# Some Results on Intuitionistic Fuzzy Soft Sets

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*Abstract*— The purpose of this paper is to study some basic operations and results available in the literature of intuitionistic fuzzy soft sets. Some new results along with illustrating examples have been put forward in our work

*Keywords*— Intuitionistic Fuzzy Set, Soft Set, Fuzzy Soft Set, Intuitionistic Fuzzy Soft Set.

#### I. INTRODUCTION

Most of our of real life problems in engineering, social and medical sciences, economics etc. involve imprecise data and their solution involves the use of mathematical principles based on uncertainty and imprecision. To handle such uncertainties a number of theories have been proposed for dealing with such systems in an effective way. Some of these are probability, fuzzy sets, intuitionistic fuzzy sets, interval mathematics and rough sets etc. All these theories, however, are associated with an inherent limitation, which is the inadequacy of the parameterization tool associated with these theories. In 1999, Molodtsov [1] introduced soft sets and established the fundamental results of the new theory. It is a general mathematical tool for dealing with objects which have been defined using a very loose and hence very general set of characteristics. A soft set is a collection of approximate descriptions of an object. Each approximate description has two parts: a predicate and an approximate value set. In classical mathematics, we construct a mathematical model of an object and define the notion of the exact solution of this model. Usually the mathematical model is too complicated and we cannot find the exact solution. So, in the second step, we introduce the notion of approximate solution and calculate that solution. In the Soft Set Theory, we have the opposite approach to this problem. The initial description of the object has an approximate nature, and we do not need to introduce the notion of exact solution. The absence of any restrictions on the approximate description in Soft Set Theory makes this theory very convenient and easily applicable in practice. We can use any parameterization we prefer with the help of words and sentences, real numbers, functions, mappings and so on. It means that the problem does not arise in Soft Set Theory. In [1], besides demarcating the basic contours of Soft Set Theory, Molodtsov also showed how Soft Set Theory is free from parameterization inadequacy syndrome of Fuzzy Set Theory, Rough Set Theory, Probability Theory and Game Theory. Soft Set Theory is a very general framework. Many of the

established paradigms appear as special cases of Soft Set Teory.

In recent times, researches have contributed a lot towards fuzzification of Soft Set Theory. Maji et al. [4] introduced the concept of Fuzzy Soft Set and some properties regarding fuzzy soft union, intersection, complement of a fuzzy soft set, De Morgan Law etc. Recently, Bora, Neog and Sut [3] have studied the basic operations of fuzzy soft sets along with examples and proofs of certain results. The notion of Intuitionistic fuzzy soft sets, which is a combination of soft sets and Intuitionistic fuzzy sets was initiated by Maji [5]. They have put forward several basic notions of this new theory.

In this paper, we have investigated some basic operations and results available in the literature of Intuitionistic fuzzy soft sets.

### II. PRELIMINARIES

In this section, we first recall some basic notions which would be used in the sequel.

Let *U* be an initial universe, and *E* be the set of all possible parameters under consideration with respect to *U*. The set of all subsets of *U*, *i.e.* the power set of *U* is denoted by P(U) and the set of all Intuitionistic fuzzy subsets of *U* is denoted by  $IF^{U}$ . Let *A* be a subset of *E*.

#### Definition 1. [1]

A pair (*F*, *A*) is called a soft set (over *U*) where *F* is a mapping  $F: A \rightarrow P(U)$ . In other words, the soft set is a parameterized family of subsets of the set *U*. Every set  $F(\varepsilon), \varepsilon \in E$ , from this family may be considered as the set of  $\varepsilon$  - elements of the soft set (*F*, *A*), or as the set of  $\varepsilon$  - approximate elements of the soft set.

Definition 2. [2]

An intuitionistic fuzzy set A over the universe U can be defined as follows –

 $A = \{ (x, \mu_A(x), v_A(x)) : x \in U \}$ , where

$$\begin{split} \mu_A(x) &: U \to [0,1], v_A(x) : U \to [0,1] \quad \text{with} \quad \text{the property} \\ 0 &\leq \mu_A(x) + v_A(x) \leq 1 \quad \forall x \in U. \quad \text{The values} \quad \mu_A(x) \quad \text{and} \\ v_A(x) \text{ represent the degree of membership and non-} \end{split}$$

membership of *x* to *A* respectively.

 $\pi_A(x) = 1 - (\mu_A(x) + \nu_A(x))$  is called the intuitionistic fuzzy index.

# Definition 3. [2]

An intuitionistic fuzzy set *A* over the universe *U* defined as  $A = \{(x,0,1) : x \in U\}$  is said to be intuitionistic fuzzy null set and is denoted by  $\overline{0}$ .

## Definition 4. [2]

An intuitionistic fuzzy set *A* over the universe *U* defined as  $A = \{(x,1,0) : x \in U\}$  is said to be intuitionistic fuzzy absolute set and is denoted by  $\overline{1}$ .

## Definition 5. [2]

Let  $A = \{(x, \mu_A(x), \nu_A(x)) : x \in U\}$  be an intuitionistic fuzzy set over the universe U, where  $\mu_A(x) : U \to [0,1]$ ,

 $v_A(x): U \to [0,1]$  with the property  $0 \le \mu_A(x) + v_A(x) \le 1$  $\forall x \in U$ . Complement of *A* is denoted by  $A^c$  and defined as the intuitionistic fuzzy set  $A^c = \{(x, v_A(x), \mu_A(x)): x \in U\}$ .

Definition 6. [2]

Let  $A = \{ (x, \mu_A(x), v_A(x)) : x \in U \}$ ,

 $B = \{(x, \mu_B(x), \nu_B(x)) : x \in U\}$  be two intuitionistic fuzzy sets over the universe U, where  $\mu_A(x) : U \to [0,1]$ ,

$$\begin{split} v_A(x): U \to [0,1], \quad \mu_B(x): U \to [0,1], \quad v_B(x): U \to [0,1] \quad \text{with} \\ \text{the property } 0 &\leq \mu_A(x) + v_A(x), \mu_B(x) + v_B(x) \leq 1 \quad \forall x \in U \ . \\ \text{Union of } A \text{ and } B \text{ is defined as} \\ A \cup B &= \left\{ x, \max(\mu_A(x), \mu_B(x)), \min(v_A(x), v_B(x)) \right\} \\ \text{and intersection of } A \text{ and } B \text{ is defined as} \\ A \cap B &= \left\{ x, \min(\mu_A(x), \mu_B(x)), \max(v_A(x), v_B(x)) \right\} \end{split}$$

Definition 7. [5]

Let *U* be an initial universe set and *E* be the set of parameters. Let  $IF^U$  denote the collection of all intuitionistic fuzzy subsets of *U*. Let  $A \subseteq E$ . A pair (*F*, *A*) is called an intuitionistic fuzzy soft set over *U* where *F* is a mapping given by  $F: A \rightarrow IF^U$ .

