Intuitionistic Neutrosphic Soft Set Over Rings

Broumi Said[1] and Florentin Smarandache[2]

[1]Administrator of Faculty of Arts and Humanities, Hay El Baraka Ben M'sik Casablanca B.P. 7951, Hassan II University Mohammedia-Casablanca , Morocco

[2]Department of Mathematics, University of New Mexico,

705 Gurley Avenue,Gallup, NM 87301, USA

Abstract :

S.Broumi and F.Smarandache introduced the concept of intuitionistic neutrosophic soft set, which is an extension to the soft set. In this paper we apply the concept of intuitionistic neutrosophic soft set to rings theory .The notion of intuitionistic neutrosophic soft rings is introduced and their basic properties are presented . Intersection, union, AND, and OR operations of intuitionistic neutrosophic soft rings are defined . Also ,we have defined the product of two intuitionistic neutrosophic soft set over Ring.

Keywords: **Intuitionistic Neutrosphic soft set, intuitionistic Neutrosphic soft ring, soft set, Neutrosphic soft set .**

I. Introduction

The theory of neutrosophic set (NS), which is the generalization of the classical sets, conventional fuzzy set [1], intuitionistic fuzzy set [2] and interval valued fuzzy set [3] ,was introduced by Samarandache [4]. This concept has recently motivated new research in several directions such as databases [5,6], medical diagnosis problem [7] ,decision making problem [8],topology [9],control theory [10] and so on .The concept of neutrosophic set handle indeterminate data whereas fuzzy set theory, and intuitionstic fuzzy set theory failed when the relation are indeterminate. Some recent research can be found in [11,12,13,14].

Another important concept that addresses uncertain information is the soft set theory originated by Molodotsov [15]. This concept is free from the parameterization inadequacy syndrome of fuzzy set theory, rough set theory, probability theory. Molodtsov has successfully applied the soft set theory in many different fields such as smoothness of functions, game theory, operations research, Riemann integration, Perron integration, and probability.

In recent years, soft set theory has been received much attention since its appearance. There are many papers devoted to fuzzify the concept of soft set theory which leads to a series of mathematical models such as fuzzy soft set [16,17,18,19,20], generalized fuzzy soft set [21,22], possibility fuzzy soft set [23] and so on. Thereafter ,P.K.Maji and his coworker [24] introduced the notion of intuitionstic fuzzy soft set which is based on a combination of the intuitionstic fuzzy sets and soft set models and studied the properties of intuitionistic fuzzy soft set. Later, a lot of extentions of intuitionistic fuzzy soft are appeared such as generalized intuitionistic fuzzy soft set [25], Possibility Intuitionistic fuzzy soft set [26] and so on. Furthermore, few researchers have contributed a lot towards neutrosophication of soft set theory. In [27] P.K.Maji, first proposed a new mathematical model called "neutrosophic soft set" and investigate some properties regarding neutrosophic soft union, neutrosophic soft intersection, complement of a neutrosophic soft set ,de Morgan law. In 2013, S.Broumi and F. Smarandache [28] combined the intuitionistic neutrosophic set and soft set which lead to a new mathematical model called" intutionistic neutrosophic soft set". They studied the notions of intuitionistic neutrosophic soft set union, intuitionistic neutrosophic soft set intersection, complement of intuitionistic neutrosophic soft set and several other properties of intuitionistic neutrosophic soft set along with examples and proofs of certain results. S.Broumi [29] presented the concept of "generalized neutrosophic soft set" by combining the generalized neutrosophic sets [13] and soft set models, studied some properties on it, and presented an application of generalized neutrosophic soft Set in decision making problem.

The algebraic structure of soft set theories has been explored in recent years. In [30], Aktas and Cagman gave a definition of soft groups and compared soft sets to the related concepts of fuzzy sets and rough sets. Sezgin and Atagün [33] defined the notion of normalistic soft groups and corrected some of the problematic cases in paper by Aktas and Cagman [30]. Aygunoglu and Aygun [31] introduced the notion of fuzzy soft groups based on Rosenfeld's approach [32] and studied its properties. In 2010, Acar et al. [34] introduced the basic notion of soft rings which are actually a parametrized family of subrings. Ghosh, Binda and Samanta [35] introduced the notion of fuzzy soft rings and fuzzy soft ideals and studied some of its algebraic properties. Inan and Ozturk [36] concurrently studied the notion of fuzzy soft rings and fuzzy soft ideals but they dealt with these concepts in a more detailed manner compared to Ghosh et al. [35]. In 2012, B.P.Varol et al [37] introduced the notion of fuzzy soft ring in different way and studied several of their basic properties. J. Zhan et al [38] introduced soft rings related to fuzzy set theory. G. Selvachandran and A. R. Salleh [39] introduced vague soft rings and vague soft ideals and studied some of their basic properties. Z.Zhang [40] introduced intuitionistic fuzzy soft rings studied the algebraic properties of intuitionistic fuzzy soft ring. Studies of fuzzy soft rings are carried out by several researchers but the notion of neutrosophic soft rings is not studied. So, in this work we first study with the algebraic properties of intuitionistic neutrosophic soft set in ring theory. This paper is organized as follows. In section 2 we gives some known and useful preliminary definitions and notations on soft set theory, neutrosophic set, intuitionistic neutrosophic set, intuitionistic neutrosophic soft set and ring theory. In section 3 we discusses intuitionistic neutrosophic soft ring. In section 4 concludes the paper.

