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Interval Valued Anti Fuzzy Weak Bi-Ideals of Near Rings

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Abstract

In this present paper, we introduce the notion of interval valued anti fuzzy weak bi-ideals of near-rings. We have characterized and investigated some related properties of interval valued anti fuzzy weak bi-ideals of near-rings.

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INTRODUCTION

The fundamental concept of fuzzy set was introduced by Zadeh[11] in 1965. Again he introduced the notion of interval valued (in short i-v) fuzzy subsets in 1975 where the values of the membership functions are closed intervals of numbers instead of a single value. In 1971, Rosenfeld [4] introduced fuzzy subgroup and gave some of its properties. In 1991, Abou-Zaid[1] introduced the notion of fuzzy subnear-rings and ideals in near-rings. Jun and Kim[7] and Davvaz [5] applied a few concepts of fuzzy ideals and i-v fuzzy ideals in near-rings. Moreover, Manikantan [8] introduced the notion of fuzzy bi-ideals of near-rings and discussed some of its properties. Yong Uk Cho et al.[10] introduced the concept of weak bi-ideals applied to near-rings. Thillaigovindan et al.[9] introduced interval valued fuzzy ideals of near rings. Chinnadurai et al.[3] introduced fuzzy weak bi-ideals of near-rings.

In 1990, Biwas[2] introduced the notion of anti fuzzy subgroups of groups and Kim, Jun and Yon[6] studied the notion of anti fuzzy ideals of near-ring.

In this paper, we define a new notion of interval valued anti fuzzy weak bi-ideals of near-rings, which is a generalized concept of interval valued anti fuzzy ideals of near rings. We also investigate some of its properties with examples.

PRELIMINARIES

In this section, we listed some basic definitions. Throughout this paper N stands for a left near-ring.

A near-ring is a non empty set N with two binary operations "+" and "." such that

(i) (N,+) is a group.

(ii) (N, .) is a semi group.

(iii) $x.(y+z) = x.y + x.z$ for all $x, y, z \in$ N.

Precisely speaking it is a left near-ring because it satisfies the left distributive law. We denote xy instead of $x.y$. A near-ring N is called zero symmetric if $x.0 = 0$ for all $x \in$ N.

Given two subsets A and B of N, the product AB is defined as

$$AB = \{ab \mid a \in A, b \in B\}.$$

A subgroup S of (N, +) is called left (right) N-subgroup of N if NS ⊆ S (SN⊆S). A subgroup M of (N, +) is called subnear-ring of N if MM ⊆ M.

Definition 2.1. An ideal of a near-ring N is a subset I of N such that

(i) (I , +) is normal subgroup of (N , +).

(ii) NI ⊆ I.

(iii) $(x + a)y - xy \in$ I for all $x, y \in$ N and $a \in$ I.

Definition 2.2. A two sided N-subgroup of a near-ring N is a subset H of N such that

(i) (H, +) is a subgroup of (N, +).
(ii) NH ⊆ H.
(iii) HN ⊆ H.

If H satisfies (i) and (ii) then it is called a left N-subgroup of N. If H satisfies (i) and (iii) then it is called a right N-subgroup of N.

Definition 2.3. A subgroup B of N is called a bi-ideal of N if BNB ∩ (BN)*B ⊆ B.

Definition 2.4. A subgroup B of (N, +) is said to be a weak bi-ideal of N if BBB⊆ B.

Proposition 2.5. If B is a bi-ideal of a near-ring N and S is a subnear-ring of N, then B ∩ S is a bi-ideal of S.

