International Research Journal of Pure Algebra-7(8), 2017, 806-811
Available online through www.rjpa.info ISSN 2248–9037

CHARACTERIZATION OF NORMAL FUZZY SOFT RIGHT NEAR-RING GROUP VIA MAX-NORMS

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(Received On: 01-08-17; Revised & Accepted On: 22-08-17)

ABSTRACT

In this paper, we discuss the notion of max-fuzzy soft N-subgroups by using Molodtsov's definition of soft sets and investigate their related properties with respect to α-inclusion of soft sets.

Keywords: *Soft set, fuzzy soft set, Soft N- group, complete, S- fuzzy soft N-group, α-inclusion, Max-norms.*

SECTION-1: INTRODUCTION

In 1999, Molodtsov's [10] proposed an approach for modeling, vagueness and uncertainty, called soft set theory. Since its inception, works on soft set theory have been progressing rapidly with a wide-range applications especially in the mean of algebraic structures as in [1-14]. The structures of soft sets, operations of soft sets and some related concepts have been studied by [10-13]. Atagun and Sezgin [3] defined soft N- subgroups and soft N-ideals of an N-group. They studied their properties with respect to soft set operations in more detail. In this paper, the notion of max- fuzzy soft N-subgroups by using Molodtsov's definition of soft sets are discussed and investigate their related properties with respect to α-inclusion of soft sets.

SECTION-2: PRELIMINARIES

This section contains some basic definition and preliminary results which will be needed in the sequal.In what follows let G and S denote a group and max-norm respectively unless otherwise specified.

Definition 2.1: By a near ring, we shall mean an algebraic system (N, +, •), where
- (i) (N,+) forms a group (not necessarily abelian)
- (ii) (N,•) forms a semi group and
- (iii) (a+b) c = ac + bc for all a, b ∈ N.

Throughout this paper, N will always denote a right near ring whose zero element in O_N. A subgroup M or N write N is contained in M is called a sub near ring of N. For a near ring N, the zero symmetric part of N denoted by N_0 is defined by $N_0 = \{n \in N / nN_0 = O_N\}$

Definition 2.2: Let (G, +) be a group and A: N×G→G , (n, g) → ng, (G, A) is called an N-group if for all x, y ∈ N, for all g ∈ G,
- (i) x(yg) = (xy)g and
- (ii) (x+y)g = xg +yg. It is denoted by N^G.

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Clearly, N itself is an N-group by natural operation. A subgroup H of G with N_H contained in H is said to be an N-subgroup of G. Let N be a near-ring and G and ψ two N-groups. Then f: G→ ψ is called N-homomorphism if for all g, H ∈ G, for all n ∈ N.

(i) f(g+H) = f(g) + f(H) and
(ii) f(ng) = nf(g). For all undefined concepts and notions, we refer [17].

From now on, U refers to an initial universe, E is a set of parameters, 2^U is the power set of U and A, B, C is subset of E.

Definition 2.3: Let X be a set. Then a mapping μ: X→ [0, 1] is called fuzzy subset of X.

Definition 2.4: Let U be a universal set, E set of parameters and A ⊂ E. Then a pair (δ, A) is called soft set over U, where δ is a mapping from A to 2^U, the power set of U.

Example: Let X = $\{c_1, c_2, c_3\}$ be the set of three cars and E= {costly (e_1), metallic colour (e_2), cheap (e_3)} be the set of parameters, where A = $\{e_1, e_2\}$ is subset of E. Then

(δ, A) = $\{\delta(e_1) = \{c_1, c_2, c_3\}, \delta(e_2) = \{c_1, c_2\}\}$ is crisp soft set over X.

Definition 2.5: Let U be a universal set, E set of parameters and A is subset of E. Let δ(X) denotes the set of all fuzzy subsets of U. Then a pair (δ, A) is called soft set over U, where F is a mapping from A to δ(U).

Example: Let U = $\{c_1, c_2, c_3\}$ be the set of three cars and E= {costly (e_1), metallic colour (e_2), cheap (e_3)} be the set of parameters, where A = $\{e_1, e_2\}$ ⊂ E. Then

(δ, A) = $\{\delta(e_1) = \{c_1/ 0.5, c_2 /0.6, c_3/0.2\}, \delta(e_2) =\{c_1/0.4, c_2/0.5, c_3/ 0.7\}\}$ is the fuzzy soft set over U denoted by δ_A.