II.Preliminaries

In this section as a preparation , we will give some known definitions and notations regarding, soft set, neutrosophic set, intuitionistic neutrosophic set, intuitionistic neutrosophic soft sets, fuzzy subring,

Definition 2.1: [15]

Molodtsov defined the notion of a soft set in the following way: Let U be an initial universe and E be a set of parameters. Let ζ (U) denotes the power set of U and A be a non-empty subset of E. Then a pair (P, A) is called a soft set over U, where P is a mapping given by P : A → ζ (U). In other words, a soft set over U is a parameterized family of subsets of the universe U. For $\varepsilon \in$ A, P (ε) may be considered as the set of ε -approximate elements of the soft set (P,A).

Definition 2.2: [4] Let U be an universe of discourse then the neutrosophic set A is an object having the form A = {< x: $T_{A(x)}$,$I_{A(x)}$,$F_{A(x)}$ >,x $\in$ U}, where the functions T,I,F : U→$]^-0,1^+[$ define respectively the degree of membership , the degree of indeterminacy, and the degree of non-membership of the element x $\in$ X to the set A with the condition.

$$^-0 \leqslant T_{A(x)} + I_{A(x)} + F_{A(x)} \leqslant 3^+.$$

From philosophical point of view, the neutrosophic set takes the value from real standard or non-standard subsets of $]^-0,1^+[$.So instead of $]^-0,1^+[$ we need to take the interval [0,1] for technical applications, because $]^-0,1^+[$will be difficult to apply in the real applications such as in scientific and engineering problems.

Definition 2.3: [11]
An element x of U is called significant with respect to neutrsophic set A of U if the degree of truth-membership or falsity-membership or indeterminancy-membership value, i.e.,$T_{A(x)}$ or $F_{A(x)}$or $I_{A(x)} \leq 0.5$. Otherwise, we call it insignificant. Also, for neutrosophic set the truth-membership, indeterminacy-membership and falsity-membership all can not be significant. We define an intuitionistic neutrosophic set by A = {< x: $T_{A(x)}$,$I_{A(x)}$,$F_{A(x)}$ >,x $\in$ U},where

min { $T_{A(x)}$, $F_{A(x)}$ } ≤ 0.5,

min { $T_{A(x)}$, $I_{A(x)}$ } ≤ 0.5,

min { $F_{A(x)}$, $I_{A(x)}$ } ≤ 0.5, for all x $\in$ U,

with the condition $0 \leq T_{A(x)} + I_{A(x)} + F_{A(x)} \leq 2$.

As an illustration ,let us consider the following example.

Example 2.4. Assume that the universe of discourse U={x_1,x_2,x_3},where x_1 characterizes the capability, x_2 characterizes the trustworthiness and x_3 indicates the prices of the objects. It may be further assumed that the values of x_1, x_2 and x_3 are in [0,1] and they are obtained from some questionnaires of some experts. The experts may impose their opinion in three components viz. the degree of goodness, the degree of indeterminacy and that of poorness to explain the characteristics of the objects. Suppose A is an intuitionistic neutrosophic set (IN S) of U, such that,

A = {< x_1,0.3,0.5,0.4 >,< x_2,0.4,0.2,0.6 >,< x_3,0.7,0.3,0.5 >}, where the degree of goodness of capability is 0.3, degree of indeterminacy of capability is 0.5 and degree of falsity of capability is 0.4 etc.

Definition 2.3:[28] Let U be an initial universe set and A $\subset$ E be a set of parameters. Let N(U) denotes the set of all intuitionistic neutrosophic sets of U. The collection (P, A) is termed to be the soft intuitionistic neutrosophic set over U, where P is a mapping given by $P : A \rightarrow N(U)$.

Remark 2.4. we will denote the intuitionistic neutrosophic soft set defined over an universe by INSS.

Let us consider the following example.

Example 2.5: Let U be the set of blouses under consideration and E is the set of parameters (or qualities). Each parameter is a intuitionistic neutrosophic word or sentence involving intuitionistic neutrosophic words. Consider E = { Bright, Cheap, Costly, very costly, Colorful, Cotton, Polystyrene, long sleeve , expensive }. In this case, to define a intuitionistic neutrosophic soft set means to point out Bright blouses, Cheap blouses, Blouses in Cotton and so on. Suppose that, there are five blouses in the universe U given by, $U = \{b_1,b_2,b_3,b_4,b_5\}$ and the set of parameters $A = \{e_1,e_2,e_3,e_4\}$, where each e_i is a specific criterion for blouses:

e_1 stands for 'Bright',

e_2 stands for 'Cheap',

e_3 stands for 'costly',

e_4 stands for 'Colorful',

Suppose that,

$P(\text{Bright})=\{<b_1,0.5,0.6,0.3>,<b_2,0.4,0.7,0.2>,<b_3,0.6,0.2,0.3>,<b_4,0.7,0.3,0.2>$
$,<b_5,0.8,0.2,0.3>\}$.

$P(\text{Cheap})=\{<b_1,0.6,0.3,0.5>,<b_2,0.7,0.4,0.3>,<b_3,0.8,0.1,0.2>,<b_4,0.7,0.1,0.3>$
$,<b_5,0.8,0.3,0.4\}$.

