INTERVALVALUED Q-FUZZY SOFT SUBHEMIRINGS OF A HEMIRING

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Abstract: In this research work, we make known to the notion of interval-valued Q-fuzzy soft subhemiring of a Hemi-ring and establish some outcomes on these. We also made an effort to study the properties of interval-valued Q- fuzzy soft subhemiring of Hemi-ring under homomorphism and anti-homomorphism.

Keywords**:** Fuzzy set, fuzzy soft set, interval valued Q-fuzzy soft set (IVQFSS), Hemi-ring, Homomorphism, Anti homomorphism.

1. INTRODUCTION

Molodtsov [1] initiated the principle of soft set as a new mathematical tool for handling uncertainties that conventional mathematical equipment can't deal with. He has proven numerous applications of this principle in fixing many realistic Problem in economics, social work and engineering ect.There are many ideas of usual algebras generalizing an associative ring (R, +, :). Some of them in particular, near rings and several varieties of semi-rings have been verified very useful. Semi-rings (referred to as also half-ring) are algebras (R, +.) share the same properties as a ring except that (R; +) is assumed to be a semigroup rather than a commutative group. Semi-rings appear in a natural manner in some applications to the theory of automata and formal languages. An algebra (R;+; .) is said to be a semi-ring if (R; +) and (R; :) are semigroups satisfying a:(b+c) = a:b+a:cand (b+c):a = b:a+c:a for all a; b and c in R. A semi-ring R is said to be additively commutative if a + b = b + a for all a; b and c in R. A semi-ring R may have an identity 1, denoted by 1:a = a = a:1 and a zero 0, denoted by 0 + a = a = a + 0 and a:0 = 0 = 0:a for all a in R. A semi-ring R is said to be a hemi-ring if it is an additively commutative with zero. A subset I of a hemi-ring R is called a left ideal of R if I is closed under addition and RI $\subset$I. A subset I of a hemi-ring R is called a right ideal of R if I is closed under addition and IR$\subset$I. Both left and right ideal I of a hemi-ring R is called an ideal of R. After the introduction of fuzzy sets by L.A.Zadeh [12], several researchers explored on the generalization of the concept of fuzzy sets. The concept of intuitionistic fuzzy subsets (IFS) was introduced by K.T.Atanassov [4], as a generalization of the notion of fuzzy set. The notion of Fuzzy left h-ideals in Hemi-rings with respect to an s-norm was

introduced in [2]. In this paper, we introduce the some concepts of in interval valued Q-fuzzy soft set under homomorphism and anti-homomorphism.

2. Premalineries

2.1Definition: Let X, Q be two non-empty sets. A Q −fuzzy subset J of X is a function $J: X \times Q \to [0,1]$.

2.2 Definition: Let R be a hemiring. An Interval valued $\mathrm{Q}-$ fuzzy soft subset J of R is said to be a interval valued $\mathrm{Q}-$ fuzzy soft subhemiring (IQFSSHR) of R if it fulfils the below properties:

(i) $\lambda_{[T,J]}(a_1 + a_2, q) \geq inf\left\{\lambda_{[T,J]}(a_1, q), \lambda_{[Q_1,Q_2]}(a_2, q)\right\}$,

(ii) $\lambda_{[T,J]}(a_1 . a_2, q) \geq inf\{\lambda_{[T,J]}(a_1, q), \lambda_{[T,J]}(a_2, q)\}$, $\forall a_1, a_2 \in \mathrm{R}$ *and* $q \in \mathrm{Q}$.