Example 1.

Let (F, A) describe the character of the students with respect to the given parameters, for finding the best student of an academic year. Let the set of students under consideration be  $U = \{s_1, s_2, s_3, s_4\}$ . Let  $E = \{\text{ good result } (r), \text{ conduct } (c),$ games and sports performances (g), sincerity(s), pleasing personality  $(p)\}$  be the set of parameters framed to choose the best student. Suppose Mr. X has the parameter set  $A = \{r, c, p\} \subseteq E$  to choose the best student. Then

$$= \{F(r) = \{(s_1, 0.8, 0.1), (s_2, 0.7, 0.05), (s_3, 0.9, 0.1), (s_4, 0.7, 0.2)\}\},$$
  
$$\{F(c) = \{(s_1, 0.6, 0.2), (s_2, 0.7, 0.1), (s_3, 0.5, 0.3), (s_4, 0.3, 0.6)\}\},$$

$$\{F(p) = \{(s_1, 0.6, 0.2), (s_2, 0.7, 0.1), (s_3, 0.5, 0.3), (s_4, 0.3, 0.6)\}\}\}$$

Definition 8. [5]

Union of two intuitionistic fuzzy soft sets (F, A) and (G, B) over (U, E) is an Intuitionistic fuzzy soft set (H, C) where  $C = A \cup B$  and  $\forall \varepsilon \in C$ ,

$$H(\varepsilon) = \begin{cases} F(\varepsilon), & \text{if } \varepsilon \in A - B \\ G(\varepsilon), & \text{if } \varepsilon \in B - A \\ F(\varepsilon) \cup G(\varepsilon), & \text{if } \varepsilon \in A \cap B \end{cases}$$

and is written as  $(F,A) \widetilde{\cup} (G,B) = (H,C)$ .

Definition 9. [5]

Let (F, A) and (G, B) be two intuitionistic fuzzy soft sets over (U, E). Then intersection (F, A) and (G, B) is an intuitionistic fuzzy soft set (H, C) where  $C = A \cap B$  and  $\forall \varepsilon \in C$ ,  $H(\varepsilon) = F(\varepsilon) \cap G(\varepsilon)$ . We write  $(F, A) \cap (G, B) = (H, C)$ .

Definition 10. [5]

For two Intuitionistic fuzzy soft sets (F, A) and (G, B) over (U, E), we say that (F, A) is an intuitionistic fuzzy soft subset of (G, B), if

(*i*) 
$$A \subseteq B$$

(*ii*) For all  $\varepsilon \in A$ ,  $F(\varepsilon) \subseteq G(\varepsilon)$  and is written as  $(F, A) \subset (G, B)$ .

Definition 11. [5]

The complement of an intuitionistic fuzzy soft set (F, A) is denoted by  $(F, A)^c$  and is defined by  $(F, A)^c = (F^c, \neg A)$ , where  $F^c$  :  $\neg A \rightarrow IF^U$  is a mapping given by  $F^c(\sigma) = (F(\neg \sigma))^c$  for all  $\sigma \in \neg A$ .

Definition 12. [5]

If (F, A) and (G, B) be two intuitionistic fuzzy soft sets, then "(F, A) AND (G, B)" is an intuitionistic fuzzy soft set denoted by  $(F, A) \land (G, B)$  and is defined by

 $(F, A) \land (G, B) = (H, A \times B)$ , where

 $H(\alpha, \beta) = F(\alpha) \cap G(\beta), \forall \alpha \in A \text{ and } \forall \beta \in B$ , where  $\cap$  is the operation intersection of two intuitionistic fuzzy sets.

#### Definition 13. [5]

If (F, A) and (G, B) be two intuitionistic fuzzy soft sets, then "(F, A) OR (G, B)" is an intuitionistic fuzzy soft set denoted by  $(F, A) \lor (G, B)$  and is defined by

 $(F, A) \lor (G, B) = (K, A \times B)$ , where

 $K(\alpha, \beta) = F(\alpha) \cup G(\beta), \forall \alpha \in A \text{ and } \forall \beta \in B$ , where  $\cup$  is the operation union of two intuitionistic fuzzy sets.

## III. A STUDY ON SOME OPERATIONS IN INTUITIONISTIC FUZZY SOFT SETS

First we give the definition of complement of an intuitionistic fuzzy soft set in our way as follows:

Definition 1.

The complement of an Intuitionistic fuzzy soft set (F, A) is denoted by (F, A)<sup>*c*</sup> and is defined by  $(F, A)^c = (F^c, A)$ , where  $F^c: A \rightarrow IF^U$  is a mapping given by  $F^c(\varepsilon) = [F(\varepsilon)]^c$  for all  $\varepsilon \in A$ . Thus if  $F(\varepsilon) = \{x, \mu_{F(\varepsilon)}(x), v_{F(\varepsilon)}(x) : x \in U\}$ , then  $\forall \varepsilon \in A, F^c(\varepsilon) = (F(\varepsilon))^c = \{x, \mu_{F(\varepsilon)}(x), v_{F(\varepsilon)}(x) : x \in U\}$ 

Now, in this section, we shall endeavour to study the basic operations and results available in the literature of intuitionistic fuzzy soft sets. We would refer to an intuitionistic fuzzy soft null set or Intuitionistic fuzzy soft absolute set with respect to the set  $A \subseteq E$  of parameters under consideration. We would use the notation  $(\varphi, A)$  to represent the intuitionistic fuzzy soft null set with respect to the set of parameters A and the notation (U, A) to represent the Intuitionistic fuzzy soft absolute set with respect to the set of parameters A and the notation (U, A) to represent the Intuitionistic fuzzy soft absolute set with respect to the set of parameters A.

