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Neutrosophic Tangent Similarity Measure and Its Application to Multiple Attribute Decision Making

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Abstract: In this paper, the tangent similarity measure of neutrosophic sets is proposed and its properties are studied. The concept of this tangent similarity measure of single valued neutrosophic sets is a parallel tool of improved cosine similarity measure of single valued neutrosophic sets. Finally, using this tangent similarity measure of single valued neutrosophic set, two applications namely, selection of educational stream and medical diagnosis are presented.

Keywords: Tangent similarity measure, Single valued neutrosophic set, Cosine similarity measure, Medical diagnosis

1 Introduction

Smarandache [1, 2] introduced the concept of neutrosophic set to deal with imprecise, indeterminate, and inconsistent data. In the concept of neutrosophic set, indeterminacy is quantified explicitly and truth-membership, indeterminacy-membership, and falsity-membership are independent. Indeterminacy plays an important role in many real world decision making problems. The concept of neutrosophic set [1, 2, 3, 4] generalizes the Cantor set discovered by Smith [5] in 1874 and introduced by German mathematician Cantor [6] in 1883, fuzzy set introduced by Zadeh [7], interval valued fuzzy sets introduced independently by Zadeh [8], Grattan-Guiness [9], Jahn [10], Sambuc [11], L-fuzzy sets proposed by Goguen [12], intuitionistic fuzzy set proposed by Atanassov [13], interval valued intuitionistic fuzzy sets proposed by Atanassov and Gargov [14], vague sets proposed by Gau, and Buehrer [15], grey sets proposed by Deng [16], paraconsistent set proposed by Brady [17], faillibilist set [2], paradoxist set [2], pseudoparadoxist set [2], tautological set [2] based on the philosophical point of view. From philosophical point of view, truth-membership, indeterminacy-membership, and falsity-membership of the neutrosophic set assume the value from real standard or non-standard subsets of $]^{-}0, 1^{+}[$. Realizing the difficulty in applying the neutrosophic sets in realistic problems, Wang et al. [18] introduced the concept of single valued neutrosophic set (SVNS) that is the subclass of a neutrosophic set. SVNS can be applied in real scientific and engineering fields. It offers us additional possibility to represent uncertainty, imprecise, incomplete, and inconsistent information that manifest the real world. Wang et al. [19] further studied interval neutrosophic sets (INSs) in which the truth-membership, indeterminacy-membership, and false-membership were extended to interval numbers.

Neutrosophic sets and its various extensions have been studied and applied in different fields such as medical diagnosis [20, 21, 22, 23], decision making problems [24, 25, 26, 27, 28, 29, 30], social problems [31,32], educational problem [33, 34], conflict resolution [35, 36], image processing [37, 38, 39], etc.

The concept of similarity is very important in studying almost every scientific field. Literature review reflects that many methods have been proposed for measuring the degree of similarity between fuzzy sets studied by Chen [40], Chen et al., [41], Hyung et al.[42], Pappis & Karacapilidis [43], presented by Wang [44]. But these methods are not capable of dealing with the similarity measures involving indeterminacy. In the literature few studies have addressed similarity measures for neutrosophic sets and single valued neutrosophic sets [24, 45, 46, 47, 48, 49, 50, 51].

In 2013, Salama [45] defined the correlation coefficient, on the domain of neutrosophic sets, which is another kind of similarity measure. In 2013, Broumi and Smarandache [46] extended the Hausdorff distance to neutrosophic sets that plays an important role in practical application, especially in many visual tasks, computer assisted surgery, etc. After that a new series of similarity measures has been proposed for neutrosophic set using different approaches. In 2013, Broumi and Smarandache [47] also proposed the correlation coefficient between interval neutrosphic sets. Majumdar and Smanta [48] studied several similarity measures of single valued neutrosophic sets based on distances, a matching function, memebership grades, and entropy measure for a SVNS.

In 2013, Ye [24] proposed the distance-based similarity measure of SVNSs and applied it to the group decision making problems with single valued neutrosophic information. Ye [26] also proposed three vector similarity measure for SNSs, an instance of SVNS and interval valued neutrosophic set, including the Jaccard, Dice, and cosine similarity and applied them to multi-criteria decision-making problems with simplified neutrosophic information. Recently, Jun [51] discussed similarity measures on interval neutrosophic set based on Hamming distance and Euclidean distance and offered a numerical example of its use in decision making problems.

