TANGENT INVERSE SIMILARITY MEASURE OF SINGLEVALUED NEUTROSOPHIC SETS IN MEDICAL DIAGNOSIS

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Abstract : In this paper, a new approach (tangent inverse similarity measure) is proposed to construct the decision method for medical diagnosis by using single valued neutrosophic sets. Also, we develop a technique to diagnose which patient is suffering from what disease.

Keywords **- Neutrosophic set, single valued neutrosophic set, tangent inverse similarity measure, medical diagnosis.**

I.INTRODUCTION

A number of real life problems in engineering, medical sciences,social sciences, economics etc.,involve imprecise data and their solution involves the use of mathematical principles based on uncertainty and imprecision.Suchuncertainties are being dealt with the help of topics like probability theory,fuzzy set theory[9],rough set theory [6] etc.,Healthcare industry has been trying to complement the services offered by conventional clinical decision making systems with the integration of fuzzy logic techniques in them. As it is not an easy task for a clinician to derive a fool proof diagnosis it is advantageous to automate few initial steps of diagnosis which would not require intervention from an expert doctor. Neutrosophicset which is a generalized set possesses all attributes necessary to encode medical knowledge base and capture medical inputs.

As medical diagnosis demands large amount of information processing, large portion of which is quantifiable, also intuitive thought process involve rapid unconscious data processing and combines available information by law of average, the whole process offers low intra and inter person consistency. So contradictions, inconsistency, indeterminacy and fuzziness should be accepted as unavoidable as it is integrated in the behavior of biological systems as well as in their characterization. To model an expert doctor it is imperative that it should not disallow uncertainty as it would be then inapt to capture fuzzy or incomplete knowledge that might lead to the danger of fallacies due to misplaced precision.

As medical diagnosis contains lots 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 disease becomes difficult.In some practical situations, there is the possibility of each element having different truth membership, indeterminate and false membership functions.So, single valued neutrosophic sets and their applications play a vital role in medical diagnosis.

In 1965, Fuzzy set theory was initially given by Zadeh[9] which is applied in many real applications to handle uncertainty. Sometimes membership function itself is uncertain and hard to be defined by a crisp value. So the concept of interval valued fuzzy sets was proposed to capture the uncertaintyof membershipgrade. In 1982, Pawlak[6]introduced the concept of rough set, as a formal tool for modeling and processing incomplete information in information systems. In 1986, Atanassov[5] introduced the intuitionistic fuzzy sets which consider both truth-membership and falsity-membership. Later on, intuitionistic fuzzy sets were extended to the interval valued intuitionistic fuzzy sets. Intuitionistic fuzzy sets and interval valued intuitionistic fuzzy sets can only handle incomplete information not the indeterminate information and inconsistent information which exists commonly in belief systems. Neutrosophic set (generalization of fuzzy sets, intuitionistic fuzzy sets and so on) defined by FlorentinSmarandache[1] has capability to deal with uncertainty, imprecise, incomplete and inconsistent information which exists in real world from philosophical point of view. Wang *et al*[2] proposed the single valued neutrosophic set.PinakiMajumdar and S.K. Samanta [7]proposed the similarity and entropy of neutrosophic sets. Jun Ye[4] proposed the cotangent similarity measure of single valued neutrosophic sets.

In this paper, by using the notion of single valued neutrosophic set, it was provided an exemplary for medical diagnosis. In order to make this, a new method was executed.

Rest of the article was structured as follows.In Section 2, the basic definitions were briefly presented. Section 3 deals with proposed definition and some of its properties. Section 4 contains medical diagnosis .Conclusion was given in Section 5.

