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# Aggregate Operators of Neutrosophic Hypersoft Set

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**Abstract:** Multi-criteria decision making (MCDM) is concerned about organizing and taking care of choice and planning issues including multi-criteria. 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, So, for this purpose a new environment namely, Neutrosophic Hypersoft set (NHSS) is defined. This paper includes basics operator's like union, intersection, complement, subset, null set, equal set etc., of Neutrosophic Hypersoft set (NHSS). The validity and the implementation are presented along with suitable examples. For more precision and accuracy, in future, proposed operations will play a vital role is decision-makings like personal selection, management problems and many others.

**Keywords:** MCDM, Uncertainty, Soft set, Neutrosophic soft set, Hyper soft set.

## 1. Introduction

The idea of fuzzy sets was presented by Lotfi A. Zadeh in 1965 [1]. From that point the fuzzy sets and fuzzy logic have been connected in numerous genuine issues in questionable and uncertain conditions. The conventional fuzzy sets are based on the membership value or the level of membership value. A few times it might be hard to allot the membership values for fuzzy sets. Therefore, the idea of interval valued fuzzy sets was proposed [2] to catch the uncertainty for membership values. In some genuine issues like real life problems, master framework, conviction framework, data combination, etc., we should consider membership just as the non- membership values for appropriate depiction of an object in questionable and uncertain condition. Neither the fuzzy sets nor the interval valued fuzzy sets is convenient for such a circumstance. Intuitionistic fuzzy sets proposed by Atanassov [3] is convenient for such a circumstance. The intuitionistic fuzzy sets can just deal with the inadequate data considering both the membership and non-membership values. It doesn't deal with the vague and conflicting data which exists in conviction framework.
Smarandache [4] presented the idea of Neutrosophic set which is a scientific apparatus for taking care of issues including uncertain, indeterminacy and conflicting information. Neutrosophic set indicate truth membership value (T), indeterminacy membership value (I) and falsity membership value (F). This idea is significant in numerous application regions since indeterminacy is evaluated exceptionally and the truth membership values, indeterminacy membership values and falsity membership values are independent.

The idea of soft sets was first defined by Molodtsov [5] as a totally new numerical device for taking care of issues with uncertain conditions. He defines a soft set as a parameterized family of subsets of universal set. Soft sets are useful in various regions including artificial insight, game hypothesis and basic decision-making problems [6] and it serves to define various functions for various parameters and utilize values against defined parameters. These functions help us to oversee various issues and choices throughout everyday life.

In the previous couple of years, the essentials of soft set theory have been considered by different researchers. Maji et al. [7] gives a hypothetical study of soft sets which covers subset and super set of a soft set, equality of soft sets and operations on soft sets, for Example, union, intersection, AND and OR-Operations between different sets. Ali at el. [8] presented new operations in soft set theory which includes restricted union, intersection and difference. Cagman and Enginoglu [9, 10] present soft matrix theory which substantiated itself a very significant measurement in taking care of issues while making various choices. Singh and Onyeozili [11] come up with the research that operations on soft set is equivalent to the corresponding soft matrices. From Molodsov [9, 6, 5, 12] up to present, numerous handy applications identified with soft set theory have been presented and connected in numerous fields of sciences and data innovation.

Maji [13] come up with Neutrosophic soft set portrayed by truth, indeterminacy, and falsity membership values which are autonomous in nature. Neutrosophic soft set can deal with inadequate, uncertain, and inconsistence data, while intuitionistic fuzzy soft set and fuzzy soft set can just deal with partial data.

Smarandache [14] presented a new technique to deal with uncertainty. He generalized the soft to hyper soft set by converting the function into multi-decision function. Smarandache, [15, 16, 17, 18, 19, 20] also discuss the various extension of neutrosophic sets in TOPSIS and MCDM. Saqlain *et.al*. [21] proposed a new algorithm along with a new decision-making environment. Many other novel approaches are also used by many researches [22-39] in decision makings.

### 1.1 Contribution

Since uncertainty is human sense which for the most part surrounds a man while taking any significant choice. Let's say if we get a chance to pick one best competitor out of numerous applicants, we originally set a few characteristics and choices that what we need in our chose up-and-comer. based on these objectives we choose the best one. To make our decision easy we use different techniques. The purpose of this paper is to overcome the uncertainty problem in more precise way by combing Neutrosophic set with Hypersoft set. This combination will produce a new mathematical tool "Neutrosophic Hypersoft Set" and will play a vital role in future decision-making research.

## 2.Preliminaries

**Definition 2.1: Soft Set**

Let ξ be the universal set and € be the set of attributes with respect to ξ. Let P(ξ) be the power set of ξ and Ą ⊆ € . A pair (F, Ą) is called a soft set over ξ and its mapping is given as

$$₣: Ą \rightarrow P(\xi)$$

It is also defined as:

$$(₣, Ą) = \{₣(e) \in P(\xi): e \in €, ₣(e) = \emptyset \; if \; e \neq Ą\}$$

**Definition 2.2: Neutrosophic Soft Set**

Let ξ be the universal set and € be the set of attributes with respect to ξ. Let P(ξ) be the set of Neutrosophic values of ξ and Ą ⊆ € . A pair (F, Ą) is called a Neutrosophic soft set over ξ and its mapping is given as

$$₣: Ą \rightarrow P(\xi)$$

**Definition 2.3: Hyper Soft Set:**

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

$$₣: L^1 \times L^2 \times L^3 \dots L^n \to P(\xi)$$

## 3. Calculations

**Definition 3.1: Neutrosophic Hypersoft Set (NHSS)**

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

$₣: L^1 \times L^2 \times L^3 \dots L^n \to P(\xi)$ and

$₣(L^1 \times L^2 \times L^3 \dots L^n) = \{< x, T(₣(\$)), I(₣(\$)), F(₣(\$)) >, x \in \xi\}$ 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 $T, I, F: \xi \to [0,1]$ also $0 \leq T(₣(\$)) + I(₣(\$)) + F(₣(\$)) \leq 3$.

