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NEUTROSOPHIC REFINED SIMILARITY MEASURE BASED ON TANGENT FUNCTION AND ITS APPLICATION TO MULTI ATTRIBUTE DECESION MAKING

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Abstract – In the paper, tangent similarity measure of neutrosophic refined set is proposed and its properties are studied. The concept of this tangent similarity measure of single valued neutrosophic refined sets is an extension of tangent similarity measure of single valued neutrosophic sets. Finally, using the propsed refined tangent similarity measure of single valued neutrosophic sets, a numerical example on medical diagnosis is presented.

Keywords – *Refined tangent similarity measure, Neutrosophic sets, Indeterminacy Membership degree, 3D vector space, decision making.*

1. Introduction

Similarity measure is now an interesting research tropic for multi attribute decision making in current neutrosophic environment. Literature review reflects that several similarity measures have been proposed by researchers to deal with different type problems. Broumi and Smarandache [1] studied the neutrosophic Hausdorff distance between neutrosophic sets. In their study, they also presented some similarity measures based on the geometric distance models, set theoretic approach, and matching function to determine the similarity degree between neutrosophic sets. Broumi and Smarandache [2] also proposed the correlation coefficient between intervals valued neutrosophic sets. Majumdar and Samanta [3] studied several distance based similarity measures of single valued neutrosophic set (SVNS), a matching function, membership grades, and then proposed an entropy measure for a SVNS. Ye [4] proposed three vector similarity measures between SVNSs as a generalization of the Jaccard, Dice, and cosine similarity measures in vector space and

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applied them to the multicriteria decision-making problem with simplified neutrosophic information. Ye [5] also proposed single-valued neutrosophic clustering methods dealing with two distance-based similarity measures of SVNSs and presented a clustering algorithm based on the similarity measures of SVNSs to cluster single-valued neutrosophic data. Ye and Ye [6] proposed Dice similarity measure and weighted Dice similarity measure for single valued neutrosophic multisets (SVNMs) and investigated their properties. The Dice similarity measure of SVNMs proposed by Ye and Ye [6] is effective in handling the medical diagnosis problems with indeterminate and inconsistent information . Ye [7] further studied multiple attribute group decision-making method with completely unknown weights based on similarity measures under single valued neutrosophic environment. In the study, Ye [7] proposed two weight models based on the similarity measures to derive the weights of the decision makers and the attributes from the decision matrices represented by the form of single valued neutrosophic numbers (SVNNs) to decrease the effect of some unreasonable evaluations. Then, he [7] introduced the weighted similarity measure between the evaluation value (SVNS) for each alternative and the ideal solution (ideal SVNS) for the ideal alternative to rank the alternatives and select the best one(s).Ye and Zhang [8] developed three similarity measures between SVNSs based on the minimum and maximum operators and investigated their properties. Then they [8] proposed weighted similarity measure of SVNS and applied them to multiple attribute decision-making problems under single valued neutrosophic environment. Ye [9] proposed improved cosine similarity measures of simplified neutrosophicsets based on cosine function, including single valued neutrosophic cosine similarity measures and interval neutrosophic cosine similarity measures and demonstrated that improved cosine similarity measures overcome some drawbacks of existing cosine similarity measures of simplified neutrosophicsets. Biswas et al. [10] studied cosine similarity measure based multi-attribute decision-making with trapezoidal fuzzy neutrosophic numbers. They [10] developed expected value theorem and cosine similarity measure of trapezoidal fuzzy neutrosophic numbers. Pramanik and Mondal [11] proposed rough cosine similarity measure in rough neutrosophic environment. Mondal and Pramanik [12] also proposed refined cotangent similarity measure in single valued neutrosophic environment. Mondal and Pramanik [13] further proposed cotangent similarity measure under rough neutrosophic environments.

