-valued neutrosophic decision-making model for medical diagnosis.

3.8 Medical diagnosis problems under the neutrosophic soft sets

The concept of a neutrosophic soft matrix was introduced by Basu and Mondal [79]. (NS-Matrix).

Different forms of NS-Matrices were also discussed, as well as numerous operations. To handle neutrosophic soft set-based real-life group decision-making problems, a new methodology termed the NSM-Algorithm based on certain of these matrix operations was introduced. The NSM-Algorithm created can be used to solve problems with disease diagnosis based on a variety of symptoms.

Mukherjee and Sarkar [80] introduced a new approach for determining the degree of similarity and weighted similarity between two neutrosophic soft sets, as well as some features of the similarity measure.Similarity measures were used to construct further algorithms for pattern identification problems in neutrosophic soft sets.The proposed method can be used in a variety of situations, such as determining whether or not a sick person with obvious symptoms is suffering from cancer.
The following steps are required for the proposed algorithms.

Step1: Construction of NSS(s) $\hat{N}_i$ (i =1, 2, 3........, n) as ideal pattern(s).

Step2: Construction of NSS(s) $\hat{M}_j$ (j=1, 2, 3........, m) for sample pattern(s) which is/are to be recognized.

Step3: Compute the similarity measure between NSS(s) for ideal pattern(s) and sample pattern(s) using the following formulas:

$$Sim(N_1,N_2) = \frac{1}{3mn}\sum_{i=1}^{n}\sum_{j=1}^{m}\begin{pmatrix}3-\left|T_{N_1}(x_i)(e_j)-T_{N_2}(x_i)(e_j)\right|-\left|I_{N_1}(x_i)(e_j)-I_{N_2}(x_i)(e_j)\right| \\ -\left|F_{N_1}(x_i)(e_j)-F_{N_2}(x_i)(e_j)\right|\end{pmatrix} \quad (21)$$

$$WSim(N_1,N_2) = \frac{1}{3m}\sum_{i=1}^{n}\sum_{j=1}^{m}w_i\begin{pmatrix}3-\left|T_{N_1}(x_i)(e_j)-T_{N_2}(x_i)(e_j)\right|-\left|I_{N_1}(x_i)(e_j)-I_{N_2}(x_i)(e_j)\right| \\ -\left|F_{N_1}(x_i)(e_j)-F_{N_2}(x_i)(e_j)\right|\end{pmatrix} \quad (22)$$

Where $w_i \in [0,1]$.

Step 4: Consider sample pattern(s) under certain predefined conditions.
If the measure of similarities between the two NSSs considered is greater than or equal to 0.75 then the ill person is possibly suffering from the diseases.
For fuzzy neutrosophic soft sets, Sumathi and Arockiarani [81] developed various types of matrix operations. Furthermore, using fuzzy neutrosophic matrices, a composition approach for creating the decision matrix for medical diagnosis is described.
The proposed method is composed of the following steps:
Step1: Input the fuzzy neutrosophic sets (F, S) over P (the set of m patients) where F is a mapping F: S $\rightarrow FNS(P)$ gives a collection of an approximate description of patient symptoms and (G, D) over S (the set of n symptoms) where G is a mapping G:D $\rightarrow FNS(S)$ gives a collection of an approximate description of disease and their symptoms. In addition, find their corresponding fuzzy neutrosophic soft matrices A and B.

Step2: Compute max-min composition $A*B$ and max-min average composition $A\psi B$ of fuzzy neutrosophic soft matrices A and B.