Definition 2.6. An interval number $\bar{a}$ on [0,1] is a closed subinterval of [0,1],that is, $\bar{a} = [a^-, a^+]$ such that $0 \le a^- \le a^+ \le 1$, where a^- and a^+ are the lower and upper end limits of $\bar{a}$ respectively. In this notion $\bar{0}$=[0,0] and $\bar{1}$=[1,1]. For any two interval numbers $\bar{a} = [a^-, a^+]$ and $\bar{b} = [b^-, b^+]$ on [0,1], we define

(i) $\bar{a} \leq \bar{b} \iff a^- \leq b^-$ and $a^+ \leq b^+$
(ii) $\bar{a} = \bar{b} \iff a^- = b^-$ and $a^+ = b^+$

Definition 2.7. Let μ and λ be any two fuzzy subsets of N. Then $\lambda\mu$ is fuzzy subset of N defined by

$$(\mu\lambda)(x) = \begin{cases} \sup_{x=yz} \min\{\mu(y), \lambda(z)\} & \text{if } x = yz \text{ for all } x, y, z \in N \\ 0 & \text{otherwise} \end{cases}$$

Definition 2.8. Let X be any set. A mapping $\mu: X \to D[0,1]$ is called an interval-valued fuzzy subset of X, where $\bar{\mu}(x) = [\mu^-(x), \mu^+(x)]$, μ^- and μ^+ are fuzzy subsets of X such that $\mu^-(x) \leq \mu^+(x)$, for all $x \in X$. Thus $\bar{\mu}(x)$ is an interval and not a number from the interval as in the case of fuzzy set.

Definition 2.9. A mapping $min^i: D[0,1] \times D[0,1] \to D[0,1]$ defined by

$min^i(\bar{a}, \bar{b}) = [\min(a^-, b^-), \min(a^+, b^+)]$ for all $\bar{a}, \bar{b} \in D[0,1]$ is called an interval min-norm.

A mapping $max^i: D[0,1] \times D[0,1] \to D[0,1]$ defined by $max^i(\bar{a}, \bar{b}) = [\max(a^-, b^-), \max(a^+, b^+)]$ for all $\bar{a}, \bar{b} \in D[0,1]$ is called an interval max-norm.

Let min^i and max^i be the interval min-norm and interval max-norm on D[0,1] respectively. Then the following are true:

(i) $min^i(\bar{a}, \bar{a}) = \bar{a}$ and $max^i(\bar{a}, \bar{a}) = \bar{a}$ for all $\bar{a} \in$ D[0,1].
(ii) $min^i(\bar{a}, \bar{b}) = min^i(\bar{b}, \bar{a})$ and $max^i(\bar{a}, \bar{b}) = max^i(\bar{b}, \bar{a})$ for all $\bar{a}, \bar{b} \in$ D[0,1].
(iii) If $\bar{a} \geq \bar{b} \in$ D[0,1], then $min^i(\bar{a}, \bar{c}) \geq min^i(\bar{b}, \bar{c})$ and $max^i(\bar{a}, \bar{c}) \geq max^i(\bar{b}, \bar{c})$ for all $\bar{c} \in$ D[0,1].

Definition 2.10. Let $\bar{\mu}$, $\bar{\nu}$, $\bar{\mu}_i (i \in \Omega)$ be interval valued fuzzy subsets of X. The following are defined by

(i) $\bar{\mu} \leq \bar{\nu} \iff \bar{\mu}(x) \leq \bar{\nu}(x)$.

(ii) $\bar{\mu} = \bar{\nu} \iff \bar{\mu}(x) = \bar{\nu}(x)$.

(iii) $(\bar{\mu} \cup \bar{\nu})(x) = \max^i(\bar{\mu}(x), \bar{\nu}(x))$.

(iv) $(\bar{\mu} \cap \bar{\nu})(x) = \min^i(\bar{\mu}(x), \bar{\nu}(x))$.

(v) $\cup_{i\in\Omega} \bar{\mu}(x) = \sup^i\{\bar{\mu}(x)/i \in \Omega\}$.

(vi) $\cap_{i\in\Omega} \bar{\mu}(x) = \inf^i\{\bar{\mu}(x)/i \in \Omega\}$.