The concept of multi sets, the generalization of normal set theory was introduced by Yager [14]. Sebastian and Ramakrishnan [15] studied multi fuzzy sets, which is the generalization of multi sets. Sebastian and Ramakrishnan [16] also established more properties on multi fuzzy sets. Shinoj and John [17] extended the concept of fuzzy multi sets (FMSs) intuitionistic fuzzy multi sets (IFMSs). An element of a FMS can occur more than once with possibly the same or different membership values. An element of intuitionistic fuzzy multi sets has repeated occurrences of membership and non-membership values. Practically, the concepts of FMS and IFMS are not capable of dealing with indeterminacy. Smarandache [18] extended the classical neutrosophic logic to n-valued refined neutrosophic logic. Here each neutrosophic component T, I, F refine into respectively,T_1 ,T_2 , ... T_p, and , I_1 ,I_2 , ... I_q and F_1 ,F_2 , ... F_r. Broumi and Smarandache [19] proposed neutrosophic refined similarity measure based on cosine function.

Pramanik and Mondal [20] studied weighted fuzzy similarity measure based on tangent function and provided its application to medical diagnosis. Mondal and Pramanik [21] also proposed tangent similarity measure on intuitionistic fuzzy environment. Mondal and Pramanik [22] also proposed tangent similarity measure on neutrosophic environment.

In the paper, motivated by study of Mondal and Pramanik [12], we propose a new similarity measure called "refined tangent similarity measure for single valued neutrosophic sets". The proposed refined tangent similarity measure is applied to medical diagnosis problem.

Rest of the paper is structured as follows. Section 2 presents neutrosophic preliminaries. Section 3 is devoted to introduce refined tangent similarity measure for single valued neutrosophic sets and some of its properties. Section 4 presents decision making based on refined tangent similarity measure. Section 5 presents the application of refined tangent similarity measure to the problem on medical diagnosis. Finally, section 6 presents the concluding remarks and future scope of this research.

2. Mathematical preliminaries

2.1 Neutrosophic Sets

Definition 1 [23] Let X be an universe of discourse. Then the neutrosophic set N is of the form $N = \{< x{:}T_N(x), I_N(x), F_N(x)> x \in X \}$, where the functions $T, I, F: X \to]^-0,1^+[$ are defined respectively the degree of membership, the degree of indeterminacy, and the degree of non-membership of the element $x \in X$ to the set N satisfying the following the condition.

$$^-0 \leq \sup T_N(x) + \sup I_N(x) + \sup F_N(x) \leq 3^+ \quad (1)$$

For two neutrosophic sets, $N = \{< x: T_N(x), I_N(x), F_N(x)> | x \in X \}$ and $P = \{< x, T_P(x), I_P(x), F_P(x)> | x \in X \}$ the two relations are defined as follows:

(1) $N \subseteq P$ if and only if $T_N(x) \leq T_P(x), I_N(x) \geq I_P(x), F_N(x) \geq F_P(x)$
(2) $N = P$ if and only if $T_N(x) = T_P(x), I_N(x) = I_P(x), F_N(x) = F_P(x)$

2.2 Single Valued Neutrosophic sets

Definition 2.2 [24] Let X be a space of points with generic elements in X denoted by x. A SVNS N in X is characterized by a truth-membership function $T_N(x)$, an indeterminacy-membership function I_N(x), and a falsity membership function $F_N(x)$, for each point x in X, $T_N(x), I_N(x), F_N(x) \in [0, 1]$. When X is continuous, a SVNS N can be written as:

$$N = \int_X \frac{<T_N(x), I_N(x), F_N(x)>}{x} : x \in X$$

When X is discrete, a SVNS N can be written as:

$$N = \sum_{i=1}^{n} \frac{<T_N(x_i), I_N(x_i), F_N(x_i)>}{x_i} : x_i \in X$$

For two SVNSs , $N_{SVNS} = \{<\mathrm{x}: T_N(x), I_N(x), F_N(x)> | x \in X\}$ and $P_{SVNS} = \{<x, T_P(x), I_P(x), F_P(x)> | x \in X \}$ the two relations are defined as follows:(1) $N_{SVNS} \subseteq P_{SVNS}$ if and only if $T_N(x) \leq T_P(x), I_N(x) \geq I_P(x), F_N(x) \geq F_P(x)$

$N_{SVNS} = P_{SVNS}$ if and only if $T_N(x) = T_P(x)$, $I_N(x) = I_P(x)$, $F_N(x) = F_P(x)$ for any $x \in X$

2.3 Neutrosophic Refined Sets

Definition 2.3 [20] Let M be a neutrosophic refined set.

