Neutrosophic Sets and Systems, Vol. 32, 2020
University of New Mexico

Single and Multi-valued Neutrosophic Hypersoft set and Tangent Similarity Measure of Single valued Neutrosophic Hypersoft Sets

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Abstract: In this paper, we present a single-valued Neutrosophic Hypersoft set, multi-valued Neutrosophic Hypersoft set and tangent similarity measure for single-valued neutrosophic hypersoft sets and its properties. Then we use this technique in an application namely selection of cricket players for different types of matches (ODI, T20, and test) based on Neutrosophic Hypersoft set in decision making of single-valued neutrosophic hypersoft sets. This technique will help us to decide the best option for the players.

Keywords: Neutrosophic hypersoft set (NHSS), single-valued neutrosophic hypersoft set (SVNHSS), multi-valued Neutrosophic Hypersoft set (MVNHSS), tangent similarity measure (TSM), multiple attribute decision making, cricket player

1. Introduction

As the analysis of classical sets, fuzzy set [1] and intuitionistic fuzzy set [2], the neutrosophic set was introduced by Smarandache [3, 4] to capture the insufficient, indicate, uncertain and conflicting information. The neutrosophic set has three free parts, which are truth, indeterminacy and falsity membership degree; subsequently, it is applied in a wide range, for example, basic decision-making problems [5-20].

By accomplishing that the neutrosophic sets are difficult to be applied in some genuine issues on account of truth, indeterminacy and falsity membership degree, Wang, Smarandache, Zhang, and Sunderraman [21] presented the idea of a single-valued neutrosophic set. The single-valued neutrosophic set can freely express truth-membership degree, indeterminacy-membership degree, and falsity-membership degree and manages inadequate, uncertain and conflicting data. All the aspects of the elements depicted by the single-valued neutrosophic set are entirely appropriate for human intuition because of the flaw of information that human gets or sees from the surrounding. The single-valued neutrosophic set has been growing quickly because of its wide scope of hypothetical distinction and application zones, as discussed in [22-30].

The idea of similarity is significant in examining approximately every logical field. Literature audit indicates that numerous strategies have been proposed for estimating the degree of similarity between fuzzy sets has been examined by Chen [32], Chen, et al., [33], Hyung et al. [34], Pappis and Karacapilidis [35] and Wang [36]. It is also a powerful instrument in building multi-criteria decision-making techniques in numerous regions, for example, therapeutic diagnosis, design acknowledgment, grouping investigation, decision making, etc. But these strategies are not fit for managing the similarity measures including indeterminacy. In the literature, few investigations have studied to similarity measures for neutrosophic sets and single-valued neutrosophic sets [37-46].

Ye [47] present the distance-based similarity measure of single-valued neutrosophic sets and applied it to the group decision-making problems with single-valued neutrosophic data. Broumi and Smarandache [48] invent another similarity measure known as cosine similarity measure of interval-valued neutrosophic sets. Ye [49] further considered and found that there exist a few flaws in existing cosine similarity measure characterized in vector space [50] in certain circumstances. He [49] referenced that they may deliver an unreasonable outcome in some real cases. To conquer these problems, Ye [49] proposed improved cosine similarity measure dependent on cosine function, including single-valued neutrosophic cosine similarity measures and interval neutrosophic cosine similarity measures.

Working on the similarity measures Pramanik and Mondal [51] also present a cotangent similarity measure of rough neutrosophic sets and their application to the medical field. Pramanik and Mondal [52] also give tangent similarity measures between intuitionistic fuzzy sets and some of its properties and applications.

Smarandache [53] presented a new technique to deal with uncertainty. He generalized the soft set to hypersoft set by converting the function into a multi-decision function. In the same way, we convert hypersoft set to neutrosophic Hypersoft set to overcome the uncertainty problems. [54] introduced the TOPSIS by using accuracy function in his work and an application of MCDM is proposed. Application of fuzzy numbers in mobile selection in metros like Lahore is proposed by [55]. In medical the application of fuzzy numbers is proposed by Naveed et.al [56]. TOPSIS technique of MCDM can also be used for the prediction of games, and it's applied in FIFA 2018 by [57]. prediction of games is a very complex topic and this game is also predicted by [58]. Many researches presented theories along with application in neutrosophic environment [59-66].

1.1 Novelties

In this paper, we have continued the idea of intuitionistic tangent similarity measure to neutrosophic class. We have characterized another similarity measure known as Tangent similarity measure for neutrosophic Hypersoft set and its properties with the application.