Definition 2.11. A fuzzy subgroup μ of N is said to be a fuzzy bi-ideal of N if

$$\mu N\mu \cap \mu * N\mu \subseteq \mu.$$

Definition 2.12. A fuzzy subset μ of N is called a fuzzy subgroup of N if

$$\mu(x - y) \geq \min\{\mu(x), \mu(y)\} \text{ for all } x, y \in N$$

Definition 2.13. Let N be a near-ring and μ be a fuzzy subset of N. We say μ is an anti fuzzy subnear-ring of N if

(i) $\mu(x - y) \leq \max\{\mu(x), \mu(y)\}$
(ii) $\mu(xy) \leq \max\{\mu(x), \mu(y)\}$ for all $x, y \in N$

Definition 2.14. A fuzzy subgroup μ of N is called an anti fuzzy weak bi-ideal of N if

$$\mu(xyz) \leq \max\{\mu(x), \mu(y), \mu(z)\} \text{ for all } x, y, z \in N$$

INTERVAL VALUED ANTI FUZZY WEAK BI-IDEAL OF NEAR-RING

Definition 3.1. Let N be a near-ring and $\bar{\mu}$ be a i-v fuzzy subset of N. We say $\bar{\mu}$ is an i-v anti fuzzy sub near-ring of N if

(i) $\bar{\mu}(x - y) \leq \max^i\{\bar{\mu}(x), \bar{\mu}(y)\}$
(ii) $\bar{\mu}(xy) \leq \max^i\{\bar{\mu}(x), \bar{\mu}(y)\}$ for all $x, y \in N$

Definition 3.2. A i-v fuzzy subset $\bar{\mu}$ of N is called a i-v anti fuzzy weak bi-ideal if $\bar{\mu}$ is an i-v anti fuzzy sub near-ring of N and

$$\bar{\mu}(xyz) \leq \max^i\{\bar{\mu}(x), \bar{\mu}(y), \bar{\mu}(z)\} \text{ for all } x, y, z \in N$$

Example 3.3. Let *N = {a, b, c, d}* be an near-ring with two binary operations + and . are defined as follows

+	a	b	c	d
a	a	b	c	d
b	b	a	d	c
c	c	d	b	a
d	d	c	a	b

.	a	b	c	d
a	a	a	a	a
b	a	a	a	a
c	a	a	a	a
d	a	b	c	d

Then (*N*, +, .) is a near-ring.

Let $\bar{\mu}$: $N \to D[0, 1]$ be an interval valued fuzzy subset defined by $\bar{\mu}(a)$ = [0.8, 0.9], $\bar{\mu}(b)$ =[0.6, 0.7] and $\bar{\mu}(c)$ = [0.4, 0.5] =$\bar{\mu}$ (*d*). Then $\bar{\mu}$ is an interval-valued anti fuzzy weak bi-ideal of *N*.

Proposition 3.4: Let $\bar{\mu}$ be a i-v fuzzy subset of N. Then $\bar{\mu}$ is a i-v anti fuzzy weak bi-ideal of N if and only if $\bar{\mu}\bar{\mu}\bar{\mu} \supseteq \bar{\mu}$.

Proof. Assume that $\bar{\mu}$ is an i-v anti fuzzy weak bi-ideal of N.

Let $x, y, z, y_1, y_2 \in$ N such that x = yz and $y = y_1y_2$.

Then

$\bar{\mu}\bar{\mu}\bar{\mu}(x) = \inf^i_{x=yz}\{\max^i((\bar{\mu}\bar{\mu})(y), \bar{\mu}(z))\}$

$= \inf^i_{x=yz}\left\{\max^i\left(\inf^i_{y=y_1y_2} \max^i(\bar{\mu}(y_1), \bar{\mu}(y_2)), \bar{\mu}(z)\right)\right\}$

$= \inf^i_{x=yz} \inf^i_{y=y_1y_2}\{\max^i(\max^i(\bar{\mu}(y_1), \bar{\mu}(y_2)), \bar{\mu}(z))\}$

$= \inf^i_{x=y_1y_2z}\left\{\max^i\{\bar{\mu}(y_1), \bar{\mu}(y_2), \bar{\mu}(z)\}\right\}$ (Since $\bar{\mu}$ is a i-v anti fuzzy weak bi-ideal of X)