Where $A*B$ =

$$\left\{ \begin{array}{l} \max\left\{ \min\limits_{j}\left[T_{ij}^{A}, T_{jk}^{B} \right] \right\}, \max\left\{ \min\limits_{j}\left[I_{ij}^{A}, I_{jk}^{B} \right] \right\}, \\ \min\left\{ \max\limits_{j}\left[F_{ij}^{A}, \mathrm{F}_{jk}^{B} \right] \right\} \end{array} \right\} \quad (23)$$

$A\psi B$ =

$$\left\{ \max\left\{ \frac{T_{ij}^{A} \cdot T_{jk}^{B}}{2} \right\}, \max\left\{ \frac{I_{ij}^{A} \cdot I_{jk}^{B}}{2} \right\}, \min\left\{ \frac{F_{ij}^{A} \cdot F_{jk}^{B}}{2} \right\} \right\} \quad (24)$$

Step3: Compute the score matrix S for $A*B$ and $A\psi B$ using the following formulas:

(i) $S_1 = T_j - I_j \cdot F_j$ (ii) $S_2 = T_j + (1 - I_j) - F_j$ (25)

Step4: Identification of the maximum score S_{ij} for each patient P_i. Conclude that the patient P_i is suffering from disease D_j.

With the goal of developing an expert system for patient diagnosis, Arockiarani [82] presented the concept of fuzzy neutrosophic soft relations and the new score function. Some novel methodologies and measures, such as hamming distances and similarity measures, have been proposed, and their properties are now being investigated. A decision-making system based on similarity measures is developed. The author next proceeds through the concept of mappings on fuzzy neutrosophic soft sets and their characteristics.

Later, Celik [83] suggested a new method for medical diagnosis based on fuzzy neutrosophic soft sets and established a mechanism for determining which patient has which illness.

Jafar et al. [89] employed neutrosophic soft matrices and their complements to determine which patient was more likely to have which disease.

As an expansion of the neutrosophic soft matrix, Debnath [92] presented the notion of an interval neutrosophic soft matrix and studied various algebraic operations.In addition, utilizing an interval neutrosophic soft matrix, a new method to group decision-making problems has been proposed.

IV. Conclusions

A medical diagnosis is the process of identifying diseases based on a person's symptoms. To medical clinicians, a large amount of data is available for diagnosis, which comprises uncertainty, inconsistency, and indeterminacy. This paper emphasizes the use of neutrosophic sets and some of their hybrid structures for medical diagnosis problems, with the expectation that they will provide an effective method of diagnosing problem.

References

[1] F. Smarandache, Neutrosophic set - a generalization of the intuitionistic fuzzy set, Granular Computing, 2006 IEEE International Conference, 2006, pp. 38 – 42.

[2] F. Smarandache, A geometric interpretation of the neutrosophic set — A generalization of the intuitionistic fuzzy set, Granular Computing (GrC), IEEE International Conference, 2011, pp.602– 606.

[3] L. Zadeh, Fuzzy sets. Inform and Control, 8, 1965, pp.338-353

[4] K. Atanassov, Intuitionistic fuzzy sets, Fuzzy Sets and Systems, vol. 20, 1986, pp. 87-96.

[5] F. Smarandache, Neutrosophy / Neutrosophic probability, set, and logic, American Res. Press, 1998,

[6] F. Smarandache, NeutrosophicPrecalculus and Neutrosophic Calculus, EuropaNova Brussels, 2015, 154 p

[7] H. Wang, F. Smarandache, Y.Q .Zhang and R. Sunderraman, Interval neutrosophic Sets and Logic: Theory and Applications in Computing. Hexis, Phoenix, AZ, 2005.

[8] J. Ye, A Multicriteria decision-making method using aggregation operators for simplified neutrosophic sets, Journal of Intelligent and Fuzzy Systems 26, 2014, pp. 2459–2466.

[9] J. Ye. Trapezoidal neutrosophic set and its application to multiple attribute decision making. Neural Computing and Applications, 26(5), 2015, pp.1157-1166.

[10] J. Ye, Multiple-attribute decision-making method under a single-valued neutrosophic hesitant fuzzy environment, Journal of Intelligent Systems, 24 (1), 2015, pp.23-36.

[11] F. Smarandache, Neutrosophic Overset, Neutrosophic Underset, and Neutrosophic Offset. Similarly for Neutrosophic Over-/Under-/Off- Logic, Probability, and Statistics, Pons Editions, Bruxelles, Belgique, 2016, 168 pages.