Proposition 1.

$$1.(\varphi, A)^{c} = (U, A)$$
Proof. Let  $(\varphi, A) = (F, A)$   
Then  $\forall \varepsilon \in A$ ,  
 $F(\varepsilon) = \{(x, \mu_{F(\varepsilon)}(x), v_{F(\varepsilon)}(x)): x \in U\}$   
 $= \{(x, 0, 1): x \in U\}$   
 $(\varphi, A)^{c} = (F, A)^{c} = (F^{c}, A)$ , where  $\forall \varepsilon \in A$ ,  
 $F^{c}(\varepsilon) = (F(\varepsilon))^{c}$   
 $= \{(x, \mu_{F(\varepsilon)}(x), v_{F(\varepsilon)}(x)): x \in U\}^{c}$   
 $= \{(x, v_{F(\varepsilon)}(x), \mu_{F(\varepsilon)}(x)): x \in U\}$   
 $= \{(x, 1, 0): x \in U\}$   
 $= U$   
Thus  $(\varphi, A)^{c} = (U, A)$   
 $2.(U, A)^{c} = (\varphi, A)$   
Proof. Let  $(U, A) = (F, A)$   
Then  $\forall \varepsilon \in A$ ,  
 $F(\varepsilon) = \{(x, \mu_{F(\varepsilon)}(x), v_{F(\varepsilon)}(x)): x \in U\}$   
 $= \{(x, 1, 0): x \in U\}$   
 $= \{(x, 1, 0): x \in U\}$ 

$$F^{c}(\varepsilon) = (F(\varepsilon))^{c}$$

$$= \{(x, \mu_{F(\varepsilon)}(x), v_{F(\varepsilon)}(x)) : x \in U\}^{c}$$

$$= \{(x, v_{F(\varepsilon)}(x), \mu_{F(\varepsilon)}(x)) : x \in U\}$$

$$= \{(x, 0, 1) : x \in U\}$$

$$= \varphi$$
Thus  $(U, A)^{c} = (\varphi, A)$ 

$$3.(F, A) \widetilde{\cup} (\varphi, A) = (F, A)$$

 $\begin{array}{ll} & \text{Proof. We have} \\ & \left(F,A\right) = \left\{ \left(\varepsilon, \left(x, \mu_{F(\varepsilon)}(x), \nu_{F(\varepsilon)}(x)\right)\right) : x \in U \right\} \quad \forall \varepsilon \in A \\ & \left(\varphi,A\right) = \left\{ \left(\varepsilon, \left(x,0,1\right)\right) : x \in U \right\} \quad \forall \varepsilon \in A \\ & \text{of} \quad (F,A) \widetilde{\cup} \left(\varphi,A\right) \\ & \text{n} \quad = \left\{ \left(\varepsilon, \left(x, \max\left(\mu_{F(\varepsilon)}(x),0\right), \min\left(\nu_{F(\varepsilon)}(x),1\right)\right)\right) : x \in U \right\} \quad \forall \varepsilon \in A \\ & \text{ft} \quad = \left\{ \left(\varepsilon, \left(x, \mu_{F(\varepsilon)}(x), \nu_{F(\varepsilon)}(x)\right)\right) : x \in U \right\} \quad \forall \varepsilon \in A \\ & \text{nt} \quad = \left(F,A\right) \\ & \text{of} \quad \text{Thus} \ (F,A) \widetilde{\cup} \left(\varphi,A\right) = \left(F,A\right) \end{array}$ 

$$4(F,A)\widetilde{\cup}(U,A) = (U,A)$$

Proof. We have  $\begin{array}{l} \left(F,A\right) &= \left\{ \left(\varepsilon, \left(x, \mu_{F(\varepsilon)}\left(x\right), \nu_{F(\varepsilon)}\left(x\right)\right)\right) : x \in U \right\} \quad \forall \varepsilon \in A \\ \left(U,A\right) &= \left\{ \left(\varepsilon, \left(x,1,0\right)\right) : x \in U \right\} \quad \forall \varepsilon \in A \\ \left(F,A\right) \widetilde{\cup} \left(U,A\right) \\ &= \left\{ \left(\varepsilon, \left(x,\max\left(\mu_{F(\varepsilon)}\left(x\right),1\right), \min\left(\nu_{F(\varepsilon)}\left(x\right),0\right)\right)\right) : x \in U \right\} \quad \forall \varepsilon \in A \\ &= \left\{ \left(\varepsilon, \left(x,1,0\right)\right) : x \in U \right\} \quad \forall \varepsilon \in A \\ &= \left(U,A\right) \\ Thus \quad \left(F,A\right) \widetilde{\cup} \left(U,A\right) = \left(U,A\right) \end{array}$ 

$$5(F, A) \widetilde{\cap} (\varphi, A) = (\varphi, A)$$

Proof. We have  $\begin{aligned} & \left(F,A\right) &= \left\{\!\!\left\{\varepsilon, \left(x, \mu_{F(\varepsilon)}(x), \nu_{F(\varepsilon)}(x)\right)\!\!\right\}: x \in U\right\} \; \forall \varepsilon \in A \\ & \left(\phi,A\right) &= \left\{\!\!\left\{\varepsilon, \left(x,0,1\right)\!\right\}: x \in U\right\} \; \forall \varepsilon \in A \\ & \left(F,A\right) \widetilde{\frown} \left(\phi,A\right) \\ &= \left\{\!\!\left\{\varepsilon, \left(x,\min\left(\mu_{F(\varepsilon)}(x),0\right)\max\left(\nu_{F(\varepsilon)}(x),1\right)\!\right)\!\!\right\}: x \in U\right\} \; \forall \varepsilon \in A \\ &= \left\{\!\!\left\{\varepsilon, \left(x,0,1\right)\!\right\}: x \in U\right\} \; \forall \varepsilon \in A \\ &= \left\{\!\!\left(\varphi,A\right) \\ & \text{Thus} \; \left(F,A\right) \widetilde{\frown} \left(\phi,A\right) \!= \!\left(\varphi,A\right) \\ & 6.\left(F,A\right) \widetilde{\frown} \left(U,A\right) \!= \!\left(F,A\right) \end{aligned}$ 