**Example 3.1:**

Let ξ be the set of decision makers to decide best mobile phone given as

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

also consider the set of attributes as

$$s^1 = Mobile\ type, s^2 = RAM, s^3 = Sim\ Card, s^4 = Resolution, s^5 = Camera, s^6 = Battery\ Power$$

And their respective attributes are given as

$S^1 = Mobile\ type = \{Iphone, Samsung, Oppo, lenovo\}$

$S^2 = RAM = \{8\ GB, 4\ GB, 6\ GB, 2\ GB\}$

$S^3 = Sim\ Card = \{Single, Dual\}$

$S^4 = Resolution = \{1440 \times 3040\ pixels, 1080 \times 780\ pixels, 2600 \times 4010\ pixels\}$

$S^5 = Camera = \{12\ MP, 10MP, 15MP\}$

$S^6 = Battery\ Power = \{4100\ mAh, 1000\ mAh, 2050\ mAh\}$

Let the function be $₣: S^1 \times S^2 \times S^3 \times S^4 \times S^5 \times S^6 \to P(\xi)$

Below are the tables of their Neutrosophic values

**Table 1**: Decision maker Neutrosophic values for mobile type

| $S^1(Mobile\ type)$ | $m^1$ | $m^2$ | $m^3$ | $m^4$ | $m^5$ |
|---|---|---|---|---|---|
| Iphone | (0.3, 0.6, 0.7) | (0.7, 0.6, 0.4) | (0.4, 0.5, 0.7) | (0.6, 0.5, 0.3) | (0.5, 0.3, 0.8) |
| Samsung | (0.7, 0.5, 0.6) | (0.3, 0.2, 0.1) | (0.3, 0.6, 0.2) | (0.8, 0.1, 0.2) | (0.5, 0.4, 0.5) |
| Oppo | (0.5, 0.2, 0.1) | (0.9, 0.5, 0.3) | (0.9, 0.4, 0.1) | (0.9, 0.3, 0.1) | (0.6, 0.1, 0.2) |
| Lenovo | (0.5, 0.3, 0.2) | (0.5, 0.2, 0.1) | (0.8, 0.5, 0.2) | (0.6, 0.4, 0.3) | (0.7, 0.4, 0.2) |

Table 2: Decision maker Neutrosophic values for RAM

| $S^2(RAM)$ | $m^1$ | $m^2$ | $m^3$ | $m^4$ | $m^5$ |
|---|---|---|---|---|---|
| 8 GB | (0.3, 0.4, 0.7) | (0.4, 0.5, 0.7) | (0.5, 0.6, 0.8) | (0.5, 0.3, 0.8) | (0.3, 0.6, 0.7) |
| 4 GB | (0.4, 0.2, 0.5) | (0.3, 0.6, 0.2) | (0.4, 0.7, 0.3) | (0.5, 0.4, 0.5) | (0.7, 0.5, 0.6) |
| 6 GB | (0.7, 0.2, 0.3) | (0.9, 0.4, 0.1) | (0.8, 0.3, 0.2) | (0.6, 0.1, 0.2) | (0.5, 0.2, 0.1) |
| 2 GB | (0.8, 0.2, 0.1) | (0.8, 0.5, 0.2) | (0.9 0.4, 0.1) | (0.7, 0.4, 0.2) | (0.5, 0.3, 0.2) |

**Table 3:** Decision maker Neutrosophic values for sim card

| $S^3(Sim\ Card)$ | $m^1$ | $m^2$ | $m^3$ | $m^4$ | $m^5$ |
|---|---|---|---|---|---|
| Single | (0.6, 0.4, 0.3) | (0.6, 0.5, 0.3) | (0.5, 0.4, 0.3) | (0.7, 0.8, 0.3) | (0.9, 0.2, 0.1) |
| Dual | (0.8, 0.2, 0.1) | (0.4, 0.8, 0.7) | (0.7, 0.3, 0.2) | (0.3, 0.6, 0.4) | (0.8, 0.4, 0.2) |

Table 4: Decision maker Neutrosophic values for resolution

| $S^4(Resolution)$ | $m^1$ | $m^2$ | $m^3$ | $m^4$ | $m^5$ |
|---|---|---|---|---|---|
| $1440 \times 3040$ | (0.7, 0.8, 0.3) | (0.7, 0.5, 0.3) | (0.6, 0.4, 0.3) | (0.5, 0.6, 0.9) | (0.4, 0.5, 0.3) |
| $1080 \times 780$ | (0.3, 0.6, 0.4) | (0.7, 0.3, 0.2) | (0.8, 0.3, 0.1) | (0.6, 0.4, 0.7) | (0.3, 0.5, 0.8) |
| $2600 \times 4010$ | (0.5, 0.2, 0.1) | (0.6, 0.3, 0.4) | (0.5, 0.7, 0.2) | (0.9, 0.3, 0.1) | (0.7, 0.4, 0.3) |

Table 5: Decision maker Neutrosophic values for camera

| $S^5(Camera)$ | $m^1$ | $m^2$ | $m^3$ | $m^4$ | $m^5$ |
|---|---|---|---|---|---|
| 12 MP | (0.6, 0.4, 0.3) | (0.7, 0.8, 0.3) | (0.6, 0.4, 0.3) | (0.4, 0.5, 0.3) | (0.9, 0.2, 0.1) |
| 10 MP | (0.8, 0.3, 0.1) | (0.3, 0.6, 0.4) | (0.8, 0.2, 0.1) | (0.3, 0.5, 0.8) | (0.8, 0.4, 0.2) |
| 15 MP | (0.5, 0.7, 0.2) | (0.5, 0.2, 0.1) | (0.8, 0.5, 0.2) | (0.7, 0.4, 0.3) | (0.7, 0.4, 0.2) |

Table 6: Decision maker Neutrosophic values for battery power

| $S^6(Battery\ Power)$ | $m^1$ | $m^2$ | $m^3$ | $m^4$ | $m^5$ |
|---|---|---|---|---|---|
| 4100 mAh | (0.7, 0.8, 0.3) | (0.7, 0.6, 0.4) | (0.4, 0.5, 0.7) | (0.9, 0.2, 0.1) | (0.5, 0.3, 0.8) |
| 1000 mAh | (0.3, 0.6, 0.4) | (0.3, 0.2, 0.1) | (0.3, 0.6, 0.2) | (0.8, 0.4, 0.2) | (0.5, 0.4, 0.5) |
| 2050 mAh | (0.5, 0.2, 0.1) | (0.9, 0.5, 0.3) | (0.9, 0.4, 0.1) | (0.7, 0.4, 0.2) | (0.6, 0.1, 0.2) |

**Neutrosophic Hypersoft set is define as,**

$$₣: (S^1 \times S^2 \times S^3 \times S^4 \times S^5 \times S^6) \rightarrow P(\xi)$$