$P(\text{Costly})=\{<b_1,0.7,0.4,0.3>,<b_2,0.6,0.1,0.2>,<b_3,0.7,0.2,0.5>,< b_4,0.5,0.2,0.6 >$
$,< b_5,0.7,0.3,0.2 >\}$.

$P(\text{Colorful})=\{<b_1,0.8,0.1,0.4>,<b_2,0.4,0.2,0.6>,<b_3,0.3,0.6,0.4>,<b_4,0.4,0.8,0.5>$
$,< b_5,0.3,0.5,0.7 >\}$.

Definition 2.6: [28]

For two intuitionistic neutrosophic soft sets (P, A) and (Q, B) over the common universe U. We say that (P, A) is an intuitionistic neutrosophic soft subset of (Q, B) if and only if

(i) $A \subset B$.

(ii) P(e) is an intuitionistic neutrosophic subset of Q(e).

Or $T_{P(e)}(x) \leq T_{Q(e)}(x)$, $I_{P(e)}(x) \geq I_{Q(e)}(x)$, $F_{P(e)}(x) \geq F_{Q(e)}(x)$, $\forall e \in A$, $x \in U$.

We denote this relationship by $(P, A) \subseteq (Q, B)$.

(P, A) is said to be intuitionistic neutrosophic soft super set of (Q, B) if (Q, B) is an intuitionistic neutrosophic soft subset of (P, A). We denote it by $(P, A) \supseteq (Q, B)$.

Definition 2.7:[28] Two INSSs (P, A) and (Q, B) over the common universe U are said to be intuitionistic neutrosophic soft equal if (P, A) is an intuitionistic neutrosophic soft subset of (Q, B) and (Q, B) is an intuitionistic neutrosophic soft subset of (P, A) which can be denoted by (P, A)= (Q, B).

Definition 2.8:[28]

Let (P,A) and (Q,B) be two INSSs over the same universe U.Then the union of (P,A) and (Q,B) is denoted by ‘(P,A)∪(Q,B)’ and is defined by (P,A)∪(Q,B)=(K,C), where C=A∪B and the truth-membership, indeterminacy-membership and falsity-membership of (K,C) are as follows:

$T_{K(e)}(m) = T_{P(e)}(m)$, if $e \in A - B$,
$= T_{Q(e)}(m)$, if $e \in B - A$,
$= \max (T_{P(e)}(m), T_{Q(e)}(m))$, if $e \in A \cap B$.

$I_{K(e)}(m) = I_{P(e)}(m)$, if $e \in A - B$,
$= I_{Q(e)}(m)$, if $e \in B - A$,
$= \min (I_{P(e)}(m), I_{Q(e)}(m))$, if $e \in A \cap B$.

$F_{K(e)}(m) = F_{P(e)}(m)$, if $e \in A - B$,
$= F_{Q(e)}(m)$, if $e \in B - A$
$= \min (F_{P(e)}(m), F_{\ (e)}(m))$, if $e \in A \cap B$.

Definition 2.9:[28]
Let (P, A) and (Q, B) be two INSSs over the same universe U such that $A \cap B \neq 0$. Then the intersection of (P,A) and (Q,B) is denoted by ‘(P, A) ∩ (Q, B)’ and is defined by (P, A) ∩(Q, B) = (K, C),where C =A∩B and the truth-membership, indeterminacy membership and falsity-membership of (K, C) are related to those of (P, A) and (Q, B) by:
$T_{K(e)}(m) = T_{P(e)}(m)$, if $e \in A - B$,
$= T_{Q(e)}(m)$, if $e \in B - A$,
$= \min (T_{P(e)}(m), T_{Q(e)}(m))$, if $e \in A \cap B$.

$I_{K(e)}(m) = I_{P(e)}(m)$, if $e \in A - B$,
$= I_{Q(e)}(m)$, if $e \in B - A$,
$= \min (I_{P(e)}(m), I_{Q(e)}(m))$, if $e \in A \cap B$.

$F_{K(e)}(m) = F_{P(e)}(m)$, if $e \in A - B$,
$= F_{Q(e)}(m)$, if $e \in B - A$
$= \max (F_{P(e)}(m), F_{\ (e)}(m))$, if $e \in A \cap B$.

Definition 2.10: [27]. Let (P, A) be a soft set. The set Supp(P, A) = $\{x \in A \mid P(x) \neq \emptyset\}$ is called the support of the soft set (P, A). A soft set (P, A) is non-null if Supp(P, A) $\neq \emptyset$.

Definition 2.11: [41] A fuzzy subset μ of a ring R is called a fuzzy subring of R (in Rosenfeld’ sense) ,if for all x, y $\in$ R the following requirements are met:

(i) $\mu(x-y) \geq \min(\mu(x), \mu(y))$ and
(ii) $\mu(xy) \geq \min(\mu(x), \mu(y))$

III. Intuitionistic Neutrosphic soft Set Over Ring

In this section, we introduce the notions of intuitionistic neutrosophic soft ring and intuitionistic neutrosophic soft subring in Rosenfeld's sense and study some of their properties related to this notions.

Throughout this paper. Let (R,+ , .) be a ring . E be a parameter set and let A ⊆ E. For the sake of simplicity , we will denote the ring (R, +, .) simply as R.

From now on, R denotes a commutative ring and all intuitionistic neutrosophic soft sets are considered over R.