2.Preliminaries

Definition 2.1: Neutrosophic Soft Set

Let Ů be the universal set and the set for respective attributes is given by Ë. Let P(Ů) be the set of Neutrosophic values of Ů and Ǻ ⊆ Ë. A pair (F, Ǻ) is called a Neutrosophic soft set over Ů and its mapping is given as

$$Ꞙ: Ǻ \to P(Ů)$$

Definition 2.2: Hyper Soft Set

Let Ů be the universal set and $P(\mathring{U})$ be the power set of Ů. Consider $p^1, p^2, p^3 \dots p^n$ for $n \geq 1$, be n well-defined attributes, whose corresponding attributive values are respectively the set $P^1, P^2, P^3 \dots P^n$ with $P^i \cap P^j = \emptyset$, for $i \neq j$ and $i, j \epsilon \{1,2,3 \dots n\}$, then the pair (₣, $P^1 \times P^2 \times P^3 \dots P^n$) is said to be Hypersoft set over Ů where

₣: $P^1 \times P^2 \times P^3 \dots P^n \rightarrow P(\mathring{U})$

Definition 2.3: Neutrosophic Hypersoft Set

Let Ů be the universal set and $P(\mathring{U})$ be the power set of Ů. Consider $p^1, p^2, p^3 \dots p^n$ for $n \geq 1$, be n well-defined attributes, whose corresponding attributive values are respectively the set $P^1, P^2, P^3 \dots P^n$ with $P^i \cap P^j = \emptyset$, for $i \neq j$ and $i, j \epsilon \{1,2,3 \dots n\}$ and their relation $P^1 \times P^2 \times P^3 \dots P^n =$ ß, then the pair (₣, ß) is said to be Neutrosophic Hypersoft set (NHSS) over Ů where

₣: $P^1 \times P^2 \times P^3 \dots P^n \rightarrow P(\mathring{U})$ and

₣$(P^1 \times P^2 \times P^3 \dots P^n) = \{< x, T(₣(ß)), I(₣(ß)), F(₣(ß)) >, x \in \mathring{U}\}$ where T is the membership value of truthiness, I is the membership value of indeterminacy and F is the membership value of falsity such that $T, I, F: \mathring{U} \rightarrow [0,1]$ also $0 \leq T(₣(ß)) + I(₣(ß)) + F(₣(ß)) \leq 3$.

3. Calculations

Definition 3.1: Single valued Neutrosophic Hypersoft Set

Let Ů be the universal set and $P(\mathring{U})$ be the power set of Ů. Consider $p^1, p^2, p^3 \dots p^n$ for $n \geq 1$, be n well-defined attributes, whose corresponding attributive values are respectively the set $P^1, P^2, P^3 \dots P^n$ with $P^i \cap P^j = \emptyset$, for $i \neq j$ and $i, j \epsilon \{1,2,3 \dots n\}$ and their relation $P^1 \times P^2 \times P^3 \dots P^n =$ ß, then the pair (₣, ß) is said to be Single valued Neutrosophic Hypersoft set (SVNHSS) over Ů where

₣: $P^1 \times P^2 \times P^3 \dots P^n \rightarrow P(\mathring{U})$ and this mapping to $P(\mathring{U})$ is single-valued.

₣$(P^1 \times P^2 \times P^3 \dots P^n) = \{< x, T(₣(ß)), I(₣(ß)), F(₣(ß)) >, x \in \mathring{U}\}$ where T is the membership value of truthiness, I is the membership value of indeterminacy and F is the membership value of falsity such that $T, I, F: \mathring{U} \rightarrow [0,1]$ also $0 \leq T(₣(ß)) + I(₣(ß)) + F(₣(ß)) \leq 3$.

Example 3.1:

Let ξ be the set of doctors under consideration given as

$$\xi = \{d^1, d^2, d^3, d^4, d^5\}$$

also consider the set of attributes as

$$l^1 = Qualification, l^2 = Experience, l^3 = Gender, l^4 = Skills$$

And their respective attributes are given as

$L^1 = Qualification$

$= \{MBBS, MS\ diploma, Diploma\ of\ national\ board(DNB), Diploma\ in\ clinical\ research(DCR)\}$

$L^2 = Experience = \{5yr, 8yr, 10yr, 15yr\}$

$L^3 = Gender = \{Male, Female\}$

$L^4 = Skills = \{Compassionate, Problem\ solving, Communicative, leadership\}$

Let the function be ₣: $L^1 \times L^2 \times L^3 \times L^4 \rightarrow P(\xi)$

Below are the tables of their Neutrosophic values from different decision makers

Table 1: Decision maker Neutrosophic values for Qualification

$L^1(Qualification)$	d^1	d^2	d^3	d^4	d^5
MBBS	(0.4, 0.5, 0.8)	(0.7, 0.6, 0.4)	(0.4, 0.5, 0.7)	(0.5, 0.3, 0.7)	(0.5, 0.3, 0.8)
MS diploma	(0.5, 0.3, 0.6)	(0.3, 0.2, 0.1)	(0.3, 0.6, 0.2)	(0.7, 0.3, 0.6)	(0.5, 0.4, 0.5)
DNB	(0.8, 0.2, 0.4)	(0.9, 0.5, 0.3)	(0.9, 0.4, 0.1)	(0.6, 0.3, 0.2)	(0.6, 0.1, 0.2)
DCR	(0.9, 0.3, 0.1)	(0.5, 0.2, 0.1)	(0.8, 0.5, 0.2)	(0.8, 0.2, 0.1)	(0.7, 0.4, 0.2)