Proof. We have  $(F, A) = \{ \varepsilon, (x, \mu_{F(\varepsilon)}(x), v_{F(\varepsilon)}(x)) : x \in U \} \quad \forall \varepsilon \in A$ 

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 $(U, A) = \{(\varepsilon, (x, 1, 0)) : x \in U\} \ \forall \varepsilon \in A$  $(F,A) \widetilde{\cap} (U,A)$  $= \left\{ \left( \varepsilon, \left( x, \min(\mu_{F(\varepsilon)}(x), 1), \max(\nu_{F(\varepsilon)}(x), 0) \right) \right) : x \in U \right\} \quad \forall \varepsilon \in A$  $= \left\{ \left( \varepsilon, \left( x, \mu_{F(\varepsilon)}(x), v_{F(\varepsilon)}(x) \right) \right) : x \in U \right\} \quad \forall \varepsilon \in A$ =(F,A)Thus  $(F, A) \widetilde{\frown} (U, A) = (F, A)$ 

7. $(F, A) \widetilde{\cup} (\varphi, B) = (F, A)$  if and only if  $B \subseteq A$ 

# Proof.

We have for (F, A) $=\left\{\!\!\left(x,\mu_{F(\varepsilon)}(x),v_{F(\varepsilon)}(x)\right)\!\!:x\!\in\!U\right\}\;\forall\varepsilon\in A$  $F(\varepsilon)$ Also, let  $(\varphi, B) = (G, B)$ , Then  $G(\varepsilon) = \{(x,0,1) \colon x \in U\} \ \forall \varepsilon \in B$ Let  $(F, A) \widetilde{\cup} (\varphi, B) = (F, A) \widetilde{\cup} (G, B) = (H, C)$ , where  $C = A \cup B$  and  $\forall \varepsilon \in C$ ,  $H(\varepsilon)$  $= \begin{cases} \left\{ \left(x, \mu_{F(\varepsilon)}(x), v_{F(\varepsilon)}(x)\right) : x \in U \right\}, \text{if } \varepsilon \in A - B \\ \left\{ \left(x, \mu_{G(\varepsilon)}(x), v_{G(\varepsilon)}(x)\right) : x \in U \right\}, \text{if } \varepsilon \in B - A \\ \left\{ \left(x, \max\left(\mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x)\right), \min\left(v_{F(\varepsilon)}(x), v_{G(\varepsilon)}(x)\right)\right) \\ : x \in U \end{cases} \right\}, \end{cases}$ if  $\varepsilon \in A \cap B$ 

$$= \begin{cases} \left\{ (x, \mu_{F(\varepsilon)}(x), v_{F(\varepsilon)}(x)) : x \in U \right\}, \text{ if } \varepsilon \in A - B \\ \left\{ (x, 0, 1) : x \in U \right\}, \text{ if } \varepsilon \in B - A \\ \left\{ (x, \max(\mu_{F(\varepsilon)}(x), 0), \min(v_{F(\varepsilon)}(x), 1)) : x \in U \right\}, \text{ if } \varepsilon \in A \cap B \end{cases}$$

$$= \begin{cases} \{(x, \mu_{F(\mathcal{E})}(x), v_{F(\mathcal{E})}(x)) : x \in U\}, \text{ if } \mathcal{E} \in A - B \\ \{(x, 0, 1) : x \in U\}, \text{ if } \mathcal{E} \in B - A \\ \{(x, \mu_{F(\mathcal{E})}(x), v_{F(\mathcal{E})}(x)) : x \in U\}, \text{ if } \mathcal{E} \in A \cap B \end{cases}$$
  
Let  $B \subseteq A$   
Then

 $H(\varepsilon) = \begin{cases} \left\{ (x, \mu_{F(\varepsilon)}(x), v_{F(\varepsilon)}(x)) : x \in U \right\} \text{ if } \varepsilon \in A - B \\ \left\{ (x, \mu_{F(\varepsilon)}(x), v_{F(\varepsilon)}(x)) : x \in U \right\} \text{ if } \varepsilon \in A \cap B \end{cases}$  $= F(\varepsilon) \ \forall \varepsilon \in A$ Conversely, let  $(F, A) \widetilde{\cup} (\varphi, B) = (F, A)$ Then  $A = A \cup B \implies B \subseteq A$ 

8.
$$(F, A) \widetilde{\cup} (U, B) = (U, B)$$
 if and only if  $A \subseteq B$ 

Proof.

We have for (F, A) $F(\varepsilon) = \left\{ \left( x, \mu_{F(\varepsilon)}(x), v_{F(\varepsilon)}(x) \right) : x \in U \right\} \quad \forall \varepsilon \in A$  Also, let (U, B) = (G, B), Then  $= \{(x,1,0): x \in U\} \forall \varepsilon \in B$  $G(\varepsilon)$ Let  $(F, A) \widetilde{\cup} (U, B) = (F, A) \widetilde{\cup} (G, B) = (H, C)$ , where  $C = A \cup B$  and  $\forall \varepsilon \in C$ ,

# $H(\varepsilon)$

 $= \begin{cases} \left\{ \begin{pmatrix} x, \mu_{F(\varepsilon)}(x), v_{F(\varepsilon)}(x) \end{pmatrix} : x \in U \\ \left\{ x, \mu_{G(\varepsilon)}(x), v_{G(\varepsilon)}(x) \end{pmatrix} : x \in U \\ \left\{ x, \max\left( \mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x) \right) \\ \min\left( v_{F(\varepsilon)}(x), v_{G(\varepsilon)}(x) \right) \\ \right\} \\ \left\{ x \in U \\ \left\{ x, \max\left( \mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x) \right) \\ \left\{ x \in U \\ \right\} \\ \left\{ x \in U \\ \left\{ x, \max\left( \mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x) \right) \\ \left\{ x \in U \\ \left\{ x, \max\left( \mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x) \right) \\ \left\{ x \in U \\ \left\{ x, \max\left( \mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x) \right) \\ \left\{ x \in U \\ \left\{ x, \max\left( \mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x) \right) \\ \left\{ x \in U \\ \left\{ x, \max\left( \mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x) \right) \\ \left\{ x \in U \\ \left\{ x, \max\left( \mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x) \right) \\ \left\{ x \in U \\ \left\{ x, \max\left( \mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x) \right) \\ \left\{ x \in U \\ \left\{ x, \max\left( \mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x) \right) \\ \left\{ x \in U \\ \left\{ x, \max\left( \mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x) \right) \\ \left\{ x \in U \\ \left\{ x, \max\left( \mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x) \right) \\ \left\{ x \in U \\ \left\{ x, \max\left( \mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x) \right) \\ \left\{ x, \max\left( \mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x) \right) \\ \left\{ x \in U \\ \left\{ x, \max\left( \mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x) \right) \right\} \\ \left\{ x, \max\left( \mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x) \right) \\ \left\{ x, \max\left( \mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x) \right) \\ \left\{ x, \max\left( \mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x) \right) \right\} \\ \left\{ x, \max\left( \mu_{F(\varepsilon)}(x), \mu_{F(\varepsilon)}(x) \right) \right\} \\ \left\{ x, \max\left( \mu_{F(\varepsilon)}(x$ 

