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CHARACTERIZATION OF COMPLEX BI FUZZY SOFT SET ON REGULAR SEMI GROUP

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Abstract:

In this article, we define a new structure of complex bi fuzzy soft left ideals (resp., right) of a semi group S, Union and Intersection of ideals is again ideals. Also, we prove the set of all idempotent elements of S from a right zero semi group of S, then C(x) = C(y) for all idempotents elements of x and y of S. If C_1 and C_2 be a complex bi fuzzy soft left and right ideals of a semi group S, respectively, then $C_1 * C_2 \subseteq C_1 \cap C_2$. For every Complex bi fuzzy soft right ideal C_1 and every Complex bi fuzzy soft left ideal C_2 of a semi groups, if $C_1 * C_2 = C_1 \cap C_2$, then S is regular.

Key Words: Fuzzy Set, Soft Set, Complex Bi Fuzzy Set, Soft Ideals, Idempotent & Right Zero Semi Group

1. Introduction:

Molodtsov [1999] initiated the concept of soft set theory as a new approach for modeling uncertainities. Then Majiet. al [2001] expanded this theory to fuzzy soft set theory. The algebraic structures of soft set theory have been studied increasingly in recent years. Aktas and Cagman [2007] defined the notion of soft groups. Feng et.al [2008] initiated the study of soft semi rings and finally soft rings are defined by Acar et.al [2010]. But in real life situation, the problems in economics, engineering, environment, social science, medical science etc do not always involve crisp data. Consequently, we cannot successfully by using the traditional classical methods because of various types of uncertainties in this problem. There are several theories, for example, theory of fuzzy sets [1965], theory of intuitionist fuzzy sets [1971], vague sets [2002], interval mathematics [2001], and rough sets [2007], which can be considered as mathematical tools for dealing with uncertainties. But all these theories have this inherents difficulties as what where point out by Molodtsov in [1999]. The reason for these difficulties is possibly the inadequacy of the parameterization tool of the theories.

Indeed, the applications of complex fuzzy sets span various fields, such as signal processing [2002], physical phenomena [2002], and economics [2002]. Chen et al. developed a neuro-fuzzy architecture using complex fuzzy sets [2011]. Jun et al. successfully applied complex fuzzy sets in multiple periodic factor prediction problems [2012]. Additional background on complex fuzzy sets can be found in [2002]. Similarly to the case of an intuitionistic fuzzy set, a complex intuitionistic fuzzy set is characterized by a complex grade of membership and complex grade of non-membership [2012]. The complex intuitionistic fuzzy sets enable defining the values of membership and non-membership for any object in these complex-valued functions.

In this article, we define a new structure of complex bi fuzzy soft left ideals (resp., right) of a semi group S, Union and Intersection of ideals is again ideals. Also, we prove the set of all idempotent elements of S from a right zero semi group of S, then C(x) = C(y) for all idempotents elements of x and y of S. If C_1 and C_2 be a complex bi fuzzy soft left and right ideals of a semi group S, respectively, then $C_1 * C_2 \subseteq C_1 \cap C_2$. For every Complex bi fuzzy soft right ideal C_1 and every Complex bi fuzzy soft left ideal C_2 of a semi groups, if $C_1 * C_2 = C_1 \cap C_2$, then S is regular.

2. BasicConcepts and Preliminaries:

In the section,we define some ideals namely complex double-framed (left,right,interior) ideal in semi group, with help of examples and study some of its related results.

Definition 2.1: A mapping μ: X → [0, 1] where X is an arbitrary non empty set and is called Fuzzy set in X.

Definition 2.2: Let G be a any group. A mapping μ :G → [0, 1] is a Fuzzy Subgroup if

- ✓ $\mu(x\,y) \geq \min\{\mu(x), \mu(y)\}$
- ✓ $\mu(x^{-1}) = \mu(x)$, for all x, y ε G.