Table 2: Decision maker Neutrosophic values for Experience

$L^2(Experience)$	d^1	d^2	d^3	d^4	d^5
5 yr.	(0.3, 0.4, 0.7)	(0.6, 0.5, 0.3)	(0.5, 0.6, 0.8)	(0.6, 0.4, 0.8)	(0.3, 0.6, 0.7)
8 yr.	(0.4, 0.2, 0.5)	(0.8, 0.1, 0.2)	(0.4, 0.7, 0.3)	(0.4, 0.8, 0.7)	(0.7, 0.5, 0.6)
10 yr.	(0.7, 0.2, 0.3)	(0.9, 0.3, 0.1)	(0.8, 0.3, 0.2)	(0.5, 0.4, 0.3)	(0.5, 0.2, 0.1)
15 yr.	(0.8, 0.2, 0.1)	(0.6, 0.4, 0.3)	(0.9 0.4, 0.1)	(0.6, 0.2, 0.3)	(0.5, 0.3, 0.2)

Table 3: Decision maker Neutrosophic values for Gender

$L^3(Gender)$	d^1	d^2	d^3	d^4	d^5
Male	(0.5, 0.6, 0.9)	(0.7, 0.8, 0.3)	(0.6, 0.4, 0.3)	(0.8, 0.5, 0.4)	(0.9, 0.2, 0.1)
Female	(0.6, 0.4, 0.7)	(0.3, 0.6, 0.4)	(0.8, 0.2, 0.1)	(0.4, 0.5, 0.6)	(0.8, 0.4, 0.2)

Table 4: Decision maker Neutrosophic values for Skills

$L^4(Skills)$	d^1	d^2	d^3	d^4	d^5
Compassionate	(0.6, 0.4, 0.5)	(0.7, 0.5, 0.3)	(0.6, 0.4, 0.3)	(0.6, 0.2, 0.1)	(0.4, 0.5, 0.3)
Problem solving	(0.8, 0.2, 0.4)	(0.7, 0.3, 0.2)	(0.8, 0.3, 0.1)	(0.3, 0.4, 0.5)	(0.3, 0.5, 0.8)
Communicative	(0.5, 0.3, 0.4)	(0.6, 0.3, 0.4)	(0.5, 0.7, 0.2)	(0.8, 0.4, 0.1)	(0.7, 0.4, 0.3)
Leadership	(0.4, 0.9, 0.6)	(0.8, 0.4, 0.2)	(0.2, 0.6, 0.5)	(0.7, 0.5, 0.2)	(0.6, 0.4, 0.7)

Single valued neutrosophic hypersoft set is define as $₣: (L^1 \times L^2 \times L^3 \times L^4) \rightarrow P(\xi)$

Let's assume $₣(£) = ₣(DNB, 10\ yr, male, compassionate) = \{d^1\}$

Then the single-valued neutrosophic hypersoft set of above-assumed relation is

$₣(£) = ₣(DNB, 10\ yr, male, compassionate) = \{$

$\ll d^1, (DNB\{0.8, 0.2, 0.4\}, 10\ yr\{0.7, 0.2, 0.3\}, male\{0.5, 0.6, 0.9\}, compassionate\{0.6, 0.4, 0.5\}) \gg\}$

Its tabular form is given as

Table 5: Tabular Representation of Single Valued Neutrosophic Hypersoft Set

$₣(£) = ₣(\boldsymbol{DNB}, \mathbf{10}\ \boldsymbol{yr}, \boldsymbol{male}, \boldsymbol{compassionate})$	$\boldsymbol{d^1}$
DNB	(0.8, 0.2, 0.4)
10 yr.	(0.7, 0.2, 0.3)
Male	(0.5, 0.6, 0.9)
Compassionate	(0.6, 0.4, 0.5)

Definition 3.2: Multi-valued Neutrosophic Hypersoft Set

Let Ů be the universal set and $P(\mathring{U})$ be the power set of Ů. Consider $p^1, p^2, p^3 \dots p^n$ for $n \geq 1$, be n well-defined attributes, whose corresponding attributive values are respectively the set $P^1, P^2, P^3 \dots P^n$ with $P^i \cap P^j = \emptyset$, for $i \neq j$ and $i, j \epsilon \{1,2,3 \dots n\}$ and their relation $P^1 \times P^2 \times P^3 \dots P^n = ß$, then the pair (Ŧ, ß) is said to be Single valued Neutrosophic Hypersoft set (SVNHSS) over Ů where

Ŧ: $P^1 \times P^2 \times P^3 \dots P^n \rightarrow P(\mathring{U})$ and this mapping to $P(\mathring{U})$ is multi-valued.

