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Some New Aggregation Operations of Intuitionistic Fuzzy Hypersoft Set

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Abstract

Multi-criteria decision-making (MCDM) deals with the organization and planning of multiple criteria of choices. To resolve the uncertainties present in MCDM, a new tool has been planned by the name of intuitionistic hypersoft set theory. The contents of this paper consist of the workings of intuitionistic fuzzy hypersoft set theory and its basic operations such as complement, union, intersection, AND, OR operators, etc. The implementation of intuitionistic hypersoft set and its validity has been shown in this study with examples. Personal selection, management problems, and many others can be solved through the proposed operations of this study for better accuracy and precision.

Keywords: MCDM; Uncertainty; Soft Set; Intuitionistic Fuzzy Set; Hypersoft Set.

1 | Introduction

The issue of uncertainty hangs as a dark cloud in our daily life whenever we are faced to make an important decision. People face troubles and unnecessary problems if they don't have any parameters defined for decision-making criteria and it is one of the most complexes and challenging circumstances for decision-makers occupying management posts. However, many tools have been developed in determining and defining the decision-making criteria. But in Mathematics, the tool dealing with the issue of uncertainty was introduced by Lotfi A. Zaddeh [1] as a theory of uncertainty by name of fuzzy set theory in 1965. Afterwards in 1975, Lotfi A. Zaddeh [2] also introduced interval fuzzy set theory. Fuzzy set theory lays the foundation and provides the tools in which a complex decision-making process affected by uncertainties can be successfully dealt with. In case the parties of a decision-making task cannot reach on an agreement regarding the linguistics variables based on the fuzzy set method, the interval valued fuzzy set theory can provide more accurate modelling of the linguistics variables.

In fuzzy set theory, it is assumed that the rejection and acceptance grades of membership are complementary in nature and in deciding the degrees of membership of an object, there is a hesitation between the membership function. To make fuzzy set theory more inclusive of the different memberships of an object affecting decision making process, Atanassov [3-7] in 1986 introduced a generalization of the Fuzzy Set theory by the name of intuitionistic fuzzy set theory, keeping in mind the human proclivity to effect decision-making.

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In intuitionistic fuzzy set theory, membership and non-membership values of an object have been mathematically related.

In 1999, D.Molotsov [8] produced a soft set theory to deal with uncertainties and it has been applied in different scenarios with great success. This theory was further worked upon by another researcher Maji et al [9] in which subset and super-subset of soft set, equality of soft sets and operation like union, intersection, AND and OR operations were applied on different soft sets.

The idea of the hypersoft set (HSS) was coined by Smarandache [10] in 2018 as an extension of the soft set. It is a very useful structure to deal with multi-attributes, multi-objective problems with disjoint attributive values. This structure has been extended in different uncertain environments. Jafar et al. [11] proposed fuzzy hypersoft sets (FHS) and their aggregation operators. Saeed et al. [12-13] proposed complex multi-fuzzy hypersoft sets (CMFHSS) and used them to solve MCDM problems using entropy and similarity measures. They advocated the use of entropy and similarity of efficient complex fuzzy hypersoft sets in the assessment of SWMS. Jafar et al. [14] proposed the matrix theory of IFHSs, proposed the MADM algorithm, and applied it in staff selection problem. Complex neutrosophic hypersoft mappings were also suggested by Saeed et al. [15-16] and used in the diagnosis and treatment of infectious disorders and diagnose hepatitis. Some more applications of NHSSs theory were given by Rahman et al. [17]. Ahsan et al. [18] CMFHS mapping and applied in HIV diagnosis with treatment. Jafar et al. [19] proposed Trigonometric Similarity measures and applied them in the renewable energy source selection.

This study analyzes the ways to overcome the problem of uncertainty by combining the intuitionistic fuzzy set theory with the hyper soft set theory. By combining these two theories it strives to produce a new tool called ‘Intuitionistic hypersoft set.

2 | Preliminaries

Definition 2.1. (Fuzzy set) A pair ($\mathcal{U}$,e) is said to be fuzzy set if there exist a function $e: \mathcal{U} \to [0,1]$ where $\mathcal{U}$ is set. The function $e = \mu_{\ddot{A}}$ is called membership function of the fuzzy set $\ddot{A} = (\mathcal{U}, e)$.

Definition 2.2. (Soft set) Let $\mathcal{U}$ be the universal set and $\mathrm{p}(\mathcal{U})$ be the power set of$\mathcal{U}$. Let $\check{A}$ be the set of attributes then the pair $(\mathrm{F}, \mathcal{U})$ is said to be soft set over $\mathcal{U}$ if $\mathrm{F}: \check{A} \to \mathrm{p}(\mathcal{U})$.

Definition 2.3. (Hypersoft set) Let $\mathcal{U}$ be the universal set and $P(\mathcal{U})$be the power set of$\mathcal{U}$. Suppose $h_1, h_2, h_3 \ldots\ldots\ldots h_n$ where $n \geq 1$ be n distinct attributes whose corresponding attributive values respectively the sets $H_1, H_2, H_3 \ldots\ldots\ldots H_n$with $H_i \cap H_J = \emptyset, i \neq j$ and $i, j\epsilon\{0,1,2,3 \ldots\ldots\ldots. n\}$ then the pair $(F, H_1 \times H_2 \times H_3 \times \ldots\ldots\ldots \times H_n)$, where.$F: H_1 \times H_2 \times H_3 \times \ldots\ldots\ldots \times H_n \to P(\mathcal{U})$ is called a hypersoft set over $\mathcal{U}$.

Definition 2.4. (Intuitionistic soft set) Consider $\mathcal{U}$ is a universal set and Ĕ be the set of parameters. Let $P(\mathcal{U})$ denote the set of all intuitionistic fuzzy sets of $\mathcal{U}$. Let $\bar{A} \subseteq$ Ĕ. A pair (F, Ĕ) is an intuitionistic soft set over $\mathcal{U}$, where is mapping given by $\mathrm{F}: \bar{A} \to P(\mathcal{U})$.