Definition 3.1 .Let ($\tilde{P}$, A) be an intuitionistic neutrosophic soft set. The set Supp($\tilde{P}$, A) = { $\varepsilon \in$ A |$\tilde{P}$ (ε)$\neq$ $\emptyset$} is called the support of the intuitionistic neutrosophic soft set ($\tilde{P}$, A). An intuitionistic neutrosophic soft set ($\tilde{P}$, A) is non-null if Supp($\tilde{P}$, A) $\neq\emptyset$.

Definition 3.2 : A pair ($\tilde{P}$, A) is called an intuitionistic neutrosophic soft ring over R, where $\tilde{P}$ is a mapping given by

$\tilde{P}$: A → ([0,1] × [0 ,1] × [0 ,1])^{R} , $\tilde{P}(\varepsilon)$: R → [0,1] × [0, 1] × [0 ,1] ,

$\tilde{P}(\varepsilon)$= $\left\{(x, T_{\tilde{P}(\varepsilon)}(x), I_{\tilde{P}(\varepsilon)}(x)\,, F_{\tilde{P}(\varepsilon)}(x): x \in R\right\}$ for all $\varepsilon \in$ A,

If for all x ,y ∈ R the following condition hold:

(1) $T_{\tilde{P}(\varepsilon)}(x-y) \geq T_{\tilde{P}(\varepsilon)}(x) \wedge T_{\tilde{P}(\varepsilon)}(y)$, $F_{\tilde{P}(\varepsilon)}(x-y) \leq F_{\tilde{P}(\varepsilon)}(x) \vee F_{\tilde{P}(\varepsilon)}(y)$ and , $I_{\tilde{P}(\varepsilon)}(x-y)$ $\leq I_{\tilde{P}(\varepsilon)}(x) \vee I_{\tilde{P}(\varepsilon)}(y)$

(2) $T_{\tilde{P}(\varepsilon)}(xy) \geq T_{\tilde{P}(\varepsilon)}(x) \wedge T_{\tilde{P}(\varepsilon)}(y)$, $F_{\tilde{P}(\varepsilon)}(xy) \leq F_{\tilde{P}(\varepsilon)}(x) \vee F_{\tilde{P}(\varepsilon)}(y)$ and , $I_{\tilde{P}(\varepsilon)}(xy) \leq I_{\tilde{P}(\varepsilon)}(x)$ $\vee\ I_{\tilde{P}(\varepsilon)}(y)$

Definition 3.3 : For two intuitionistic neutrosophic soft ring($\tilde{P}$, A) and ($\tilde{Q}$, B) over a R , we say that ($\tilde{P}$, A) is an intuitionistic neutrosophic soft subring of ($\tilde{Q}$, B) and write ($\tilde{P}$, A) ⊆ ($\tilde{Q}$, B) if

(i) A ⊆ B

(ii) for each x ∈ R , $\varepsilon \in$ A, $T_{\tilde{P}(\varepsilon)}(x) \leq T_{\tilde{Q}(\varepsilon)}(x)$, $I_{\tilde{P}(\varepsilon)}(x) \geq I_{\tilde{Q}(\varepsilon)}(x)$, $F_{\tilde{P}(\varepsilon)}(x) \geq F_{\tilde{Q}(\varepsilon)}(x)$.

Definition 3 .4 : Two intuitionistic neutrosophic soft rings ($\tilde{P}$,A) and ($\tilde{Q}$,B) over R are said to be equal if ($\tilde{P}$,A) ⊆ ($\tilde{Q}$, B) and ($\tilde{Q}$, B) ⊆ ($\tilde{P}$, A).

Theorem 3.5 : Let be two intuitionistic neutrosophic soft rings over a universe R. if $\tilde{P}$ (ε) ≤ $\tilde{Q}$ (ε) for all $\varepsilon \in$ A and A ⊂ B ,then ($\tilde{P}$, A) is an intuitionistic neutrosophic soft subring of ($\tilde{Q}$, B).

Proof. The proof is straightforward

Definition 3.6 : The union of two intuitionistic neutrosophic soft rings ($\tilde{P}$,A) and ($\tilde{Q}$,B) over R is denoted by ($\tilde{P}$,A)$\tilde{\cup}$($\tilde{Q}$,B) aand is defined by a intuitionistic neutrosophic soft ring$\widetilde{H}$:

$A \cup B \to [0,1]^R$ such that for each $\varepsilon \in A \cup B$.

$$\widetilde{H}(\varepsilon)=\begin{cases} < x, T_{\tilde{P}(\varepsilon)}(x),\ I_{\tilde{P}(\varepsilon)}(x),\ F_{\tilde{P}(\varepsilon)}(x) > if\ \varepsilon \in A-B \\ < x, T_{\tilde{Q}(\varepsilon)}(x),\ I_{\tilde{Q}(\varepsilon)}(x),\ F_{\tilde{Q}(\varepsilon)}(x) > if\ \varepsilon \in B-A \\ < x, T_{\tilde{P}(\varepsilon)}(x) \vee T_{\tilde{Q}(\varepsilon)}(x), I_{\tilde{P}(\varepsilon)}(x) \wedge I_{\tilde{Q}(\varepsilon)}(x),\ F_{\tilde{P}(\varepsilon)}(x) \wedge F_{\tilde{Q}(\varepsilon)}(x) > if\ \varepsilon \in A \cap B \end{cases}$$

This is denoted by $(\widetilde{H}, C) = (\tilde{P}, A)\widetilde{\cup}(\tilde{Q}, B)$,where $C = A \cup B$

Theorem 3.7 : If $(\tilde{P}, A)$ and $(\tilde{Q}, B)$ are two intuitionistic neutrosophic soft rings over a R, then , so are $(\tilde{P}, A)\widetilde{\cup}(\tilde{Q}, B)$.