Ŧ$(P^1 \times P^2 \times P^3 \dots P^n) = \{< x, T(Ŧ(ß)), I(Ŧ(ß)), F(Ŧ(ß)) >, x \in \mathring{U}\}$ where T is the membership value of truthiness, I is the membership value of indeterminacy and F is the membership value of falsity such that $T, I, F: \mathring{U} \rightarrow [0,1]$ also $0 \leq T(Ŧ(ß)) + I(Ŧ(ß)) + F(Ŧ(ß)) \leq 3$.

Example 3.2:

Let ξ be the set of doctors under consideration given as $\xi = \{d^1, d^2, d^3, d^4, d^5\}$

also consider the set of attributes as

$$l^1 = Qualification, l^2 = Experience, l^3 = Gender, l^4 = Skills$$

And their respective attributes are given as

$L^1 = Qualification$

$= \{MBBS, MS\ diploma, Diploma\ of\ national\ board(DNB), Diploma\ in\ clinical\ research(DCR)\}$

$L^2 = Experience = \{5yr, 8yr, 10yr, 15yr\}$

$L^3 = Gender = \{Male, Female\}$

$L^4 = Skills = \{Compassionate, Problem\ solving, Communicative, leadership\}$

Let the function be Ŧ: $L^1 \times L^2 \times L^3 \times L^4 \rightarrow P(\xi)$

Below are the tables of their Neutrosophic values from different decision makers

Table 6: Decision maker Neutrosophic values for Qualification

$L^1(Qualification)$	d^1	d^2	d^3	d^4	d^5
MBBS	(0.4, 0.5, 0.8)	(0.7, 0.6, 0.4)	(0.4, 0.5, 0.7)	(0.5, 0.3, 0.7)	(0.5, 0.3, 0.8)
MS diploma	(0.5, 0.3, 0.6)	(0.3, 0.2, 0.1)	(0.3, 0.6, 0.2)	(0.7, 0.3, 0.6)	(0.5, 0.4, 0.5)
DNB	(0.8, 0.2, 0.4)	(0.9, 0.5, 0.3)	(0.9, 0.4, 0.1)	(0.6, 0.3, 0.2)	(0.6, 0.1, 0.2)
DCR	(0.9, 0.3, 0.1)	(0.5, 0.2, 0.1)	(0.8, 0.5, 0.2)	(0.8, 0.2, 0.1)	(0.7, 0.4, 0.2)

Table 7: Decision maker Neutrosophic values for Experience

$L^2(Experience)$	d^1	d^2	d^3	d^4	d^5
5 yr.	(0.3, 0.4, 0.7)	(0.6, 0.5, 0.3)	(0.5, 0.6, 0.8)	(0.6, 0.4, 0.8)	(0.3, 0.6, 0.7)
8 yr.	(0.4, 0.2, 0.5)	(0.8, 0.1, 0.2)	(0.4, 0.7, 0.3)	(0.4, 0.8, 0.7)	(0.7, 0.5, 0.6)
10 yr.	(0.7, 0.2, 0.3)	(0.9, 0.3, 0.1)	(0.8, 0.3, 0.2)	(0.5, 0.4, 0.3)	(0.5, 0.2, 0.1)
15 yr.	(0.8, 0.2, 0.1)	(0.6, 0.4, 0.3)	(0.9 0.4, 0.1)	(0.6, 0.2, 0.3)	(0.5, 0.3, 0.2)

Table 8: Decision maker Neutrosophic values for Gender

$L^3(Gender)$	d^1	d^2	d^3	d^4	d^5
Male	(0.5, 0.6, 0.9)	(0.7, 0.8, 0.3)	(0.6, 0.4, 0.3)	(0.8, 0.5, 0.4)	(0.9, 0.2, 0.1)
Female	(0.6, 0.4, 0.7)	(0.3, 0.6, 0.4)	(0.8, 0.2, 0.1)	(0.4, 0.5, 0.6)	(0.8, 0.4, 0.2)