2.3 Definition: *If* $(\mathrm{R}, +, .)$ *and*$(\mathrm{R}', +, .)$ *are any two hemi-ring and* Q *be a non-void set. The function* $g: \mathrm{R} \times \mathrm{Q} \to \mathrm{R}' \times \mathrm{Q}$ *is said to be an* $\mathrm{Q}-$ *homomorphism if*

$g(a_1 + a_2, q) = g(a_1, q) + g(a_2, q)$

2.4 Definition: If R andR' are any two Hemi-ring and Q be a non-void set.The mapping $g: \mathrm{R} \times \mathrm{Q} \to \mathrm{R}' \times \mathrm{Q}$ is said to be an Anti $\mathrm{Q}-$ homomorphism if

$g(a_1 + a_2, q) = g(a_2, q) + g(a_1, q)$

$g(a_1 . a_2, q) = g(a_2, q)g(a_1, q), \forall\, a_1, a_2 \in \mathrm{R}$ *and* $q \in \mathrm{Q}$.

2.5 Definition: *Let* R *and* R' *be two Hemi-rings and* Q *be a non-void set . Let* $g: \mathrm{R} \times \mathrm{Q} \to \mathrm{R}' \times \mathrm{Q}$ *be any mapping and let* $[\mathrm{T}, \mathrm{J}]$ *be a* $\mathrm{Q}-$*fuzzy interval valued soft subhemiring in* R,

$[\mathrm{I}, \mathrm{O}]$ *be an* $\mathrm{Q}-$ *fuzzy interval valued soft subhemiring in* $g(\mathrm{R}) = \mathrm{R}'$, *stated by* $\lambda_{[[I,O]}(a_2, q) = \underset{(a_1,q)\in g^{-1}(a_2,q)}{max} \lambda_{[T,J]}(a_1, q), \forall\, a_1 \in \mathrm{R}, a_2 \in \mathrm{R}'$ *and* $q \in \mathrm{Q}$. *Hence* $[\mathrm{T}, \mathrm{J}]$ *is said to be inverse of* $[\mathrm{I}, \mathrm{O}]$ *under* g *and is symbolized by* $g^{-1}([\mathrm{I}, \mathrm{O}])$.

2.6. Definition: *Let* $[\mathrm{T}, \mathrm{J}]$ *be a* $\mathrm{Q} \subseteq \mathrm{A}_{[\mathrm{T},\mathrm{J}]}$. *for* $\alpha_1 \in [0,1]$, *the sets* $\mathrm{U}(\lambda_{[\mathrm{T},\mathrm{J}]}, \alpha_1) = \{a_1 \in \mathrm{A}_{[\mathrm{T},\mathrm{J}]} : \lambda_{[\mathrm{T},\mathrm{J}]}(a_1, q) \geq \alpha_1\}$ *and is said to be* $\mathrm{Q}-$ *soft fuzzy* α_1 −*cut of* J.

2.7. Definition: *Let* $\mathrm{T}, \mathrm{J}]$ *be a* $\mathrm{Q}-$*fuzzy soft subhemiring of*X. *For*$\alpha_1 \in [0,1]$, *the level subset of* $[\mathrm{T}, \mathrm{J}]$ *is the set* $\lambda_{[\mathrm{T},\mathrm{J}]\alpha_1} = \left\{a_1 \in \mathrm{X}_{[\mathrm{T},\mathrm{J}]} : \lambda_{[\mathrm{T},\mathrm{J}]}(a_1, q) \geq \alpha_1\right\}$. *this is said to a* $\mathrm{Q}-$ *fuzzy soft level subset of* J.

2.8 Definition: Let $[T, J]$ be an interval –valued Q −fuzzy soft subhemiring of a hemi-ring $(R, +, .)$.The level subhemiring $\lambda_{[T,J]\alpha_1}$, for $\alpha_1 \in [0,1]$such that $\alpha_1 \leq \lambda_{[T,J]}(0)$, $\alpha_1 \leq \lambda_{[T,J]}(1)$ is said to be Q −fuzzy interval valued soft level subset of J.

3. SOME PROPERTIES OF INTERVALVALUED Q- FUZZY SOFT SUBHEMIRINGS OF A HEMIRING

3.1 Theorem: If $[T, J]$ be an interval valued Q −fuzzy soft subhemiring of a hemiring $(R, +, .)$,then $L = \{a_1 / a_1 \in R : \lambda_{[T,J]}(a_1, q) = 0\}$ is either void or is a subhemiring of R.