Broumi and Smarandache [52] proposed a cosine similarity measure of interval valued neutrosophic sets

Ye [53] further studied and found that there exsit some disadvantages of existing cosine similarity measures defined in vector space [26] in some situations. He [53] mentioned that they may produce absurd result in some real cases. In order to overcome theses disadvantages, Ye [53] proposed improved cosine similarity measures based on cosine function, including single valued neutrosophic cosine similarity measures and interval neutrosophic cosine similarity measures. In his study Ye [53] proposed medical diagnosis method based on the improved cosine similarity measures. Ye [54] further studied medical diagnosis problem namely,“Multi-period medical diagnosis using a single valued neutrosophic similarity measure based on tangent function`` However, it is yet to publish. Recently, Biswas et al. [50] studied cosine similarity measure based multi-attribute decision-making with trapezoidal fuzzy neutrosophic numbers. In hybrid environment Pramanik and Mondal [55] proposed cosine similarity measure of rough neutrosophic sets and provided its application in medical diagnosis. Pramanik and Mondal [56] also proposed cotangent similarity measure of rough neutrosophic sets and its application to medical diagnosis.

Pramanik and Mondal [57] proposed weighted fuzzy similarity measure based on tangent function and its application to medical diagnosis. Pramanik and Mondal [58] also proposed tangent similarity measures between intuitionistic fuzzy sets and studied some of its properties and applied it for medical diagnosis.

In this paper we have extended the concept of intuitionistic tangent similarity measure [56] to neutrosophic environment. We have defined a new similarity measre called “tangent similarity measure for single valued neutrosophic sets``. The properties of tangent similarity are established. The proposed tangent similarity measure is applied to medical diagnosis.

Rest of the paper is structured as follows. Section 2 presents preliminaries of neutrosophic sets. Section 3 is devoted to introduce tangent similarity measure for single valued neutrosophic sets and some of its properties. Section 4 presents decision making based on neutrosophic tangent similarity measure. Section 5 presents the application of tangent similarity measure to two problems namely, neutrosophic decision making of student’s educational stream selection and neutrosophic decision making on medical diagnosis. Finally, section 6 presents concluding remarks and scope of future research.

2 Neutrosophic preliminaries

2.1 Neutrosophic sets

Definition 2.1[1, 2]

Let U be an universe of discourse. Then the neutrosophic set P can be presented of the form:

$P = \{< x: T_P(x), I_P(x), F_P(x)>, x \in U\}$, where the functions T, I, F: $U \to\ ]^-0,1^+[$ define respectively the degree of membership, the degree of indeterminacy, and the degree of non-membership of the element $x \in U$ to the set P satisfying the following the condition.

$$^-0 \le \sup T_P(x) + \sup I_P(x) + \sup F_P(x) \le 3^+ \quad (1)$$

From philosophical point of view, the neutrosophic set assumes the value from real standard or non-standard subsets of $]^-0, 1^+[$. So instead of $]^-0, 1^+[$ one needs to take the interval [0, 1] for technical applications, because $]^-0, 1^+[$ will be difficult to apply in the real applications such as scientific and engineering problems. For two netrosophic sets (NSs), $P_{NS} = \{<x: T_P(x), I_P(x), F_P(x)> \mid x \in X\}$ and $Q_{NS} = \{<x, T_Q(x), I_Q(x), F_Q(x)> \mid x \in X\}$ the two relations are defined as follows:

(1) $P_{NS} \subseteq Q_{NS}$ if and only if $T_P(x) \le T_Q(x)$, $I_P(x) \ge I_Q(x)$, $F_P(x) \ge F_Q(x)$

(2) $P_{NS} = Q_{NS}$ if and only if $T_P(x) = T_Q(x)$, $I_P(x) = I_Q(x)$, $F_P(x) = F_Q(x)$

2.2 Single valued neutrosophic sets

Definition 2.2 [18]