if  $\varepsilon \in A \cap B$ 

 $= \begin{cases} \left\{ (x, \mu_{F(\varepsilon)}(x), v_{F(\varepsilon)}(x) \right\} : x \in U \end{cases} \text{if } \varepsilon \in A - B \\ \left\{ (x, 1, 0) : x \in U \right\} \text{, if } \varepsilon \in B - A \\ \left\{ (x, \max(\mu_{F(\varepsilon)}(x), 1), \min(v_{F(\varepsilon)}(x), 0) \right\} : x \in U \end{cases} \text{, if } \varepsilon \in A \cap B \end{cases}$ 

 $\left[\left\{\!\!\left(x,\mu_{F(\varepsilon)}(x),v_{F(\varepsilon)}(x)\right)\!\!:x\in U\right\}\!\!,\text{if }\varepsilon\in A-B$  $= \left\{ \{(x,1,0): x \in U\}, \text{ if } \varepsilon \in B - A \right\}$  $\{(x,1,0): x \in U\}, \text{ if } \varepsilon \in A \cap B$ 

Let 
$$A \subseteq B$$

Then

$$H(\varepsilon) = \begin{cases} \{(x,1,0) : x \in U\}, \text{if } \varepsilon \in B - A \\ \{(x,1,0) : x \in U\}, \text{if } \varepsilon \in A \cap B \\ = G(\varepsilon) \ \forall \varepsilon \in B \end{cases}$$
  
Conversely, let  $(F, A) \widetilde{\cup} (U, B) = (U, B)$   
Then  $B = A \cup B \Longrightarrow A \subset B$ 

$$9(F, A) \widetilde{\cap} (\varphi, B) = (\varphi, A \cap B)$$

Proof. We have for (F, A) $=\left\{\!\!\left(x,\mu_{F(\varepsilon)}(x),v_{F(\varepsilon)}(x)\right)\!\!:x\!\in\!U\right\}\;\forall\varepsilon\in A$  $F(\varepsilon)$ Also, let  $(\varphi, B) = (G, B)$ , Then  $= \{(x,0,1): x \in U\} \forall \varepsilon \in B$  $G(\varepsilon)$ Let  $(F, A) \widetilde{\frown} (\varphi, B) = (F, A) \widetilde{\frown} (G, B) = (H, C)$ , where  $C = A \cap B$  and  $\forall \varepsilon \in C$ ,  $H(\varepsilon)$  $= \left\| \left( x, \min\left( \mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x) \right), \max\left( v_{F(\varepsilon)}(x), v_{G(\varepsilon)}(x) \right) \right) \right\|$  $: x \in U$  $= \left\{ \left(x, \min\left(\mu_{F(\varepsilon)}(x), 0\right), \max\left(v_{F(\varepsilon)}(x), 1\right)\right) : x \in U \right\}$  $= \{(x,0,1): x \in U\}$ Thus  $(F, A) \widetilde{\cup} (\varphi, B) = (\varphi, A \cap B)$ 

$$10.(F,A) \widetilde{\frown} (U,B) = (F,A \cap B)$$

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Proof. We have for (F, A) $=\left\{\!\!\left(x,\mu_{F(\varepsilon)}(x),v_{F(\varepsilon)}(x)\right)\!\!:x\in U\right\} \;\forall \varepsilon\in A$  $F(\varepsilon)$ Also, let (U, B) = (G, B), Then  $G(\varepsilon)$  $=\{(x,1,0): x \in U\} \forall \varepsilon \in B$ Let  $(F, A) \widetilde{\frown} (U, B) = (F, A) \widetilde{\frown} (G, B) = (H, C)$ , where  $C = A \cap B$  and  $\forall \varepsilon \in C$ ,  $H(\varepsilon)$  $= \left\{ \left(x, \min\left(\mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x)\right), \max\left(v_{F(\varepsilon)}(x), v_{G(\varepsilon)}(x)\right) \right) \right\}$  $: x \in U$  $= \{ (x, \min(\mu_{F(\varepsilon)}(x), 1), \max(\nu_{F(\varepsilon)}(x), 0)) : x \in U \}$  $= \left\{ \left( x, \mu_{F(\varepsilon)}(x), v_{F(\varepsilon)}(x) \right) : x \in U \right\}$ Thus  $(F, A) \cap (U, B) = (F, A \cap B)$ 

Proposition 2.  $1.((F,A)\widetilde{\cup}(G,B))^c \cong (F,A)^c \widetilde{\cup}(G,B)^c$ 2.  $(F,A)^c \widetilde{\frown} (G,B)^c \cong ((F,A) \widetilde{\frown} (G,B))^c$ 

Proof.