Proof: If no element fulfils this properties, then L is void

If $a_1, a_2 \in R$ then $\lambda_{[T,J]}(a_1 + a_2, q) \geq \inf\{\lambda_{[T,J]}(a_1, q), \lambda_{[T,J]}(a_2, q)\}$

$= \inf\{0,0\} = 0$

Hence, $[T,J](a_1 + a_2, q) = 0, \forall a_1, a_2 \in R$ and $q \in Q$.
Therefore we get $a_1 + a_2 \in L$
And, $\lambda_{[T,J]}(a_1 a_2, q) \geq \inf\{\lambda_{[T,J]}(a_1, q), \lambda_{[T,J]}(a_2, q)\}$
$= \inf\{0,0\} = 0$
Hence, $[T,J](a_1 a_2, q) = 0, \forall a_1, a_2 \in R$ and $q \in Q$.
Therefore we get $a_1 a_2 \in L$
Therefore, L is a subhemiring of R.
Hence L is either void or is a subhemiring of R.

3.2. Theorem: Let $[T,J]$ be an interval valued $Q-$ fuzzy soft subhemiring of a hemiring $(R,+,.)$

(i) If $\lambda_{[T,J]}(a_1 + a_2, q) = 1$then either $\lambda_{[T,J]}(a_1, q) = 1$ or$\lambda_{[T,J]}(a_2, q) = 1$, $\forall\, a_1, a_2 \in R$ and $q \in Q$.

(ii)) If $\lambda_{[T,J]}(a_1 a_2, q) = 1$then either $\lambda_{[T,J]}(a_1, q) = 1$ or$\lambda_{[T,J]}(a_2, q) = 1$, $\forall\, a_1, a_2 \in R$ and $q \in Q$.

Proof: Let$a_1, a_2 \in R$, then by definition $\lambda_{[T,J]}(a_1 + a_2, q) \geq \inf\{\lambda_{[T,J]}(a_1, q), \lambda_{[T,J]}(a_2, q)\}$,
$\Rightarrow 1 \geq inf\{\lambda_{[T,J]}(a_1, q), \lambda_{[T,J]}(a_2, q)\}$.
Hence, either $\lambda_{[T,J]}(a_1, q) = 1$ or$\lambda_{[T,J]}(a_2, q) = 1$, $\forall\, a_1, a_2 \in R$ and $q \in Q$.

3.3. Theorem: Let$[T,J]$ and $[I,O]$ be two interval valued Q −fuzzy soft subhemiring of a hemiring $(R,+,.)$ then there $[T,J] \sqcap [[I,O]$ is a Q −fuzzy soft subhemiring of R.

Proof: Leta_1,$a_2 \in R$,$[T,J] = \{(a_1, q), \lambda_{[T,J]}(a_1, q)/a_1 \in R, q \in Q\}$ and
$[I,O] = \{(a_2, q), \lambda_{[I,O]}(a_2, q)/a_2 \in R, q \in Q\}$.

Let$[L,H] = \{(a_1, q), \lambda_{[L,H]}(a_1, q)/a_1 \in R, q \in Q\}$,

Where $\lambda_{[L,H]}(a_1, q) = \inf\{\lambda_{[L,H]}(a_1, q), \lambda_{[L,H]}(a_2, q)\}$.

(i) $\lambda_{[L,H]}(a_1 + a_2, q) = inf\{\lambda_{[L,H]}(a_1 + a_2, q), \lambda_{[I,O]}(a_1 + a_2, q)\}$

$\geq inf\{\{inf\{(\lambda_{[T,J]}(a_1, q), \lambda_{[T,J]}(a_2, q)\}, inf\{\lambda_{[I,O]}(a_1, q), \lambda_{[I,O]}(a_2, q)\}\}$

$\geq inf\{inf\{(\lambda_{[T,J]}(a_1, q), \lambda_{[I,O]}(a_2, q)\}, inf\{\lambda_{[T,J]}(a_2, q), \lambda_{[I,O]}(a_2, q)\}\}\}$

$= inf\{\lambda_{[L,H]}\{(a_1, q), \lambda_{[L,H]}(a_2, q)\}\}$.