Definition 2.6: Let δ_A be a fuzzy soft set over U and α be a subset of U. Then upper α- inclusion of δ_A denoted by

$\delta_A^{+\alpha} =\{ x\in A / \delta(x) \geq \alpha\}$ similarly

$\delta_A^{-\alpha} =\{ x \in A / \delta(x) \leq \alpha\}$ is called lower α-inclusion of δ_A.

Definition 2.7: A triangular conorm (*t*-conorm) is a mapping max*:* [0, 1] × [0, 1] → [0, 1] that satisfies the following conditions:

(S1) max (x, 0) = x,
(S2) max(x, y) = max(y, x),
(S3) max(x, max(y, z)) = max(max(x, y), z),
(S4) max(x, y) ≤ max(x, z) whenever y ≤ z, for all x, y, z ∈ [0, 1].
Replacing 0 by 1 in condition max, we obtain the concept of *t*-norm min.

Lemma 2.8: Let 'min' be a t- norm. Then t- co norm 'max' can be defined as max(x, y) = 1- min(1-x, 1-y).

Proof: straight forward

Definition 2.9: Let δ_A and Δ_B be fuzzy soft sets over the common universe U and ψ: A → B a function. Then fuzzy soft image of δ_A under ψ over U denoted by $\psi(\delta_A)$ is a set-valued function, when $\psi(\delta_A)$: B→ 2^U defined by

$$\psi(\delta_A)(b) = \begin{cases} \max\{ \delta(a) / a\in A \text{ and } \psi(a) = b \}, & \text{if } \psi^{-1}(b) = \Phi \\ \Phi & \text{otherwise} \end{cases} \quad \text{for all } b\in B.$$

The fuzzy soft pre image of Δ_B under ψ over U, denoted by $\psi^{-1}(G_B)$ is a set valued function where $\psi^{-1}(G_B)$: A→ 2^U defined by $\psi^{-1}(\Delta_B)(b) = G(\psi(a))$ for all a∈A. Then fuzzy soft anti image of δ_A under Δ over U denoted by $\psi^*(\delta_A)$ is a set valued function, where

$$\psi^*(\delta) = \begin{cases} \min \{\delta(a) / a \in A \text{ and } \psi(a) = b\}, & \text{if } \psi^{-1}(b) = \Phi \\ \Phi & \text{otherwise} \end{cases} \quad \text{for all } b\in B.$$

Definition 2.10: Let H be an N- subgroup of G and δ_H be a fuzzy soft set over G. If for all x, y∈H and n ∈ N,

(i) $\delta_H(x-y) \geq \min\{\delta_H(x), \delta_H(y)\}$ and
(ii) $\delta_H(nx) \geq \delta_H(x)$, then the fuzzy soft set F_H is called a fuzzy soft N-subgroup of G.

Definition 2.11: Let H be an N- subgroup of G and F_H be a fuzzy soft set over G. If for all x, y∈H and n ∈ N,

(i) $\delta_H(x-y) \leq \max\{\delta_H(x), \delta_H(y)\}$ and
(ii) $\delta_H(nx) \leq \delta_H(x)$, then the fuzzy soft set δ_H is called max - fuzzy soft N-subgroup of G.
It is denoted by $\delta_H \hat{\subset}_N G$

Example: Consider N = {0, 1, 2, 3} be a near-ring with operations + and •

+	0	1	2	3
0	0	1	2	3
1	1	2	3	0
2	2	3	0	1
3	3	0	1	2

•	0	1	2	3
0	0	0	0	0
1	0	1	2	3
2	0	2	1	2
3	0	3	2	1

Let G = N, H = {0, 2}$\triangle_N$ G and F_H be a fuzzy soft set over G, where δ: H→ 2^G is a set valued function defined by δ(x) = {0} ∪{y ∊ G / 3x=y} for x ∈ H. Then δ(0) = {0} and δ(2) = {0,2}. Therefore $\delta_H \triangle_N$ G. If we define a fuzzy soft set Δ_H over G by Δ(x) = {y ∈ G / 3x = y} for all x∈ H. Then Δ(0) = {0} and Δ(2) = {2}. since Δ(2-2) = Δ(0) not in Δ(2). Δ_H is not a max- fuzzy soft N-subgroup of G.

Definition 2.12: The relative complement of the fuzzy soft set δ_A over G is denoted by δ_A^r, where δ_A^r: A → 2^U is a mapping given as $\delta_A^r(x) = G / \delta_A(x)$, for all x ∈ A.

SECTION-3: Properties of max- fuzzy soft N-subgroup

Proposition 3.1: Let δ_H be a fuzzy soft set over G and α be a subset of G. If δ_H is max- fuzzy soft N-subgroup of G, then lower α-inclusion of δ_H is an N-subgroup of G.