1. Let  $(F, A) \widetilde{\cup} (G, B) = (H, C)$ , where  $C = A \cup B$  and  $\forall \varepsilon \in C$ ,  $H(\varepsilon)$  $\{x, \mu_{F(\varepsilon)}(x), v_{F(\varepsilon)}(x), \}$ , if  $\varepsilon \in A$ -B  $\begin{cases} x, \mu_{G(\varepsilon)}(x), \nu_{G(\varepsilon)}(x) \end{cases} \text{ if } \varepsilon \in B\text{-}A \\ \{x, \max\left(\mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x)\right), \min(\nu_{F(x)}(x), \nu_{G(x)}(x)) \end{cases} \end{cases}$ if  $\varepsilon \in A \cap B$ Thus  $((F, A) \widetilde{\cup} (G, B))^c = (H, C)^c = (H^c, C)$ , where  $C = A \cup B$ and  $\forall \varepsilon \in C$ ,  $H^{c}(\varepsilon)$ 

$$= (H(\varepsilon))^c$$

$$(F(\varepsilon))^c$$
, if  $\varepsilon \in A$ -B

$$= \begin{cases} (G(\varepsilon))^{c}, \text{if } \varepsilon \in B - A \\ (F(\varepsilon) \cup G(\varepsilon))^{c}, \text{if } \varepsilon \in A \cap B \end{cases}$$
$$= \begin{cases} \{x, v_{F(\varepsilon)}(x), \mu_{F(\varepsilon)}(x)\}, \text{if } \varepsilon \in A - B \\ \{x, v_{G(x)}(x), \mu_{G(\varepsilon)}(x)\}, \text{if } \varepsilon \in B - A \\ \{x, \min(v_{F(\varepsilon)}(x), v_{G(\varepsilon)}(x)\}, \max(\mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x))\}, \text{if } \varepsilon \in A \cap B \end{cases}$$

Again,  
$$(F, A)^c \widetilde{\cup} (G, B)^c = (F^c, A) \widetilde{\cup} (G^c, B) = (I, J)$$
, say

Where 
$$J = A \cup B$$
 and  $\forall \varepsilon \in J$ ,  

$$I(\varepsilon) = \begin{cases} F^{c}(\varepsilon), \text{if } \varepsilon \in A - B \\ G^{c}(\varepsilon), \text{if } \varepsilon \in B - A \\ F^{c}(\varepsilon) \cup G^{c}(\varepsilon), \text{if } \varepsilon \in A \cap B \end{cases}$$

$$=\begin{cases} \left\{x, v_{F(\varepsilon)}(x), \mu_{F(\varepsilon)}(x)\right\} \text{ if } \varepsilon \in A - B\\ \left\{x, v_{G(\varepsilon)}(x), \mu_{G(\varepsilon)}(x)\right\} \text{ if } \varepsilon \in B - A\\ \left\{x, \max\left(v_{F(\varepsilon)}(x), v_{G(\varepsilon)}(x)\right), \min\left(\mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x)\right)\right\} \text{ if } \varepsilon \in A \cap B\end{cases}$$

We see that  $C \subseteq J$  and  $\forall \varepsilon \in C, H^c(\varepsilon) \subseteq I(\varepsilon)$ Thus  $((F,A) \widetilde{\cup} (G,B))^c \widetilde{\subseteq} (F,A)^c \widetilde{\cup} (G,B)^c$ 

2. Let  $(F, A) \widetilde{\frown} (G, B) = (H, C)$ , Where  $C = A \cap B$  and  $\forall \varepsilon \in C$ ,  $H(\varepsilon) = F(\varepsilon) \cap G(\varepsilon)$  $= \left\{ x, \min\left( \mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x) \right), \max\left( \mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x) \right) \right\}$ Thus  $((F, A) \widetilde{\cap} (G, B))^c = (H, C)^c = (H^c, C)$ , Where  $C = A \cap B$  and  $\forall \varepsilon \in C$ ,  $H^{c}(\varepsilon)$  $= \left\{ x, \min\left(\mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x)\right), \max\left(\nu_{F(\varepsilon)}(x), \nu_{G(\varepsilon)}(x)\right) \right\}^{c}$  $= \left\{ x, \max\left\{ v_{F(\varepsilon)}(x), v_{G(\varepsilon)}(x) \right\}, \min\left\{ \mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x) \right\} \right\}$ Again,  $(F, A)^c \widetilde{\frown} (G, B)^c = (F^c, A) \widetilde{\frown} (G^c, B) = (I, J)$ , say Where  $J = A \cap B$  and  $\forall \varepsilon \in J$ ,  $I(\varepsilon) = F^{c}(\varepsilon) \cap G^{c}(\varepsilon)$  $= \left\{ x, \min\left( v_{F(\varepsilon)}(x), v_{G(\varepsilon)}(x) \right), \max\left( \mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x) \right) \right\}$ 

We see that C = J and  $\forall \varepsilon \in C, I(\varepsilon) \subset H^{c}(\varepsilon)$ Thus  $(F,A)^c \widetilde{\frown} (G,B)^c \widetilde{\subset} ((F,A)\widetilde{\frown} (G,B))^c$ 

Proposition 3. (De Morgan Inclusions) For intuitionistic fuzzy soft sets (F, A) and (G, B) over the same universe U, we have the following -

1. 
$$(F, A)^c \widetilde{\frown} (G, B)^c \cong ((F, A) \widetilde{\cup} (G, B))^c$$
  
2.  $((F, A) \widetilde{\frown} (G, B))^c \cong (F, A)^c \widetilde{\cup} (G, B)^c$ 

Proof

1. Let  $(F, A) \widetilde{\cup} (G, B) = (H, C)$ , where  $C = A \cup B$  and  $\forall \varepsilon \in C$ ,

$$H(\varepsilon) = \begin{cases} F(\varepsilon), \text{if } \varepsilon \in A \text{-}B \\ G(\varepsilon), \text{if } \varepsilon \in B \text{-}A \\ F(\varepsilon) \cup G(\varepsilon), \text{if } \varepsilon \in A \cap B \end{cases}$$
$$= \begin{cases} \left\{ x, \mu_{F(\varepsilon)}(x), v_{F(\varepsilon)}(x) \right\}, \text{if } \varepsilon \in A \text{-}B \\ \left\{ x, \mu_{G(\varepsilon)}(x), v_{G(\varepsilon)}(x) \right\}, \text{if } \varepsilon \in B \text{-}A \\ \left\{ x, \max\left( \mu_{F(\varepsilon)}, \mu_{G(\varepsilon)} \right), \min\left( v_{F(\varepsilon)}, v_{G(\varepsilon)} \right) \right\}, \\ \text{if } \varepsilon \in A \cap B \end{cases}$$