3 | Calculation

Definition 3.1. Intuitionistic Hypersoft set (IHSS). Let E be the initial universe of discourse and P (E) is the set of all possibilities of$E$. suppose $h_1, h_2, h_3 \ldots\ldots\ldots h_n$ where $n \geq 1$ be n distinct attributes whose corresponding attributive values respectively the sets $H_1, H_2, H_3 \ldots\ldots\ldots H_n$with $H_i \cap H_J = \emptyset, i \neq j$ and $i, j\epsilon\{0,1,2,3 \ldots\ldots\ldots. n\}$ then the relation $H_1 \times H_2 \times H_3 \times \ldots\ldots\ldots \times H_n = \alpha$ then the pair (F, α) is said to be Intuitionistic hypersoft set (IHSS). $F: H_1 \times H_2 \times H_3 \times \ldots\ldots\ldots \times H_n \to P(E)$ and$F(H_1 \times H_2 \times H_3 \times \ldots\ldots\ldots \times H_n) = \{< x, \mu(F(\alpha)), \gamma(F(\alpha)) >, x\epsilon E\}$where μ is the value of membership and γ is the value of non-membership such that $\mu: E \to [0,1]\,, \gamma: E \to [0,1]$ and also $0 < \mu(F(\alpha)) + \gamma(F(\alpha)) < 2$

Example 3.1. Let E be the set of Laptops under consideration given as:

$E = \{e_1, e_2, e_3 \dots \dots \dots e_n\}$

Also consider the set of attributes

S_{11} = Laptop type, S_{12} =Ram capacity, S_{13} = Screen resolution, S_{14} =Battery life, S_{15} =Graphic card, S_{16} = Processor generation

And their respective attributes

S_{11} = Laptop type $= \{$Dell, HP, Samsung, Lenovo$\}$

S_{12} = Ram capacity $= \{$2GB, 4GB, and 8GB$\}$

S_{13} = Screen resolution $= \{1366\times 768Pixels, 1920 \times 1080Pixels, 2560 \times 1440Pixels\}$

S_{14} = Battery life $= \{$4400MAH, 4800MAH, 5200MAH$\}$

S_{15} = Graphic card $= \{$4GB, 8GB, 11GB$\}$

S_{16} = Processor generation $= \{5^{th}, 6^{th}, 8th\}$

Let the function be $F: (S_{11} \times S_{12} \times S_{13} \times S_{14} \times S_{15}) \rightarrow P(E)$

The tabulated forms of the the above discussed Example 3.1 are Table 1 to Table 7.

Table 1. Decision maker intuitionistic values for Laptop type.

S_{11} (Laptop type)	e_1	e_2	e_3	e_4	e_5
Dell	(0.7,0.4)	(0.9,1.0)	(0.2,0.3)	(0.4,0.9)	(0.4,0.3)
HP	(0.4,0.2)	(0.6,0.9)	(0.9,0.1)	(0.4,0.8)	(0.3,0.1)
Samsung	(0.3,0.1)	(0.4,0.5)	(0.3,0.7)	(0.1,0.4)	(0.6,0.4)
Lenovo	(0.1,0.4)	(0.4,0.3)	(0.4,0.1)	(0.1,0.4)	(0.7,0.9)

Table 2. Decision maker intuitionistic values for Ram capacity.

S_{12}(Ram capacity)	e_1	e_2	e_3	e_4	e_5
2GB	(0.6,0.3)	(0.4,0.2)	(0.4,0.1)	(0.6,0.3)	(0.1,0.1)
4GB	(0.7,0.2)	(0.6,0.1)	(0.6,0.2)	(0.4,0.1)	(0.3,0.1)
8GB	(0.9,0.1)	(0.7,0.2)	(0.4,0.3)	(0.1,0.3)	(0.4,0.2)

Table 3. Decision maker intuitionistic values for Screen resolution.

S_{13}(Screen resolution)	e_1	e_2	e_3	e_4	e_5
$1366\times$ **768Pixels**	(0.3,0.2)	(0.9,0.1)	(0.4,0.3)	(0.7,0.2)	(0.2,0.1)
1920 × 1080Pixels	(0.1,0.1)	(0.9,0.3)	(0.3,0.1)	(0.3,0.1)	(0.1,0.1)
2560 × 1440Pixels	(0.2,0.1)	(0.2,0.1)	(0.4,0.3)	(0.7,0.1)	(0.4,0.3)

Table 4. Decision maker intuitionistic values for Battery life.

S_{14} (Battery life)	e_1	e_2	e_3	e_4	e_5
4400MAH	(0.4,0.1)	(0.7,0.1)	(0.9,0.1)	(0.1,0.1)	(0.1,0.2)
4800MAH	(0.3,0.2)	(0.9,0.1)	(0.4,0.5)	(0.4,0.5)	(0.3,0.1)
5200MAH	(0.4,0.2)	(0.6,0.3)	(0.4,0.3)	(0.9,0.1)	(0.6,0.1)

Table 5. Decision maker intuitionistic values for Graphic card.

S_{15} (Graphic card)	e_1	e_2	e_3	e_4	e_5
4GB	(0.1,0.7)	(0.3,0.1)	(0.3,0.7)	(0.3,0.1)	(0.1,0.2)
8GB	(0.7,0.4)	(0.5,0.3)	(0.1,0.9)	(0.9,0.1)	(0.3,0.6)
11GB	(0.1,0.7)	(0.7,0.1)	(0.7,0.1)	(0.7,0.3)	(0.9,0.1)

Table 6. Decision maker intuitionistic values for Processor generation.

S_{16} (Processor Generation)	e_1	e_2	e_3	e_4	e_5
5^{th} Generation	(0.1,0.3)	(0.4,0.9)	(0.7,0.9)	(0.1,0.3)	(0.1,0.2)
6^{th} Generation	(0.1,0.6)	(1.0,0.7)	(1.1,0.3)	(0.7,0.1)	(0.2,0.1)
8^{th} Generation	(0.1,0.6)	(0.9,0.3)	(0.9,0.3)	(0.4,0.6)	(0.3,0.2)

Intuitionistic fuzzy hypersoft set is define as: $F: (S_{11} \times S_{12} \times S_{13} \times S_{14} \times S_{15}) \rightarrow P(E)$.