[12] I. Deli, M.Ali, F. Smarandache, Bipolar neutrosophic sets and their application based on multi-criteria decision making problems, Advanced Mechatronic Systems (ICAMechS), 2015 International Conference, 2015, pp.249 – 254.

[13] I. Deli, S. Yusuf, F. Smarandache and M. Ali, Interval valued bipolar neutrosophic sets and their application in pattern recognition, IEEE World Congress on Computational Intelligence 2016.

[14] R. Chatterjee, P. Majumdar and S. K. Samanta, Single valued neutrosophicmultisets Sets, Annals of fuzzy Mathematics and Informatics, Vol 10, No.3, 2015, pp.499-514.

[15] S. Broumi, F. Smarandache, and M. Dhar, M. 2014. Rough neutrosophic sets. Italian Journal of Pure and Applied Mathematics, 32, 2014, pp. 493–502.

[16] İ. Deli, Y. Şubaş, Bipolar Neutrosophic Refined Sets and Their Applications in Medical Diagnosis International Conference on Natural Science and Engineering (ICNASE'16), 2016, pp.1121-1132.

[17] I. Deli, S. Broumi and F. Smarandache, On Neutrosophic Refined Sets and their Applications in Medical Diagnosis, Journal of New Theory, 6, 2015, pp.88-89.

[18] http://fs.gallup.unm.edu/NSS.

[19] A. Q. Ansari, R. Biswas & S. Aggarwal, Extension to fuzzy logic representation: Moving towards neutrosophic logic - A new laboratory rat, Fuzzy Systems (FUZZ), IEEE International Conference, 2013, pp.1 –8.

[20] F. Smarandache, L. Vladareanu, Applications of Neutrosophic Logic to Robotics-An Introduction. IEEE International Conference on Granular Computing, 2011, pp.607-612.

[21] J. Ye, Improved cosine similarity measures of simplified neutrosophic sets for medical diagnoses, Artif. Intell. Med.63, 2015, pp.171–179.

[22] I. Deli and Y. Subas, A Ranking methods of single valued neutrosophic numbers and its application to multi-attribute decision making problems, International Journal of Machine Learning and Cybernetics, 2016, 1-14.

[23] P. Biswas, S. Pramanik and B. C. Giri, Cosine Similarity Measure Based Multi-attribute Decision-Making with Trapezoidal fuzzy Neutrosophic numbers, Neutrosophic sets and systems, 8, 2014, pp.47-57.

[24] P. Biswas, S. Pramanik and B. C. Giri, Aggregation of Triangular Fuzzy Neutrosophic Set Information and its Application to Multiattribute Decision Making, Neutrosophic sets and systems, 12, 2016, pp.20-40.

[25] S. Broumi, F. Smarandache, New distance and similarity measures of interval neutrosophic sets, Information Fusion (FUSION), IEEE 17th International Conference, 2014, pp.1 – 7.

[26] H. Wang, F. Smarandache, Y. Zhang, R. Sunderraman, Single valued neutrosophic nets. Multispace and Multistructure, 4, 2010, pp.410-413.

[27] A. Aydogdu, On entropy and similarity measure of interval valued neutrosophic sets, Neutrosophic Sets and Systems, 9(2015), 47-19.

[28] S. Broumi, M. Talea, F. Smarandache and A. Bakali, Single Valued NeutrosophicGraphs: Degree, Order and Size, IEEE World Congress on Computational Intelligence, 2016, pp.2444-2451

[29] S. Broumi, F. Smarandache, M. Talea and A. Bakali, An Introduction to Bipolar Single Valued Neutrosophic Graph Theory. Applied Mechanics and Materials, vol.841, 2016, 184-191.

[30] S. Broumi, M. Talea, A. Bakali, F.Smarandache, On bipolar single valued neutrosophic graphs, Journal of New Theory N11,2016 pp. 84–102

[31] F. Steimann, Fuzzy set theory in medicine, Artificial Intelligence in Medicine 1, 1997, pp. 1–7.