$\geq \inf^i_{x=y_1y_2z} \bar{\mu}(y_1y_2z)$

$= \bar{\mu}(x)$

If x cannot be expressed as x=yz, then $\bar{\mu}\bar{\mu}\bar{\mu}(x) = 0 \geq \bar{\mu}(x)$

In both cases $\bar{\mu}\bar{\mu}\bar{\mu} \supseteq \bar{\mu}$

Conversely assume that $\bar{\mu}\bar{\mu}\bar{\mu} \supseteq \bar{\mu}$

For $x', x, y, z \in$ N.

Let x' be such that $x' = xyz$. Then

$\bar{\mu}(xyz) = \bar{\mu}(x') \le \bar{\mu}\bar{\mu}\bar{\mu}(x')$

$\bar{\mu}(xyz) = \inf^{i}_{x'=pq}\{\max^{i}(\bar{\mu}\bar{\mu}(p), \bar{\mu}(q))\}$

$= \inf^{i}_{x'=pq}\left\{\max^{i}\left(\inf^{i}_{p=p_1p_2}\max^{i}(\bar{\mu}(p_1), \bar{\mu}(p_2)), \bar{\mu}(q)\right)\right\}$

$= \inf^{i}_{x'=p_1p_2q}\{\max^{i}((\bar{\mu}(p_1), \bar{\mu}(p_2)), \bar{\mu}(q))\}$(Since $\bar{\mu}$ is a i-v anti fuzzy weak bi-ideal of X)

$\le \max^{i}\{\bar{\mu}(x), \bar{\mu}(y), \bar{\mu}(z)\}$

Hence $\bar{\mu}$ is an i-v anti fuzzy weak bi-ideal of N.

Lemma 3.5. Let $\bar{\mu}$ and $\bar{\lambda}$ be i-v anti fuzzy weak bi-ideals of N. Then the product $\bar{\mu}\bar{\lambda}$ is a i-v anti fuzzy weak bi-ideals of N.

Proof: Let $\bar{\mu}$ and $\bar{\lambda}$ be i-v anti fuzzy weak bi-ideals of N. Then

$(\bar{\mu}\bar{\lambda})(x-y) = \inf^{i}_{x-y=ab}\max^{i}\{\bar{\mu}(a), \bar{\lambda}(b)\}$

$\le \inf^{i}_{x-y=a_1b_1-a_2b_2<(a_1-a_2)(b_1-b_2)}\max^{i}\{\bar{\mu}(a_1-a_2), \bar{\lambda}(b_1-b_2)\}$

$= \inf^{i}\max^{i}\{\max^{i}\{\bar{\mu}(a_1), \bar{\mu}(a_2)\}\max^{i}\{\bar{\lambda}(b_1), \bar{\lambda}(b_2)\}\}$

$= \inf^{i}\max^{i}\{\max^{i}\{\bar{\mu}(a_1), \bar{\lambda}(b_1)\}\max^{i}\{\bar{\mu}(a_2), \bar{\lambda}(b_2)\}\}$

$\le \max^{i}\{\inf^{i}_{x=a_1b_1}\max^{i}\{\bar{\mu}(a_1), \bar{\lambda}(b_1)\}\inf^{i}_{y=a_2b_2}\max^{i}\{\bar{\mu}(a_2), \bar{\lambda}(b_2)\}\}$

$= \max^{i}\{(\bar{\mu}\bar{\lambda})(x), (\mu\lambda)(y)\}$

It follows that $\bar{\mu}\bar{\lambda}$ is a i-v anti fuzzy subgroup of N.