Let assume that F {Samsung, 8GB,$1920 \times 1080 Pixels, 4800MAH, 8GB, 6^{th}\ Generation\}= \{e_2, e_4\}$

Then Intuitionistic fuzzy hypersoft set of above assumed relation is

$F(\alpha) = F$ {Samsung, 8GB,$1920 \times 1080\text{Pixels}, 4800\text{MAH}, 8\text{GB}, 6^{\text{th}}$ Generation}

$= \{< \mathrm{e}_2(\text{Samsung}\{0.3,0.1\}, 8\text{GB}\{0.9,0.1\}, 1920 \times 1080\text{Pixels}\{0.1,0.1\}, 4800\text{MAH}\{0.3,0.2\},$
$8\text{GB}\{0.7,0.4\}, 6^{\text{th}}\ \text{Generation}\{0.1,0.6\}) >< \mathrm{e}_4(\text{Samsung}\{0.1,0.4\}, 8\text{GB}\{0.1,0.3\}, 1920 \times 1080\text{Pixels}$
$\{0.3,0.1\}, 4800\text{MAH}\{0.4,0.5\}, 8\text{GB}\{0.9,0.1\}, 6^{\text{th}}\ \text{Generation}\{0.7,0.1\}) >\}$

Its tabular form is written as

Table 7. Tabular representation of intuitionistic Hypersoft set.

$F(\alpha)$	e_2	e_4
Samsung	(0.3,0.1)	(0.1,0.4)
8GB	(0.9,0.1)	(0.1,0.3)
1920×1080Pixels	(0.1,0.1)	(0.3,0.1)
4800MAH	(0.3,0.2)	(0.4,0.5)
8GB	(0.7,0.4)	(0.9,0.1)
6^{th} Generation	(0.1,0.6)	(0.7,0.1)

Definition 3.2. (Intuitionistic hypersoft subset). Suppose $F(\alpha_1)$ and $F(\alpha_2)$ be two intuitionistic fuzzy hypersoft sets over E. Suppose $h_1, h_2, h_3 \dots\dots\dots h_n$ where $n \geq 1$ be n distinct attributes whose corresponding attributive values respectively the sets $H_1, H_2, H_3 \dots\dots\dots H_n$with $H_i \cap H_J = \emptyset, i \neq j$ and $i, j \epsilon \{0,1,2,3 \dots\dots\dots. n\}$ then the relation $H_1 \times H_2 \times H_3 \times \dots\dots\dots \times H_n = \alpha$ then $F(\alpha_1)$ is the Intuitionistic fuzzy hypersoft subset of $F(\alpha_2)$ if

$$\mu(F(\alpha_1)) \leq \mu(F(\alpha_2))$$

$$\gamma(F(\alpha_1)) \geq \gamma(F(\alpha_2))$$

Example 3.2. Consider the two intuitionistic hypersoft sets $IHSS\ F(\alpha_1)$ and $IHSS\ F(\alpha_2)$ over same universe $E = \{e_1, e_2, e_3 \dots\dots\dots e_n\}$. The $IHSS$

$\mathrm{F}(\alpha_1) =$ F{Samsung, 8GB,$1920 \times 1080\text{Pixels}, 4800\text{MAH}, 8\text{GB}, 6^{\text{th}}\ \text{Generation}\} = \{e_2, e_4\}$ is the subset of $IHSS$

$\mathrm{F}(\alpha_2) =$ F{Samsung, 8GB,$1920 \times 1080\text{Pixels}, 4800\text{MAH}, 8\text{GB}, 6^{\text{th}}\ \text{Generation}\} = \{e_2\}$

if$\mu(F(\alpha_1)) \leq \mu(F(\alpha_2))$, $\gamma(F(\alpha_1)) \geq \gamma(F(\alpha_2))$. The tabulated forms of the the above discussed Example 3.2 are Table 8 and Table 9.

Table 8. Tabular representation of intuitionistic Hyper soft set $F(\alpha_1)$.

$F(\alpha_1)$	e_2	e_4
Samsung	(0.3,0.1)	(0.1,0.4)
8GB	(0.9,0.1)	(0.1,0.3)
1920×1080Pixels	(0.1,0.1)	(0.3,0.1)
4800MAH	(0.3,0.2)	(0.4,0.5)
8GB	(0.7,0.4)	(0.9,0.1)
6^{th} Generation	(0.1,0.6)	(0.7,0.1)

Table 9. Tabular representation of intuitionistic Hyper soft set $F(\alpha_2)$.

$F(\alpha_2)$	e_2
Samsung	(0.4,0.1)
8GB	(0.9,0.1)
1920×1080Pixels	(0.2,0.1)
4800MAH	(0.4,0.1)
8GB	(0.9,0.3)
6^{th} Generation	(0.4,0.5)

It can be written as

$(F(\alpha_1)) \subset (F(\alpha_2)) =$ F{Samsung, 8GB,1920×1080Pixels, 4800MAH, 8GB, 6^{th} Generation}$\subset$ F{Samsung, 8GB,1920×1080Pixels, 4800MAH, 8GB, 6^{th} Generation}$= \{<$ e_2(Samsung{0.3,0.1}, 8GB{0.9,0.1}, 1920×1080Pixels{0.1,0.1}, 4800MAH{0.3,0.2}, 8GB{0.7,0.4}, 6^{th} Generation{0.1,0.6}) $><$ e_4(Samsung{0.1,0.4}, 8GB{0.1,0.3}, 1920×1080Pixels{0.3,0.1}, 4800MAH{0.4,0.5},8GB{0.9,0.1},6^th Generation{0.7,0.1}) $>\} \subset \{<$ e_2(Samsung{0.4,0.1}, 8GB{0.9,0.1}, 1920×1080Pixels{0.2,0.1}, 4800MAH{0.4,0.1}, 8GB{0.9,0.3}, 6^{th} Generation{0.4,0.5}) $>\}$

Here we deduce that the membership values of Samsung for e_2 is (0.3,0.1) and (0.4,0.1) which hold the definition of Intuitionistic fuzzy hypersoft subset as $0.4 \leq 0.3$ and 0.1≥0.1. This shows that (0.3,0.1) $\subset$ (0.4,0.1) and same for the rest of the attributes of $IFHSS\ F(\alpha_1)$ and $IFHSS\ F(\alpha_2)$.