Definition 2.3: A pair (f, A), is called a soft set over the lattice L, If f:A → P(L). Here L be the initial universe and E be the set of parameters. Let P(L) denotes the power set of L and I^L denotes the set of all fuzzy sets on L.

Definition 2.4: A pair (f, A) is called a fuzzy soft set over L, where f:A →I^L, ie. for each a ε A, f_a: L → I is a fuzzy set in L.

Definition 2.5: Let (f, A) be a non-null soft set over a ring R. Then (f, A) is said to be a soft ring over R if and only if f(a) is sub ring of R for each a ε A.

Definition 2.6: Let μ: X → Y and υ: A →B be two functions, where A and B are parameter sets for the crisp sets X and Y respectively. Then the pair (μ, υ) is called a fuzzy soft function from X to Y.

Definition 2.7: A complex bi fuzzy soft set C on a semigroup S is known as complex bi fuzzy soft left ideal of S,if C(xy) >,C (y) .

Definition (Fuzzy Number) 2.8: It is a fuzzy set the following conditions:

- ✓ Convex fuzzy set
- ✓ Normalized fuzzy set
- ✓ Its membership function is piecewise continuous.
- ✓ It is defined in the real number.

A complex fuzzy subset A, defined on a universe of discourse X, is characterized by a membership function τ_A(x) that assigns any element x∈X a complex valued grade of membership in A. The values of τ_A(x) all lie within the unit circle in the complex plane and thus all of the form P_A(x) $e^{j\mu_A(x)}$ where P_A(x) and $e^{j\mu_A(x)}$ are both real valued and P_A(x) ∈[0,1]. Here P_A(x) is termed as amplitude term and $e^{j\mu_A(x)}$ is termed as phase term.

The complex fuzzy set may be represented in the set form as A = {(x,τ_A(x)) / x∈X }. It is denoted by CFS.The phase term of complex membership function belongs to (0,2π). Now we take those forms which Ramot.et.al presented in [8] to define the game of winner, neutral and lose.

$$\mu_{A\cup B}(x) = \begin{cases} \mu_A(x) & \text{if} p_A > p_B \\ \mu_B(x) & \text{if} p_A < p_B \end{cases}$$

This is a novel concept and it is the generalization of the concept "winner take all" introduced by Ramot.et.al [8] for the union of phase terms.

Example 2.9: Let X = {x_1, x_2, x_3} be a universe of discourse. Let A and B be complex fuzzy sets in X as shown below.

$$A = \{0.6\, e^{i(0.8)}, 0.3\, e^{i\frac{3\pi}{4}}, 0.5\, e^{i(0.3)}\}$$
$$B = \{0.8\, e^{i(0.9)}, 0.1\, e^{i\frac{\pi}{4}}, 0.4\, e^{i(0.5)}\}$$
$$A\cup B = \{0.8\, e^{i(0.9)}, 0.3\, e^{i\frac{3\pi}{4}}, 0.5\, e^{i(0.3)}\}$$

We can easily calculate the phase terms $e^{i\mu_{A\cap B}(x)}$ on the same line by winner, neutral and loser game.

3. Some Characterisations of Complex Bifuzzy Soft Ideals:

In this section, we deal with main theorems based on complex bi fuzzy soft left ideals (resp, right).

Theorem 3.1: Let C be a Complex bi fuzzy soft left ideal of a semigroup S of the set of all idempotent elements of S form a left Zero Semi group of S, then C(x) = C(y) for all idempotent elements of x and y of S.