(ii) $\lambda_{[L,H]}(a_1 a_2, q) = inf\{\lambda_{[L,H]}(a_1 a_2, q), \lambda_{[I,O]}(a_1 a_2, q)\}$

$\geq inf\{\{inf\{(\lambda_{[T,J]}(a_1, q), \lambda_{[T,J]}(a_2, q)\}, inf\{\lambda_{[I,O]}(a_1, q), \lambda_{[I,O]}(a_2, q)\}\}$

$\geq inf\{inf\{(\lambda_{[T,J]}(a_1, q), \lambda_{[I,O]}(a_2, q)\}, inf\{\lambda_{[T,J]}(a_2, q), \lambda_{[I,O]}(a_2, q)\}\}\}$

$= inf\{\lambda_{[L,H]}\{(a_1, q), \lambda_{[L,H]}(a_2, q)\}\}$.

Therefore, $\lambda_{[L,H]}(a_1 a_2, q) \geq \inf\{\lambda_{[L,H]}(a_1, q), \lambda_{[L,H]}(a_2, q)\}$, $\forall\, a_1, a_2 \in R$ and $q \in Q$.

Hence$[T,J] \sqcap [I,O]$ be an interval valued $Q-$ fuzzy soft subhemiring of a hemiring R.

3.4. Theorem: The $\sqcap$ of a family of an inteval valued Q −fuzzy soft subhemiring of a hemiring $(R,+,.)$ is a Q −fuzzy soft subhemiring of R.

Proof: Let $\{\lambda_{[T,J]i}\}i \in I$ be a family of a interval valued Q −fuzzy soft subhemiring of a hemiring R and $\lambda_{[T,J]} = \sqcap_{i \in I} \lambda_{[T,J]i}$

Then $\forall\, a_1, a_2 \in R$, we have

(i) $\lambda_{[T,J]}(a_1+a_2,q)=\min_{i\in I}\big(\lambda_{[T,J]}\big)i\,((a_1+a_2,q)$

$\geq \min_{i\in I} inf\ \{(\lambda_{[T,J]i}(a_1,q),\lambda_{[T,J]i}(a_2,q)$

$\geq \inf\{\min_{i\in I}((\lambda_{[T,J]i}(a_1,q)),\min_{i\in I}(\lambda_{[T,J]i}(a_2,q)\}$

$=\inf\{\lambda_{[T,J]}(a_1,q),\lambda_{[T,J]}(a_2,q)\}.$

Therefore, $\lambda_{[T,J]}(a_1+a_2,q)\geq \inf\{\lambda_{[T,J]}(a_1,q),\lambda_{[T,J]}(a_2,q)\},\forall\ a_1,a_2\in R$ and $q\in Q$.

(ii) $\lambda_{[T,J]}(a_1a_2,q)=\min_{i\in I}\big(\lambda_{[T,J]}\big)i\,((a_1a_2,q)$

$\geq \min_{i\in I} inf\ \{(\lambda_{[T,J]i}(a_1,q),\lambda_{[T,J]i}(a_2,q)$

$\geq \inf\{\min_{i\in I}((\lambda_{[T,J]i}(a_1,q)),\min_{i\in I}(\lambda_{[T,J]i}(a_2,q)\}$

$=\inf\{\lambda_{[T,J]}(a_1,q),\lambda_{[T,J]}(a_2,q)\}.$

Therefore, $\lambda_{[T,J]}(a_1a_2,q)\geq \inf\{\lambda_{[T,J]}(a_1,q),\lambda_{[T,J]}(a_2,q)\},\forall\ a_1,a_2\in R$ and $q\in Q$.