[32] D. Pandey and K. Kumar, Interval valued intuitionistic fuzzy sets in Medical, Journal of International Academy of Physical Science, Vol 14, No.2, 2010, pp. 137-147.

[33] H. M. Ju and F. Y. Wang, A similarity Measure for Interval-Valued Fuzzy Sets and Its Application in Supporting Medical Diagnosis Reasoning, The Tenth International Sympsium on operations and its application (ISORA), 2011, pp.251-257.

[34] J. Y. Ahn, K.S.Han, S. Y.Oh and C. D. Lee, An Application of Interval-Valued Intuitionstic Fuzzy Sets For Medical Diagnosis of Headache, International Journal of Innovative Computing, information and Control, Vol 7, N.5(B), 2011, pp.2755-2762.

[35] H. Davarzani, M. A. Khorheh, A novel application of intuitionistic fuzzy sets theory in medical science: Bacillus colonies recognition, Artificial Intelligence Research, 2013, Vol. 2, No. 2, pp.1-7.

[36] T. Maoying, A New Fuzzy Similarity Measure Based On Cotangent Function For Medical Diagnosis, Advanced Modeling and Optimization, Vol 15, No.2, 2013, pp.151-156.

[37] S. Elizabeth and L. Sujatha, Application of Fuzzy Membership Matrix in Medical Diagnosis and Decision Making, Applied Mathematical Science, Vol 7, No 127, 2013, pp. 6297-6307.

[38] V. Aswin and S. Deepak, Medical Diagnosis Using Cloud Computing with Fuzzy Logic and uncertainty Factor in Mobile Devices, lecture Notes On Software Engineering, Vol 1, No.1, 2013, pp.117-121.

[39] P. Rajarajeswari and N. Uma. Normalized Hamming Similarity Measure for Intuitionistic Fuzzy Multi Sets and Its Application in Medical diagnosis. International Journal of Mathematics Trends and Technology, 5(3), 2014, pp.219-225.

[40] S. J. Savarimuthu and P. Vidhya, Application of Intuitionistic Fuzzy Set With n-parametres in Medical Diagnosis, International Journal of Computing Algorithm, Vol 3, 2014, pp. 749-752.

[41] K. Kumar, Type -2 Fuzzy Theory In Medical Diagnosis, Annals of Pur and Applied Mathematics, Vol 9, No.1, 2015, pp. 35-44.

[42] P. Biswas, S. Pramanik and B.C Giri, A Study on Information technology Professional's Health Problem Based on Intuitionistic Fuzzy Cosine Similarity Measure, Swiss Journal of Statistical and Applied Mathematics, Vol 2, issue 1, pp.44-50.

[43] R. S. Porchelvi, P. Selvvathi and R. Vanitha, An Application of Fuzzy Matrices in Medical Diagnosis, International Journal of Fuzzy Mathematical Archive, Vol 9, No 2, 2015, pp. 211-216.

[44] A Meenakshi and M. Kaliraja, An application of interval valued fuzzy matrices in medical diagnosis, International Journal of Mathematical Analysis 5(36),pp.1791-1802.

[45] R. Dangwal, M.K. Sharma and Anita, A Comparative Study of Health Status Index Using Vague Sets and Interval Valued Vague Sets, International Journal of Innovative Research in Science, Engineering and Technology, Vol. 5, Issue 8,2016, pp.15024-15030

[46] D. Vankova, E. Sotirova and V. Bureva, An application of the Inter Criteria Analysis approach to health-related quality of life, Notes on Intuitionistic Fuzzy Sets, Vol. 21, No. 5, 2015, pp.40–48

[47] B.C. Cuong, P. H. Phong, Max- Min Composition of Linguistic Intuitionistic Fuzzy Relations and Application in Medical Diagnosis, VNU Journal of Science: Comp. Science & Com. Eng., Vol. 30, No. 4, 2014, pp.57-65.