Proof. For any $\varepsilon = (\alpha, \beta) \in A \cup B$ and x, y $\in$ R,we consider the following cases.

Case 1. Let $\varepsilon \in A-B$ .Then,

$$T_{\widetilde{H}(\varepsilon)}(x-y) = T_{\tilde{P}(\varepsilon)}(x-y)$$
$$\geq T_{\tilde{P}(\varepsilon)}(x) \wedge T_{\tilde{P}(\varepsilon)}(y)$$
$$= T_{\widetilde{H}(\varepsilon)}(x) \wedge T_{\widetilde{H}(\varepsilon)}(y),$$

$$T_{\widetilde{H}(\varepsilon)}(xy) = T_{\tilde{P}(\varepsilon)}(xy)$$
$$\geq T_{\tilde{P}(\varepsilon)}(x) \wedge T_{\tilde{P}(\varepsilon)}(y)$$
$$= T_{\widetilde{H}(\varepsilon)}(x) \wedge T_{\widetilde{H}(\varepsilon)}(y),$$

$$I_{\widetilde{H}(\varepsilon)}(x-y) = I_{\tilde{P}(\varepsilon)}(x-y)$$
$$\leq I_{\tilde{P}(\varepsilon)}(x) \vee I_{\tilde{P}(\varepsilon)}(y)$$
$$= I_{\widetilde{H}(\varepsilon)}(x) \vee I_{\widetilde{H}(\varepsilon)}(y),$$

$$I_{\widetilde{H}(\varepsilon)}(xy) = I_{\tilde{P}(\varepsilon)}(xy)$$
$$\leq I_{\tilde{P}(\varepsilon)}(x) \vee I_{\tilde{P}(\varepsilon)}(y)$$
$$= I_{\widetilde{H}(\varepsilon)}(x) \vee I_{\widetilde{H}(\varepsilon)}(y),$$

$$F_{\widetilde{H}(\varepsilon)}(x-y) = F_{\tilde{P}(\varepsilon)}(x-y)$$
$$\leq F_{\tilde{P}(\varepsilon)}(x) \vee F_{\tilde{P}(\varepsilon)}(y)$$
$$= F_{\widetilde{H}(\varepsilon)}(x) \vee F_{\widetilde{H}(\varepsilon)}(y),$$

$$F_{\widetilde{H}(\varepsilon)}(xy) = F_{\tilde{P}(\varepsilon)}(xy)$$
$$\leq F_{\tilde{P}(\varepsilon)}(x) \vee F_{\tilde{P}(\varepsilon)}(y)$$
$$= F_{\widetilde{H}(\varepsilon)}(x) \vee F_{\widetilde{H}(\varepsilon)}(y),$$

Case 2. Let $if\ \varepsilon\ \in$ B − A .Then ,analogus to the proof of case 1, we have

$T_{\tilde{H}(\varepsilon)}(x-y) \geq T_{\tilde{H}(\varepsilon)}(x) \wedge T_{\tilde{H}(\varepsilon)}(y)$

$T_{\tilde{H}(\varepsilon)}(xy) \quad \geq T_{\tilde{H}(\varepsilon)}(x) \wedge T_{\tilde{H}(\varepsilon)}(y)$

$I_{\tilde{H}(\varepsilon)}(x-y) \leq I_{\tilde{H}(\varepsilon)}(x) \vee I_{\tilde{H}(\varepsilon)}(y)$

$I_{\tilde{H}(\varepsilon)}(xy) \quad \leq I_{\tilde{H}(\varepsilon)}(x) \vee I_{\tilde{H}(\varepsilon)}(y)$

$F_{\tilde{H}(\varepsilon)}(x-y) \leq F_{\tilde{H}(\varepsilon)}(x) \vee F_{\tilde{H}(\varepsilon)}(y)$

$F_{\tilde{H}(\varepsilon)}(xy) \quad \leq F_{\tilde{H}(\varepsilon)}(x) \vee F_{\tilde{H}(\varepsilon)}(y)$

Case 3. Let $\varepsilon\ \in$ A ∩ B. In this case the proof is straightforward thus ,in any cases ,we have

$T_{\tilde{H}(\varepsilon)}(x-y) \geq T_{\tilde{H}(\varepsilon)}(x) \wedge T_{\tilde{H}(\varepsilon)}(y)$

$T_{\tilde{H}(\varepsilon)}(xy) \quad \geq T_{\tilde{H}(\varepsilon)}(x) \wedge T_{\tilde{H}(\varepsilon)}(y)$

$I_{\tilde{H}(\varepsilon)}(x-y) \leq I_{\tilde{H}(\varepsilon)}(x) \vee I_{\tilde{H}(\varepsilon)}(y)$

$I_{\tilde{H}(\varepsilon)}(xy) \quad \leq I_{\tilde{H}(\varepsilon)}(x) \vee I_{\tilde{H}(\varepsilon)}(y)$

$F_{\tilde{H}(\varepsilon)}(x-y) \leq F_{\tilde{H}(\varepsilon)}(x) \vee F_{\tilde{H}(\varepsilon)}(y)$

$F_{\tilde{H}(\varepsilon)}(xy) \quad \leq F_{\tilde{H}(\varepsilon)}(x) \vee F_{\tilde{H}(\varepsilon)}(y)$

Therefore , ($\tilde{P}$, A)$\tilde{\cup}$($\tilde{Q}$, B) is an intuitionistic neutrosophic soft ring.