$M = \{< x,\ T_M^1(x_i), T_M^2(x_i), ..., T_M^r(x_i)), (I_M^1(x_i), I_M^2(x_i), ..., I_M^r(x_i)), (F_M^1(x_i), F_M^2(x_i), ..., F_M^r(x_i)))>: x \in X\}$

where, $T_M^1(x_i)$, $T_M^2(x_i)$, ..., $T_M^r(x_i)$: $X \in [0,1]$, $I_M^1(x_i)$, $I_M^2(x_i)$, ..., $I_M^r(x_i)$: $X \in [0,1]$, and $F_M^1(x_i)$, $F_M^2(x_i)$, ..., $F_M^r(x_i)$: $X \in [0,1]$, such that $0 \le \sup T_M^i(x_i) + \sup I_M^i(x_i) + \sup F_M^i(x_i) \le 3$, for i = 1, 2, …, r for any $x \in X$.

Now, $(T_M^1(x_i), T_M^2(x_i), ..., T_M^r(x_i))$, $(I_M^1(x_i), I_M^2(x_i), ..., I_M^r(x_i))$, $(F_M^1(x_i), F_M^2(x_i), ..., F_M^r(x_i))$ is the truth-membership sequence, indeterminacy-membership sequence and falsity-membership sequence of the element x, respectively. Also, r is called the dimension of neutrosophic refined sets M.

3. Tangent Similarity Measure for Single Valued Refined Neutrosophic Sets

Let N = $<x(T_N^j(x_i), I_N^j(x_i), F_N^j(x_i))>$ and P = $< x(T_P^j(x_i), I_P^j(x_i), F_P^j(x_i))>$ be two single valued refined neutrosophic numbers. Now refined tangent similarity function which measures the similarity between two vectors based only on the direction, ignoring the impact of the distance between them can be presented as:

$$T_{NRS}(N,P) = \frac{1}{p}\sum_{j=1}^{p}\left[\frac{1}{n}\sum_{i=1}^{n}\left\langle 1-\tan\left(\frac{\pi}{12}\left(\left|T_P^j(x_i)-T_Q^j(x_i)\right|+\left|I_P^j(x_i)-I_Q^j(x_i)\right|+\left|F_P^j(x_i)-F_Q^j(x_i)\right|\right)\right)\right\rangle\right] \quad (2)$$

Proposition 3.1. The defined refined tangent similarity measure $T_{NRS}(N, P)$ between NRSs N and P satisfies the following properties:

1. $0 \le T_{NRS}(N, P) \le 1$
2. $T_{NRS}(N, P) = 1$ iff $N = P$
3. $T_{NRS}(N, P) = T_{NRS}(P, N)$
4. If R is a NRS in X and $N \subset P \subset R$ then $T_{NRS}(N, R) \le T_{NRS}(N, P)$ and $T_{NRS}(N, R) \le T_{NRS}(P, R)$

Proofs: (1) The membership, indeterminacy and non-membership functions of the NRSs are within [0 ,1]. Again $0 \le \tan\left(\frac{\pi}{12}\left(\left|T_P^j(x_i)-T_Q^j(x_i)\right|+\left|I_P^j(x_i)-I_Q^j(x_i)\right|+\left|F_P^j(x_i)-F_Q^j(x_i)\right|\right)\right) \le 1.$ So, refined tangent similarity function is also within [0,1]. Hence $0 \le T_{NRS}(N, P) \le 1$