[48] D. Molodtsov. Soft Set Theory - First Results. Computers and Mathematics with Applications 37(4-5), 1999, pp.19-31.

[49] P. Rajarajeswari and P. Dhanalakshmi, Soft Set Theory in Medical Diagnosis using Trapezoidal Fuzzy Number. International Journal of Computer Applications, Vol 57, No.19, 2012, pp.8-11.

[50] P. Rajarajeswari, P .Dhanalakshmi, An Application of Interval Valued Intuitionistic Fuzzy soft matrix theory in medical diagnosis, Annals of Fuzzy Mathematics and Informatics, Vol 9, issue 3, pp.463-472.

[51] P. Shanmugasundarm, C.V. Seshaiah and K. Rathi, Intuitionistic Fuzzy Soft Matrix Theory in Medical Diagnosis Using Max-Min Average Composition Method, Journal of Theoretical and Applied Information Technology, Vol 67, N.1, 2014, pp.186-190.

[52] M. Agarwal, M. Hanmandlu and K. K. Biswas, Generalized In tuitionistic Fuzzy Soft Sets and its Application In Practical Medical Diagnosis Problem, IEEE international Conference on Fuzzy Systems, 2011, pp. 2972-2978.

[53] Y. Celik and S. Yamak, Fuzzy soft set theory applied to medical diagnosis using fuzzy arithmetic Operations, Journal of Inequalities and Applications, 82, 2013, pp.1-11.

[54] Q. Feng and W. Zheng, New Similarity of Fuzzy Soft Sets Based on Distance Measures, Annals of fuzzy Mathematics and Informatics, 2013, pp.

[55] M. Bora, B. Bora, T. J. Neog and D. K. Sut, Intuitionistic fuzzy soft matrix theory and its application in medical diagnosis, Annals of Fuzzy Mathematics and Informatics, Vol 7, No.1 3, 2014, pp.143-153.

[56] P. Muthukumar, G. S. S. Krishnan, A Mean Potentiality Approach of An Intuitionistic Fuzzy Soft Sets Based Decision Making Problem in Medical Science, International Journal Advance, Soft, Comput.Appl,Vol.6,No.3, 2014, pp.1-25

[57] N. Sarala and S. Rajkumari, Drug Addiction Effect in Medical Diagnosis by Using Fuzzy Soft Sets Matrices, International Journal of Current Engineering and Technology, Vol 5, No.1, 2015, pp.247-251.

[58] P. Muthukumar, G. S. S. Krishnan, A Similarity measure of Intuitionistic fuzzy soft sets and its application in Medical Diagnosis, Applied Soft Computing, 41, 2016, pp.148-156.

[59] A. Q. Ansari, R. Biswas and S. Aggarwal, Proposal for Applicability of Neutrosophic Set Theory in Medical AI, International Journal of Computer Applications, Vol 27, No.5, 2011, pp.5-11.

[60] A. Q. Ansari, R. Biswas & S. Aggarwal, Neutrosophication of Fuzzy Models, IEEE Workshop On Computational Intelligence: Theories, Applications and Future Directions (hosted by IIT Kanpur), 14th July 2013.

[61] AtharKharal, Automated medical diagnosis: a method using neutrosophic set, New Mathematics and Natural Computation,Vol22, Issue: 2, 2014,pp. 451-462

[62] A. Kharal, A Neutrosophic Multi-Criteria Decision Making Method, New Mathematics and Natural Computation (NMNC), Vol. 10, Issue 02, 2014, pp.143-162.

[63] S. De and J. Mishra, Neutrosophic Logic Based New Methodology to handle Indeterminacy Data for taking Accurate Decision, Advances in Intelligent Systems and Computing 410, 2016, pp-139- 147.

[64] J. M. Jency and I. Arockiarani, Application of Fuzzy Neutrosophic Relation in Decision Making, Global Journal of Advanced Research, Vol 2, Issue6, 2016, pp.453-456.