Proof: Let us assume that Idm(s) be the set of all idempotent elements of S and is a left Zero Semi group of S. For any x,y € Idm (S), we have xy = x and yx = y, Thus

$$Pc(x)\bullet e^{i\,\delta c(xy)} = Pc(xy)\bullet e^{i\,\delta c(xy)} \geq Pc(y)\bullet e^{i\,\delta c(y)} = Pc(y)\bullet e^{i\,\delta c(yx)} \geq Pc(x)\bullet e^{i\,\delta c(x)}$$
$$= Pc(x)\bullet e^{i\,\delta c(y)} \quad \text{and}$$

$$\mathfrak{I}_C(x)\bullet e^{i\,\Delta c(x)} = \mathfrak{I}_C(xy)\bullet e^{i\,\Delta c(xy)}$$
$$\leq \mathfrak{I}_C(y)\bullet e^{i\,\Delta c(y)} = \mathfrak{I}_C(yx)\bullet e^{i\,\Delta c(yx)} \leq \mathfrak{I}_C(x)\bullet e^{i\,\Delta c(x)}$$
$$= \mathfrak{I}_C(y)\bullet e^{i\,\Delta c(y)}$$

Thus for C(x) = C(y) for all x,y € Idm (S).

Theorem 3.2: Let C be a Complex bi fuzzy soft right ideal of a semi group S. If the set of all idempotent elements of S from a right zero semigroup of S, then C(x) = C(y) for all idempotents elements of x and y of S.

Proof: Proof is similar to the theorem 3.1.

Proposition 3.3: If S be a Semi group, then the following properties are hold.

- ✓ The intersection of two Complex bi fuzzy soft semi group of S is a Complex bi fuzzy soft semi group of S.
- ✓ The intersection of two complex bi fuzzy left (respectively right) ideals of S is a complex bi fuzzy soft left (respectively right) ideal of S.

Proof: Let

C_1 = {C_{1T} = $Pc_1 \bullet e^{i\,\delta c1}$, C_{1F} = $rc1 \bullet e^{i\,\Delta c1}$ } and

C_2= {C_{2T} = $Pc_2 \bullet e^{i\,\delta c2}$,C_{2F} = $rc1 \bullet e^{i\,\Delta c2}$ } be any two complex bi fuzzy soft semi groups of S

Let x, y € S, then

$$(Pc_1\bullet e^{i\,\delta c_1} \cap Pc_2\bullet e^{\delta c_2})(xy)$$
$$= \inf\{Pc_1(xy)\bullet e^{i\,\delta c_1(xy)}, Pc_2(xy)\bullet e^{i\,\delta c_2(xy)}\}$$
$$\geq \inf\{\inf Pc_1(x)\bullet e^{i\,\delta c_1(x)}, Pc_2(x)\bullet e^{i\,\delta c_2(y)},$$
$$\inf\{Pc_2(x)\bullet e^{i\,\delta c_2(x)}, Pc_2(xy)\bullet e^{i\,\delta c_2(y)}\}$$
$$= \inf\{\inf Pc_1(x)\bullet e^{i\,\delta c_1(x)}, Pc_2(x)\bullet e^{i\,\delta c_2(y)},$$
$$\inf\{Pc_1(x)\bullet e^{i\,\delta c_2(x)}, Pc_2(xy)\bullet e^{i\,\delta c_2(y)}\}$$

$= \inf\{ (Pc_1 \bullet e^{i\delta c_1} \cap Pc_2 e^{i\delta c_2 (y)})(x),$
$(Pc_1 e^{i\delta c_1} \cap Pc_2 e^{i\delta c_2})(y) \}$

$rc_1 \bullet e^{i\Delta c_1} \cup rc_2 \bullet e^{\Delta c_2})(xy)$

$=\text{Sup}\{rc_1 (xy)\bullet e^{i\Delta c_1 (xy)}, rc_2 (xy)\bullet e^{i\Delta c_2 (xy)}\}$
$\leq \text{Sup}\{\text{Sup} rc_1 (x)\bullet e^{i\Delta c_1 (y)}, rc_1 (y)\bullet e^{i\Delta c_1 (y)}\},$
$\text{Sup}\{\text{Sup } rc_2 (x)\bullet e^{i\Delta c_1 (x)}, rc_2 (y)\bullet e^{i\Delta c_2 (x)}\}$
$= \text{Sup}\{\text{Sup } rc_1 (x)\bullet e^{i\Delta c_1 (x)}, rc_2 (y)\bullet e^{i\Delta c_2 (x)}\},$
$\text{Sup}\{\text{Sup } rc_1 (x)\bullet e^{i\Delta c_1 (y)}, rc_2 (y)\bullet e^{i\Delta c_2 (y)}\}$
$= \text{Sup}\{ (rc_1 \bullet e^{i\Delta c_1} \cup rc_2 e^{i\Delta c_2})(x),$
$(rc_1 \bullet e^{i\Delta c_1} \cup rc_2 e^{i\Delta c_2})(y) \}$