(2) For any two NRS N and P if $N = P$ this implies $T_P^j(x) = T_P^j(x)$, $I_P^j(x) = I_P^j(x)$, $F_P^j(x) = F_P^j(x)$. Hence

$\left|T_N^j(x)-T_P^j(x)\right| = 0$, $\left|I_N^j(x)-I_P^j(x)\right| = 0$, $\left|F_N^j(x)-F_P^j(x)\right| = 0$, Thus $T_{NRS}(N, P) = 1$

Conversely,

If $T_{NRS}(N, P) = 1$ then $\left|T_N^j(x)-T_P^j(x)\right|=0$, $\left|I_N^j(x)-I_P^j(x)\right|=0$, $\left|F_N^j(x)-F_P^j(x)\right|=0$ since tan(0)=0. So we can write $T_P^j(x)=T_P^j(x),\ I_P^j(x)=I_P^j(x),\ F_P^j(x)=F_P^j(x)$
Hence $N = P$**.**

(3) This proof is obvious.

(4) If $N\subset P\subset R$ then $T_N^j(x)\le T_P^j(x)\le T_R^j(x)$, $I_N^j(x)\le I_P^j(x)\le I_R^j(x)$, $F_N^j(x)\le F_P^j(x)\le F_R^j(x)$ for $x\in X$.

Now we can write the following inequalities:

$$\left|T_N^j(x)-T_P^j(x)\right|\le\left|T_N^j(x)-T_R^j(x)\right|, \left|T_P^j(x)-T_R^j(x)\right|\le\left|T_N^j(x)-T_R^j(x)\right|;$$
$$\left|I_N^j(x)-I_P^j(x)\right|\le\left|I_N^j(x)-I_R^j(x)\right|, \left|I_P^j(x)-I_R^j(x)\right|\le\left|I_N^j(x)-I_R^j(x)\right|;$$
$$\left|F_N^j(x)-F_P^j(x)\right|\le\left|F_N^j(x)-F_R^j(x)\right| \left|F_P^j(x)-F_R^j(x)\right|\le\left|F_N^j(x)-F_R^j(x)\right|$$

Thus $T_{NRS}(N, R) \le T_{NRS}(N, P)$ and $T_{NRS}(N, R) \le T_{NRS}(P, R)$, since tangent function is increasing in the interval $\left[0, \frac{\pi}{4}\right]$.

4. Decision Making Under Single Valued Refined Neutrosophic Environment Based on Tangent Similarity Measure

Let $A_1, A_2, ..., A_m$ be a discrete set of candidates, $C_1, C_2, ..., C_n$ be the set of criteria of each candidate, and $B_1, B_2, ..., B_k$ are the alternatives of each candidates. The decision-maker provides the ranking of alternatives with respect to each candidate. The ranking presents the performances of candidates A_i (i = 1, 2,..., m) against the criteria C_j (j = 1, 2, ..., n). The single valued neutrosophic values associated with the candidates and their attributes for MADM problem can be presented in the following decision matrix (see the table 1).
Table 1: The relation between candidates and attributes

	C_1	C_2	...	C_n
A_1	$\langle d_{11}^1, d_{11}^2, \cdots, d_{11}^r\rangle$	$\langle d_{12}^1, d_{12}^2, \cdots, d_{12}^r\rangle$	...	$\langle d_{1n}^1, d_{1n}^2, \cdots, d_{1n}^r\rangle$
A_2	$\langle d_{21}^1, d_{21}^2, \cdots, d_{21}^r\rangle$	$\langle d_{22}^1, d_{22}^2, \cdots, d_{22}^r\rangle$	...	$\langle d_{2n}^1, d_{2n}^2, \cdots, d_{2n}^r\rangle$
...	...	...	...	...
A_m	$\langle d_{n1}^1, d_{n1}^2, \cdots, d_{n1}^r\rangle$	$\langle d_{n2}^1, d_{n2}^2, \cdots, d_{n2}^r\rangle$	...	$\langle d_{mn}^1, d_{mn}^2, \cdots, d_{mn}^r\rangle$

The relational values between attributes and alternatives in terms of single valued neutrosophic numbers can be presented as follows (see the table 2).