Definition 3.8 : The intersection of two intuitionistic neutrosophic soft rings ($\tilde{P}$, A) and ($\tilde{Q}$,B) over a universe R is denoted by ($\tilde{P}$, A)$\tilde{\cap}$($\tilde{Q}$, B) and is defined by an intuitionistic neutrosophic soft ring $\tilde{H}$:

A ∪ B → $[0\ 1]^R$ such that for each $\varepsilon \in$ A ∪ B.

$$\tilde{H}(\varepsilon)=\begin{cases} < x,\ T_{\tilde{P}(\varepsilon)}(x), I_{\tilde{P}(\varepsilon)}(x)\ , F_{\tilde{P}(\varepsilon)}(x) > if\ \varepsilon\ \in\ \mathrm{A}-\mathrm{B} \\ < x,\ T_{\tilde{Q}(\varepsilon)}(x), I_{\tilde{Q}(\varepsilon)}(x)\ , F_{\tilde{Q}(\varepsilon)}(x) > if\ \varepsilon\ \in\ \mathrm{B}-\mathrm{A} \\ < x,\ T_{\tilde{P}(\varepsilon)}(x) \wedge T_{\tilde{Q}(\varepsilon)}(x),\ I_{\tilde{P}(\varepsilon)}(x) \wedge I_{\tilde{Q}(\varepsilon)}(x)\ , F_{\tilde{P}(\varepsilon)}(x) \vee F_{\tilde{Q}(\varepsilon)}(x) > if\ \varepsilon\ \in\ \mathrm{A} \cap \mathrm{B} \end{cases}$$

This is denoted by $(\tilde{H}, C)$ = ($\tilde{P}$,A) ∩ ($\tilde{Q}$,B) ,where C = A∪ B

Theorem 3.9 : If ($\tilde{P}$, A) and ($\tilde{Q}$, B) are two intuitionistic neutrosophic soft rings a universe R, then , so are ($\tilde{P}$, A)$\tilde{\cap}$($\tilde{Q}$, B) .

Proof. The proof is similar to that of Theorem 3.8.

Definition 3.10 : Let ($\tilde{P}$, A) and ($\tilde{Q}$, B) be two intuitionistic neutrosophic soft rings over a universe R.Then , "($\tilde{P}$, A) AND ($\tilde{Q}$, B)" is denoted by ($\tilde{P}$, A) $\tilde{\wedge}$ ($\tilde{Q}$, B) and is defined by ($\tilde{P}$, A) $\tilde{\wedge}$ ($\tilde{Q}$, B) =$(\tilde{H}, C)$,where C= A × B and $\tilde{H}$: C → $([0,1] \times [0,1])^R$ is defined as

$\tilde{H}$ (α, β) = $\tilde{P}$ $(\alpha) \cap$ $\tilde{Q}$ (β) , for all (α, β) $\in$ C.

Theorem 3.11 : If ($\tilde{P}$, A) and ($\tilde{Q}$, B) are two intuitionistic neutrosophic soft rings over a universe R, then , so are ($\tilde{P}$, A)$\tilde{\wedge}$($\tilde{Q}$, B).

Proof, For all x, y ∈ R and (α, β) ∈ A xB we have

$$T_{\tilde{H}(\alpha,\beta)}(x-y) = (T_{\tilde{P}(\alpha)}(x-y) \cap T_{\tilde{Q}(\beta)}(x-y))$$

$$\geq(T_{\tilde{P}(\alpha)}(x) \wedge T_{\tilde{P}(\alpha)}(y)) \cap (T_{\tilde{Q}(\beta)}(x) \wedge T_{\tilde{Q}(\beta)}(y))$$

$$= (T_{\tilde{P}(\alpha)}(x) \cap T_{\tilde{Q}(\beta)}(x)) \wedge (T_{\tilde{P}(\alpha)}(y) \cap T_{\tilde{Q}(\beta)}(y))$$

$$=T_{\tilde{H}(\alpha,\beta)}(x) \wedge T_{\tilde{H}(\alpha,\beta)}(y)$$

$$T_{\tilde{H}(\alpha,\beta)}(xy) = (T_{\tilde{P}(\alpha)}(xy) \cap T_{\tilde{Q}(\beta)}(xy))$$

$$\geq(T_{\tilde{P}(\alpha)}(x) \wedge T_{\tilde{P}(\alpha)}(y)) \cap (T_{\tilde{Q}(\beta)}(x) \wedge T_{\tilde{Q}(\beta)}(y))$$

$$= (T_{\tilde{P}(\alpha)}(x) \cap T_{\tilde{Q}(\beta)}(x)) \wedge (T_{\tilde{P}(\alpha)}(y) \cap T_{\tilde{Q}(\beta)}(y))$$

$$=T_{\tilde{H}(\alpha,\beta)}(x) \wedge T_{\tilde{H}(\alpha,\beta)}(y)$$

In a similar way ,we have

$$I_{\tilde{H}(\alpha,\beta)}(x-y) \leq I_{\tilde{H}(\alpha,\beta)}(x) \vee I_{\tilde{H}(\alpha,\beta)}(y)$$

$$I_{\tilde{H}(\alpha,\beta)}(xy) \leq I_{\tilde{H}(\alpha,\beta)}(x) \vee I_{\tilde{H}(\alpha,\beta)}(y)$$

$$F_{\tilde{H}(\alpha,\beta)}(x-y) \leq F_{\tilde{H}(\alpha,\beta)}(x) \vee F_{\tilde{H}(\alpha,\beta)}(y)$$

$$\boldsymbol{F_{\tilde{H}(\alpha,\beta)}(xy) \leq F_{\tilde{H}(\alpha,\beta)}(x) \vee F_{\tilde{H}(\alpha,\beta)}(y)}$$