Thus for $C_1 \cap C_2$ is a Complex bi fuzzy soft semi group of S.
Let C_1 and C_2 be any two Complex bi fuzzy soft left ideals of semi group S, and x, y € S. Then
Let x, y € S, then

$(Pc_1 \bullet e^{i\delta c_1} \cap Pc_2 \bullet e^{\delta c_2})(xy)$

$= \inf\{Pc_1 (xy)\bullet e^{i\delta c_1 (xy)}, Pc_2 (xy)\bullet e^{i\delta c_2 (xy)}\}$
$\geq \inf\{Pc_1 (y)\bullet e^{i\delta c_1 (y)}, Pc_2 (y)\bullet e^{i\delta c_2 (y)}$,
$= \{ Pc_1 \bullet e^{i\delta c_1} \cap Pc_2 \bullet e^{i\delta c_2} \} (y)$'

and $rc_1 \bullet e^{i\Delta c_1} \cup rc_2 \bullet e^{\Delta c_2})(xy)$

$=\text{Sup}\{rc_1 (y)\bullet e^{i\Delta c_1 (y)}, rc_2 (xy)\bullet e^{i\Delta c_2 (y)}\}$
$= \{ rc_1 \bullet e^{i\Delta c_1} \cup, rc_2 \bullet e^{i\Delta c_2} \} (y)$

Thus for $C_1 \cap C_2$ is a Complex bi fuzzy soft semi left ideal of S. The intersection of Complex bi fuzzy soft right ideal can be proved in a similar manner.

Proposition 3.4: If S be a semi group. Then the following properties are hold.

- ✓ The Union of two Complex bi fuzzy soft semi group of S is a complex bi fuzzy soft semi group of S.
- ✓ The Union of two Complex bi fuzzy left (respectively right) ideals of S is a Complex bi fuzzy soft left (respectively right) ideal of S.

Theorem 3.5: If C_1 and C_2 be a complex bi fuzzy soft left and right ideals of a semi group S, respectively, then $C_1 * C_2 \subseteq C_1 \cap C_2$.

Proof: If C_1 is Complex bi fuzzy soft right ideal and C_2 is any Complex left bi fuzzy soft ideal of S.
We have $C_1 * C_2 \subseteq C_1 * S \subseteq C_1$ and $C_1 * C_2 \subseteq S * C_2 \subseteq C_2$.
Hence $C_1 * C_2 \subseteq C_1 \cap C_2$.

Theorem 3.6: If S is regular semi group, then $C_1 * C_2 \subseteq C_1 \cap C_2$.For every Complex bi fuzzy soft right ideal of C_1 and C_2 of S.

Proof: Let α be any element of S. Since S is regular, there exist an element x € S such that α x α.
Hence we have

$(Pc_1 \bullet e^{i\delta c_1} \cap Pc_2 \bullet e^{\delta c_2})(\alpha)$
$=(\max)_{\alpha=y\rho} \{ \inf\{Pc_1 (y)\bullet e^{i\delta c_1 (y)}, Pc_2 (\rho)\bullet e^{i\delta c_2 (\rho)}\}\}$
$=(\max)_{\alpha x\alpha=y\rho} \{ \inf\{Pc_1 (y)\bullet e^{i\delta c_1 (y)}, Pc_2 (\rho)\bullet e^{i\delta c_2 (\rho)}\}\},$
$\geq \inf\{Pc_1 (\alpha)\bullet e^{i\delta c_1 (\alpha)}, Pc_2 (\alpha)\bullet e^{i\delta c_2 (\alpha)}\}\},$
$\geq \inf\{Pc_1 (\alpha)\bullet e^{i\delta c_1 (\alpha)}, Pc_2 (\alpha)\bullet e^{i\delta c_2 (\alpha)}\}\},$
$= \{Pc_1 \bullet e^{i\delta c_1 (\alpha)} \cap Pc_2 \bullet e^{i\delta c_2}\}\},(\alpha)$