Proof: since δ_H is max- fuzzy soft N-subgroup of G. Assume x, y ∈ H

Let $\delta_H^{-\alpha}$ and n ∈N, then $\delta_H(x) \le \alpha$ and $\delta_H(y) \le \alpha$. We need to show that x-y∊ $\delta_H^{-\alpha}$ and n ∊ $\delta_H^{-\alpha}$. Since δ_A is max- fuzzy soft N-subgroup of G, it follows that $\delta_H(x-y) \le \max\{\delta_H(x), \delta_H(y)\} \le \max\{\alpha, \alpha\} \le \alpha$ and $\delta_H(nx) \le \delta_H(x) \le \alpha$ which completes the proof.

Proposition 3.2: Let δ_H be a fuzzy soft set over G and α be a subset of G. If δ_H is fuzzy soft N-subgroup of G, then upper α-inclusion of δ_H is an N-subgroup of G.

Proof: since δ_H is fuzzy soft N-subgroup of G.

Assume x, y ∊ $\delta_H^{+\alpha}$ and n ∈ N, then $\delta_H(x) \ge \alpha$ and $\delta_H(y) \ge \alpha$. We need to show that x-y ∊ $\delta_H^{+\alpha}$ and n ∊ $\delta_H^{+\alpha}$. Since δ_H is fuzzy soft N-subgroup of G, it follows that $\delta_H(x-y) \ge \min\{\delta_H(x), \delta_H(y)\} \ge \min\{\alpha,\alpha\} \ge \alpha$ and $\delta_H(nx) \ge \delta_H(x) \ge \alpha$ which completes the proof.

Proposition 3.3: Let δ_H be a fuzzy soft set over G. Then δ_H is max- fuzzy soft N- subgroup of G if δ_H^r is min-fuzzy soft N-subgroup of G.

Proof: Let δ_H be a max- fuzzy soft N-subgroup of G, then, for all x, y ∊ H and n ∈ N.

$\delta_H^r(x-y) = G / \delta_H(x-y) \ge (G / \max\{\delta_H(x), \delta_H(y)\}) = \min\{(G/ \delta_H(x)), (G /\delta_H(y))\}= \min\{\delta_H^r(x), \delta_H^r(y)\}$

$\delta_H^r(nx) = G / \delta_H(nx) \ge (G /\delta_H(x)) = \delta_H^r(x)$

δ_H^r is fuzzy soft N-subgroup of G.

Proposition 3.4: Let δ_H: X→X^1 be a soft homomorphism of N-subgroups. If δ_H^f is max- fuzzy soft N-subgroups of X, then δ_H is max- fuzzy soft N-subgroup of X^1.

Proof: Suppose δ_H is max- fuzzy soft N-subgroups of X^1, then

(i) Let x^1, y^1 ∈ X^1, there exists x, y ∊ X such that f(x) = x^1 and f(y) = y^1. We have
$\delta_H(x^1-y^1) = \delta_H(f(x)- f(y) \le \max\{\delta_H(x), \delta_H(y)\} = \max\{\delta_H^f(x), \delta_H^f(y)\}$ and

(ii) $\delta_H(nx^1) = \delta_H(nf(x)) \leq \delta_H(f(x)) = \delta_H{}^f(x)$.
Therefore δ_H is max- fuzzy soft N-subgroups of X^1.

Proposition 3.5: Let δ_H be max- fuzzy soft N-subgroups of X and δ_H* be a fuzzy soft in X given by $\delta_H*(x) = \delta_H(x) + 1- \delta_H(1)$ for all $x \in X$. Then F_H* is max- fuzzy soft N-subgroups of X and $\delta_H \subset \delta_H*$.

Proof: Since δ_H is max- fuzzy soft N-subgroups of X and $\delta_H*(x) = \delta_H(x) +1-\delta_H(1)$ for all $x\in X$. For any $x,y \in X$,we have $\delta_H*(1) = \delta_H(1) +1- \delta_H(1) = 1 > \delta_H*(x)$ and

(i) For all $x, y \in X$, we have
$$\begin{aligned}\delta_H*(x-y) &= \delta_H(x-y) + 1- \delta_H(1)\\ &\leq \max\{\delta_H(x), \delta_H(y)\} +1 -\delta_H(1)\\ &= \max\{\delta_H(x)+1-\delta_H(1), \delta_H(y) +1- \delta_H(1)\}\\ &= \max\{\delta_H*(x), \delta_H*(y)\}\end{aligned}$$

(ii) $$\begin{aligned}\delta_H*(nx) &= \delta_H(nx) +1- \delta_H(1)\\ &\leq \delta_H(x) +1- \delta_H(1) = \delta_H*(x)\end{aligned}$$

Therefore δ_H* is max- fuzzy soft N-subgroup of X and δ_H is subset of δ_H*.