Table 2: The relation between attributes and alternatives

	B_1	B_2	...	B_k
C_1	ξ_{11}	ξ_{12}	...	ξ_{1k}
C_2	ξ_{21}	ξ_{22}	...	ξ_{2k}
...	...	...	...	...
C_n	ξ_{n1}	ξ_{n2}	...	ξ_{nk}

Here d_{ij}^r and ξ_{ij} and are all single valued neutrosophic numbers.

The steps corresponding to refined neutrosophic similarity measure based on tangent function are presented as follows.

Step 1: Determination the relation between candidates and attributes: Each candidate A_i (i = 1, 2, ..., m) having the attribute C_j (j = 1, 2, ..., n) is presented as follows (see the table 3):

Table 3: Relation between candidates and attributes in terms of NRSs

	C_1	C_2	...	C_n
A_1	$\begin{Bmatrix} \langle T_{11}^1, I_{11}^1, F_{11}^1 \rangle, \\ \langle T_{11}^2, I_{11}^2, F_{11}^2 \rangle, \\ \ldots\ldots\ \ldots\ldots, \\ \ldots\ldots\ \ldots\ldots, \\ \langle T_{11}^r, I_{11}^r, F_{11}^r \rangle \end{Bmatrix}$	$\begin{Bmatrix} \langle T_{12}^1, I_{12}^1, F_{12}^1 \rangle, \\ \langle T_{12}^2, I_{12}^2, F_{12}^2 \rangle, \\ \ldots\ldots\ \ldots\ldots, \\ \ldots\ldots\ \ldots\ldots, \\ \langle T_{12}^r, I_{12}^r, F_{12}^r \rangle \end{Bmatrix}$	...	$\begin{Bmatrix} \langle T_{1n}^1, I_{1n}^1, F_{1n}^1 \rangle, \\ \langle T_{1n}^2, I_{1n}^2, F_{1n}^2 \rangle, \\ \ldots\ldots\ \ldots\ldots, \\ \ldots\ldots\ \ldots\ldots, \\ \langle T_{2n}^r, I_{2n}^r, F_{2n}^r \rangle \end{Bmatrix}$
A_2	$\begin{Bmatrix} \langle T_{21}^1, I_{21}^1, F_{21}^1 \rangle, \\ \langle T_{21}^2, I_{21}^2, F_{21}^2 \rangle, \\ \ldots\ldots\ \ldots\ldots, \\ \ldots\ldots\ \ldots\ldots, \\ \langle T_{21}^r, I_{21}^r, F_{21}^r \rangle \end{Bmatrix}$	$\begin{Bmatrix} \langle T_{22}^1, I_{22}^1, F_{22}^1 \rangle, \\ \langle T_{22}^2, I_{22}^2, F_{22}^2 \rangle, \\ \ldots\ldots\ \ldots\ldots, \\ \ldots\ldots\ \ldots\ldots, \\ \langle T_{22}^r, I_{22}^r, F_{22}^r \rangle \end{Bmatrix}$	...	$\begin{Bmatrix} \langle T_{2n}^1, I_{2n}^1, F_{2n}^1 \rangle, \\ \langle T_{2n}^2, I_{2n}^2, F_{2n}^2 \rangle, \\ \ldots\ldots\ \ldots\ldots, \\ \ldots\ldots\ \ldots\ldots, \\ \langle T_{1n}^r, I_{1n}^r, F_{1n}^r \rangle \end{Bmatrix}$
...	...	...	...	...
A_m	$\begin{Bmatrix} \langle T_{m1}^1, I_{m1}^1, F_{m1}^1 \rangle, \\ \langle T_{m1}^2, I_{m1}^2, F_{m1}^2 \rangle, \\ \ldots\ldots\ \ldots\ldots, \\ \ldots\ldots\ \ldots\ldots, \\ \langle T_{m1}^r, I_{m1}^r, F_{m1}^r \rangle \end{Bmatrix}$	$\begin{Bmatrix} \langle T_{m2}^1, I_{m2}^1, F_{m2}^1 \rangle, \\ \langle T_{m2}^2, I_{m2}^2, F_{m2}^2 \rangle, \\ \ldots\ldots\ \ldots\ldots, \\ \ldots\ldots\ \ldots\ldots, \\ \langle T_{m2}^r, I_{m2}^r, F_{m2}^r \rangle \end{Bmatrix}$	...	$\begin{Bmatrix} \langle T_{mn}^1, I_{mn}^1, F_{mn}^1 \rangle, \\ \langle T_{mn}^2, I_{mn}^2, F_{mn}^2 \rangle, \\ \ldots\ldots\ \ldots\ldots, \\ \ldots\ldots\ \ldots\ldots, \\ \langle T_{mn}^r, I_{mn}^r, F_{mn}^r \rangle \end{Bmatrix}$