Let X be a space of points (objects) with generic elements in X denoted by x. A SVNS P in X is characterized by a truth-membership function $T_P(x)$, an indeterminacy-membership function $I_P(x)$, and a falsity membership function $F_P(x)$, for each point x in X, $T_P(x)$, $I_P(x)$, $F_P(x) \in [0, 1]$. When X is continuous, a SVNS P can be written as follows:

$$P = \int_X \frac{<T_P(x), I_P(x), F_P(x)>}{x} : x \in X$$

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

$$P = \sum_{i=1}^{n} \frac{<T_P(x_i), I_P(x_i), F_P(x_i)>}{x_i} : x_i \in X$$

For two SVNSs, $P_{SVNS} = \{<x: T_P(x), I_P(x), F_P(x)> \mid x \in X\}$ and $Q_{SVNS} = \{<x, T_Q(x), I_Q(x), F_Q(x)> \mid x \in X\}$ the two relations are defined as follows:

(1) $P_{SVNS} \subseteq Q_{SVNS}$ if and only if $T_P(x) \le T_Q(x)$, $I_P(x) \ge I_Q(x)$, $F_P(x) \ge F_Q(x)$

(2) $P_{SVNS} = Q_{SVNS}$ if and only if $T_P(x) = T_Q(x)$, $I_P(x) = I_Q(x)$, $F_P(x) = F_Q(x)$ for any $x \in X$

3 Tangent similarity measures for single valued neutrosophic sets

Let $P = <x(T_P(x)I_P(x)F_P(x))>$ and $Q = <x(T_Q(x), I_Q(x), F_Q(x))>$ be two single valued neutrosophic numbers. Now 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 follows:

$$T_{SVNS}(P,Q)= \frac{1}{n}\sum_{i=1}^{n}\left\langle 1-tan\left(\frac{\pi\left(\begin{array}{l}|T_P(x_i)-T_Q(x_i)|+|I_P(x_i)-I_Q(x_i)|+\\ |F_P(x_i)-F_Q(x_i)|\end{array}\right)}{12}\right)\right\rangle \quad (1)$$

Proposition 3.1. The defined tangent similarity measure $T_{SVNS}(A, B)$ between SVNS P and Q satisfies the following properties:

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

$T_{SVNS}(P, R) \leq T_{SVNS}(P, Q)$ and $T_{SVNS}(P, R) \leq T_{SVNS}(Q, R)$

Proofs:

(1)

As the membership, indeterminacy and non-membership functions of the SVNSs and the value of the tangent function are within [0 ,1], the similarity measure based on tangent function also is within [0,1].

Hence $0 \leq T_{SVNS}(P, Q) \leq 1$

(2)

For any two SVNS P and Q if $P = Q$, this implies $T_P(x) = T_Q(x)$, $I_P(x) = I_Q(x)$, $F_P(x) = F_Q(x)$. Hence

$|T_P(x)-T_Q(x)| = 0$, $|I_P(x)-I_Q(x)| = 0$, $|F_P(x)-F_Q(x)| = 0$,

Thus $T_{SVNS}(P, Q) = 1$

Conversely,

If $T_{SVNS}(P, Q) = 1$ then $|T_P(x)-T_Q(x)| = 0$, $|I_P(x)-I_Q(x)| = 0$, $|F_P(x)-F_Q(x)| = 0$ since tan(0)=0.

So we can we can write, $T_P(x) = T_Q(x)$, $I_P(x) = I_Q(x)$, $F_P(x) = F_Q(x)$. Hence $P = Q$.

(3)

This proof is obvious.

(4)

If $P \subset Q \subset R$ then $T_P(x) \leq T_Q(x) \leq T_R(x)$, $I_P(x) \geq I_Q(x) \geq I_R(x)$, $F_P(x) \geq F_Q(x) \geq F_R(x)$ for $x \in X$.

Now we have the following inequalities:

$|T_P(x)-T_Q(x)| \leq |T_P(x)-T_R(x)|$,

$|T_Q(x)-T_R(x)| \leq |T_P(x)-T_R(x)|$;

$|I_P(x)-I_Q(x)| \leq |I_P(x)-I_R(x)|$,

$|I_Q(x)-I_R(x)| \leq |I_P(x)-I_R(x)|$;

$|F_P(x)-F_Q(x)| \leq |F_P(x)-F_R(x)|$,

$|F_Q(x)-F_R(x)| \leq |F_P(x)-F_R(x)|$.