Let's assume $₣(\$) = ₣(samsung, 6\ GB, Dual) = \{m^1, m^4\}$

Then Neutrosophic Hypersoft set of above assumed relation is

$$₣(\$) = ₣(samsung, 6\ GB, Dual\ ) = \{$$
$$< m^1, (samsung\{0.7, 0.5, 0.6\}, 6\ GB\{0.7, 0.2, 0.3\}, Dual\{0.8,0.2,0.1\}) >$$
$$< m^4(samsung\{0.8,0.1,0.2\}, 6\ GB\{0.6, 0.1, 0.2\}, Dual\{0.3, 0.6,0.4\}) >\}$$

Its tabular form is given as

**Table 7**: Tabular Representation of Neutrosophic Hypersoft Set

| $₣(\$) = ₣(\boldsymbol{samsung}, \boldsymbol{6\ GB}, \boldsymbol{Dual}\ )$ | $\boldsymbol{m^1}$ | $\boldsymbol{m^4}$ |
|---|---|---|
| Samsung | (0.7,0.5, 0.6) | (0.8, 0.1, 0.2) |
| 6 GB | (0.7, 0.2, 0.3) | (0.6, 0.1, 0.2) |
| Dual | (0.8, 0.2, 0.1) | (0.3, 0.6, 0.4) |

**Definition 3.2: Neutrosophic Hypersoft Subset**

Let $₣(\$^1)$ and $₣(\$^2)$ be two Neutrosophic Hypersoft set over ξ. Consider $l^1, l^2, l^3 \dots l^n$ for $n \geq 1$, be $n$ well-defined attributes, whose corresponding attributive values are respectively the set $L^1, L^2, L^3 \dots L^n$ with $L^i \cap L^j = \emptyset$, for $i \neq j$ and $i, j \epsilon \{1,2,3 \dots n\}$ and their relation $L^1 \times L^2 \times L^3 \dots L^n = \$$ then $₣(\$^1)$ is the Neutrosophic Hypersoft subset of $₣(\$^2)$ if

$$T(₣(\$^1)) \leq T\big(₣(\$^2)\big)$$
$$I(₣(\$^1)) \leq I\big(₣(\$^2)\big)$$

$$F(₣(\$^1)) \geq F\big(₣(\$^2)\big)$$

**Numerical Example of Subset**

Consider the two NHSS $₣(\$^1)$ and NHSS $₣(\$^2)$ over the same universe $\xi = \{m^1, m^2, m^3, m^4, m^5\}$. The NHSS $₣(\$) = ₣(samsung, 6\ GB, Dual\ ) = \{m^1, m^4\}$ is the subset of NHSS $₣(\$^2) = ₣(Samsung, 6GB) = \{m^1\}$ if $T(₣(\$^1)) \leq T(₣(\$^2))$ , $I(₣(\$^1)) \leq I(₣(\$^2))$ , $F(₣(\$^1)) \geq F(₣(\$^2))$ . Its tabular form is given below

**Table 8:** Tabular Representation of NHSS $₣(\$^1)$

| $₣(\$^1) = ₣(\boldsymbol{samsung, 6\ GB, Dual}\ )$ | $\boldsymbol{m^1}$ | $\boldsymbol{m^4}$ |
|---|---|---|
| Samsung | (0.7,0.5, 0.6) | (0.8, 0.1, 0.2) |
| 6 GB | (0.7, 0.2, 0.3) | (0.6, 0.1, 0.2) |
| Dual | (0.8, 0.2, 0.1) | (0.3, 0.6, 0.4) |

**Table 9:** Tabular Representation of NHSS $₣(\$^2)$

| $₣(\$^2) = ₣(\boldsymbol{samsung, 6\ GB})$ | $\boldsymbol{m^1}$ |
|---|---|
| Samsung | (0.9, 0.6, 0.3) |
| 6 GB | (0.8, 0.4, 0.1) |

This can also be written as

$$₣(\$^1) \subset ₣(\$^2) = ₣(samsung, 6\ GB, Dual\ ) \subset ₣(samsung, 6\ GB)$$

$$= \left\{\begin{matrix} < m^1, (samsung\{0.7, 0.5, 0.6\}, 6\ GB\{0.7, 0.2, 0.3\}, Dual\{0.8,0.2,0.1\}) >, \\ < m^4(samsung\{0.8,0.1,0.2\}, 6\ GB\{0.6, 0.1, 0.2\}, Dual\{0.3, 0.6,0.4\}) > \end{matrix}\right\}$$

$$\subset \{< m^1, (samsung\{0.9, 0.6, 0.3\}, 6\ GB\{0.8, 0.4, 0.1\})>\}$$

Here we can see that membership value of Samsung for $m^1$ in both sets is $(0.7, 0.5, 0.6)$ and $(0.9, 0.6, 0.3)$ which satisfy the Definition of Neutrosophic Hypersoft subset as $0.7 < 0.9, 0.5 < 0.6$, and $0.6 > 0.3$. This shows that $(0.7, 0.5, 0.6) \subset (0.9, 0.6, 0.3)$ and same was the case with the rest of the attributes of NHSS $₣(\$^1)$ and NHSS $₣(\$^2)$.

**Definition 3.3: Neutrosophic Equal Hypersoft Set**

Let $₣(\$^1)$ and $₣(\$^2)$ be two Neutrosophic Hypersoft set over ξ. Consider $l^1, l^2, l^3 \ldots l^n$ for $n \geq 1$, be $n$ well-defined attributes, whose corresponding attributive values are respectively the set $L^1, L^2, L^3 \ldots L^n$ with $L^i \cap L^j = \emptyset$, for $i \neq j$ and $i, j \epsilon \{1,2,3 \ldots n\}$ and their relation $L^1 \times L^2 \times L^3 \ldots L^n = \$$ then $₣(\$^1)$ is the Neutrosophic equal Hypersoft subset of $₣(\$^2)$ if

$$T\big(₣(\$^1)\big) = T\big(₣(\$^2)\big)$$
$$I\big(₣(\$^1)\big) = I\big(₣(\$^2)\big)$$
$$F\big(₣(\$^1)\big) = F\big(₣(\$^2)\big)$$

**Numerical Example of Equal Neutrosophic Hypersoft Set**

Consider the two NHSS $₣(\$^1)$ and NHSS $₣(\$^2)$ over the same universe $\xi = \{m^1, m^2, m^3, m^4, m^5\}$.