II.PRELIMINARIES

2.1 Definition[8]

Let X be a Universe of discourse,with a generic element in X denoted by x, theneutrosophicset(NS) A is an object having the form $A=\{\langle x:T_A(x),I_A(x),F_A(x)\rangle,x\in X\}$

where the functions define $T,I,F:X\to\,]^-0,1^+[$ respectively the degree of membership(or Truth), the degree of indeterminacy and the degree of non-membership(or Falsehood) ofthe element $x\in X$ to the set A with the condition $^-0\le T_A(x)+I_A(x)+F_A(x)\le 3^+$

2.2 Definition[2]

Let X be aspace of points (objects) with a generic element in X denoted by x. A single valued neutrosophic set A in X is characterized by truth membership function T_A, indeterminacy function I_A and falsity membership function F_A. For each point x in X, $T_A(x), I_A(x), F_A(x) \in [0,1]$

When X is continuous, a SVNS A can be written as $A = \int_x \langle T(x), I(x), F(x) \rangle / x, x \in X$

When X is discrete, a SVNS A can be written as $A = \sum_{i=1}^{n} \langle T(x_i), I(x_i), F(x_i) \rangle / x_i, x_i \in X$

III. Proposed Definition

Let $A = \sum_{i=1}^{n} \frac{x_i}{\langle T_A(x_i), I_A(x_i), F_A(x_i) \rangle}$ and $B = \sum_{i=1}^{n} \frac{x_i}{\langle T_B(x_i), I_B(x_i), F_B(x_i) \rangle}$ be two single valued neutrosophic sets in $X = \{x_1, x_2, \ldots, x_n\}$. Then the tangent inverse similarity measure is defined as

$$TISM_{SVNS}(A,B) = \frac{1}{2n+3} \sum_{i=1}^{n} \frac{2}{\tan^{-1}\left[1 + |T_A(x_i) - T_B(x_i)| + |I_A(x_i) - I_B(x_i)| + |F_A(x_i) - F_B(x_i)|\right]}$$

Proposition 1

(i) $TISM_{SVNS}(A,B) > 0$

(ii) $TISM_{SVNS}(A,B) = TISM_{SVNS}(B,A)$

(iii) If $A \subseteq B \subseteq C$ then $TISM_{SVNS}(A,C) \leq TISM_{SVNS}(A,B)$ & $IHD_{SVNS}(A,C) \leq IHD_{SVNS}(B,C)$

Proof

(i) The proof is straightforward

(ii) The proof is straightforward

(iii) We know that,

$$T_A(x_i) \leq T_B(x_i) \leq T_C(x_i)$$
$$I_A(x_i) \geq I_B(x_i) \geq I_C(x_i)$$
$$F_A(x_i) \geq F_B(x_i) \geq F_C(x_i)$$
$$(\Theta\ A \subseteq B \subseteq C).$$

Hence,

$$|T_A(x_i) - T_B(x_i)| \leq |T_A(x_i) - T_C(x_i)|$$
$$|I_A(x_i) - I_B(x_i)| \leq |I_A(x_i) - I_C(x_i)|$$
$$|F_A(x_i) - F_B(x_i)| \leq |F_A(x_i) - F_C(x_i)|$$
$$|T_B(x_i) - T_C(x_i)| \leq |T_A(x_i) - T_C(x_i)|$$
$$|I_B(x_i) - I_C(x_i)| \leq |I_A(x_i) - I_C(x_i)|$$
$$|F_B(x_i) - F_C(x_i)| \leq |F_A(x_i) - F_C(x_i)|$$

Here, the tangent inverse similarity measure is a decreasing function

$$\therefore\ TISM_{SVNS}(A,C) \leq TISM_{SVNS}(A,B) \ \&\ IHD_{SVNS}(A,C) \leq IHD_{SVNS}(B,C)$$

IV. Medical Diagnosis

4.1 Medical diagnosis under single valued neutrosophicenvironment

The steps involved in medical diagnosis problem are as follows:

Step 1:Determination of relation between patients and symptoms

Table 1: Patient – Symptom relation

Q	S_1	S_2	Λ	S_m
P_1	$\langle T_{11}, I_{11}, F_{11} \rangle$	$\langle T_{12}, I_{12}, F_{12} \rangle$	Λ	$\langle T_{1m}, I_{1m}, F_{1m} \rangle$
P_2	$\langle T_{21}, I_{21}, F_{21} \rangle$	$\langle T_{22}, I_{22}, F_{22} \rangle$	Λ	$\langle T_{2m}, I_{2m}, F_{2m} \rangle$
Λ	Λ	Λ	Λ	Λ
P_n	$\langle T_{n1}, I_{n1}, F_{n1} \rangle$	$\langle T_{n2}, I_{n2}, F_{n2} \rangle$	Λ	$\langle T_{nm}, I_{nm}, F_{nm} \rangle$