[65] J. Ye, Multi-Period Diagnosis Method Using a Single Valued Neutrosophic similarity Measuure Based On tangent function, Computer Methods and Programs in Biomedicine, 123, 2016, pp.142-149.

[66] K. Bhutani, S. Aggarwal, Experimenting with neutrosophic ontologies for medical data classification, IEEE Workshop on Computational Intelligence: Theories, Applications and Future Directions (WCI), 2015, pp. 1 – 6.

[67] P. K. Singh, Three-way fuzzy concept lattice representation using neutrosophic set, Int. J. Mach. Learn. & Cyber, 2016, pp. 1-11DOI 10.1007/s13042-016-0585-0,

[68] Y. X. Ma, J. Q. Wang, J. Wang, X. H. Wu, An Interval Neutrosophic Linguistic Multi-criteria Group Decision-Making method and its application in selecting medical treatment options, Neural Computing & Application, 2016

[69] J. Ye, Improved cosine similarity measures of simplified neutrosophic sets for medical diagnoses, Artificial Intelligence in Medicine, Volume 63, Issue 3, 2015, pp.171-179.

[70] S. Broumi, F. Smarandache, Extended Hausdorff Distance and Similarity measures for neutrosophic Refined sets and their Application in medical diagnosis, Journal of New Theory, N.7, 2015, pp. 64-78.

[71] S. Broumi, I. Deli, Correlation Measure for Neutrosophic Refined Sets and Its Application in Medical Diagnosis, In Palestine Journal of Mathematics, Vol. 3, 2014, pp. 11–19.

[72] S. Broumi, F. Smarandache, Neutrosophic Refined Similarity Measure Based on Cosine Function, Neutrosophic Sets and Systems, Vol. 6, 2014, pp.42-48.

[73] K. Mondal and S. Pramanik, Neutrosophic Refined Similarity Measure Based On Cotangent Function And Its application to Multi-Attribute Decision Making, Global Journal of Advanced Research, Vol 2, Issue2, 2015, pp.489-496.

[74] S. Ye, J. fu and J. Ye, Medical Diagnosis Using Distance–Based Similarity Measure of Single valued neutrosophicMultisets, Neutrosophic Sets and Systems, 7, 2015, pp.47-52.

[75] S. Ye and J. Ye. Dice similarity measure between single valued NeutrosophicMultisets and its Application in Medical Diagnosis, Neutrosophic Sets and Systems, 6, 2014, pp.48-52.

[76] S. Pramanik and K. Mondal, Cosine similarity Measure of Rough Neutrosophic Sets And Its Application in Medical Diagnosis, Global Journal of Advanced Research, Vol. 2, Issue1, 2015, pp.212-220.

[77] S. Pramanik, K. Mondal, Cotangent similarity measure of rough Neutrosophic sets and its application to medical diagnosis, Journal of New Theory, N4, 2015, pp. 90-102.

[78] S. Pramanik and K. Mondal, Some rough neutrosophic Similarity Measures and their Application to Multi attribute Decision Making. Global Journal of Engineering Science and Research Management, 2(7), 2015, pp.61-73.

[79] T. M. Basu, S. K. Mondal, Neutrosophic Soft Matrix And It's Application in Solving Group Decision Making Problems from Medical Science, Computer Communication & Collaboration, Vol. 3, Issue 1, 2015, pp.1-31

[80] A. Mukherjee and S. Sarkar, A New method of measuring Similarity between two Neutrosophic soft sets and its application in pattern recognition problems, Neutrosophic Sets and Systems, Vol. 8, 2015, pp.72-77.

[81] I. Sumathi and I. Arockiarani, Fuzzy Neutrosophic Soft Matrix Model in decision Making, Elixir Applied Mathematics, 78, 2015, pp.29666-29673.

[82] I.Arockiarani, A Fuzzy Neutrosophic Soft Set Model in Medical Diagnosis, Norbert Wiener in the 21st Century (21CW), 2014 IEEE Conference, 2014, pp.1-8.