Hence the theorem//

3.5 Theorem: If $[T,J]$ and $[I,O]$ are any two interval valued Q −fuzzy soft subhemiring of a hemiring $(R,+,.)$, Then their $[T,J]\sqcup[I,O]$ is a IVQFSSHR of R.

Proof: $a_1,a_2\in R$ and $q\in Q$.

$[T,J]=\{\big((a_1,q),\lambda_{[T,J]}(a_1q)\big)/a_1\in R,q\in Q\}$ and

$[I,O]=\{\big((a_1,q),\lambda_{[I,O]}(a_1q)\big)/a_1\in R,q\in Q\}.$

Let $[L,H]=[T,J]\sqcup[I,O]$ and $[L,H=\{\big((a_1,q),\lambda_{[L,H]}(a_1q)\big)/a_1\in R,q\in Q\}$, where $\lambda_{[L,H]}(a_1,q)=sup\{\lambda_{[T,J]}(a_1,q),\lambda_{[I,O]}(a_1,q)\}.$

(i) $\lambda_{[L,H]}=(a_1+a_2,q)=sup\{\lambda_{[T,J]}(a_1+a_2,q),\lambda_{[I,O]}(a_1+a_2,q)\}$

$\geq sup\{inf\{\lambda_{[T,J]}(a_1,q),\lambda_{[T,J]}(a_2,q)\},inf\{\lambda_{[I,O]}(a_1,q),\lambda_{[I,O]}(a_2,q)\}\}$

$\geq inf\{inf\{\lambda_{[T,J]}(a_1,q),\lambda_{[I,O]}(a_1,q)\},inf\{\lambda_{[T,J]}(a_2,q),\lambda_{[I,O]}(a_2,q)\}\}$

$=inf\{\lambda_{[L,H]}(a_1,q),\lambda_{[L,H]}(a_2,q)\}.$

Therefore, $\lambda_{[L,H]}(a_1+a_2,q)\geq inf\{\lambda_{[L,H]}(a_1,q),\lambda_{[L,H]}(a_2,q),\forall\ a_1,a_2\in R$ and $q\in Q$.

(ii) $\lambda_{[L,H]}=(a_1a_2,q)=sup\{\lambda_{[T,J]}(a_1a_2,q),\lambda_{[I,O]}(a_1a_2,q)\}$

$\geq sup\{inf\{\lambda_{[T,J]}(a_1,q),\lambda_{[T,J]}(a_2,q)\},inf\{\lambda_{[I,O]}(a_1,q),\lambda_{[I,O]}(a_2,q)\}\}$

$\geq inf\{inf\{\lambda_{[T,J]}(a_1,q),\lambda_{[I,O]}(a_1,q)\},inf\{\lambda_{[T,J]}(a_2,q),\lambda_{[I,O]}(a_2,q)\}\}$

$=inf\{\lambda_{[L,H]}(a_1,q),\lambda_{[L,H]}(a_2,q)\}.$

Therefore, $\lambda_{[L,H]}(a_1+a_2,q)\geq inf\{\lambda_{[L,H]}(a_1,q),\lambda_{[L,H]}(a_2,q),\forall\ a_1,a_2\in R$ and $q\in Q$.

3.6 Theorem: The family of union of a IVQFSSHR $(R,+,.)$ is a IVAFSSHR of R.

Proof: Let $\{\lambda_{[T,J]i\in I}$ be a family of IVQFSSHR and $\lambda_{[T,J]}=\sqcup_{i\in I}\lambda_{[T,J]_i}$, then $\forall\ a_1,a_2\in R,q\in Q$, we have