The NHSS $₣(\$^1) = ₣(samsung, 6\ GB, Dual\ ) = \{m^1, m^4\}$ is the equal to NHSS $₣(\$^2) = ₣(samsung, 6\ GB) = \{m^1\}$ if $T(₣(\$^1)) = T(₣(\$^2))$ , $I(₣(\$^1)) = I(₣(\$^2))$ , $F(₣(\$^1)) = F(₣(\$^2))$. Its tabular form is given below

**Table 10:** Tabular Representation of NHSS $₣(\$^1)$

| $₣(\$^1) = ₣(samsung, 6\ GB, Dual\ )$ | $m^1$ | $m^4$ |
|---|---|---|
| Samsung | (0.7,0.5, 0.6) | (0.8, 0.1, 0.2) |
| 6 GB | (0.7, 0.2, 0.3) | (0.6, 0.1, 0.2) |
| Dual | (0.8, 0.2, 0.1) | (0.3, 0.6, 0.4) |

**Table 11:** Tabular Representation of NHSS $₣(\$^2)$

| $₣(\$^2) = ₣(\boldsymbol{samsung, 6\ GB})$ | $\boldsymbol{m^1}$ |
|---|---|
| Samsung | (0.7,0.5, 0.6) |
| 6 GB | (0.7, 0.2, 0.3) |

This can also be written as

$$\big(₣(\$^1) = ₣(\$^2)\big) = \big(₣(samsung, 6\ GB, Dual\ ) = ₣(samsung, 6\ GB)\big)$$
$$= \big((\{< m^1, (samsung\{0.7, 0.5, 0.6\}, 6\ GB\{0.7, 0.2, 0.3\}, Dual\{0.8,0.2,0.1\}) >,$$
$$< m^4(samsung\{0.8,0.1,0.2\}, 6\ GB\{0.6, 0.1, 0.2\}, Dual\{0.3, 0.6,0.4\}) >\}$$
$$= \{< m^1, (samsung\{0.7, 0.5, 0.6\}, 6\ GB\{0.7, 0.2, 0.3\}) >\})\big)$$

Here we can see that membership value of Samsung for $m^1$ in both sets is $(0.7, 0.5, 0.6)$ and $(0.7, 0.5, 0.6)$ which satisfy the Definition of Neutrosophic Equal Hypersoft set as $0.7 = 0.7, 0.5 = 0.5$ and $0.6 = 0.6$. This shows that $(0.7, 0.5, 0.6) = (0.7, 0.5, 0.6)$ and same was the case with the rest of the attributes of NHSS $₣(\$^1)$ and NHSS $₣(\$^2)$.

**Definition 3.4: Null Neutrosophic Hypersoft Set**

Let $₣(\$^1)$ be the Neutrosophic Hypersoft set over ξ. Consider $l^1, l^2, l^3 \dots l^n$ for $n \geq 1$, be $n$ well-defined attributes, whose corresponding attributive values are respectively the set $L^1, L^2, L^3 \dots L^n$ with $L^i \cap L^j = \emptyset$, for $i \neq j$ and $i, j \epsilon \{1,2,3 \dots n\}$ and their relation $L^1 \times L^2 \times L^3 \dots L^n = \$$ then $₣(\$^1)$ is Null Neutrosophic Hypersoft set if

$$T\big(₣(\$^1)\big) = 0$$
$$I\big(₣(\$^1)\big) = 0$$
$$F\big(₣(\$^1)\big) = 0$$

**Numerical Example of Null Neutrosophic Hypersoft Set**

Consider the NHSS $₣(\$^1)$ over the universe $\xi = \{m^1, m^2, m^3, m^4, m^5\}$. The NHSS $₣(\$^1) = ₣(samsung, 6\ GB, Dual\ ) = \{m^1, m^4\}$ is said to be null NHSS if its Neutrosophic values are 0. Its tabular form is given below

**Table 12:** Tabular Representation of NHSS $₣(\$^1)$

| $₣(\$^1) = ₣(samsung, 6\ GB, Dual\ )$ | $m^1$ | $m^4$ |
|---|---|---|
| Samsung | (0, 0, 0) | (0, 0, 0) |
| 6 GB | (0, 0, 0) | (0, 0, 0) |
| Dual | (0, 0, 0) | (0, 0, 0) |

This can also be written as

$$₣(\$^1) = ₣(samsung, 6\ GB, Dual\ )$$
$$= \{< m^1, (samsung\{0, 0, 0\}, 6\ GB\{0, 0, 0\}, Dual\{0,0,0\}) >,$$
$$< m^4(samsung\{0,0,0\}, 6\ GB\{0, 0, 0\}, Dual\{0, 0,0\}) >\}$$

**Definition 3.5: Compliment of Neutrosophic Hypersoft Set**

Let $Ꞙ(\$^1)$ be the Neutrosophic Hypersoft set over ξ. Consider $l^1, l^2, l^3 \dots l^n$ for $n \geq 1$, be $n$ well-defined attributes, whose corresponding attributive values are respectively the set $L^1, L^2, L^3 \dots L^n$ with $L^i \cap L^j = \emptyset$, for $i \neq j$ and $i, j\epsilon\{1,2,3 \dots n\}$ and their relation $L^1 \times L^2 \times L^3 \dots L^n = \$$ then $Ꞙ^c(\$^1)$ is the Compliment of Neutrosophic Hypersoft set of $Ꞙ(\$^1)$ if

$$Ꞙ^c(\$^1): (\neg L^1 \times \neg L^2 \times \neg L^3 \dots \neg L^n) \rightarrow P(\xi)$$

Such that

$$T^C(Ꞙ(\$^1)) = F(Ꞙ(\$^1))$$
$$I^C(Ꞙ(\$^1)) = I(Ꞙ(\$^1))$$
$$F^C(Ꞙ(\$^1)) = T(Ꞙ(\$^1))$$

**Numerical Example of Compliment of NHSS**

Consider the NHSS $Ꞙ(\$^1)$ over the universe $ξ = \{m^1, m^2, m^3, m^4, m^5\}$. The compliment of NHSS $Ꞙ(\$^1) = Ꞙ(samsung, 6\ GB, Dual\ ) = \{m^1, m^4\}$ is given as $T^C(Ꞙ(\$^1)) = F(Ꞙ(\$^1))$ , $I^C(Ꞙ(\$^1)) = I(Ꞙ(\$^1))$, $F^C(Ꞙ(\$^1)) = T(Ꞙ(\$^1))$.Its tabular form is given below