For all x, y ∈ R and (α, β) ∈ C .It follows that ($\tilde{P}$, A)$\tilde{\wedge}$($\tilde{Q}$, B) is an intuitionistic neutrosophic soft rings over R.

Definition 3.12 : Let ($\tilde{P}$, A) and ($\tilde{Q}$, B) be two intuitionistic neutrosophic soft rings over a R.Then , "($\tilde{P}$, A) OR ($\tilde{Q}$, B)" is denoted by ($\tilde{P}$, A) $\tilde{\vee}$ ($\tilde{Q}$,B) and is defined by ($\tilde{P}$, A) $\tilde{\vee}$ ($\tilde{Q}$,B) =$(\tilde{O}, C)$,where C= A × B and $\tilde{O}$: C → $([0,1] \times [0,1])^R$ is defined as

$\tilde{O}$ (α, β) = $\tilde{P}$ $(\alpha)\tilde{\cup}$ $\tilde{Q}$ (β) , for all (α, β) $\in$ C.

Theorem 3.13 : If ($\tilde{P}$, A) and ($\tilde{Q}$, B) are two intuitionistic neutrosophic soft rings over a universe R, then , so are ($\tilde{P}$, A)$\tilde{\vee}$($\tilde{Q}$, B).

Proof. The proof is straightforward.

The following theorem is a generalization of previous results.

Theorem 3.14 : Let ($\tilde{P}$, A) be an intuitionistic neutrosophic soft rings over R, and let $\{(\tilde{P}_i, A_i)\}_{i\in I}$ be a nonempty family of intuitionistic neutrosophic soft ring, where I is an index set .Then , one has the following.

(1) $\wedge_{i\in I}(\tilde{P}_i, A_i)$ is an intuitionistic neutrosophic soft ring over R.

(2) if $A_i \cap A_j = 0$,for all i, j ∈ I ,then $\vee_{i\in I}(\tilde{P}_i, A_i)$ is an intuitionistic neutrosophic soft ring over R.

Definition 3.15 : Let ($\tilde{P}$, A) and ($\tilde{Q}$, B) be two intuitionistic neutrosophic soft rings over a R.Then ,the product of ($\tilde{P}$, A) and ($\tilde{Q}$, B) is defined to be the intuitionistic neutrosophic soft ring ($\tilde{P} \circ \tilde{Q}$, C) ,where C= A∪ B and

$$T_{\tilde{P}\circ\tilde{Q}(\varepsilon)}(x) = \begin{cases} T_{\tilde{P}(\varepsilon)}(x) \ if \ \varepsilon \in \mathrm{A-B} \\ T_{\tilde{Q}(\varepsilon)}(x) \ if \ \varepsilon \in \mathrm{B-A} \\ \vee_{x=ab}\{T_{\tilde{P}(\varepsilon)}(a) \wedge T_{\tilde{Q}(\varepsilon)}(b)\} \ if \ \varepsilon \in \mathrm{A\cap B} \end{cases}$$

$$I_{\tilde{P}\circ\tilde{Q}(\varepsilon)}(x) = \begin{cases} I_{\tilde{P}(\varepsilon)}(x) \ if \ \varepsilon \in \mathrm{A-B} \\ I_{\tilde{Q}(\varepsilon)}(x) \ if \ \varepsilon \in \mathrm{B-A} \\ \wedge_{x=ab}\{I_{\tilde{P}(\varepsilon)}(a) \vee I_{\tilde{Q}(\varepsilon)}(b)\} \ if \ \varepsilon \in \mathrm{A\cap B} \end{cases}$$

$$F_{\tilde{P}\circ\tilde{Q}(\varepsilon)}(x) = \begin{cases} F_{\tilde{P}(\varepsilon)}(x) \ if \ \varepsilon \in \mathrm{A-B} \\ F_{\tilde{Q}(\varepsilon)}(x) \ if \ \varepsilon \in \mathrm{B-A} \\ \wedge_{x=ab}\{F_{\tilde{P}(\varepsilon)}(a) \vee F_{\tilde{Q}(\varepsilon)}(b)\} \ if \ \varepsilon \in \mathrm{A\cap B}, \mathrm{a}, \mathrm{b} \in R \end{cases}$$

For all ε ∈ C and ε ∈ R .This is denoted by ($\tilde{P} \circ \tilde{Q}$, C) = ($\tilde{P}$,A) ° ($\tilde{Q}$,B).

Theorem 3.16 : If ($\tilde{P}$, A) and ($\tilde{Q}$, B) are two intuitionistic neutrosophic soft rings over a R. Then , so is ($\tilde{P}$, A) ∘ ($\tilde{Q}$, B) .

Proof. Let ($\tilde{P}$, A) and ($\tilde{Q}$, B) be two intuitionistic neutrosophic soft rings over a universe R. Then ,for any ε ∈ A ∪ B ,and x ,y ∈ R, we consider the following cases.