(i) $\lambda_{[T,J]}(a_1+a_2,q)=\max_{i\in I}\lambda_{[T,J]_i}(a_1+a_2,q)$

$\geq \max_{i\in I}\{inf\{\lambda_{[T,J]_i}(a_1,q),\lambda_{[T,J]_i}(a_2,q)\}$

$$\geq inf\left\{\max_{i\in I}(\lambda_{[T,J]_i}(a_1,q),\lambda_{[T,J]_i}(a_2,q)\right\}$$
$$= inf\{\lambda_{[T,J]}(a_1,q),\lambda_{[T,J]}(a_2,q)\}.$$

Therefore, $\lambda_{[T,J]}(a_1+a_2,q) \geq inf\{\lambda_{[T,J]}(a_1,q),\lambda_{[T,J}(a_2,q)\}, \forall\, a_1,a_2 \in R, q \in Q.$

(ii) $\lambda_{[T,J]}(a_1a_2,q) = \max_{i\in I}\lambda_{[T,J]_i}(a_1a_2,q)$

$$\geq \max_{i\in I}\{inf\{\lambda_{[T,J]_i}(a_1,q),\lambda_{[T,J]_i}(a_2,q)\}$$
$$\geq inf\left\{\max_{i\in I}(\lambda_{[T,J]_i}(a_1,q),\lambda_{[T,J]_i}(a_2,q)\right\}$$
$$= inf\{\lambda_{[T,J]}(a_1,q),\lambda_{[T,J]}(a_2,q)\}.$$

Therefore, $\lambda_{[T,J]}(a_1a_2,q) \geq inf\{\lambda_{[T,J]}(a_1,q),\lambda_{[T,J}(a_2,q)\}, \forall\, a_1,a_2 \in R, q \in Q.$

Hence the proof is complete //

4. INTERVAL VALUED Q –FUZZY SOFT SUBHEMIRING OF A HEMIRING

4.1 Theorem: *Let* $[T,J]$ *be a fuzzy soft sub subset of a hemiring* $(R,+,.)$ *and* $[W,G]$ *be the strongest fuzzy soft relation* R.*Then* $[T,J]$ *is a IVQFSSHR of* $R \Leftrightarrow [W,G]$ *is a IVQFSSHR of* $R \times R$.

Proof: *Suppose that* $[T,J]$ *is an IVQFSSHR of*R.

Then for any $a = (a_1,a_2)$ *and* $b = (b_1,b_2)$ *are in* $R \times R$.

We, have $\lambda_{[W,G]}\left((a+b,q) = \lambda_{[W,G]}((a_1,a_2)+(b_1,b_2),q)\right)$

$= \lambda_{[W,G]}((a_1+b_1,a_2+b_2),q)$

$= inf\{\lambda_{[T,J]}((a_1+b_1),q),\lambda_{[T,J]}((a_2+b_2),q)\}$

$\geq inf\left\{\inf\{\lambda_{[T,J]}(a_1,q),\lambda_{[T,J]}(b_1,q)\},\inf\left\{\lambda_{[T,J]}(a_2,q),\lambda_{[T,J]}(b_2,q)\right)\right\}$

$\geq inf\{\inf\{\lambda_{[T,J]}(a_1,q),\lambda_{[T,J]}(a_2,q)\},\inf\{\lambda_{[T,J]}(b_1,q),\lambda_{[T,J]}(b_2,q)\}\}$

$= inf\{\lambda_{[W,G]}\{((a_1,a_2),q),\lambda_{[W,G]}((b_1,b_2),q)\}$

$= inf\{\lambda_{[W,G]}(a,q),\lambda_{[W,G]}(b,q)\}.$

Therefore,

$\lambda_{[W,G]}(a+b),q) \geq \inf\{\lambda_{[W,G]}(a,q),\lambda_{[W,G]}(b,q)\}, \forall\, a,b \in R \times R, q \in Q.$ And

$\lambda_{[W,G]}\left((ab,q) = \lambda_{[W,G]}((a_1,a_2)(b_1,b_2),q)\right)$

$= \lambda_{[W,G]}((a_1+b_1,a_2+b_2),q)$

$= inf\{\lambda_{[T,J]}((a_1b_1),q),\lambda_{[T,J]}((a_2b_2),q)\}$

$\geq inf\left\{\inf\{\lambda_{[T,J]}(a_1,q),\lambda_{[T,J]}(b_1,q)\},\inf\left\{\lambda_{[T,J]}(a_2,q),\lambda_{[T,J]}(b_2,q)\right)\right\}$