Further

$(\bar{\mu}\bar{\lambda})(\bar{\mu}\bar{\lambda})(\bar{\mu}\bar{\lambda}) = \bar{\mu}\bar{\lambda}((\bar{\mu}\bar{\lambda}\bar{\mu})\bar{\lambda}$

$\ge \bar{\mu}\bar{\lambda}(\bar{\lambda}\bar{\lambda}\bar{\lambda})\bar{\lambda}$

$\ge \bar{\mu}(\bar{\lambda}\bar{\lambda}\bar{\lambda})$ (Since $\bar{\lambda}$ is an i-v anti fuzzy weak bi-ideal of N)

$\ge \bar{\mu}\,\bar{\lambda}$

Therefore $\bar{\mu}\,\bar{\lambda}$ is an i-v anti fuzzy weak bi-ideal of N.

Remark 3.6. Let $\bar{\mu}$ & $\bar{\lambda}$ be two interval valued anti fuzzy weak bi-ideals of N then the product $\bar{\lambda}\,\bar{\mu}$ is also an interval valued anti fuzzy weak bi-ideal of N.

Theorem 3.7. Let $\{\bar{\mu}_i / i \in \boldsymbol{\Omega}\}$be family of i-v anti fuzzy weak bi-ideals of N, then $\cup_{i\in\Omega}\bar{\mu}_i$ is also an i-v anti fuzzy weak bi-ideals of N, where $\boldsymbol{\Omega}$ is any index set.

Proof:

Let $\{\bar{\mu}_i\}_{i\in\Omega}$ be a family of i-v anti fuzzy weak bi-ideals of N

Let x,y,z ∈ N and

$\bar{\mu} = \cup_{i\in\Omega}\bar{\mu}_i$ *then*

$\bar{\mu}(x) = \cup_{i\in\Omega}\bar{\mu}_i(x) = (\sup^{i}_{i\in\Omega}\bar{\mu}_i)(x)$

$= \sup^{i}_{i\in\Omega}\bar{\mu}_i(x)$

$\bar{\mu}(x-y) = \sup^{i}_{i\in\Omega}\bar{\mu}_i(x-y)$

$\le \sup^{i}_{i\in\Omega}\max^{i}\{\bar{\mu}_i(x), \bar{\mu}_i(y)\}$

$= \max^{i}\{(\sup_{i\in\Omega}\bar{\mu}_i(x), (\sup_{i\in\Omega}\bar{\mu}_i(y)\}$

$= \max^{i}\{\cup_{i\in\Omega}\bar{\mu}_i(x), \cup_{i\in\Omega}\bar{\mu}_i(y)\}$

$= \max^{i}\{\bar{\mu}(x), \bar{\mu}(y)\}$

and

$\bar{\mu}(xyz) = \sup^{i}_{i\in\Omega}\bar{\mu}_i(xyz)$

$\le \sup^{i}_{i\in\Omega}\max^{i}\{\bar{\mu}(x), \bar{\mu}(y), \bar{\mu}(z)\}$

$= \max^{i}\{\sup^{i}_{i\in\Omega}\bar{\mu}_i(x), \sup^{i}_{i\in\Omega}\bar{\mu}_i(y), \sup^{i}_{i\in\Omega}\bar{\mu}_i(z)\}$

$= \max^{i}\{\cup_{i\in\Omega}\bar{\mu}_i(x), \cup_{i\in\Omega}\bar{\mu}_i(y), \cup_{i\in\Omega}\bar{\mu}_i(z)\}$

$= \max^{i}\{\bar{\mu}(x), \bar{\mu}(y), \bar{\mu}(z)\}$

Theorem 3.8. Let $\bar{\mu}$ be an i-v fuzzy subset of N. Then $\bar{\mu} = [\mu^-, \mu^+]$ is an i-v anti fuzzy weak bi-ideal of N iff μ^- and μ^+ are anti fuzzy weak bi-ideals of N.

Proof: Assume that $\bar{\mu}$ is an i-v anti fuzzy weak bi-ideal of N.