Case 1. Let ε ∈ A − B. Then,

$$T_{\tilde{P}\circ\tilde{Q}(\varepsilon)}(x-y) = T_{\tilde{P}(\varepsilon)}(x-y)$$
$$\geq T_{\tilde{P}(\varepsilon)}(x) \wedge T_{\tilde{P}(\varepsilon)}(y)$$
$$= T_{\tilde{P}\circ\tilde{Q}(\varepsilon)}(x) \wedge T_{\tilde{P}\circ\tilde{Q}(\varepsilon)}(y),$$

$$T_{\tilde{P}\circ\tilde{Q}(\varepsilon)}(xy) = T_{\tilde{P}(\varepsilon)}(xy)$$
$$\geq T_{\tilde{P}(\varepsilon)}(x) \wedge T_{\tilde{P}(\varepsilon)}(y)$$
$$= T_{\tilde{P}\circ\tilde{Q}(\varepsilon)}(x) \wedge T_{\tilde{P}\circ\tilde{Q}(\varepsilon)}(y)$$

$I_{\tilde{P} \circ \tilde{Q}(\varepsilon)}(x-y)= I_{\tilde{P}(\varepsilon)}(x-y)$

$\leq I_{\tilde{P}(\varepsilon)}(x) \vee I_{\tilde{P}(\varepsilon)}(y)$

$=I_{\tilde{P} \circ \tilde{Q}(\varepsilon)}(x) \vee I_{\tilde{P} \circ \tilde{Q}(\varepsilon)}(y),$

$I_{\tilde{P} \circ \tilde{Q}(\varepsilon)}(xy)= I_{\tilde{P}(\varepsilon)}(xy)$

$\leq I_{\tilde{P}(\varepsilon)}(x) \vee I_{\tilde{P}(\varepsilon)}(y)$

$=I_{\tilde{P} \circ \tilde{Q}(\varepsilon)}(x) \vee I_{\tilde{P} \circ \tilde{Q}(\varepsilon)}(y)$

$F_{\tilde{P} \circ \tilde{Q}(\varepsilon)}(x-y)= F_{\tilde{P}(\varepsilon)}(x-y)$

$\leq F_{\tilde{P}(\varepsilon)}(x) \vee F_{\tilde{P}(\varepsilon)}(y)$

$=F_{\tilde{P} \circ \tilde{Q}(\varepsilon)}(x) \vee F_{\tilde{P} \circ \tilde{Q}(\varepsilon)}(y),$

$F_{\tilde{P} \circ \tilde{Q}(\varepsilon)}(xy)=F_{\tilde{P}(\varepsilon)}(xy)$

$\leq F_{\tilde{P}(\varepsilon)}(x) \vee F_{\tilde{P}(\varepsilon)}(y)$

$= F_{\tilde{P} \circ \tilde{Q}(\varepsilon)}(x) \vee F_{\tilde{P} \circ \tilde{Q}(\varepsilon)}(y)$

Case 2. Let $\varepsilon \in$ B − A. Then, analogous to the proof of case 1,the proof is straightforward.

Case 3. Let $\varepsilon \in$ B ∩ A. Then,

$T_{\tilde{P} \circ \tilde{Q}(\varepsilon)}(x)= \bigvee_{x=ab}(T_{\tilde{P}(\varepsilon)}(a) \wedge T_{\tilde{Q}(\varepsilon)}(b))$

$\leq \bigvee_{xy=aby}(T_{\tilde{P}(\varepsilon)}(a) \wedge T_{\tilde{Q}(\varepsilon)}(by))$

$\leq \bigvee_{xy=cd}(T_{\tilde{P}(\varepsilon)}(c) \wedge T_{\tilde{Q}(\varepsilon)}(d))$

$=T_{\tilde{P} \circ \tilde{Q}(\varepsilon)}(xy)$

Similarly ,we have $T_{\tilde{P} \circ \tilde{Q}(\varepsilon)}(xy) \geq T_{\tilde{P} \circ \tilde{Q}(\varepsilon)}(y)$, and so $T_{\tilde{P} \circ \tilde{Q}(\varepsilon)}(xy) \geq T_{\tilde{P} \circ \tilde{Q}(\varepsilon)}(x) \wedge T_{\tilde{P} \circ \tilde{Q}(\varepsilon)}(y)$

In a similar way , we prove that $I_{\tilde{P} \circ \tilde{Q}(\varepsilon)}(xy) \leq I_{\tilde{P} \circ \tilde{Q}(\varepsilon)}(x) \vee I_{\tilde{P} \circ \tilde{Q}(\varepsilon)}(y)$ and

$F_{\tilde{P} \circ \tilde{Q}(\varepsilon)}(xy) \leq F_{\tilde{P} \circ \tilde{Q}(\varepsilon)}(x) \vee F_{\tilde{P} \circ \tilde{Q}(\varepsilon)}(y)$

Therefore ($\tilde{P}$, A) ∘ ($\tilde{Q}$, B) is an intuitionistic neutrosophic soft ring over R

4.Conclusion

Soft sets and neutrosophic sets are new mathematical tool to deal with uncertainties. In this paper we introduced the concept of intuitionistic neutrosophic soft set in ring theory. We also studied an discussed some properties related to this concept, then obtained results can be applied to other algebraic structures.

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