**Table 13**: Tabular Representation of NHSS $Ꞙ(\$^1)$

| $Ꞙ^C(\$^1) = Ꞙ(Not\ samsung, Not\ 6\ GB, Not\ Dual\ )$ | $m^1$ | $m^4$ |
|---|---|---|
| Not Samsung | (0.6, 0.5, 0.7) | (0.2, 0.1, 0.8) |
| Not 6 GB | (0.3, 0.2, 0.7) | (0.2, 0.1, 0.6) |
| Not Dual | (0.1, 0.2, 0.8) | (0.4, 0.6, 0.3) |

This can also be written as

$$Ꞙ^c(\$^1) = Ꞙ(\ not\ samsung, not\ 6\ GB, not\ Dual\ )$$
$$= \{< m^1, (not\ samsung\{0.6, 0.5, 0.7\}, not\ 6\ GB\{0.3, 0.2, 0.7\}, not\ Dual\{0.1,0.2,0.8\}) >,$$
$$< m^4(not\ samsung\{0.2,0.1,0.8\}, not\ 6\ GB\{0.2, 0.1, 0.6\}, not\ Dual\{0.4, 0.6,0.3\}) >\}$$

Here we can see that membership value of Samsung for $m^1$ in $Ꞙ(\$^1)$ is $(0.7, 0.5, 0.6)$ and its compliment is $(0.6, 0.5, 0.7)$ which satisfy the Definition of compliment of Neutrosophic Hypersoft set. This shows that $(0.6, 0.5, 0.7)$ is the compliment of $(0.7, 0.5, 0.6)$ and same was the case with the rest of the attributes of NHSS $Ꞙ(\$^1)$.

**Definition 3.6: Union of Two Neutrosophic Hypersoft Set**

Let $Ꞙ(\$^1)$ and $Ꞙ(\$^2)$ be two Neutrosophic Hypersoft set over ξ. Consider $l^1, l^2, l^3 \dots l^n$ for $n \geq 1$, be $n$ well-defined attributes, whose corresponding attributive values are respectively the set $L^1, L^2, L^3 \dots L^n$ with $L^i \cap L^j = \emptyset$, for $i \neq j$ and $i, j\epsilon\{1,2,3 \dots n\}$ and their relation $L^1 \times L^2 \times L^3 \dots L^n = \$$ then $Ꞙ(\$^1) \cup Ꞙ(\$^2)$ is given as

$$T\big(Ꞙ(\$^1) \cup Ꞙ(\$^2)\big) = \begin{cases} T\big(Ꞙ(\$^1)\big) & if\ x \in \$^1 \\ T\big(Ꞙ(\$^2)\big) & if\ x \in \$^2 \\ \max\Big(T\big(Ꞙ(\$^1)\big), T\big(Ꞙ(\$^2)\big)\Big) & if\ x \in \$^1 \cap \$^2 \end{cases}$$

$$I\big(Ꞙ(\$^1) \cup Ꞙ(\$^2)\big) = \begin{cases} I\big(Ꞙ(\$^1)\big) & if\ x \in \$^1 \\ I\big(Ꞙ(\$^2)\big) & if\ x \in \$^2 \\ \frac{\left(I\left(Ꞙ(\$^1)\right) + I\left(Ꞙ(\$^2)\right)\right)}{2} & if\ x \in \$^1 \cap \$^2 \end{cases}$$

$$F\big(₣(\$^1) \cup ₣(\$^2)\big) = \begin{cases} F\big(₣(\$^1)\big) & if\ x \in \$^1 \\ F\big(₣(\$^2)\big) & if\ x \in \$^2 \\ \min\Big(F\big(₣(\$^1)\big), F\big(₣(\$^2)\big)\Big) & if\ x \in \$^1 \cap \$^2 \end{cases}$$

**Numerical Example of Union**

Consider the two NHSS $₣(\$^1)$ and NHSS $₣(\$^2)$ over the same universe $\xi = \{m^1, m^2, m^3, m^4, m^5\}$. Tabular representation of NHSS $₣(\$^1) = ₣(samsung, 6\ GB, Dual\ ) = \{m^1, m^4\}$ and NHSS $₣(\$^2) = ₣(samsung, 6\ GB) = \{m^1\}$ is given below,

**Table 14:** Tabular Representation of NHSS $₣(\$^1)$

| $₣(\$^1) = ₣(samsung, 6\ GB, Dual\ )$ | $m^1$ | $m^4$ |
|---|---|---|
| Samsung | (0.7,0.5, 0.6) | (0.8, 0.1, 0.2) |
| 6 GB | (0.7, 0.2, 0.3) | (0.6, 0.1, 0.2) |
| Dual | (0.8, 0.2, 0.1) | (0.3, 0.6, 0.4) |

**Table 15:** Tabular Representation of NHSS $₣(\$^2)$

| $₣(\$^2) = ₣(samsung, 6\ GB)$ | $m^1$ |
|---|---|
| Samsung | (0.9, 0.5, 0.3) |
| 6 GB | (0.8, 0.4, 0.1) |

Then the union of above NHSS is given as

**Table 16:** Union of NHSS $₣(\$^1)$ and NHSS $₣(\$^2)$

| $₣(\$^1) \cup ₣(\$^2)$ | $m^1$ | $m^4$ |
|---|---|---|
| Samsung | (0.9, 0.5, 0.3) | (0.8, 0.1, 0.2) |
| 6 GB | (0.8, 0.3, 0.1) | (0.6, 0.1, 0.2) |
| Dual | (0.8, 0.1, 0.0) | (0.3, 0.6, 0.4) |

This can also be written as

$$₣(\$^1) \cup ₣(\$^2) = ₣(samsung, 6\ GB, Dual\ ) \cup ₣(samsung, 6\ GB)$$
$$= \{< m^1, (samsung\{0.9, 0.5, 0.3\}, 6\ GB\{0.8, 0.3, 0.1\}, Dual\{0.8,0.1,0.0\}) >,$$
$$< m^4(samsung\{0.8,0.1,0.2\}, 6\ GB\{0.6, 0.1, 0.2\}, Dual\{0.3, 0.6,0.4\}) >\}$$