Thus $T_{SVNS}(P, R) \leq T_{SVNS}(P, Q)$ and $T_{SVNS}(P, R) \leq T_{SVNS}(Q, R)$. Since tangent function is increasing in the interval $\left[0, \frac{\pi}{4}\right]$.

4. Single valued neutrosophic decision making 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 values associated with the alternatives for MADM problem can be presented in the following decision matrix (see Table 1 and Table 2). The relation between candidates and attributes are given in the Table 1. The relation between attributes and alternatives are given in the Table 2.

Table 1: The relation between candidates and attributes

	C_1	C_2	...	C_n
A_1	d_{11}	d_{12}	...	d_{1n}
A_2	d_{21}	d_{22}	...	d_{2n}
...	...	...	...	...
A_m	d_{m1}	d_{m2}	...	d_{mn}

Table 2: The relation between attributes and alternatives

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

Here d_{ij} and δ_{ij} are all single valued neutrosophic numbers.

The steps corresponding to single valued neutrosophic number based on tangent function are presented using the following steps.

Step 1: Determination of the relation between candidates and attributes

The relation between candidate A_i (i = 1, 2, ..., m) and the attribute C_j (j = 1, 2, ..., n) is presented in the Table 3.

Table 3: relation between candidates and attributes in terms of SVNSs

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

Step 2: Determination of the relation between attributes and alternatives

The relation between attribute C_i (i = 1, 2, ..., n) and alternative B_t (t = 1, 2, ..., k) is presented in the table 4.

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

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

Step 3: Determination of the relation between attributes and alternatives

Determine the correlation measure between the table 3 and the table 4 using $T_{SVNS}(P,Q)$.

Step 4: Ranking the alternatives

Ranking the alternatives is prepared based on the descending order of correlation measures. Highest value reflects the best alternative.

Step 5: End

5. Example 1: Selection of educational stream for higher secondary education (XI-XII)

Consider the illustrative example which is very important for students after secondary examination (X) to select suitable educational stream for higher secondary education (XI-XII). After class X, the student takes up subjects of his choice and puts focused efforts for better career prospects in future. This is the crucial time when most of the students get confused too much and takes a decision which he starts to dislike later. Students often find it difficult to decide which path they should choose and go. Selecting a career in a particular stream or profession right at this point of time has a long lasting impact on a student's future. If the chosen branch is improper, the student may encounter a negative impact to his/her carrier. It is very important for any student to choose carefully from various options available to him/her in which he/she is interested. So it is necessary to use a suitable mathematical method for decision making. The proposed similarity measure among the students' attributes and attributes versus educational streams will give the proper selection of educational stream of students. The feature of the proposed method is that it includes truth membership, indeterminate and falsity membership function simultaneously. Let $A = \{A_1, A_2, A_3\}$ be a set of students, B = {science (B_1), humanities/arts (B_2), commerce (B_3), vocational course (B_4)} be a set of educational streams and C = {depth in basic science and mathematics (C_1), depth in language (C_2), good grade point in secondary examination (C_3), concentration (C_4), and laborious (C_5)} be a set of attributes. Our solution is to examine the students and make decision to choose suitable educational stream for them (see Table 5, 6, 7). The decision making procedure is presented using the following steps.

Step 1: The relation between students and their attributes in the form SVNSs is presented in the table 5.

Table 5: The relation between students and attributes

Relation-1	C_1	C_2	C_3	C_4	C_5
A_1	(0.7, 0.3, 0.3)	(0.6, 0.3, 0.2)	(0.7, 0.1, 0.1)	((0.7, 0.4, 0.4))	(0.5, 0.3, 0.4)
A_2	(0.5, 0.2, 0.3)	(0.6, 0.2, 0.3)	(0.6, 0.1, 0.1))	(0.6, 0.3, 0.3))	(0.6, 0.3, 0.2)
A_3	(0.6, 0.2, 0.2))	(0.6, 0.3, 0.2)	(0.6, 0.1, 0.0)	(0.6, 0.3, 0.2))	(0.5, 0.3, 0.3)

Step 2: The relation between student's attributes and educational streams in the form SVNSs is presented in the table 6.