Proposition 3.6: Let δ_H and δ_Δ be fuzzy soft sets over G. where H and Δ are N-subgroups of G and ψ: $H\rightarrow \Delta$ is an N-homomorphism. If δ_H is max - fuzzy N-subgroups of G, then so is $\psi(\delta_H)$.

Proof: Let $\alpha_1, \alpha_2 \in \Delta$ such ψ is surjective, there exists $a_1, a_2 \in H$ such that $\psi(a_1) = \alpha_1$ and $\psi(a_2) = \alpha_2$. Thus
$$\begin{aligned}\Psi(\delta_H)(x) &= \max\{\delta(H) / H \in H, \psi(H) = \alpha_1-\alpha_2\}\\ &= \max\{\delta(H) / H \in H, H = \psi^{-1}(\alpha_1-\alpha_2)\}\\ &= \max\{\delta(H) / H \in H, H = \psi^{-1}(\psi(\alpha_1-\alpha_2))= A_1-A_2\}\\ &= \max\{\delta(a_1-a_2) / \alpha_1,\alpha_2 \in \Delta, \psi(H_i) = \alpha_i, i= 1, 2\}\\ &= \max\{(\max\{\delta(a_1) / \alpha_1 \in \Delta, \psi(H_1) = \alpha_1\}), (\max\{\delta(a_2) / \alpha_2 \in \Delta, \psi(H_2) = \alpha_2\})\}\\ &= \max\{\psi(\delta_H)(a_1), \psi(\delta_H)(a_2)\}\end{aligned}$$

Now let $n\in N$ and $\alpha \in \Delta$. Since ψ is surjective, there exists $H\in H$ such that $\psi(H) = 0$
$$\begin{aligned}\psi(\delta_H)(n\alpha) &= \max\{\delta(H) / H \in H, \psi(H) = n\alpha\}\\ &= \max\{\delta(H) / H \in H, H = \psi^{-1}(n\alpha)\}\\ &= \max\{\delta(H) / H \in H, H = \psi^{-1}(n\,\psi(H)\}\\ &= \max\{\delta(H) / H \in H, H = \psi^{-1}(\psi(nH)= nH\}\\ &= \max\{\delta(nH) / H \in H, H = \psi^{-1}(H)= \alpha\}\\ &= \max\{\delta(H) / H \in H, H = \psi^{-1}(H)= \alpha\}\\ &= \psi(\delta_H)(\alpha)\end{aligned}$$

$\psi(\delta_H)$ is max - fuzzy soft N-subgroup of G.

Proposition 3.7: Let δ_H: $X\rightarrow Y$ be a soft homomorphism of N-subgroups. If δ_H is max - fuzzy soft N-subgroups of Y, then $\delta_H{}^f$ is max - fuzzy soft N-subgroups of X.

Proof: Suppose δ_H is max - fuzzy soft N-subgroups of Y, then
For all $x, y \in X$, we have
$\delta_H{}^f(x-y) = \delta_H(f(x)- f(y) \leq \max\{\delta_H(f(x)), \delta_H(f(y))\}= \max\{\delta_H{}^f(x), \delta_H{}^f(y)\}$ and
(i) $\delta_H{}^f(nx) = \delta_H(nf(x))\leq \delta_H(f(x)) = \delta_H{}^f(x)$.
Therefore $\delta_H{}^f$ is max- fuzzy soft N-subgroups of Y.

Proposition 3.8: Let δ_H and δ_Δ be fuzzy soft sets over G, where H and Δ are N-subgroups of G and ψ be an N-homomorphism from H to Δ. If δ_Δ is max - fuzzy soft N- subgroups of G, then so is $\psi^{-1}(\delta_\Delta)$.

Proof: Let $a_1, a_2 \in H$, then
$$\begin{aligned}\psi^{-1}(\delta_\Delta)(a_1-a_2) &= \delta(\psi(a_1-a_2))\\ &\leq \max\{\delta(\psi(a_1), \psi(a_2))\}\\ &\leq \max\{\psi^{-1}(\delta_\Delta)(a_1), \psi^{-1}(\delta_\Delta)(a_2)\}\end{aligned}$$

Now let $n \in N$ and $H \in H$, then
$$\psi^{-1}(\delta_\Delta)(nH) = \delta(\psi(nH)) = \delta(n\,\psi(H)) = G(\psi(H)) = \psi^{-1}(\delta_\Delta)(H)$$

Therefore $\psi^{-1}(\delta_\Delta)$ is max - fuzzy soft N-subgroups of G.