Step 2:Determination ofrelation between symptoms and diseases

Table 2: Symptom – Diseaserelation

R	D_1	D_2	Λ	D_p
S_1	$\langle T_{11}, I_{11}, F_{11} \rangle$	$\langle T_{12}, I_{12}, F_{12} \rangle$	Λ	$\langle T_{1p}, I_{1p}, F_{1p} \rangle$
S_2	$\langle T_{21}, I_{21}, F_{21} \rangle$	$\langle T_{22}, I_{22}, F_{22} \rangle$	Λ	$\langle T_{2p}, I_{2p}, F_{2p} \rangle$
Λ	Λ	Λ	Λ	Λ

S_m	$\langle T_{m1}, I_{m1}, F_{m1}\rangle$	$\langle T_{m2}, I_{m2}, F_{m2}\rangle$	Λ	$\langle T_{mp}, I_{mp}, F_{mp}\rangle$

Step 3:Determination of relation between patients anddiseases

Determine the tangent inverse similarity measure

$$TISM_{SVNS}(A,B)=\frac{1}{2n+3}\sum_{i=1}^{n}\frac{2}{\tan^{-1}\left[1+\left|T_A(x_i)-T_B(x_i)\right|+\left|I_A(x_i)-I_B(x_i)\right|+\left|F_A(x_i)-F_B(x_i)\right|\right]}$$ between Table 1&Table 2

Step 4:Ranking the alternatives

Rank the alternatives in descending order of tangent inverse similarity measure. Highest value indicates the disease affecting the patient.

Step 5:End

4.2 Example on medical diagnosis[3]

Let there be three patients P=(Ali,Hamza,Imran) and the set of symptoms S={Temperature,Insulin, Blood Pressure, Blood Platelets, Cough}.The Single valued neutrosophic relation $Q(P \rightarrow S)$ is given as in Table 1.Let the set of diseases D = {Diabetes, Dengue, Tuberculosis}.The Single valued neutrosophic relation$R(S \rightarrow D)$ is given as in Table 2.

Table 1:Patient-Symptom relation

Q	Temperature	Insulin	Blood Pressure	Blood Platelets	Cough
Ali	(0.8,0.1,0.1)	(0.2,0.2,0.6)	(0.4,0.2,0.4)	(0.8,0.1,0.1)	(0.3,0.3,0.4)
Hamza	(0.6,0.2,0.2)	(0.9,0.0,0.1)	(0.1,0.1,0.8)	(0.2,0.1,0.7)	(0.5,0.1,0.4)
Imran	(0.4,0.2,0.4)	(0.2,0.1,0.7)	(0.1,0.2,0.7)	(0.3,0.1,0.6)	(0.8,0.0,0.2)

Table 2:Symptom-Disease relation

R	Diabetes	Dengue	Tuberculosis
Temperature	(0.2,0.0,0.8)	(0.9,0.0,0.1)	(0.6,0.2,0.2)
Insulin	(0.9,0.0,0.1)	(0.0,0.2,0.8)	(0.0,0.1,0.9)
Blood Pressure	(0.1,0.1,0.8)	(0.8,0.1,0.1)	(0.4,0.2,0.4)
Blood Platelets	(0.1,0.1,0.8)	(0.9,0.0,0.1)	(0.0,0.2,0.8)
Cough	(0.1,0.1,0.8)	(0.1,0.1,0.8)	(0.9,0.0,0.1)

Table 3:Tangent inverse similarity measure

T	Diabetes	Dengue	Tuberculosis
Ali	0.6817	**0.8023**	0.7719
Hamza	**0.8464**	0.6835	0.7722
Imran	0.7437	0.6968	**0.8032**

From Table 3,it is obvious that, if the doctor agrees, then Ali is suffering from Dengue, Hamza is suffering from Diabetes and Imran is suffering from Tuberculosis.

V.CONCLUSION

Our propounded technique is most reliable to handle medical diagnosis problems quiet comfortably. The recommended methods can invade in other areas such as clustering,image processing etc., In future, we will enhance this method to other types of neutrosophic sets.

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