For x,y ∈ N we have

$[\mu^-(x-y), \mu^+(x-y)] = \bar{\mu}(x-y)$

$\le \max^{i}\{\bar{\mu}(x), \bar{\mu}(y)\}$

$= \max^{i}\{[\mu^-(x), \mu^+(x)], [\mu^-(y), \mu^+(y)]\}$

$= [\max[\mu^-(x), \mu^-(y)], \max[\mu^+(x), \mu^+(y)]]$

It follows that

$\mu^-(x-y) \le \max[\mu^-(x), \mu^-(y)]$ and

$\mu^+(x-y) \le \max[\mu^+(x), \mu^+(y)]$

and

$[\mu^-(xyz), \mu^+(xyz)] = \bar{\mu}(xyz)$

$\le \max^{i}\{\bar{\mu}(x), \bar{\mu}(y), \bar{\mu}(z)\}$

$= \max^{i}\{[\mu^-(x), \mu^+(x)], [\mu^-(y), \mu^+(y)], [\mu^-(z), \mu^+(z)]\}$

$= [\max[\mu^-(x), \mu^-(y), \mu^-(z)], \max[\mu^+(x), \mu^+(y), \mu^+(z)]]$

It follows that

$\mu^-(xyz) \le \max[\mu^-(x), \mu^-(y), \mu^-(z)]$ and

$\mu^+(xyz) \le \max[\mu^+(x), \mu^+(y), \mu^+(z)]$.

Conversely, assume that μ^-, μ^+ are fuzzy bi ideals of N

Let x,y,z ∈ N then

$\bar{\mu}(x-y) = [\mu^-(x-y), \mu^+(x-y)]$

$\le [\max[\mu^-(x), \mu^-(y)], \max[\mu^+(x), \mu^+(y)]]$

$= \max^{i}\{[\mu^-(x), \mu^+(x)], [\mu^-(y), \mu^+(y)]\}$

$= \max^{i}\{\overline{\mu}(x), \overline{\mu}(y)\}$

and

$\overline{\mu}(xyz) = [\mu^{-}(xyz), \mu^{+}(xyz)]$

$\leq [\max\{\mu^{-}(x), \mu^{-}(y), \mu^{-}(z)\}, \max\{\mu^{+}(x), \mu^{+}(y), \mu^{+}(z)\}]$

$\leq \max^{i}\{[\mu^{-}(x), \mu^{+}(x)], [\mu^{-}(y), \mu^{+}(y)], [\mu^{-}(z), \mu^{+}(z)]\}$

$= \max^{i}\{\overline{\mu}(x), \overline{\mu}(y), \overline{\mu}(z)\}$

Therefore, $\overline{\mu}$ is an i-v anti fuzzy weak bi ideal of N.

Theorem 3.9. Let $\overline{\mu}$ be i-v anti fuzzy weak bi-ideal of N, then the set $N_{\overline{\mu}} = \{x \in N / \overline{\mu}(x) = \overline{\mu}(0)\}$ is a weak bi-ideal of N.

Proof: Let $\overline{\mu}$ be an i-v anti fuzzy weak bi-ideal of N.

Let x,y $\in N_{\overline{\mu}}$ then

$\overline{\mu}(x) = \overline{\mu}(0)$ and $\overline{\mu}(y) = \overline{\mu}(0)$

and $\overline{\mu}(x-y) \leq \max^{i}\{\overline{\mu}(x), \overline{\mu}(y)\}$

$= \max^{i}\{\overline{\mu}(0), \overline{\mu}(0)\}$

$= \overline{\mu}(0)$

So $x - y \in N_{\overline{\mu}}$

For every $x, y, z \in N_{\overline{\mu}}$.

$\overline{\mu}(x) = \overline{\mu}(0)$, $\overline{\mu}(y) = \overline{\mu}(0)$ and $\overline{\mu}(z) = \overline{\mu}(0)$

Then we have $\overline{\mu}(xyz) \leq \max^{i}\{\overline{\mu}(x), \overline{\mu}(y), \overline{\mu}(z)\}$

$= \max^{i}\{\overline{\mu}(0), \overline{\mu}(0), \overline{\mu}(0)\}$

$= \overline{\mu}(0)$

Hence $xyz \in N_{\overline{\mu}}$

Therefore $N_{\overline{\mu}}$ is a weak bi-ideal of N

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