and $(rc_1 . e^{i\Delta c_1} \bullet rc_2 e^{\Delta c_2})(xy)$

$=(\min)_{\alpha=y\rho} \{ \text{Sup}\{rc_1 (y)\bullet e^{i\Delta c_1 (y)}, rc_2 (\rho)\bullet e^{i\Delta c_2 (\rho)}\}\}$
$=(\min)_{\alpha x\alpha=y\rho} \{ \text{Sup}\{rc_1 (y)\bullet e^{i\Delta c_1 (y)}, rc_2 (\rho)\bullet e^{i\Delta c_2 (\rho)}\}\},$
$\leq \text{Sup}\{rc_1 (\alpha x)\bullet e^{i\Delta c_1 (\alpha x)}, rc_2 (\alpha)\bullet e^{i\Delta c_2 (\alpha)}\}\},$

$$\leq \text{Sup}\ \{rc_1(\alpha)\bullet e^{i\Delta c_1(\alpha)},\ rc_2(\alpha)\bullet e^{i\Delta c_2(\alpha)}\}$$

$$= \{rc_1\bullet e^{i\Delta c_1} \cup rc_2\bullet e^{i\Delta c_2}\}(\alpha)$$

We have $C_1 * C_2 \supseteq C_1 \cap C_2$ and $C_1 * C_2 \subseteq C1 \cup C_2$ is true from theorem 3.

Hence $C_1 * C_2 = C_1 \cap C_2$.

Theorem 3.6: For any non-empty subset H of a semi group S, We have

- ✓ H is a Semi group of S if and only if the characteristic complex bi fuzzy soft set C_H of H in S is a Complex bi fuzzy soft semi group of S.
- ✓ H is a left (respectively right) ideal of S if and only if the characteristic Complex bi fuzzy soft set $C_H$of H in S is a Complex bi fuzzy soft left (respectively right) ideal of S.

Proof: The Proof is straight forward.

Theorem 3.7: For every Complex bi fuzzy soft right ideal C_1 and every Complex bi fuzzy soft left ideal C_2 of a semi groups, if $C_1 * C_2 = C_1 \cap C_2$, then S is regular.

Proof: Assume that $C_1 * C_2 = C_1 \cap C_2$for every complex bi fuzzy soft right ideal C_1 and every complex bi fuzzy soft left ideal C_2 of a semi group S. Let M and N be any right and left ideal of S, respectively.

In order to see that $M \cap N \subseteq MN$ holds**.** Let α be only element of $M \cap N$, then the characteristic complex bi fuzzy soft set C_M and C_N on complex bifuzzy soft right ideal and a complex bi fuzzy left ideal of S, respectively, by theorem 5.

At follows from the hypothesis.

$$T_{CMN}(\alpha) = (T_{CM}\bullet T_{CN})(\alpha) = (T_{CM}\cap T_{CN})(\alpha) = T_{CM\cap N}(\alpha) = 1.e^{i2\pi}$$

$$F_{CMN}(\alpha) = (F_{CM}\bullet F_{CN})(\alpha) = (F_{CM}\cup F_{CN})(\alpha) = F_{CMN}(\alpha) = 0$$

So that α € M_N. Thus $M \cap N \subseteq MN$. Since the inclusion in the other direction always holds. We obtain that $R \cap L \subseteq RL$. It follows that S is regular.