Proposition 3.9: A fuzzy soft subset δ_H of G is min- fuzzy soft N-subgroups of G. if and only if δ_H^c is max - fuzzy soft N-subgroups of G.

Proof: Let δ_H be a min- fuzzy soft N-subgroups of G. For all x, y ∈ G, we have

(i) $\delta_H^c(x-y) = 1 - \delta_H(x-y)$
$\leq 1 - \min(\delta_H(x), \delta_H(y))$
$= 1 - \min(1 - \delta_H^c(x), 1 - \delta_H^c(y))$
$= \max(\delta_H^c(x), \delta_H^c(y))$

(ii) $\delta_H^c(nx) = 1 - \delta_H(nx)$
$\leq 1 - \delta_H(x) = \delta_H^c(x)$
δ_H^c is max - fuzzy soft N-subgroups of G.

Proposition 3.10: If δ_H and δ_Δ be two max -fuzzy soft N-subgroups of G, then $\delta_H \cup \delta_\Delta$ also max -fuzzy soft N-subgroup of G

Proof: Since H and Δ are N-subgroup of G, then H∩Δ is an N-subgroup of G.

Let $P = \delta_H \cup \delta_\Delta$. , where $P(x) = \delta_H(x) \cup \delta_\Delta(x)$ for all x ∈ H∩Δ not equal to empty. Then for all x, y ∈ H∩Δ and n ∈ N,

$P(x-y) = \delta_H(x-y) \cup \delta_\Delta(x-y)$
$\leq \max\{\max\{\delta_H(x), \delta_H(y)\}, \max\{\delta_\Delta(x), \delta_\Delta(y)\}\}$
$= \max\{\max\{\delta_H(x), \delta_\Delta(x)\}, \max\{\delta_H(y), \delta_\Delta(y)\}\}$
$= \max\{P(x), P(y)\}$

$P(nx) = \delta_H(nx) \cup \delta_\Delta(nx)$
$\leq \max\{\delta_H(x), \delta_\Delta(x)\}$
$= P(x)$

Therefore $\delta_H \cup \delta_\Delta$ also max -fuzzy soft N-subgroup of G.

Definition 3.1: A max -fuzzy soft N-subgroup FH of G is said to be complete if it is normal and there exists x ∈X such that $\delta_H(z) = 0$.

Proposition 3.11: Let δ_H be max -fuzzy soft N-subgroup of G and let w be a fixed element of G such that $\delta_H(1) = \delta_H(w)$. Define a fuzzy soft set δ_H^* in G by $\delta_H^*(x) = \delta_H(x) - \delta_H(w) / \delta_H(1) - \delta_H(w)$ for all x∈G. Then δ_H^* is complete max -fuzzy soft N-subgroup of G.

Proof: For any x, y ∈ G, we have

$\delta_H^*(x-y) = \delta_H(x-y) - \delta_H(w) / \delta_H(1) - \delta_H(w)$
$\leq \max\{\delta_H(x), \delta_H(y)\} - \delta_H(w) / \delta_H(1) - \delta_H(w)$
$= \max\{\{\delta_H(x), \delta_H(y)\} - \delta_H(w) / \delta_H(1) - \delta_H(w), \{\delta_H(x), \delta_H(y)\} - \delta_H(w) / \delta_H(1) - \delta_H(w)\}$
$= \max\{\delta_H^*(x), \delta_H^*(y)\}$

$\delta_H^*(nx) = \delta_H(nx) - \delta_H(w) / \delta_H(1) - \delta_H(w)$
$\leq \delta_H(x) - \delta_H(w) / \delta_H(1) - \delta_H(w)$
$= \delta_H^*(x)$ Therefore δ_H^* is an complete max -fuzzy soft N-subgroup of G.

CONCLUSION

This paper summarized the basic concepts of fuzzy soft sets. By using these concepts, we studied the algebraic properties of max- fuzzy soft N-subgroups. This work focused on fuzzy pre-image, fuzzy soft image, fuzzy soft anti-image.

FUTURE WORK

To extend this work, one could study the properties of min-fuzzy soft N-subgroups in other algebraic structures such as rings and fields.

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Source of Support: Nil, Conflict of interest: None Declared