$\geq inf\{\inf\{\lambda_{[T,J]}(a_1,q),\lambda_{[T,J]}(a_2,q)\},\inf\{\lambda_{[T,J]}(b_1,q),\lambda_{[T,J]}(b_2,q)\}\}$

$= inf\{\lambda_{[W,G]}\{((a_1,a_2),q),\lambda_{[W,G]}((b_1,b_2),q)\}$

$= inf\{\lambda_{[W,G]}(a,q),\lambda_{[W,G]}(b,q)\}.$

Therefore, $\lambda_{[W,G]}(ab),q) \geq \inf\{\lambda_{[W,G]}(a,q),\lambda_{[W,G]}(b,q)\}, \forall\, a,b \in R \times R, q \in Q.$

And

Hence $[W,G]$ is a $Q-$ fuzzy subhemiring of $R \times R$.

Assume conversely that $[W, G]$ is a Q −fuzzy subhemiring of $R \times R$ then for any $a = (a_1, a_2)$ and $b = (b_1, b_2)$ are in $R \times R$. We have

$\inf\{\lambda_{[T,J]}((a_1 + b_1), q), \lambda_{[T,J]}(a_2, b_2), q)\} = \lambda_{[W,G]}((a_1 + b_1, a_2 + b_2), q)$

$= inf\{\lambda_{[T,J]}((a_1 b_1), q), \lambda_{[T,J]}((a_2 b_2), q)\}$

$\geq inf\left\{\inf\{\lambda_{[T,J]}(a_1, q), \lambda_{[T,J]}(b_1, q)\}, \inf\left\{\lambda_{[T,J]}(a_2, q), \lambda_{[T,J]}(b_2, q)\right\}\right\}$

$\geq inf\{\inf\{\lambda_{[T,J]}(a_1, q), \lambda_{[T,J]}(a_2, q)\}, \inf\{\lambda_{[T,J]}(b_1, q), \lambda_{[T,J]}(b_2, q)\}\}$

$= inf\{\lambda_{[W,G]}\{((a_1, a_2), q), \lambda_{[W,G]}((b_1, b_2), q)\}$

$= inf\{\lambda_{[W,G]}(a, q), \lambda_{[W,G]}(b, q)\}.$

Therefore, $\lambda_{[W,G]}(ab), q) \geq \inf\{\lambda_{[W,G]}(a, q), \lambda_{[W,G]}(b, q)\}, \forall\, a, b \in R \times R, q \in Q.$

And

Hence $[W, G]$ is a Q − fuzzy subhemiring of $R \times R$.

Hence complete the proof.

2. Premalineries

2.1Definition: Let X, Q be two non-empty sets. A Q −fuzzy subset J of X is a function $J: X \times Q \to [0, 1]$.

2.2 Definition: Let R be a hemiring. An Interval valued Q − fuzzy soft subset J of R is said to be a interval valued Q − fuzzy soft subhemiring (IQFSSHR) of R if it fulfils the below properties*:*

(i) $\lambda_{[T,J]}(a_1 + a_2, q) \geq inf\left\{\lambda_{[T,J]}(a_1, q), \lambda_{[Q_1,Q_2]}(a_2, q)\right\}$,

(ii) $\lambda_{[T,J]}(a_1 . a_2, q) \geq inf\{\lambda_{[T,J]}(a_1, q), \lambda_{[T,J]}(a_2, q)\}$, $\forall a_1, a_2 \in R$ *and* $q \in Q$.