Step 2: Determination the relation between attributes and alternatives: The relation between attributes C_i (i = 1, 2, ..., n) and alternatives B_t (t = 1, 2, ..., k) is presented in the table 4.

Table 4: The relation between attributes and alternatives in terms of NRSs

	B_1	B_2	$\ldots$	B_k
C_1	$\langle T_{11}, I_{11}, F_{11} \rangle$	$\langle T_{12}, I_{12}, F_{12} \rangle$	$\ldots$	$\langle T_{1k}, I_{1k}, F_{1k} \rangle$
C_2	$\langle T_{21}, I_{21}, F_{21} \rangle$	$\langle T_{22}, I_{22}, F_{22} \rangle$	$\ldots$	$\langle T_{2k}, I_{2k}, F_{2k} \rangle$
$\ldots$	$\ldots$	$\ldots$	$\ldots$	$\ldots$
C_n	$\langle T_{n1}, I_{n1}, F_{n1} \rangle$	$\langle T_{n2}, I_{n2}, F_{n2} \rangle$	$\ldots$	$\langle T_{nk}, I_{nk}, F_{nk} \rangle$

Step 3: Determination of the relation between attributes and alternatives: Determine the correlation measure ($T_{NRS}(N, P)$) between the table 3 and the table 4 using equation 1.

Step 4: Ranking the alternatives: Ranking of alternatives is prepared based on the descending order of correlation measures. Highest value indicates the best alternatives.

Step 5: End

5. Example on Medical Diagnosis

Let us consider an illustrative example on medical diagnosis. As medical diagnosis contains a large amount of uncertainties and increased volume of information available to physicians from new updated technologies, the process of classifying different set of symptoms under a single name of a disease. In some practical situations, there is the possibility of each element having different truth membership, indeterminate and falsity membership functions. The proposed similarity measure among the patients versus symptoms and symptoms versus diseases will give the proper medical diagnosis. The main feature of the proposed method is that it includes multi truth membership, multi-indeterminate and multi-falsity membership by taking many times inspection for diagnosis. Now, an example of a medical diagnosis will be presented. Example: Let P = {P_1, P_2, P_3, P_4} be a set of patients, D = {Viral fever, malaria, typhoid, stomach problem, chest problem} be a set of diseases and S ={Temperature, headache, stomach pain, cough, chest pain.} be a set of symptoms. The solution strategy is to examine the patient which will provide truth membership, indeterminate and false membership function for each patient regarding the relation between patient and different symptoms. Here we take three observations in a day: at 7 am, 1 pm and 6pm. (see the table 5).