Definition 3.3. (Intuitionistic Equal fuzzy hypersoft set). Suppose $F(\alpha_1)$ and $F(\alpha_2)$ be two intuitionistic fuzzy hypersoft sets over E. suppose $h_1, h_2, h_3 \ldots\ldots\ldots h_n$ where $n \geq 1$ be n distinct attributes whose corresponding attributive values respectively the sets $H_1, H_2, H_3 \ldots\ldots\ldots H_n$with $H_i \cap H_J = \emptyset, i \neq j$ and $i, j \epsilon \{0,1,2,3 \ldots\ldots\ldots. n\}$ then the relation $H_1 \times H_2 \times H_3 \times \ldots\ldots\ldots \times H_n = \alpha$ then $F(\alpha_1)$ is the Intuitionistic equal fuzzy hypersoft set of $F(\alpha_2)$ if

$$\mu(F(\alpha_1)) = \mu(F(\alpha_2))$$

$$\gamma(F(\alpha_1)) = \gamma(F(\alpha_2))$$

Example 3.3. Consider the two intuitionistic fuzzy hypersoft sets $IFHSS\ F(\alpha_1)$ and $IFHSS\ F(\alpha_2)$ over same universe $E = \{e_1, e_2, e_3 \ldots\ldots\ldots e_n\}$. The $IFHSS\ F(\alpha_1) =$ F{Samsung, 8GB,$1920 \times 1080 Pixels, 4800MAH, 8GB, 6^{th}\ Generation\} = \{e_2, e_4\}$ is the subset of $IFHSS\ F(\alpha_2) =$ F{Samsung, 8GB,$1920 \times 1080 Pixels,\ 4800MAH, 8GB,\ 6^{th}\ Generation\} = \{e_2\}$ if$\mu(F(\alpha_1)) = \mu(F(\alpha_2))$, $\gamma(F(\alpha_1)) = \gamma(F(\alpha_2))$. The tabulated forms of the the above discussed Example 3.3 are Table 10 and Table 11.

Table 10. Tabular representation of intuitionistic Hypersoft set $F(\alpha_1)$.

$F(\alpha_1)$	e_2	e_4
Samsung	(0.3,0.1)	(0.1,0.4)
8GB	(0.9,0.1)	(0.1,0.3)
1920×1080Pixels	(0.1,0.1)	(0.3,0.1)
4800MAH	(0.3,0.2)	(0.4,0.5)
8GB	(0.7,0.4)	(0.9,0.1)
6^{th} Generation	(0.1,0.6)	(0.7,0.1)

Table 11. Tabular representation of intuitionistic Hypersoft set $F(\alpha_2)$.

$F(\alpha_2)$	e_2
Samsung	(0.3,0.1)
8GB	(0.9,0.1)
1920×1080Pixels	(0.1,0.1)
4800MAH	(0.3,0.2)
8GB	(0.7,0.4)
6^{th} Generation	(0.1,0.6)

It can be written as

$\left(F(\alpha_1) = F(\alpha_2)\right) = F\{$Samsung, 8GB,$1920 \times 1080Pixels, 4800MAH, 8GB, 6^{th}\ Generation\} =$ $F\{$Samsung, 8GB,$1920 \times 1080Pixels, 4800MAH, 8GB, 6^{th}\ Generation\} = \{< e_2(Samsung\{0.3,0.1\}, 8GB\{0.9,0.1\}, 1920 \times 1080Pixels\{0.1,0.1\}, 4800MAH\{0.3,0.2\}, 8GB\{0.7,0.4\}, 6^{th}\ Generation\{0.1,0.6\}) e_4(Samsung\{0.1,0.4\}, 8GB\{0.1,0.3\}, 1920 \times 1080Pixels\{0.3,0.1\}, 4800MAH\{0.4,0.5\}, 8GB\{0.9,0.1\}, 6^{th}\ Generation\{0.7,0.1\}) >\} = \{< e_2(Samsung\{0.3,0.1\}, 8GB\{0.9,0.1\}, 1920 \times 1080Pixels\{0.1,0.1\}, 4800MAH\{0.3,0.2\}, 8GB\{0.7,0.4\}, 6^{th}\ Generation\{0.1,0.6\}) >\}$

Here we deduce that the membership values of Samsung for e_2 is (0.3,0.1) and $(0.3,0.1)$ which hold the definition of Intuitionistic equal fuzzy hypersoft set as $0.3 = 0.3$ and 0.1=0.1. This shows that (0.3,0.1) = $(0.3,0.1)$ and same for the rest of the attributes of $IFHSS\ F(\alpha_1)$ and $IFHSS\ F(\alpha_2)$.

Definition 3.4. (Null Intuitionistic fuzzy hypersoft set). Let $F(\alpha_1)$ be the intuitionistic fuzzy hypersoft set over E. Suppose $h_1, h_2, h_3 \dots \dots \dots h_n$ where $n \geq 1$ be n distinct attributes whose corresponding attributive values respectively the set $H_1, H_2, H_3 \dots \dots \dots H_n$with $H_i \cap H_J = \emptyset, i \neq j$ and $i, j \epsilon \{0,1,2,3 \dots \dots \dots . n\}$ then the relation $H_1 \times H_2 \times H_3 \times \dots \dots \dots \times H_n = \alpha_1$ then $F(\alpha_1)$ is the null Intuitionistic fuzzy hypersoft set of if

$$\mu(F(\alpha_1)) = 0$$

$$\gamma(F(\alpha_1)) = 0$$

Example 3.4. Consider $F(\alpha_1)$ be the intuitionistic fuzzy hypersoft set over same universe $E = \{e_1, e_2, e_3 \dots \dots \dots e_n\}$. The $IFHSS\ F(\alpha_1) = F\{$Samsung, 8GB,$1920 \times 1080Pixels, 4800MAH, 8GB, 6^{th}\ Generation\} = \{e_2, e_4\}$ if $\mu(F(\alpha_1)) = 0$, $\gamma(F(\alpha_1)) = 0$. The tabulated forms of the the above discussed Example 3.4 are Table 12.