Theorem 3.8: If C_1 and C_2 are two complex bi fuzzy soft sets of a semi group S, then

(i) $(C_1 \cap C_2)_x = C_{1x} \cap C_{2x}$

(ii) $(C_1 \cup C_2)_x = C_{1x} \cup C_{2x}$

(iii) $C_{1x} + C_{2x} \subseteq (C1 + C2)_x$

Proof:

Let $f(x) = \sum_{i=0}^{n} a_i x^i$ be any element of S then

(i) $\delta\ (C_1 \cap C_2)_x (f(x)) = \delta_{(C1 \cap C2)x} = (\inf)_i\{\delta_{(C1 \cap C2)}(ai) = (\inf)_i\ \{\delta_{C1}(ai), \inf\{\delta_{C2}(ai)\}$

$= (\inf)\ \{\delta_{C1}(ai), \inf\{\delta_{C2}(ai)\} = (\inf)\ \{\delta_{C1x}(f(x)), \{\delta_{C2X}(f(x)\}$

$= \delta_{(C1x \cap C2x)}(f(x)$.

Similarly, we can show that $\Delta\ (C_1 \cap C_2)_x = \Delta_{(C1 \cap C2)x}(f(x))$

Hence $(C_1 \cap C_2)_x = C_{1x} \cap C_{2x}$

(ii) $\delta\ (C_1 \cup C_2)_x (f(x)) = \delta_{(C1 \cup C2)x} = (\inf)_i\{\delta_{(C1 \cup C2)}(ai) = (\inf)_i\ \{\text{Sup}\{\delta_{C1}(ai), \{\delta_{C2}(ai)\}$

$\geq (\text{Sup})\{(\inf)i\{\delta_{C1}(ai), \{\delta_{C2}(ai)\} = \{(\text{Sup})\{\{(\inf)i\{\delta_{C1}(ai), (\inf)i\ \delta_{C2}(ai)$

$= (\text{Sup})\ \{\delta_{C1x}(f(x)), \{\delta_{C2X}(f(x)\} = \delta_{(C1x \cup C2x)}(f(x)$.

Similarly, we can show that $\Delta\ (C_1 \cup C_2)_x = \Delta_{(C1 \cup \cap C2)x}(f(x))$

Hence $(C_1 \cup C_2)_x \supseteq = C_{1x} \cup C_{2x}$

Now $\delta_{C1x+C2x}(f(x)) = \text{Sup}\{\inf\{\delta\ Ax(g(x)), \delta\ Bx\ (h(x)\}\ g(x)$

f(x)= g(x)+h(x)

$= \sum_{i=0}^{p} b_i x^i \quad h(x) = \sum_{i=0}^{p} C_i x^i$

$= \text{Sup}\ \{\inf\{\inf(\delta\ c1(bi), \delta\ c2\ (ci)\}\}$

f(x)= g(x)+h(x)

$= \text{Sup}\ \{\inf\{\inf(\delta\ c_1(bi), \delta\ c_2(ci)\}\}$

$a_i = b_i + c_i \quad = (\inf)_i \max\{\{\inf(\delta\ c_1(bi), \delta\ c_2\ (ci)\}$

$$a_i = b_i + c_i$$
$$= \delta\ (c_1+c_2)x\ (f(x)$$

Similarly, we can show that $\Delta_{c1x+c2x}$ $(f(x)) = \Delta_{(c1+c2)x}$ $(f(x))$.

Conclusion:

We prove the set of all idempotent elements of S from a right zero semi group of S, then C(x) = C(y) for all idempotents elements of x and y of S. If C_1 and C_2 be a complex bi fuzzy soft left and right ideals of a semi group S, respectively, then $C_1 * C_2 \subseteq C_1 \cap C_2$. For every Complex bi fuzzy soft right ideal C_1 and every Complex bi fuzzy soft left ideal C_2 of a semi groups, if $C_1 * C_2 = C_1 \cap C_2$, then S is regular.

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