Thus

 $((F, A) \widetilde{\cup} (G, B))^c = (H, C)^c = (H^c, C)$ , where  $C = A \cup B$ and  $\forall \varepsilon \in C$ ,

$$H^{c}(\varepsilon) = (H(\varepsilon))^{c}$$

$$= \begin{cases} (F(\varepsilon))^{c}, \text{ if } \varepsilon \in A - B \\ (G(\varepsilon))^{c}, \text{ if } \varepsilon \in B - A \\ (F(\varepsilon) \cup G(\varepsilon))^{c}, \text{ if } \varepsilon \in A \cap B \end{cases}$$

$$= \begin{cases} \{x, v_{F(\varepsilon)}(x), \mu_{F(\varepsilon)}(x)\}, \text{ if } \varepsilon \in A - B \\ \{x, v_{G(\varepsilon)}(x), \mu_{G(\varepsilon)}(x)\}, \text{ if } \varepsilon \in B - A \\ \{x, \min(v_{F(\varepsilon)}, v_{G(\varepsilon)}), \max(\mu_{F(\varepsilon)}, \mu_{G(\varepsilon)})\}, \text{ if } \varepsilon \in A \cap B \end{cases}$$

Again, 
$$(F, A)^c \widetilde{\cap} (G, B)^c = (F^c, A) \widetilde{\cap} (G^c, B) = (I, J)$$
, say  
Where  $J = A \cap B$  and  $\forall \varepsilon \in J$ ,  
 $I(\varepsilon) = F^c(\varepsilon) \cap G^c(\varepsilon)$   
 $= \{x, \min\{v_{F(\varepsilon)}(x), v_{G(\varepsilon)}(x)\}, \max\{\mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x)\}\}$ 

We see that  $J \subseteq C$  and  $\forall \varepsilon \in J, I(\varepsilon) = H^c(\varepsilon)$ Thus  $(F, A)^c \widetilde{\frown} (G, B)^c \cong ((F, A) \widetilde{\cup} (G, B))^c$ 

2. Let  $(F, A) \cap (G, B) = (H, C)$ , Where  $C = A \cap B$  and  $\forall \varepsilon \in C$ ,  $H(\varepsilon) = F(\varepsilon) \cap G(\varepsilon)$  $= \{x, \min(\mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x)), \max(v_{F(\varepsilon)}(x), v_{G(\varepsilon)}(x))\}$ 

Thus  $((F, A) \cap (G, B))^c = (H, C)^c = (H^c, C)$ , Where  $C = A \cap B$  and  $\forall \varepsilon \in C$ ,  $H^c(\varepsilon) = (F(\varepsilon) \cap G(\varepsilon))^c$   $= \{x, \min(\mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x)), \max(v_{F(\varepsilon)}(x), v_{G(\varepsilon)}(x))\}^c$   $= \{x, \max(v_{F(\varepsilon)}(x), v_{G(\varepsilon)}(x)), \min(\mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x))\}$ Again,  $(F, A)^c \cup (G, B)^c = (F^c, A) \cup (G^c, B) = (I, J)$ , say Where  $J = A \cup B$  and  $\forall \varepsilon \in J$ ,

$$I(\varepsilon) = \begin{cases} F^{c}(\varepsilon), \text{if } \varepsilon \in A \text{-} B \\ G^{c}(\varepsilon), \text{if } \varepsilon \in B \text{-} A \\ F^{c}(\varepsilon) \cup G^{c}(\varepsilon), \text{if } \varepsilon \in A \cap B \end{cases}$$
$$= \begin{cases} \{x, v_{F(\varepsilon)}(x), \mu_{F(\varepsilon)}(x)\}, \text{if } \varepsilon \in A \text{-} B \\ \{x, v_{G(\varepsilon)}(x), \mu_{G(\varepsilon)}(x)\}, \text{if } \varepsilon \in B \text{-} A \\ \{x, \max\{v_{F(\varepsilon)}(x), v_{G(\varepsilon)}(x)\}, \min\{\mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x)\}\}, \text{if } \varepsilon \in A \cap B \end{cases}$$

We see that  $C \subseteq J$  and  $\forall \varepsilon \in C, H^c(\varepsilon) = I(\varepsilon)$ 

Thus  $((F, A) \widetilde{\frown} (G, B))^c \cong (F, A)^c \widetilde{\cup} (G, B)^c$ 

Proposition 4. (De Morgan Laws) For intuitionistic fuzzy soft sets (F, A) and (G, A) over the same universe U, we have the following -

1. 
$$((F, A) \widetilde{\cup} (G, A))^c = (F, A)^c \widetilde{\cap} (G, A)^c$$
  
2.  $((F, A) \widetilde{\cap} (G, A))^c = (F, A)^c \widetilde{\cup} (G, A)^c$ 

Proof.

1. Let 
$$(F, A) \widetilde{\cup} (G, A) = (H, A)$$
, where  $\forall \varepsilon \in A$ ,  
 $H(\varepsilon) = F(\varepsilon) \cup G(\varepsilon)$   
 $= \left\{ x, \max(\mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x)), \min(v_{F(\varepsilon)}(x), v_{G(\varepsilon)}(x)) \right\}$ 

Thus

$$\begin{split} ((F,A)\widetilde{\cup}(G,A))^c &= (H,A)^c = (H^c,A), \text{ where } \forall \varepsilon \in A, \\ H^c(\varepsilon) &= (H(\varepsilon))^c \\ &= (F(\varepsilon) \cup G(\varepsilon))^c \\ &= \left\{ x, \max\left(\mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x)\right), \min\left(\nu_{F(\varepsilon)}(x), \nu_{G(\varepsilon)}(x)\right)\right\}^c \\ &= \left\{ x, \min\left(\nu_{F(\varepsilon)}(x), \nu_{G(\varepsilon)}(x)\right), \max\left(\mu_{F(\varepsilon)}, \mu_{G(\varepsilon)}\right)\right\} \end{split}$$

Again,  $(F, A)^c \cap (G, A)^c = (F^c, A) \cap (G^c, A) = (I, A)$ , Say, where  $\forall \varepsilon \in A$ ,

$$I(\varepsilon) = F^{c}(\varepsilon) \cap G^{c}(\varepsilon)$$
  
=  $\left\{x, \min\left(v_{F(\varepsilon)}(x), v_{G(\varepsilon)}(x)\right), \max\left(\mu_{F(\varepsilon)}, \mu_{G(\varepsilon)}\right)\right\}$ 