Table 12. Tabular representation of intuitionistic Hypersoft set $F(\alpha_1)$.

$F(\alpha_1)$	e_2	e_4
Samsung	(0,0)	(0,0)
8GB	(0,0)	(0,0)
1920×1080Pixels	(0,0)	(0,0)
4800MAH	(0,0)	(0,0)
8GB	(0,0)	(0,0)
6^{th} Generation	(0,0)	(0,0)

It can be written as

$$\left(\mathrm{F}(\alpha_1)\right) = \mathrm{F}\{\text{Samsung, 8GB}, 1920 \times 1080\text{Pixels}, 4800\text{MAH}, 8\text{GB}, 6^{\text{th}} \text{ Generation}\} =$$

$$< \mathrm{e}_2(\text{Samsung}\{0,0\}, 8\text{GB}\{0,0\}, 19 \times 1080\text{Pixels}\{0,0\}, 4800\text{MAH}\{0,0\}, 8\text{GB}\{0,0\}, 6^{\text{th}} \text{ Generation}\{0,0\}) > \mathrm{e}_4(\text{Samsung}\{0,0\}, 8\text{GB}\{0,0\}, 1920 \times 1080\text{Pixels}\{0,0\}, 4800\text{MAH}\{0,0\}, 8\text{GB}\{0,0\}, 6^{\text{th}} \text{ Generation}\{0,0\}) >\}$$

Definition 3.5. (Compliment of intuitionistic fuzzy hypersoft set). Let $F(\alpha_1)$ be the intuitionistic fuzzy hypersoft set over$E$. Suppose $h_1, h_2, h_3 \dots \dots \dots h_n$ where $n \geq 1$ be n distinct attributes whose corresponding attributive values respectively the set $H_1, H_2, H_3 \dots \dots \dots H_n$with $H_i \cap H_J = \emptyset, i \neq j$ and $i, j \epsilon \{0,1,2,3 \dots \dots \dots . n\}$ then the relation $H_1 \times H_2 \times H_3 \times \dots \dots \dots \times H_n = \alpha_1$ then $F^c(\alpha_1)$ is the compliment of Intuitionistic fuzzy hypersoft set if

$$F^c(\alpha_1): (\neg H_1 \times \neg H_2 \times \neg H_3 \dots \dots \neg H_n) \to F(\alpha_1)$$

Such that

$$\mu^c(F(\alpha_1)) = \gamma(F(\alpha_1))$$

$$\gamma^c(F(\alpha_1)) = \mu(F(\alpha_2))$$

Example 3.5. Consider $F(\alpha_1)$ be the intuitionistic fuzzy hypersoft set over same universe $E = \{e_1, e_2, e_3 \dots \dots \dots e_n\}$. The $IFHSS\ F(\alpha_1) = F\{$Samsung, 8GB,$1920 \times 1080Pixels$, $4800MAH, 8GB$, $6^{th}\ Generation\} = \{e_2, e_4\}$ if $\mu^c(F(\alpha_1)) = \gamma(F(\alpha_1))$ and $\gamma^c(F(\alpha_1)) = \mu(F(\alpha_1))$. The tabulated forms of the the above discussed Example 3.5 are Table 13 and Table 14.

Table 13. Tabular representation of intuitionistic Hypersoft set $\mathrm{F}(\alpha_1)$.

$\mathbf{F}(\alpha_1)$	$\mathbf{e_2}$	$\mathbf{e_4}$
Samsung	(0.3,0.1)	(0.1,0.4)
8GB	(0.9,0.1)	(0.1,0.3)
1920 × 1080Pixels	(0.1,0.1)	(0.3,0.1)
4800MAH	(0.3,0.2)	(0.4,0.5)
8GB	(0.7,0.4)	(0.9,0.1)
6^{th} Generation	(0.1,0.6)	(0.7,0.1)

Table 14. Tabular representation of intuitionistic Hypersoft set $\mathrm{F}^c(\alpha_1)$.

$\mathbf{F}^c(\alpha_1)$	$\mathbf{e_2}$	$\mathbf{e_4}$
Not Samsung	(0.1,0.3)	(0.4,0.1)
Not 8GB	(0.1,0.9)	(0.3,0.1)
Not 1920 × 1080Pixels	(0.1,0.1)	(0.1,0.3)
Not 4800MAH	(0.2,0.3)	(0.5,0.4)
Not 8GB	(0.4,0.7)	(0.1,0.9)
Not 6^{th} Generation	(0.6,0.1)	(0.1,0.7)

It can be written as

$$\left(\mathrm{F}(\alpha_1)\right) = \mathrm{F}\{\text{Samsung, 8GB}, 1920 \times 1080\text{Pixels}, 4800\text{MAH}, 8\text{GB}, 6^{\text{th}} \text{ Generation}\}$$

$$= \{< \mathrm{e}_2(\text{Not Samsung}\{0.1,0.3\}, \text{Not 8GB}\{0.1,0.9\}, \text{Not } 1920 \times 1080\text{Pixels}\{0.1,0.1\}, \text{Not 4800MAH}\{0.2,0.3\}, \text{Not 8GB}\{0.4,0.7\}, \text{Not } 6^{\text{th}} \text{ Generation}\{0.6,0.1\}) ><$$

e_4(Not Samsung{0.4,0.1}, Not 8GB{0.3,0.1} , Not 1920 × 1080Pixels{0.1,0.3}, Not 4800MAH{0.5,0.4}, Not 8GB{0.1,0.9}, Not6th Generation{0.1,0.7}) >}