Table 9: Decision maker Neutrosophic values for Skills

$L^4(Skills)$	d^1	d^2	d^3	d^4	d^5
Compassionate	(0.6, 0.4, 0.5)	(0.7, 0.5, 0.3)	(0.6, 0.4, 0.3)	(0.6, 0.2, 0.1)	(0.4, 0.5, 0.3)
Problem solving	(0.8, 0.2, 0.4)	(0.7, 0.3, 0.2)	(0.8, 0.3, 0.1)	(0.3, 0.4, 0.5)	(0.3, 0.5, 0.8)
Communicative	(0.5, 0.3, 0.4)	(0.6, 0.3, 0.4)	(0.5, 0.7, 0.2)	(0.8, 0.4, 0.1)	(0.7, 0.4, 0.3)
Leadership	(0.4, 0.9, 0.6)	(0.8, 0.4, 0.2)	(0.2, 0.6, 0.5)	(0.7, 0.5, 0.2)	(0.6, 0.4, 0.7)

Multi-valued neutrosophic hyper soft set is define as

$$₣: (L^1 \times L^2 \times L^3 \times L^4) \rightarrow P(\xi)$$

Let's assume $₣(£) = ₣(DNB, 10\ yr, male, compassionate) = \{d^1, d^4\}$

Then multi-valued neutrosophic hyper soft set of above assumed relation is

$₣(£) = ₣(DNB, 10\ yr, male, compassionate) = \{$

$\ll d^1, (DNB\{0.8, 0.2, 0.4\}, 10\ yr\{0.7, 0.2, 0.3\}, male\{0.5, 0.6, 0.9\}, compassionate\{0.6, 0.4, 0.5\}) \gg,$

$\ll d^4(DNB\{0.6, 0.3, 0.2\}, 10\ yr\{0.5, 0.4, 0.3\}, male\{0.8, 0.5, 0.4\}, compassionate\{0.6, 0.2, 0.1\}) \gg\}$

Its tabular form is given as

Table 10: Tabular Representation of Multi-valued Neutrosophic Hypersoft Set

$₣(£) = ₣(DNB, 10\ yr, male, compassionate)$	d^1	d^4
DNB	(0.8, 0.2, 0.4)	(0.6, 0.3, 0.2)
10 yr.	(0.7, 0.2, 0.3)	(0.5, 0.4, 0.3)
Male	(0.5, 0.6, 0.9)	(0.8, 0.5, 0.4)
Compassionate	(0.6, 0.4, 0.5)	(0.6, 0.2, 0.1)

3.3: Tangent similarity measures for single valued neutrosophic hypersoft set

Let $Ŕ =< x, T^{Ŕ}(₣(ß)), I^{Ŕ}(₣(ß)), F^{Ŕ}(₣(ß)) >$ and $Ś =< x, T^{Ś}(₣(ß)), I^{Ś}(₣(ß)), F^{Ś}(₣(ß)) >$ be two single valued neutrosophic hypersoft set(SVNHSS) for $₣(ß)$. Tangent similarity measure for these sets to measure the similarity between them is presented as

$$T_{SVNHSS}(Ŕ, Ś) =< x, \frac{1}{n}\sum_{i=1}^{n}\left[1 - \tan\left(\frac{\pi\left(\left|T^{Ŕ}(₣(ß)_i) - T^{Ś}(₣(ß)_i)\right| + \left|I^{Ŕ}(₣(ß)_i) - I^{Ś}(₣(ß)_i)\right| + \left|F^{Ŕ}(₣(ß)_i) - F^{Ś}(₣(ß)_i)\right|\right)}{12}\right)\right] > \quad, \quad x \in ₣(ß)$$

3.3.1: Proposition

Tangent similarity measure between two single valued Neutrosophic hypersoft set $T_{SVNHSS}(Ŕ, Ś)$ satisfies the following properties.

1. $0 \leq T_{SVNHSS}(Ŕ, Ś) \leq 1$
2. $T_{SVNHSS}(Ŕ, Ś) = 1\ if\ and\ only\ if\ Ŕ = Ś$
3. $T_{SVNHSS}(Ŕ, Ś) = T_{SVNHSS}(Ś, Ŕ)$
4. If $Ő$ is a SVNHSS and $Ŕ \subset Ś \subset Ő$ then $T_{SVNHSS}(Ŕ, Ő) \leq T_{SVNHSS}(Ŕ, Ś)$ and $T_{SVNHSS}(Ŕ, Ő) \leq T_{SVNHSS}(Ś, Ő)$.

It is easy to see that the define similarity measure satisfies the above properties easily so the proofs are left for the reader.

3.4: Decision making using single-valued neutrosophic hypersoft set based on the tangent similarity measure

Let $L^1, L^2, L^3 \dots L^n$ be the distinct set of participants, $M^1, M^2, M^3 \dots M^n$ by the set of norms for participants and $N^1, N^2, N^3 \dots N^n$ be the set of options for each participant. By using a decision-making technique, the decision-makers add ranking of options concerning each participant. This ranking gives the effectiveness of participants L against the norms of participants M then theses values associated with the options for multiple attribute decision making. Algorithm of this procedure are given below

3.4.1: Algorithm

Step 1: Determine the association between participants and the norms.