Thus  $((F, A) \widetilde{\cup} (G, A))^c = (F, A)^c \widetilde{\cap} (G, A)^c$ 

2. Let 
$$(F, A) \cap (G, A) = (H, A)$$
, where  $\forall \varepsilon \in A$ ,  
 $H(\varepsilon) = F(\varepsilon) \cap G(\varepsilon)$   
 $= \{x, \min(\mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x)), \max(v_{F(\varepsilon)}(x), v_{G(\varepsilon)}(x))\}$ 

Thus  $((F, A) \widetilde{\cap} (G, A))^c = (H, A)^c = (H^c, A)$ , where  $\forall \varepsilon \in A$ ,  $H^c(\varepsilon) = (H(\varepsilon))^c$  $= (F(\varepsilon) \cap G(\varepsilon))^c$ 

 $= \left\{ x, \max\left( v_{F(\varepsilon)}(x), v_{G(\varepsilon)}(x) \right), \min\left( \mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x) \right) \right\}$ Again,  $(F, A)^c \widetilde{\cup} (G, A)^c = (F^c, A) \widetilde{\cup} (G^c, A) = (I, A)$ , say Where  $\forall \varepsilon \in A$ .

$$I(\varepsilon) = F^{c}(\varepsilon) \cup G^{c}(\varepsilon) = \left\{ x, \max\left( v_{F(\varepsilon)}(x), v_{G(\varepsilon)}(x) \right), \min\left( \mu_{F(\varepsilon)}(x), \mu_{G(\varepsilon)}(x) \right) \right\}$$

 $((F,A)\widetilde{\cup}(G,A))^c = (F,A)^c \widetilde{\cap}(G,A)^c$ Thus

The following De Morgan types of results are valid for Intuitionistic fuzzy soft sets in our way.

#### Proposition 5.

For intuitionistic fuzzy soft sets (F, A) and (G, B) over the same universe U, we have the following -

1. 
$$((F, A) \land (G, B))^c = (F, A)^c \lor (G, B)^c$$
  
2.  $((F, A) \lor (G, B))^c = (F, A)^c \land (G, B)^c$ 

Proof.

1. Let  $(F, A) \land (G, B) = (H, A \times B)$ , Where  $H(\alpha, \beta) = F(\alpha) \cap G(\beta)$ ,  $\forall \alpha \in A$  and  $\forall \beta \in B$ ,

where  $\cap$  is the operation intersection of two intuitionistic fuzzy sets. Thus  $H(\alpha, \beta) = F(\alpha) \cap G(\beta)$ 

$$H(\alpha, \beta) = F(\alpha) \cap G(\beta)$$
  
=  $\{x, \min(\mu_{F(\alpha)}(x), \mu_{G(\beta)}(x)), \max(v_{F(\alpha)}(x), v_{G(\beta)}(x))\}$ 

/

Thus 
$$((F, A) \land (G, B))^c = (H, A \times B)^c = (H^c, A \times B)$$
, where  
 $\forall (\alpha, \beta) \in A \times B$ ,  
 $H^c(\alpha, \beta)$   
 $= (H(\alpha, \beta))^c$   
 $= \{x, \max\{v_{F(\alpha)}(x), v_{G(\beta)}(x)\}, \min\{\mu_{F(\alpha)}(x), \mu_{G(\beta)}(x)\}\}$   
Let  $(F, A)^c \lor (G, B)^c = (F^c, A) \lor (G^c, B) = (O, A \times B)$ ,  
Where  $O(\alpha, \beta) = F^c(\alpha) \cup G^c(\beta), \forall \alpha \in A \text{ and } \forall \beta \in B$ ,  
where  $\cup$  is the operation union of two intuitionistic fuzzy  
sets.

$$= \left\{ x, \max\left( \nu_{F(\alpha)}(x), \nu_{G(\beta)}(x) \right) \min\left( \mu_{F(\alpha)}(x), \mu_{G(\beta)}(x) \right) \right\}$$
  
It follows that  $\left( (F, A) \land (G, B) \right)^c = (F, A)^c \lor (G, B)^c$ 

2. Let 
$$(F, A) \lor (G, B) = (H, A \times B)$$
,  
Where  $H(\alpha, \beta) = F(\alpha) \cup G(\beta)$ ,  $\forall \alpha \in A$  and  $\forall \beta \in B$ ,  
where  $\cup$  is the operation union of two intuitionistic fuzzy  
sets. Thus  
 $H(\alpha, \beta) = F(\alpha) \lor C(\beta)$ 

$$H(\alpha,\beta) = F(\alpha) \cup G(\beta)$$
  
=  $\{x, \max(\mu_{F(\alpha)}(x), \mu_{G(\beta)}(x)), \min(\nu_{F(\alpha)}(x), \nu_{G(\beta)}(x))\}$ 

Thus 
$$((F, A) \lor (G, B))^c = (H, A \times B)^c$$
  
  $= (H^c, A \times B)$ , where  
  $\forall (\alpha, \beta) \in A \times B$ ,  
  $H^c(\alpha, \beta)$   
  $= (H(\alpha, \beta))^c$   
  $= \{x, \max(\mu_{F(\alpha)}(x), \mu_{G(\beta)}(x)), \min(\nu_{F(\alpha)}(x), \nu_{G(\beta)}(x))\}^c$   
  $= \{x, \min(\nu_{F(\alpha)}(x), \nu_{G(\beta)}(x)), \max(\mu_{F(\alpha)}(x), \mu_{G(\beta)}(x))\}$   
 Let  $(F, A)^c \land (G, B)^c = (F^c, A) \land (G^c, B) = (O, A \times B)$ ,  
 Where  $O(\alpha, \beta) = F^c(\alpha) \cap G^c(\beta)$ ,  $\forall \alpha \in A$  and  $\forall \beta \in B$ ,  
 where  $\cap$  is the operation union of two intuitionistic fuzzy  
 sets.  
  $= \{x, \min(\nu_{F(\alpha)}(x), \nu_{G(\beta)}(x)), \max(\mu_{F(\alpha)}(x), \mu_{G(\beta)}(x))\}$   
 It follows that  $((F, A) \lor (G, B))^c = (F, A)^c \land (G, B)^c$ 

## IV. CONCLUSION

We have made an investigation on existing basic notions and results on intuitionistic fuzzy soft sets. Some new results have been stated in our work. Future work in this regard would be required to study whether the notions put forward in this paper yield a fruitful result

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