Definition 3.6. (Union of a two intuitionistic fuzzy hypersoft set). Suppose $F(\alpha_1)$ and $F(\alpha_2)$ be two intuitionistic fuzzy hypersoft sets over E. suppose $h_1, h_2, h_3 \ldots \ldots \ldots h_n$ where $n \geq 1$ be n distinct attributes whose corresponding attributive values respectively the sets $H_1, H_2, H_3 \ldots \ldots \ldots H_n$ with $H_i \cap H_J = \emptyset, i \neq j$ and $i, j \epsilon \{0,1,2,3 \ldots \ldots \ldots . n\}$ then the relation $H_1 \times H_2 \times H_3 \times \ldots \ldots \ldots \times H_n = \alpha$ then $F(\alpha_1) \cup F(\alpha_2)$ is given as

$$\mu(F(\alpha_1) \cup F(\alpha_2)) = \begin{cases} \mu(F(\alpha_1)) & if\ x \epsilon\ \alpha_1 \\ \mu(F(\alpha_2)) & if\ x \epsilon\ \alpha_2 \\ max\left(\mu(F(\alpha_1)), \mu(F(\alpha_2))\right) & if\ x \epsilon\ \alpha_1 \cap \alpha_2 \end{cases}$$

$$\gamma(F(\alpha_1) \cup F(\alpha_2)) = \begin{cases} \gamma(F(\alpha_1)) & if\ x \epsilon\ \alpha_1 \\ \gamma(F(\alpha_2)) & if\ x \epsilon\ \alpha_2 \\ min\left(\gamma(F(\alpha_1)), \gamma(F(\alpha_2))\right) & if\ x \epsilon\ \alpha_1 \cap \alpha_2 \end{cases}$$

Example 3.6. Consider the two intuitionistic fuzzy hypersoft sets $IFHSS\ F(\alpha_1)$ and $IFHSS\ F(\alpha_2)$ over same universe $E = \{e_1, e_2, e_3 \ldots \ldots \ldots e_n\}$. The $IFHSS\ F(\alpha_1) =$ F {Samsung, 8GB,1920 × $1080 Pixels$, $4800 MAH$, $8GB$, 6^{th} $Generation$}$= \{e_2, e_4\}$ is the subset of $IFHSS\ F(\alpha_2) =$ F {Samsung, 8GB,1920 × $1080 Pixels$, $4800 MAH$, $8GB$, 6^{th} $Generation$} $= \{e_2, e_4\}$. The tabulated forms of the the above discussed Example 3.6 are Table 15 to Table 17.

Table 15. Tabular Representation of intuitionistic Hypersoft Set $F(\alpha_1)$.

$F(\alpha_1)$	e_2	e_4
Samsung	(0.3,0.1)	(0.1,0.4)
8GB	(0.9,0.1)	(0.1,0.3)
1920 × 1080Pixels	(0.1,0.1)	(0.3,0.1)
4800MAH	(0.3,0.2)	(0.4,0.5)
8GB	(0.7,0.4)	(0.9,0.1)
6th Generation	(0.1,0.6)	(0.7,0.1)

Table 16. Tabular representation of intuitionistic Hypersoft set $F(\alpha_2)$.

$F(\alpha_2)$	e_2	e_4
Samsung	(0.1,0.3)	(0.4,0.1)
8GB	(0.1,0.9)	(0.3,0.1)
1920 × 1080Pixels	(0.1,0.1)	(0.1,0.3)
4800MAH	(0.2,0.3)	(0.5,0.4)
8GB	(0.4,0.7)	(0.1,0.9)
6th Generation	(0.6,0.1)	(0.1,0.7)

Table 17. Tabular Representation of intuitionistic Hypersoft Set $F(\alpha_1) \cup F(\alpha_2)$.

$F(\alpha_1) \cup F(\alpha_2)$	e_2	e_4
Samsung	(0.3,0.1)	(0.4,0.1)
8GB	(0.9,0.1)	(0.3,0.1)
1920 × 1080Pixels	(0.1,0.1)	(0.3,0.1)
4800MAH	(0.3,0.2)	(0.5,0.4)
8GB	(0.7,0.4)	(0.9,0.1)
6th Generation	(0.6,0.1)	(0.7,0.1)

It can be written as

$\big(F(\alpha_1)\big) \cup \big(F(\alpha_2)\big) = F\{$Samsung, 8GB,$1920 \times 1080 Pixels, 4800 MAH, 8GB,$ 6^{th} $Generation\} \cup$ $F\{$Samsung, 8GB,$1920 \times 1080 Pixels, 4800 MAH, 8GB,$ 6^{th} $Generation\} = \{< e_2(Samsung\{0.3,0.1\}, 8GB\{0.9,0.1\}, 1920 \times 1080 Pixels\{0.1,0.1\}, 4800MAH\{0.3,0.2\}, 8GB\{0.7,0.4\}, 6^{th}$ $Generation\{0.6,0.1\}) >< e_4(Samsung\{0.4,0.1\}, 8GB\{0.3,0.1\}, 1920 \times 1080 Pixels\{0.3,0.1\}, 4800MAH\{0.5,0.4\}, 8GB\{0.9,0.1\}, 6\text{^}th$ $Generation\{0.7,0.1\}) >\}$