The association between participants and the norms is given by the below decision matrix in terms of single-valued Neutrosophic hyper soft sets.

Table 21: Association between participants and the norms in term of SVNHSS

	M^1	M^2	…	M^n
L^1	$\langle T_{11}, I_{11}, F_{11} \rangle$	$\langle T_{12}, I_{12}, F_{12} \rangle$	…	$\langle T_{1n}, I_{1n}, F_{1n} \rangle$
L^2	$\langle T_{21}, I_{21}, F_{21} \rangle$	$\langle T_{22}, I_{22}, F_{22} \rangle$	…	$\langle T_{2n}, I_{2n}, F_{2n} \rangle$
…	…	…	…	…
L^m	$\langle T_{m1}, I_{m1}, F_{m1} \rangle$	$\langle T_{m2}, I_{m2}, F_{m2} \rangle$	…	$\langle T_{mn}, I_{mn}, F_{mn} \rangle$

Step 2: Determine the association between norms and options.

The association between the norms and the options is given by the below decision matrix in terms of single-valued Neutrosophic hypersoft sets.

Table 22: Association between the norms and the options in term of SVNHSS

	N^1	N^2	…	N^k
M^1	$\langle T_{11}, I_{11}, F_{11} \rangle$	$\langle T_{12}, I_{12}, F_{12} \rangle$	…	$\langle T_{1k}, I_{1k}, F_{1k} \rangle$
M^2	$\langle T_{21}, I_{21}, F_{21} \rangle$	$\langle T_{22}, I_{22}, F_{22} \rangle$	…	$\langle T_{2k}, I_{2k}, F_{2k} \rangle$
…	…	…	…	…
M^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: Determine the association between participants and options.

The association between participants and the options is determined with the help of tangent similarity measures for single-valued neutrosophic hypersoft numbers.

Step 4: Decision of best option

The best option is decided by arranging the results in the descending orders and choosing the highest value as the highest value represents the best option for the participants.