Table 5: (Relation-1)The relation between patients and symptoms

	Temperature	Headache	Stomach pain	Cough	Chest pain
P_1	(0.8, 0.1, 0.1) (0.6, 0.3, 0.3) (0.6, 0.3, 0.1)	(0.6, 0.1, 0.3) (0.5, 0.2, 0.4) (0.5, 0.1, 0.2)	(0.2, 0.8, 0.0) (0.3, 0.5, 0.2) (0.2, 0.3, 0.4)	(0.6, 0.1, 0.3) (0.4, 0.4, 0.4) (0.4, 0.3, 0.3)	(0.1,0.6, 0.3) (0.3,0.4, 0.5) (0.2,0.5, 0.4)
P_2	(0.0, 0.8, 0.2) (0.2, 0.6, 0.4) (0.1, 0.6, 0.4)	(0.4, 0.4, 0.2) (0.5, 0.4, 0.1) (0.4, 0.6, 0.3)	(0.6, 0.1, 0.3) (0.4, 0.2, 0.5) (0.3, 0.2, 0.4)	(0.1, 0.7, 0.2) (0.2, 0.7, 0.5) (0.3, 0.5, 0.4)	(0.1, 0.8, 0.1) (0.3, 0.6, 0.4) (0.3, 0.6, 0.3)
P_3	(0.8, 0.1, 0.1) (0.6, 0.4, 0.1) (0.5, 0.3, 0.3)	(0.8, 0.1, 0.1) (0.6, 0.2, 0.4) (0.6, 0.1, 0.3)	(0.0, 0.6, 0.4) (0.2, 0.5, 0.5) (0.3, 0.4, 0.6)	(0.2, 0.7, 0.1) (0.2, 0.5, 0.5) (0.1, 0.6, 0.3)	(0.0, 0.5, 0.5) (0.2, 0.5, 0.3) (0.3, 0.3, 0.4)
P_4	(06, 0.1, 0.3) (04, 0.3, 0.2) (05, 0.2, 0.3)	(0.5, 0.4, 0.1) (0.4, 0.4, 0.4) (0.5, 0.2, 0.4)	(0.3, 0.4, 0.3) (0.2, 0.4, 0.5) (0.1, 0.5, 0.4)	(0.7, 0.2, 0.1) (0.5, 0.2, 0.4) (0.6, 0.4, 0.1)	(0.3, 0.4, 0.3) (0.4, 0.3, 0.4) (0.3, 0.5, 0.5)

Now the relation between symptoms and diseases in terms of single valued neutrosophic form are given below (see table 6).

Table 6: (Relation-2)The relation between symptoms and diseases

	Viral fever	Malaria	Typhoid	Stomach problem	Chest problem
Temperature	(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)
Headache	(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)
Stomach pain	(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)
Cough	(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)
Chest pain	(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)

Using equation (1) the tangent refined correlation measures (TRCM) between Relation-1 and Relation-2 are presented as follows (see the table 7).

Table 7: The tangent refined correlation measure between Relation-1 and Relation-2

TRSM	Viral Fever	Malaria	Typhoid	Stomach problem	Chest problem
P_1	**0.8963**	0.8312	0.8237	0.8015	0.7778
P_2	0.8404	0.8386	**0.8877**	0.8768	0.8049
P_3	**0.8643**	0.8091	0.8393	0.7620	0.7540
P_4	**0.8893**	0.8465	0.8335	0.7565	0.7959

The highest correlation measure from the Table 7 reflects the proper medical diagnosis. Therefore, patient P_1 suffers from viral fever, P_2 suffers from typhoid, P_3 suffers from viral fever and P_4 also suffers from viral fever.

6. Conclusions

In this paper, we have proposed a refined tangent similarity measure approach of single valued neutrosophic set and proved some of their basic properties. We have presented an application of tangent similarity measure of single valued neutrosophic sets in medical diagnosis. The concept presented in the paper can be applied in other practical decision making problems involving uncertainity, falsity and indeterminacy. The proposed concept can be extended to the hybrid envirobment namely, rough neutrosophic environment.

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