Definition 3.7: intersection of a two intuitionistic fuzzy hypersoft set

Suppose $F(\alpha_1)$ and $F(\alpha_2)$ be two intuitionistic fuzzy hypersoft sets over E. Suppose $h_1, h_2, h_3 \dots\dots\dots h_n$ where $n \geq 1$ be n distinct attributes whose corresponding attributive values respectively the sets $H_1, H_2, H_3 \dots\dots\dots H_n$with $H_i \cap H_J = \emptyset, i \neq j$ and $i, j\epsilon\{0,1,2,3 \dots\dots\dots . n\}$ then the relation $H_1 \times H_2 \times H_3 \times \dots\dots\dots \times H_n = \alpha$ then $F(\alpha_1) \cap F(\alpha_2)$ given as

$$\mu\big(F(\alpha_1) \cap F(\alpha_2)\big) = \begin{cases} \mu\big(F(\alpha_1)\big) & if\ x \in \alpha_1 \\ \mu\big(F(\alpha_2)\big) & if\ x \in \alpha_2 \\ min\Big(\mu\big(F(\alpha_1)\big), \mu\big(F(\alpha_2)\big)\Big) & if\ x \in\ \alpha_1 \cap \alpha_2 \end{cases}$$

$$\gamma\big(F(\alpha_1) \cap F(\alpha_2)\big) = \begin{cases} \gamma\big(F(\alpha_1)\big) & if\ x \in \alpha_1 \\ \gamma\big(F(\alpha_2)\big) & if\ x \in \alpha_2 \\ max\Big(\gamma\big(F(\alpha_1)\big), \gamma\big(F(\alpha_2)\big)\Big) & if\ x \in\ \alpha_1 \cap \alpha_2 \end{cases}$$

Example 3.7. Consider the two intuitionistic fuzzy hyper soft sets $IFHSS\ F(\alpha_1)$ and $IFHSS\ F(\alpha_2)$ over same universe $E = \{e_1, e_2, e_3 \dots\dots\dots e_n\}$. The IFHSS $F(\alpha_1) = F\{$Samsung, 8GB, $1920 \times 1080 Pixels, 4800MAH, 8GB, 6^{th}$ $Generation\} = \{e_2, e_4\}$ is the subset of $IFHSS\ F(\alpha_2) = F\{$Samsung, 8GB,$1920 \times 1080 Pixels$, $4800MAH, 8GB$, 6^{th} $Generation\} = \{e_2, e_4\}$ The tabulated forms of the the above discussed Example 3.7 are Table 18 to Table 20.

Table 18. Tabular representation of intuitionistic Hyper soft set $F(\alpha_1)$.

$F(\alpha_1)$	e_2	e_4
Samsung	(0.3,0.1)	(0.1,0.4)
8GB	(0.9,0.1)	(0.1,0.3)
1920 × 1080Pixels	(0.1,0.1)	(0.3,0.1)
4800MAH	(0.3,0.2)	(0.4,0.5)
8GB	(0.7,0.4)	(0.9,0.1)
6^{th} Generation	(0.1,0.6)	(0.7,0.1)

Table 19. Tabular representation of intuitionistic Hypersoft set $F(\alpha_2)$.

$F(\alpha_2)$	e_2	e_4
Samsung	(0.1,0.3)	(0.4,0.1)
8GB	(0.1,0.9)	(0.3,0.1)
1920 × 1080Pixels	(0.1,0.1)	(0.1,0.3)
4800MAH	(0.2,0.3)	(0.5,0.4)
8GB	(0.4,0.7)	(0.1,0.9)
6^{th} Generation	(0.6,0.1)	(0.1,0.7)

Table 20. Tabular representation of intuitionistic Hypersoft set $F(\alpha_1) \cap F(\alpha_2)$.

$F(\alpha_1) \cap F(\alpha_2)$	e_2	e_4
Samsung	(0.1,0.3)	(0.1,0.4)
8GB	(0.1,0.9)	(0.1,0.3)
1920 × 1080Pixels	(0.1,0.1)	(0.1,0.3)
4800MAH	(0.2,0.3)	(0.4,0.5)
8GB	(0.4,0.7)	(0.1,0.9)
6^{th} Generation	(0.1,0.6)	(0.1,0.7)

It can be written as

$(F(\alpha_1)) \cap (F(\alpha_2)) = F\{\text{Samsung}, \ 8\text{GB}, 1920 \times 1080 Pixels, 4800MAH, 8GB, \ 6^{th}\ Generation\} \cap F\{\text{Samsung}, 8\text{GB}, 1920 \times 1080 Pixels, 4800MAH, 8GB, 6^{th}\ Generation\} = \{< e_2(Samsung\{0.1,0.3\}, 8GB\{0.1,0.9\}, 1920 \times 1080 Pixels\{0.1,0.1\}, 4800MAH\{0.2,0.3\}, 8GB\{0.4,0.7\}, 6^{th}\ Generation\{0.1,0.6\}) >< (Samsung\{0..1,0.4\}, 8GB\{0.1,0.3\}, 1920 \times 1080 Pixels\{0.1,0.3\}, 4800MAH\{0.4,0.5\}, 8GB\{0.9,0.1\}, 6^{th}\ \ Generation\{0.1,0.7\}) >\}$

Definition 3.8. (AND operation on two intuitionistic fuzzy hypersoft set). Suppose $F(\alpha_1)$ and $F(\alpha_2)$ be two intuitionistic fuzzy hypersoft sets over E. Suppose $h_1, h_2, h_3 \ldots \ldots \ldots h_n$ where $n \geq 1$ be n distinct attributes whose corresponding attributive values respectively the sets $H_1, H_2, H_3 \ldots \ldots \ldots H_n$ with $H_i \cap H_J = \emptyset, i \neq j$ and $i, j \epsilon \{0,1,2,3 \ldots \ldots \ldots . n\}$ then the relation $H_1 \times H_2 \times H_3 \times \ldots \ldots \ldots \times H_n = \alpha$ then $F(\alpha_1) \wedge F(\alpha_2) = F(\alpha_1 \times \alpha_2)$ given as

$$\mu(\alpha_1 \times \alpha_2) = min\left(\mu(F(\alpha_1)), \mu(F(\alpha_2))\right)$$

$$\gamma(\alpha_1 \times \alpha_2) = max\left(\gamma(F(\alpha_1)), \gamma(F(\alpha_2))\right)$$

Example 3.8. Consider the two intuitionistic fuzzy hypersoft sets $IFHSS\ F(\alpha_1)$ and $IFHSS\ F(\alpha_2)$ over same universe $E = \{e_1, e_2, e_3 \ldots \ldots \ldots e_n\}$. The $IFHSS\ F(\alpha_1) = F\{\text{Samsung, 8GB}, 1920 \times 1080 Pixels\} = \{e_2, e_4\}$ is the subset of $IFHSS\ F(\alpha_2) = F\{\text{Samsung, 8GB}\} = \{e_2, e_4\}$. The tabulated forms of the the above discussed Example 3.8 are Table 21 to Table 23.