**Definition 3.7: Intersection of Two Neutrosophic Hypersoft Set**

Let $₣(\$^1)$ and $₣(\$^2)$ be two Neutrosophic Hypersoft set over $\xi$. Consider $l^1, l^2, l^3 \dots l^n$ for $n \geq 1$, be $n$ well-defined attributes, whose corresponding attributive values are respectively the set $L^1, L^2, L^3 \dots L^n$ with $L^i \cap L^j = \emptyset$, for $i \neq j$ and $i, j \epsilon \{1,2,3 \dots n\}$ and their relation $L^1 \times L^2 \times L^3 \dots L^n = \$$ then $₣(\$^1) \cap ₣(\$^2)$ is given as

$$T\big(₣(\$^1) \cap ₣(\$^2)\big) = \begin{cases} T\big(₣(\$^1)\big) & if\ x \in \$^1 \\ T\big(₣(\$^2)\big) & if\ x \in \$^2 \\ \min\Big(T\big(₣(\$^1)\big), T\big(₣(\$^2)\big)\Big) & if\ x \in \$^1 \cap \$^2 \end{cases}$$

$$I\big(₣(\$^1) \cap ₣(\$^2)\big) = \begin{cases} I\big(₣(\$^1)\big) & if\ x \in \$^1 \\ I\big(₣(\$^2)\big) & if\ x \in \$^2 \\ \frac{\left(I\left(₣(\$^1)\right) + I\left(₣(\$^2)\right)\right)}{2} & if\ x \in \$^1 \cap \$^2 \end{cases}$$

$$F\big(₣(\$^1) \cap ₣(\$^2)\big) = \begin{cases} F\big(₣(\$^1)\big) & if\ x \in \$^1 \\ F\big(₣(\$^2)\big) & if\ x \in \$^2 \\ \max\Big(F\big(₣(\$^1)\big), F\big(₣(\$^2)\big)\Big) & if\ x \in \$^1 \cap \$^2 \end{cases}$$

**Numerical Example of Intersection**

Consider the two NHSS $₣(\$^1)$ and NHSS $₣(\$^2)$ over the same universe $\xi = \{m^1, m^2, m^3, m^4, m^5\}$. Tabular representation of NHSS $₣(\$^1) = ₣(samsung, 6\ GB, Dual\ ) = \{m^1, m^4\}$ and NHSS $₣(\$^2) = ₣(samsung, 6\ GB) = \{m^1\}$ is given below

**Table 17:** Tabular Representation of NHSS $₣(\$^1)$

| $₣(\$^1) = ₣(samsung, 6\ GB, Dual\ )$ | $m^1$ | $m^4$ |
|---|---|---|
| Samsung | (0.7,0.5, 0.6) | (0.8, 0.1, 0.2) |
| 6 GB | (0.7, 0.2, 0.3) | (0.6, 0.1, 0.2) |
| Dual | (0.8, 0.2, 0.1) | (0.3, 0.6, 0.4) |

**Table 18:** Tabular Representation of NHSS $₣(\$^2)$

| $₣(\$^2) = ₣(samsung, 6\ GB)$ | $m^1$ |
|---|---|
| Samsung | (0.9, 0.5, 0.3) |
| 6 GB | (0.8, 0.4, 0.1) |

Then the intersection of above NHSS is given as

**Table 19:** Intersection of NHSS $₣(\$^1)$ and NHSS $₣(\$^2)$

| $₣(\$^1) \cap ₣(\$^2)$ | $m^1$ |
|---|---|
| Samsung | (0.7, 0.5, 0.6) |
| 6 GB | (0.7, 0.3, 0.3) |
| Dual | (0.0, 0.1, 0.1) |

This can also be written as

$$₣(\$^1) \cap ₣(\$^2) = ₣(samsung, 6\ GB, Dual\ ) \cap ₣(samsung, 6\ GB)$$
$$= \{< m^1, (samsung\{0.7, 0.5, 0.6\}, 6\ GB\{0.7, 0.3, 0.3\}, Dual\{0.0,0.1,0.1\}) >\}$$

**Definition 3.8: AND Operation on Two Neutrosophic Hypersoft Set**

Let $₣(\$^1)$ and $₣(\$^2)$ be two Neutrosophic Hypersoft set over ξ. Consider $l^1, l^2, l^3 \dots l^n$ for $n \geq 1$, be $n$ well-defined attributes, whose corresponding attributive values are respectively the set $L^1, L^2, L^3 \dots L^n$ with $L^i \cap L^j = \emptyset$, for $i \neq j$ and $i, j \epsilon \{1,2,3 \dots n\}$ and their relation $L^1 \times L^2 \times L^3 \dots L^n = \$$ then $₣(\$^1) \wedge ₣(\$^2) = ₣(\$^1 \times \$^2)$ is given as

$$T(\$^1 \times \$^2) = min\left(T(₣(\$^1)), T(₣(\$^2))\right)$$

$$I(\$^1 \times \$^2) = \frac{\left(I(₣(\$^1)), I(₣(\$^2))\right)}{2}$$

$$F(\$^1 \times \$^2) = max\left(F(₣(\$^1)), F(₣(\$^2))\right)$$

**Numerical Example of AND-Operation**

Consider the two NHSS $₣(\$^1)$ and NHSS $₣(\$^2)$ over the same universe $\xi = \{m^1, m^2, m^3, m^4, m^5\}$. Tabular representation of NHSS $₣(\$^1) = ₣(samsung, 6\ GB, Dual\ ) = \{m^1, m^4\}$ and NHSS $₣(\$^2) = ₣(samsung, 6\ GB, ) = \{m^1\}$ is given below

**Table 20:** Tabular representation of NHSS $₣(\$^1)$

| $₣(\$^1) = ₣(samsung, 6\ GB, Dual\ )$ | $m^1$ | $m^4$ |
|---|---|---|
| Samsung | (0.7,0.5, 0.6) | (0.8, 0.1, 0.2) |
| 6 GB | (0.7, 0.2, 0.3) | (0.6, 0.1, 0.2) |
| Dual | (0.8, 0.2, 0.1) | (0.3, 0.6, 0.4) |

**Table 21:** Tabular representation of NHSS $₣(\$^2)$

| $₣(\$^{\mathbf{2}}) = ₣(\boldsymbol{samsung}, \mathbf{6}\ \boldsymbol{GB})$ | $\boldsymbol{m^1}$ |
|---|---|
| Samsung | (0.9, 0.5, 0.3) |
| 6 GB | (0.8, 0.4, 0.1) |