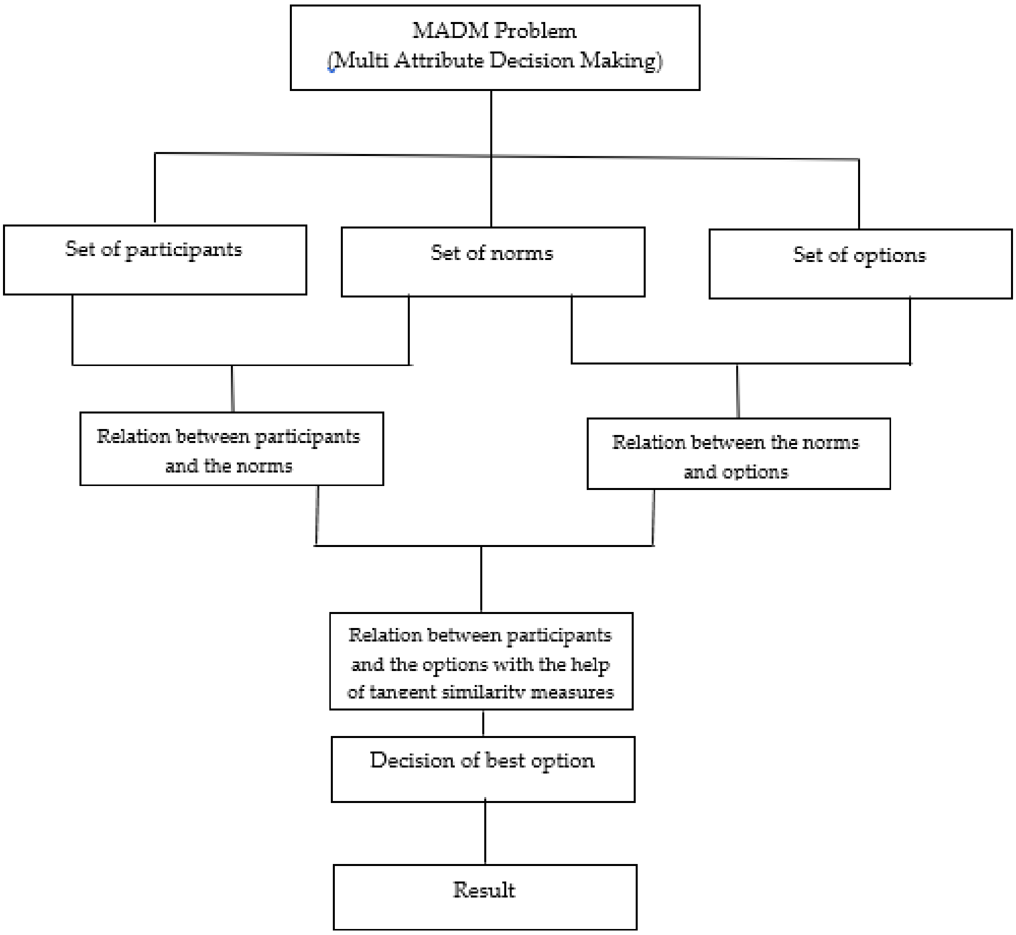

Figure 1: Algorithm design for the proposed technique

4. Example

We have seen a large number of the matches that a team loses because of improper selection of players. we can't choose which player is perfect for which sort of matches like the test, ODI and T20 due to the presence of the huge amount of uncertainties and a large volume of information about the players. With such a piece of vast information, we are unable to focus on every aspect because we may have the cases in which we have the same truth membership, indeterminate membership, and falsity membership values.

To overcome this issue, let us consider an illustrative example by using proposed method for the selection of the players in any type of match which is significant for cricket board as cricket board is the administering body for cricket in the state and the selection of cricket crew is likewise a key duty of cricket board. For this purpose, let us consider two sets, μ, and η. μ be the set of players and η be the set of type of matches played by players i.e.

$\mu = \{ P^1, P^2, P^3, P^4, P^5, P^6, P^7, P^8, P^9, P^{10}, P^{11}, P^{12}, P^{13}\}$ and

$\eta = \{\text{Test match, ODI match, T20 match}\}$.

ζ be the set of attributes corresponding to μ and η.

$$\zeta^1 = Players\ Strike\ Rate, \zeta^2 = Players\ Average, \zeta^3 = Players\ Economy, \zeta^4 = Players\ attitude,$$
$$\zeta^5 = Players\ Fitness\ \ test$$

And respective attributes for the above-mentioned attributes are given as

$$ς^1 = Players\ Strike\ Rate(PSR) = \{below\ 40\ , 40-60, 60-80, 80-100, 100-150, 150\ above\}$$

$$ς^2 = Players\ Average(PAv) = \{below\ 30, 30-50, 50-70, 70\ above\}$$

$$ς^3 = Players\ Economy(PE) = \{below\ 3, 3-7, 7-13, above\ 13\}$$

$$ς^4 = Players\ attitude(PA) = \{coperative, rude, emotional, moody\}$$

$$ς^5 = Players\ Fitness\ \ test(PFT) = \{passed, not\ passed\}$$

Then Neutrosophic Hypersoft set is given as

$$₣: (ς^1 \times ς^2 \times ς^3 \times ς^4 \times ς^5) \rightarrow P(\mu)$$

And $₣: (ς^1 \times ς^2 \times ς^3 \times ς^4 \times ς^5) \rightarrow P(\eta)$

Let's assume $₣(\alpha) = ₣(100-150, 30-50, above\ 13, cooperative, passed) = \{P^1, P^3, P^6, P^8, P^9\}$ and

$$₣(\beta) = ₣(100-150, 30-50, above\ 13, cooperative, passed) = \{\text{Test match, ODI match, T20 match}\}$$

Now using the proposed tangent similarity measures for single-valued neutrosophic hypersoft sets, we will decide which player is best for which type of match. For this purpose first we will provide ranking between $\{100-150, 30-50, above\ 13, cooperative, passed\}$ and $\{P^1, P^3, P^6, P^8, P^9\}$ in terms of the single-valued neutrosophic hypersoft sets. In the 2nd step we will provide ranking between $\{100-150, 30-50, above\ 13, cooperative, passed\}$ and $\{\text{Test match, ODI match, T20 match}\}$. In the 3rd step, we will find a correlation between $\{P^1, P^3, P^6, P^8, P^9\}$ and $\{\text{Test match, ODI match, T20 match}\}$ using T_{SVNHSS}. In the last step, we will decide by arranging the results in the descending order and selecting the highest value.

Step 1: Determine the association between $\{\mathbf{P^1, P^3, P^6, P^8, P^9}\}$ and $\{\mathbf{100-150, 30-50, above\ 13, coperative, passed}\}$.

The association between $\{100-150, 30-50, above\ 13, cooperative, passed\}$ and $\{P^1, P^3, P^6, P^8, P^9\}$ is given by the below decision matrix in terms of single-valued Neutrosophic hypersoft sets.