[83] Y. Celik, A Model for Medical Diagnosis via Fuzzy Neutrosophic Soft Sets, Asian Journal of Mathematics and Computer Research, 10(1), 2016, pp.60-68.

[84] G. Shahzadi, Muhammad Akram and A. B. Saeid, An Application of Single- Valued Neutrosophic Sets in Medical Diagnosis, Neutrosophic Sets and Systems, 18, 2017, pp. 80-88.

[85] A. Edward Samuel and R. Narmadhagnanam,Cosine Logarithmic distance of Singled Valued Neutrosophic Sets in Medical Diagnosis, International Journal of Engineering Science and Mathematics, 7(6), 2018, 14-18

[86] A.Edward Samuel and R. Narmadhagnanam, Tangent Inverse Similarity Measure of Singled Valued Neutrosophic Sets In Medical Diagnosis, International Journal of Creative Research Thoughts, 6(2), 2018, 77-79

[87] Edward Samuel And R.Narmadhagnanam, Utilization of Rough Neutrosophic Sets In Medical Diagnosis, International Journal of Engineering Science Invention (IJESI),2018, olume 7 Issue 3 Ver. V, pp. P01-05

[88] A.Edward Samuel and R .Narmadhagnanam,Rough neutrosophic sets in medical diagnosis, Proc. of the International conf. on Mathematical and Computer Engineering,V.I.T Chennai, Tamilnadu , India,2017(November 3 to 4),118-119

[89] Muhammad NaveedJafar, Raiha Imran, Sabahat Hassan Asma Riffat&Rubina Shuaib, MEDICAL DIAGNOSIS USING NEUTROSOPHIC SOFT MATRICES AND THEIR COMPLIMENTS, International Journal of Advanced Research in Computer Science, Volume 11, No. 1, 2020

[90] Alias, S., Mohamad, D., Shuib, . A., MohdYusoff, N. S. ,AbdRhani, N. , &FitriahMohamad, S. N. . (2022). Medical Diagnosis via Distance-based Similarity Measure for Rough Neutrosophic Set. Neutrosophic Sets and Systems, 46, 142-150. Retrieved from http://fs.unm.edu/NSS2/index.php/111/article/view/1948

[91] Olgun, M. .,T¨urkarslan, E., Unver, M. ., & Ye, J. . (2021). 2-Additive Choquet Similarity Measures For Multi-Period Medical Diagnosis in Single-Valued Neutrosophic Set Setting. Neutrosophic Sets and Systems, 45, 8-25. Retrieved from http://fs.unm.edu/NSS2/index.php/111/article/view/1766

[92] Ye, S. ., Fu, J., & Ye, J. . (2020). Medical Diagnosis Using Distance-Based Similarity Measures of Single Valued NeutrosophicMultisets. Neutrosophic Sets and Systems, 7, 47-52. Retrieved from http://fs.unm.edu/NSS2/index.php/111/article/view/122

[93] Habib, S. ., Ashraf, A. ., Arif Butt, M. ., & Ahmad, M. . (2021). Medical diagnosis based on single-valued neutrosophic information. Neutrosophic Sets and Systems, 42, 302-323. Retrieved from http://fs.unm.edu/NSS2/index.php/111/article/view/129

[94] ThiNgan, R. .,Smarandache, F. ., &Broumi, S. . (2021). H-Max Distance Measure of Bipolar Neutrosophic Sets and an Application to Medical Diagnosis. Neutrosophic Sets and Systems, 45, 444-458. Retrieved from http://fs.unm.edu/NSS2/index.php/111/article/view/1803

[95] Debnath, S. . (2021). A New Approach to Group Decision Making Problem in Medical Diagnosis using Interval Neutrosophic Soft Matrix. Neutrosophic Sets and Systems, 45, 162-180. Retrieved from http://fs.unm.edu/NSS2/index.php/111/article/view/1778

Received: Dec. 3, 2021. Accepted: April 5, 2022.