Table 21. Tabular representation of intuitionistic Hypersoft set $F(\alpha_1)$.

$F(\alpha_1)$	e_2	e_4
Samsung	(0.3,0.1)	(0.1,0.4)
8GB	(0.9,0.1)	(0.1,0.3)
1920 × 1080Pixels	(0.1,0.1)	(0.3,0.1)

Table 22. Tabular representation of intuitionistic Hypersoft set $F(\alpha_2)$.

$F(\alpha_2)$	e_2	e_4
Samsung	(0.1,0.3)	(0.4,0.1)
8GB	(0.1,0.9)	(0.3,0.1)

Table 23. Tabular representation of intuitionistic Hypersoft set $F(\alpha_1) \wedge F(\alpha_2)$.

$F(\alpha_1) \wedge F(\alpha_2)$	e_2	e_4
Samsung × Samsung	(0.1,0.3)	(0.1,0.4)
Samsung × 8GB	(0.1,0.9)	(0.1,0.4)
8GB ×Samsung	(0.1,0.3)	(0.1,0.3)
8GB × 8GB	(0.1,0.9)	(0.1,0.3)
1920 × 1080Pixels × Samsung	(0.1,0.3)	(0.3,0.1)
1920 × 1080Pixels × 8GB	(0.1,0.9)	(0.3,0.1)

Definition 3.9. (OR operation on two intuitionistic fuzzy hypersoft set). Suppose $F(\alpha_1)$ and $F(\alpha_2)$ be two intuitionistic fuzzy hypersoft sets over E. Suppose $h_1, h_2, h_3 \ldots\ldots\ldots h_n$ where $n \geq 1$ be n distinct attributes whose corresponding attributive values respectively the sets $H_1, H_2, H_3 \ldots\ldots\ldots H_n$with $H_i \cap H_J = \emptyset, i \neq j$ and $i, j \epsilon \{0,1,2,3 \ldots\ldots\ldots. n\}$ then the relation $H_1 \times H_2 \times H_3 \times \ldots\ldots\ldots \times H_n = \alpha$ then $F(\alpha_1) \vee F(\alpha_2) = F(\alpha_1 \times \alpha_2)$ given as

$$\mu(\alpha_1 \times \alpha_2) = max\left(\mu(F(\alpha_1)), \mu(F(\alpha_2))\right)$$

$$\gamma(\alpha_1 \times \alpha_2) = min\left(\gamma(F(\alpha_1)), \gamma(F(\alpha_2))\right)$$

Example 3.9. Consider the two intuitionistic fuzzy hypersoft sets $IFHSS\ F(\alpha_1)$ and $IFHSS\ F(\alpha_2)$ over same universe $E = \{e_1, e_2, e_3 \ldots\ldots\ldots e_n\}$. The $IFHSS\ F(\alpha_1) = F\{$Samsung, 8GB,$1920 \times 1080 Pixels\}=\{e_2, e_4\}$ is the subset of $IFHSS\ F(\alpha_2) = F\{$Samsung, 8GB$\} = \{e_2, e_4\}$. The tabulated forms of the the above discussed Example 3.9 are Table 24 to Table 26.

Table 24. Tabular representation of intuitionistic Hypersoft set $F(\alpha_1)$.

$F(\alpha_1)$	e_2	e_4
Samsung	(0.3,0.1)	(0.1,0.4)
8GB	(0.9,0.1)	(0.1,0.3)
1920 × 1080Pixels	(0.1,0.1)	(0.3,0.1)

Table 25. Tabular representation of intuitionistic Hypersoft set $F(\alpha_2)$.

$F(\alpha_2)$	e_2	e_4
Samsung	(0.1,0.3)	(0.4,0.1)
8GB	(0.1,0.9)	(0.3,0.1)

Table 26. Tabular representation of intuitionistic Hypersoft set $F(\alpha_1) \vee F(\alpha_2)$.

$F(\alpha_1) \vee F(\alpha_2)$	e_2	e_4
Samsung × Samsung	(0.3,0.1)	(0.4,0.1)
Samsung × 8GB	(0.3,0.1)	(0.3,0.1)
8GB ×Samsung	(0.9,0.1)	(0.4,0.1)
8GB × 8GB	(0.9,0.1)	(0.3,0.1)
1920 × 1080Pixels × Samsung	(0.1,0.1)	(0.4,0.1)
1920 × 1080Pixels × 8GB	(0.1,0.1)	(0.3,0.1)

4 | Result Discussion

Decision-making problems have many dimensions, such as having more than one attribute or further bifurcation, which makes it a very complex issue for the decision-makers. Tackling of such problems or issues cannot be handled alone by Intuitionistic soft set. So, a new approach was needed to solve these problems. A new tool has been introduced by the name of Intuitionistic hypersoft set and its important operations have been presented by suitable examples.

5 | Conclusions

In this paper, operations such as union, intersection, compliment AND and OR operations of intuitionistic Hypersoft set have been presented. Suitable examples have been used to prove the implementation and validity of the operations and definitions of intuitionistic hypersoft set. Using the proposed operations of this tool, many problems related to decision-making can be solved in personal selection, office management, industrial equipment etc. In future, further research work can be done on the tool intuitionistic Hypersoft which include its properties of union, intersection operations, cardinality and functions.

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Conflicts of Interest

The author declare that there is no conflict of interest in the research.

Ethical Approval

This article does not contain any studies with human participants or animals performed by any of the authors.

Data Availability

There was no data used in the inquiry that was as stated in the article.

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