Then the AND Operation of above NHSS is given as

**Table 22:** AND of NHSS $₣(\$^1)$ and NHSS $₣(\$^2)$

| $₣(\$^1) \wedge ₣(\$^2)$ | $\boldsymbol{m^1}$ | $\boldsymbol{m^4}$ |
|---|---|---|
| $Samsung \times\ Samsung$ | (0.7,0.5,0.6) | (0.0,0.1,0.2) |
| $Samsung \times\ 6\ GB$ | (0.7, 0.45,0.6) | (0.0,0.1,0.2) |
| $6\ GB\ \times Samsung$ | (0.7, 0.35,0.3) | (0.0,0.1,0.2) |
| $6\ GB \times\ 6\ GB$ | (0.7,0.3, 0.3) | (0.0,0,1,0.2) |
| $Dual\ \times Samsung$ | (0.8,0.35,0.3) | (0.0,0.6,0.4) |
| $Dual \times\ 6\ GB$ | (0.8, 0.3, 0.1) | (0.0,0.6,0.4) |

**Definition 3.9: OR Operation on Two Neutrosophic Hypersoft Set**

Let $₣(\$^1)$ and $₣(\$^2)$ be two Neutrosophic Hypersoft set over ξ. Consider $l^1, l^2, l^3 \dots l^n$ for $n \geq 1$, be $n$ well-defined attributes, whose corresponding attributive values are respectively the set $L^1, L^2, L^3 \dots L^n$ with $L^i \cap L^j = \emptyset$, for $i \neq j$ and $i, j\epsilon\{1,2,3 \dots n\}$ and their relation $L^1 \times L^2 \times L^3 \dots L^n = \$$ then $₣(\$^1) \vee ₣(\$^2) = ₣(\$^1 \times \$^2)$ is given as

$$T(\$^1 \times \$^2) = max\left(T\big(₣(\$^1)\big), T\big(₣(\$^2)\big)\right)$$

$$I(\$^1 \times \$^2) = \frac{\left(I\big(₣(\$^1)\big), I\big(₣(\$^2)\big)\right)}{2}$$

$$F(\$^1 \times \$^2) = min\left(F\big(₣(\$^1)\big), F\big(₣(\$^2)\big)\right)$$

**Numerical Example of OR-Operation**

Consider the two NHSS $₣(\$^1)$ and NHSS $₣(\$^2)$ over the same universe $ξ = \{m^1, m^2, m^3, m^4, m^5\}$. Tabular representation of NHSS $₣(\$^1) = ₣(samsung, 6\ GB, Dual\ ) = \{m^1, m^4\}$ and NHSS $₣(\$^2) = ₣(samsung, 6\ GB, ) = \{m^1\}$ is given below

**Table 23:** Tabular representation of NHSS $₣(\$^1)$

| $₣(\$^{\mathbf{1}}) = ₣(\boldsymbol{samsung}, \mathbf{6}\ \boldsymbol{GB}, \boldsymbol{Dual}\ )$ | $\boldsymbol{m^1}$ | $\boldsymbol{m^4}$ |
|---|---|---|
| Samsung | (0.7,0.5, 0.6) | (0.8, 0.1, 0.2) |
| 6 GB | (0.7, 0.2, 0.3) | (0.6, 0.1, 0.2) |
| Dual | (0.8, 0.2, 0.1) | (0.3, 0.6, 0.4) |

| $₣(\$^{\mathbf{2}}) = ₣(\boldsymbol{samsung}, \mathbf{6}\ \boldsymbol{GB})$ | $\boldsymbol{m^1}$ |
|---|---|
| Samsung | (0.9, 0.5, 0.3) |
| 6 GB | (0.8, 0.4, 0.1) |

Table 24: Tabular representation of NHSS $₣(\$^2)$

Then the OR Operation of above NHSS is given as

**Table 25:** OR of NHSS $₣(\$^1)$ and NHSS $₣(\$^2)$

| $₣(\$^1) \vee ₣(\$^2)$ | $\boldsymbol{m^1}$ | $\boldsymbol{m^4}$ |
|---|---|---|
| $Samsung \times\ Samsung$ | (0.9,0.5,0.3) | (0.8,0.1,0.0) |
| $Samsung \times\ 6\ GB$ | (0.8, 0.45,0.1) | (0.8,0.1,0.0) |
| $6\ GB\ \times Samsung$ | (0.9, 0.35,0.3) | (0.6,0.1,0.0) |
| $6\ GB \times\ 6\ GB$ | (0.8,0.3, 0.1) | (0.6,0,1,0.0) |
| $Dual\ \times Samsung$ | (0.9,0.35,0.1) | (0.3,0.6,0.0) |
| $Dual \times\ 6\ GB$ | (0.8, 0.3, 0.1) | (0.3,0.6,0.0) |

## 4. Result Discussion

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, So, for this purpose neutrosophic hypersoft set environment is defined along with necessary operations and elaborated with examples**.**

## 5. Conclusions

In this paper, operations of Neutrosophic Hypersoft set like union, intersection, compliment, AND OR operations are presented. The validity and implementation of the proposed operations and definitions are verified by presenting suitable example. Neutrosophic hypersoft set NHSS will be a new tool in decision-making problems for suitable selection. In future, many decision-makings like personal selection, office management, industrial equipment and many other problems can be solved with the proposed operations [23]. Properties of Union and Intersection operations, cardinality and functions on NHSS are to be defined in future.

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**Conflicts of Interest**

The authors declare that they have no conflict of interest.

## References

1. L. A. Zadeh, Fuzzy sets, *Information and Control*, **8** (1965) 338–353.
2. I. Turksen, Interval valued fuzzy sets based on normal forms, *Fuzzy Sets and Systems,* 20 (1986) 191–210.
3. K. Atanassov, Intuitionistic fuzzy sets, Fuzzy Sets and Systems 20 (1986) 87–96.
4. F. Smarandache, Neutrosophic set, a generalization of the intuitionistic fuzzy sets, Inter. J. Pure Appl. Math. 24 (2005) 287–297.
5. D. Molodtsov, Soft set theory - First results, Computers and mathematics with applications. 37(1999), 19-31.
6. P.K. Maji, A.R. Roy, R. Biswas, An application of soft sets in a decision making problem, Computers and mathematics with applications. 44 (2002) 1077-1083.
7. P.K. Maji, A.R. Roy, R. Biswas, Soft set theory, Computers and mathematics with applications. 45(2003), 555-562.
8. M.I. Ali, F. Feng, X. Liu, W.K. Min, On some new operations in soft set theory, Computers and mathematics with applications. 57(9) (2009) 1547-1553.
9. N. Cagman, S. Enginoglu, Soft matrix theory and its decision making, Computers and mathematics with applications. 59 (2010) 3308-3314.