Table 13: Association between $\{P^1, P^3, P^6, P^8, P^9\}$ and $\{100-150, 30-50, above\ 13, coperative, passed\}$ in term of SVNHSS

	$\mathbf{100-150(PSR)}$	$\mathbf{30-50(PAv)}$	$\boldsymbol{Above\ 13(PE)}$	$\boldsymbol{Cooperative\ (PA)}$	$\boldsymbol{Passed\ (PFT)}$
P^1	(0.7,0.3,0,2)	(0.4, 0.5, 0.7)	(0.5, 0.3, 0.8)	(0.7, 0.6, 0.4)	(0.5, 0.3, 0.7)
P^3	(0.5,0.4,0.7)	(0.3, 0.6, 0.2)	(0.5, 0.4, 0.5)	(0.3, 0.2, 0.1)	(0.7, 0.3, 0.6)
P^6	(0.8,0.2,0.1)	(0.9, 0.4, 0.1)	(0.6, 0.1, 0.2)	(0.9, 0.5, 0.3)	(0.6, 0.3, 0.2)
P^8	(0.9,0.1,0.3)	(0.8, 0.5, 0.2)	(0.7, 0.4, 0.2)	(0.5, 0.2, 0.1)	(0.8, 0.2, 0.1)
P^9	(0.6,0.3,0.3)	(0.5, 0.4, 0.3)	(0.8, 0.3, 0.2)	(0.9, 0.2, 0.1)	(0.4, 0.5, 0.7)

Step 2: Determine the association between $\{\mathbf{Test\ match, ODI\ match, T20\ match}\}$ and $\{\mathbf{100-150, 30-50}, \boldsymbol{above\ 13, coperative, passed}\}$.

The association between $\{100-150, 30-50, above\ 13, cooperative, passed\}$ and $\{\text{Test match, ODI match, T20 match}\}$ is given by the below decision matrix in terms of single-valued Neutrosophic hypersoft sets.

Table 14: Association between $\{100-150, 30-50, above\ 13, coperative, passed\}$ and $\{Test\ match, ODI\ match, T20\ match\}$ in term of SVNHSS

	$Test\ match$	$ODI\ match$	$T20\ match$
$100-150(PSR)$	(0.7, 0.5, 0.3)	(0.6, 0.4, 0.3)	(0.4, 0.5, 0.3)
$30-50(PAv)$	(0.7, 0.3, 0.2)	(0.8, 0.3, 0.1)	(0.3, 0.5, 0.8)
$Above\ 13(PE)$	(0.6, 0.3, 0.4)	(0.5, 0.7, 0.2)	(0.7, 0.4, 0.3)
$Cooperative\ (PA)$	(0.5, 0.4, 0.5)	(0.9, 0.2, 0.1)	(0.5, 0.2, 0.1)
$Passed\ (PFT)$	(0.6, 0.4, 0.7)	(0.3, 0.6, 0.4)	(0.8, 0.2, 0.1)

Step 3: Determine the association between $\{\mathbf{Test\ match}, \mathbf{ODI\ match}, \mathbf{T20\ match}\}$ and $\{\boldsymbol{P^1}, \boldsymbol{P^3}, \boldsymbol{P^6}, \boldsymbol{P^8}, \boldsymbol{P^9}\}$.

The association between $\{P^1, P^3, P^6, P^8, P^9\}$ and $\{\text{Test match}, \text{ODI match}, \text{T20 match}\}$ is determined with the help of tangent similarity measures for single-valued neutrosophic hypersoft numbers.

Table 14: Association between $\{P^1, P^3, P^6, P^8, P^9\}$ and $\{Test\ match, ODI\ match, T20\ match\}$ using tangent similarity measure for SVNHSS

	$Test\ match$	$ODI\ match$	$T20\ match$
P^1	**0.8728**	0.7752	0.8137
P^3	0.8513	0.8143	**0.8627**
P^6	**0.8786**	0.8519	0.7798
P^8	0.8463	0.8402	**0.8875**
P^9	0.8729	**0.8997**	0.8289

Step 4: Decision of best option

The best option is decided by choosing the highest value as the highest value represents the best match type for the players. The table shows that player P^1 should be selected for a test match, player P^3 should be selected for the T20 match, player P^6 should be selected for a test match, player P^8 should be selected for T20 match and player P^9 should be selected for ODI match.

5. Conclusions

Decision-making is a complex issue due to vague, imprecise and indeterminate environment specially, when attributes are more than one, and further bifurcated. Neutrosophic softset environment cannot be used to tackle such type of issues. Therefore, there was a dire need to define a new approach to solve such type of problems.

In this paper, we have proposed a single-valued Neutrosophic hypersoft set and multi-valued neutrosophic hypersoft set, then using a single-valued Neutrosophic hypersoft set we present a tangent similarity measure and some of its properties. We have also presented an application namely selection of cricket team players for any type of match based on multi-attribute decision making using tangent similarity measure. The concept of this paper is to make our decision more precise.

Acknowledgement

The authors are highly thankful to the Editor-in-chief and the referees for their valuable comments and suggestions for improving the quality of our paper.

Conflicts of Interest

The authors declare that they have no conflict of interest.

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Received: 15 Oct, 2019. Accepted 17 Mar, 2020