Table 6: The relation between attributes and educational streams

Relation-2	B_1	B_2	B_3	B_4
C_1	(0.9, 0.2, 0.2)	(0.7, 0.3, 0.2)	(0.8, 0.3, 0.3)	(0.4, 0.3, 0.6)
C_2	(0.6, 0.2, 0.2)	(0.8, 0.4, 0.2)	(0.4, 0.3, 0.5)	(0.3, 0.2, 0.5)

C_3	$\begin{pmatrix}0.7,\\0.2,\\0.2\end{pmatrix}$	$\begin{pmatrix}0.7,\\0.4,\\0.2\end{pmatrix}$	$\begin{pmatrix}0.5,\\0.3,\\0.3\end{pmatrix}$	$\begin{pmatrix}0.5,\\0.2,\\0.4\end{pmatrix}$
C_4	$\begin{pmatrix}0.8,\\0.2,\\0.1\end{pmatrix}$	$\begin{pmatrix}0.8,\\0.3,\\0.1\end{pmatrix}$	$\begin{pmatrix}0.7,\\0.1,\\0.1\end{pmatrix}$	$\begin{pmatrix}0.5,\\0.3,\\0.3\end{pmatrix}$
C_5	$\begin{pmatrix}0.7,\\0.3,\\0.2\end{pmatrix}$	$\begin{pmatrix}0.6,\\0.3,\\0.2\end{pmatrix}$	$\begin{pmatrix}0.8,\\0.2,\\0.2\end{pmatrix}$	$\begin{pmatrix}0.7,\\0.2,\\0.1\end{pmatrix}$

Step 3: Determine the correlation measure between the table 5 and the table 6 using tangent similarity measures (equation 1). The obtained measure values are presented in table 7.

Table 7: The correlation measure between Reation-1(table 5) and Relation-2 (table 6)

Tangent similarity measure	B_1	B_2	B_3	B_4
A_1	0.91056	**0.91593**	0.87340	0.84688
A_2	**0.92112**	0.90530	0.90534	0.90003
A_3	**0.92124**	0.91588	0.87362	0.85738

Step 4: Highest correlation measure value of A_1, A_2 and A_3 are **0.91593**, **0.92112** and **0.92124** respectively. The highest correlation measure from the table 7 gives the proper decision making of students for educational stream selection. Therefore student A_1 should select in arts stream, student A_2 should select in science stream and student A_3 should select the science stream.

Example2: Medical diagnosis

Let us consider an illustrative example adopted from Szmidt and Kacprzyk [59] with minor changes. As medical diagnosis contains a large amount of uncertainties and increased volume of information available to physicians from new medical 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 this proposed method is that it includes truth membership, indeterminate and false membership by taking one time 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 patien regarding the relatiom between patient and different symptoms (see the table 8), the relation among symptoms and diseases (see the table 9), and the correlation measure between R-1 and R-2 (see the table 10).

Table 8: (R-1) The relation between Patient and Symptoms

R-1	Temper-ature	Headache	Stom-ach pain	Cough	Chest-pain
P_1	$\begin{pmatrix}0.8,\\0.1,\\0.1\end{pmatrix}$	$\begin{pmatrix}0.6,\\0.1,\\0.3\end{pmatrix}$	$\begin{pmatrix}0.2,\\0.8,\\0.0\end{pmatrix}$	$\begin{pmatrix}0.6,\\0.1,\\0.3\end{pmatrix}$	$\begin{pmatrix}0.1,\\0.6,\\0.3\end{pmatrix}$
P_2	$\begin{pmatrix}0.0,\\0.8,\\0.2\end{pmatrix}$	$\begin{pmatrix}0.4,\\0.4,\\0.2\end{pmatrix}$	$\begin{pmatrix}0.6,\\0.1,\\0.3\end{pmatrix}$	$\begin{pmatrix}0.1,\\0.7,\\0.2\end{pmatrix}$	$\begin{pmatrix}0.1,\\0.8,\\0.1\end{pmatrix}$
P_3	$\begin{pmatrix}0.8,\\0.1,\\0.1\end{pmatrix}$	$\begin{pmatrix}0.8,\\0.1,\\0.1\end{pmatrix}$	$\begin{pmatrix}0.0,\\0.6,\\0.4\end{pmatrix}$	$\begin{pmatrix}0.2,\\0.7,\\0.1\end{pmatrix}$	$\begin{pmatrix}0.0,\\0.5,\\0.5\end{pmatrix}$
P_4	$\begin{pmatrix}0.6,\\0.1,\\0.3\end{pmatrix}$	$\begin{pmatrix}0.5,\\0.4,\\0.1\end{pmatrix}$	$\begin{pmatrix}0.3,\\0.4,\\0.3\end{pmatrix}$	$\begin{pmatrix}0.7,\\0.2,\\0.1\end{pmatrix}$	$\begin{pmatrix}0.3,\\0.4,\\0.3\end{pmatrix}$