10. N. Cagman, S. Enginoglu, Soft set theory and uni-int decision making, Eur. J. Oper. Res. 207 (2010) 848-855.
11. Z. Pawlak, Rough sets, Int. J. Inform. Comput. Sci. 11 (1982) 341-356.
12. Tripathy B.K., Arun K.R.: A new approach to soft sets, soft multisets and their properties. Int. J. Reasoning Based Intell. Syst. 7(3/4) (2015), 244-253.
13. P. K. Maji, Neutrosophic soft set. Annals of Fuzzy Mathematics and Informatics 5 (1) (2013), 157-168.
14. F. Smarandache, Extension of Soft Set to Hypersoft Set, and then to Plithogenic Hypersoft Set, Neutrosophic sets and system. 22(2018), 168-170.
15. Abdel-Basset, M., Saleh, M., Gamal, A., & Smarandache, F. (2019). An approach of the TOPSIS technique for developing supplier selection with group decision making under type-2 neutrosophic number. Applied Soft Computing, 77, 438-452.
16. Abdel-Baset, M., Chang, V., Gamal, A., & Smarandache, F. (2019). An integrated neutrosophic ANP and VIKOR method for achieving sustainable supplier selection: A case study in the importing field. Computers in Industry, 106, 94-110.
17. Abdel-Basset, M., Manogaran, G., Gamal, A., & Smarandache, F. (2019). A group decision-making framework based on the neutrosophic TOPSIS approach for smart medical device selection. Journal of medical systems, 43(2), 38.
18. Abdel-Basset, M., Manogaran, G., Gamal, A., & Smarandache, F. (2018). A hybrid approach of neutrosophic sets and DEMATEL method for developing supplier selection criteria. Design Automation for Embedded Systems, 1-22.
19. Nabeeh, N. A., Smarandache, F., Abdel-Basset, M., El-Ghareeb, H. A., & Aboelfetouh, A. (2019). An Integrated Neutrosophic-TOPSIS Approach and Its Application to Personnel Selection: A New Trend in Brain Processing and Analysis. IEEE Access, 7, 29734-29744.
20. F. Smarandache, Neutrosophy. Neutrosophic probability, set, and logic, ProQuest Information & Learning, Ann Arbor, Michigan, USA, 1998.
21. Saqlain M, Saeed M, Ahmad M. R, Smarandache F, Generalization of TOPSIS for Neutrosophic Hypersoft set using Accuracy Function and its Application, Neutrosophic Sets and Systems (NSS), 27: (2019) 131-137.
22. Abdel-Baset, M., Chang, V., & Gamal, A. (2019). Evaluation of the green supply chain management practices: A novel neutrosophic approach. Computers in Industry, 108, 210-220.
23. Abdel-Basset, M., Atef, A., & Smarandache, F. (2019). A hybrid Neutrosophic multiple criteria group decision making approach for project selection. Cognitive Systems Research, 57, 216-227.
24. Abdel-Basset, Mohamed, Mumtaz Ali, and Asma Atef. "Resource levelling problem in construction projects under neutrosophic environment." The Journal of Supercomputing (2019): 1-25.
25. Saqlain M, Sana M, Jafar N, Saeed. M, Said. B, Single and Multi-valued Neutrosophic Hypersoft set and Tangent Similarity Measure of Single valued Neutrosophic Hypersoft Sets, *Neutrosophic Sets and Systems (NSS),* 32: (2020).
26. S. Pramanik, P. P. Dey and B. C. Giri, TOPSIS for single valued neutrosophic soft expert set based multi-attribute decision making problems, *Neutrosophic Sets and Systems*, 10, (2015), 88-95.
27. Saqlain. M., Jafar. N. and Riffat. A., Smart phone selection by consumers' in Pakistan: FMCGDM fuzzy multiple criteria group decision making approach, *Gomal University Journal of Research,* 34(1): 27-31 (2018).
28. Saqlain. M, Jafar.N. M, and Muniba. K, Change in The Layers of Earth in Term of Fractional Derivative: A Study, *Gomal University Journal of Research*, 34(2): 27-31 (2018).
29. Saqlain M, Jafar N, Hamid R, Shahzad A. Prediction of Cricket World Cup 2019 by TOPSIS Technique of MCDM-A Mathematical Analysis, *International Journal of Scientific & Engineering Research*, 10(2): 789-792 (2019).
30. Saqlain M, Saeed M, Ahmad M. R, Smarandache F, (2019), Generalization of TOPSIS for Neutrosophic Hypersoft set using Accuracy Function and its Application, *Neutrosophic Sets and Systems (NSS*), 27: 131-137.
31. Riaz.M., Saeed.M. Saqlain.M. and Jafar.N. Impact of Water Hardness in Instinctive Laundry System based on Fuzzy Logic Controller, Punjab *University Journal of Mathematics*, 51(4) (2018) 73-84.
32. Riaz. M., Saqlain. M. and Saeed. M. (2019). Application of Generalized Fuzzy TOPSIS in Decision Making for Neutrosophic Soft set to Predict the Champion of FIFA 2018: A Mathematical Analysis, *Punjab University Journal of Mathematics*, 51(8): 111-126 .
33. I. Deli and S. Broumi, Neutrosophic Soft Matrices and NSM-decision Making, Journal of Intelligent and Fuzzy Systems, 28(5), (2015), 2233-2241.

34. T. Bera and N. K. Mahapatra, Introduction to neutrosophic soft groups, *Neutrosophic Sets and Systems*, 13, (2016), 118-127, doi.org/10.5281/zenodo.570845.
35. P. Biswas, S. Pramanik, and B. C. Giri. A new methodology for neutrosophic multi-attribute decision making with unknown weight information. *Neutrosophic Sets and Systems*, 3(2014), 42-52.
36. K. Mondal, and S. Pramanik. Neutrosophic decision making model of school choice. *Neutrosophic Sets and Systems*, 7 (2015), 62-68.

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