Table 9: (R-2) The relation among symptoms and diseases

R-2	Viral fever	Malaria	Typhoid	Stomach problem	Chest problem
Temperature	$\begin{pmatrix}0.4,\\0.0,\\0.6\end{pmatrix}$	$\begin{pmatrix}0.7,\\0.0,\\0.3\end{pmatrix}$	$\begin{pmatrix}0.3,\\0.3,\\0.4\end{pmatrix}$	$\begin{pmatrix}0.1,\\0.7,\\0.2\end{pmatrix}$	$\begin{pmatrix}0.1,\\0.8,\\0.1\end{pmatrix}$
Headache	$\begin{pmatrix}0.3,\\0.5,\\0.2\end{pmatrix}$	$\begin{pmatrix}0.2,\\0.6,\\0.2\end{pmatrix}$	$\begin{pmatrix}0.6,\\0.1,\\0.3\end{pmatrix}$	$\begin{pmatrix}0.2,\\0.4,\\0.4\end{pmatrix}$	$\begin{pmatrix}0.0,\\0.8,\\0.2\end{pmatrix}$
Stomach pain	$\begin{pmatrix}0.1,\\0.7,\\0.2\end{pmatrix}$	$\begin{pmatrix}0.0,\\0.9,\\0.1\end{pmatrix}$	$\begin{pmatrix}0.2,\\0.7,\\0.1\end{pmatrix}$	$\begin{pmatrix}0.8,\\0.0,\\0.2\end{pmatrix}$	$\begin{pmatrix}0.2,\\0.8,\\0.0\end{pmatrix}$

Cough	$\begin{pmatrix}0.4,\\0.3,\\0.3\end{pmatrix}$	$\begin{pmatrix}0.7,\\0.0,\\0.3\end{pmatrix}$	$\begin{pmatrix}0.2,\\0.6,\\0.2\end{pmatrix}$	$\begin{pmatrix}0.2,\\0.7,\\0.1\end{pmatrix}$	$\begin{pmatrix}0.2,\\0.8,\\0.0\end{pmatrix}$
Chest pain	$\begin{pmatrix}0.1,\\0.7,\\0.2\end{pmatrix}$	$\begin{pmatrix}0.1,\\0.8,\\0.1\end{pmatrix}$	$\begin{pmatrix}0.1,\\0.9,\\0.0\end{pmatrix}$	$\begin{pmatrix}0.2,\\0.7,\\0.1\end{pmatrix}$	$\begin{pmatrix}0.8,\\0.1,\\0.1\end{pmatrix}$

Table 10: The correlation measure between R-1 and R-2

Tangent similarity measure	Viral Fever	Malaria	Typhoid	Stomach problem	Chest problem
P_1	0.8522	**0.8729**	0.8666	0.6946	0.6929
P_2	0.7707	0.7257	0.8288	**0.9265**	0.7724
P_3	0.7976	0.7630	**0.8296**	0.7267	0.6921
P_4	**0.8469**	0.8407	0.7978	0.7645	0.6967

The highest correlation measure (shown in the Table 10) reflects the proper medical diagnosis. Therefore, patient P_1 suffers from malaria, P_2 suffers from stomach problem, and P_3 suffers from typhoid and P_4 suffers from viral fever.

Conclusion

In this paper, we have proposed tangent similarity measure based multi-attribte decision making of single valued neutrosophic set and proved some of its basic properties. We have presented two applications, namely selection of educational stream and medical diagnosis. The concept presented in this paper can be applied to other multiple attribute decision making problems in neutrosophic envirobment.

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