2.3 Definition: If $(R, +, .)$ and$(R', +, .)$ are any two hemi-ring and Q be a non-void set. The function $g: R \times Q \to R' \times Q$ is said to be an Q − homomorphism if

$g(a_1 + a_2, q) = g(a_1, q) + g(a_2, q)$

2.4 Definition: If R andR' are any two Hemi-ring and Q be a non-void set. The mapping $g: R \times Q \to R' \times Q$ is said to be an Anti Q − homomorphism if

$g(a_1 + a_2, q) = g(a_2, q) + g(a_1, q)$

$g(a_1 . a_2, q) = g(a_2, q)g(a_1, q), \forall\, a_1, a_2 \in R$ *and* $q \in Q$.

2.5 Definition: *Let* R *and* R' *be two Hemi-rings and* Q *be a non-void set . Let* $g: R \times Q \to R' \times Q$ *be any mapping and let* $[T, J]$ *be a* Q − *fuzzy interval valued soft subhemiring in* R*,* $[I, O]$ *be an* Q − *fuzzy interval valued soft subhemiring in* $g(R) = R'$*, stated by* $\lambda_{[[I,O]}(a_2, q) = \max_{(a_1,q) \in g^{-1}(a_2,q)} \lambda_{[T,J]}(a_1, q), \forall\, a_1 \in R, a_2 \in R'$ *and* $q \in Q$*. Hence* $[T, J]$ *is said to be inverse of* $[I, O]$ *under* g *and is symbolized by* $g^{-1}([I, O])$*.*

2.6. Definition: *Let* $[T, J]$ *be a* $Q \subseteq A_{[T,J]}$*. for* $\alpha_1 \in [0,1]$*, the sets* $U(\lambda_{[T,J]}, \alpha_1) = \{a_1 \in A_{[T,J]} : \lambda_{[T,J]}(a_1, q) \geq \alpha_1\}$ *and is said to be* Q − *soft fuzzy* α_1 −*cut of* J*.*

2.7. Definition: *Let* $T, J]$ *be a* Q −*fuzzy soft subhemiring of*X*. For*$\alpha_1 \in [0,1]$*, the level subset of* $[T, J]$ *is the set* $\lambda_{[T,J]\alpha_1} = \left\{a_1 \in X_{[T,J]} : \lambda_{[T,J]}(a_1, q) \geq \alpha_1\right\}$*. this is said to a* Q − *fuzzy soft level subset of* J*.*

2.8 Definition: Let $[T,J]$ be an interval –valued Q −fuzzy soft subhemiring of a hemi-ring $(R,+,.)$.The level subhemiring $\lambda_{[T,J]\alpha_1}$, for $\alpha_1 \in [0,1]$such that $\alpha_1 \leq \lambda_{[T,J]}(0)$, $\alpha_1 \leq \lambda_{[T,J]}(1)$ is said to be Q −fuzzy interval valued soft level subset of J.

3. SOME PROPERTIES OF INTERVALVALUED Q- FUZZY SOFT SUBHEMIRINGS OF A HEMIRING

3.1 Theorem: If $[T,J]$ be an interval valued Q −fuzzy soft subhemiring of a hemiring $(R,+,.)$,then $L = \{a_1/a_1 \in R: \lambda_{[T,J]}(a_1,q) = 0\}$ is either void or is a subhemiring of R.

Proof: If no element fulfils this properties, then L is void

If $a_1, a_2 \in R$ then $\lambda_{[T,J]}(a_1 + a_2, q) \geq \inf\{\lambda_{[T,J]}(a_1,q), \lambda_{[T,J]}(a_2,q)\}$

$= \inf\{0,0\} = 0$

Hence, $[T,J](a_1 + a_2, q) = 0, \forall a_1, a_2 \in R$ and $q \in Q$.

Therefore we get $a_1 + a_2 \in L$

And, $\lambda_{[T,J]}(a_1a_2, q) \geq \inf\{\lambda_{[T,J]}(a_1,q), \lambda_{[T,J]}(a_2,q)\}$

$= \inf\{0,0\} = 0$

Hence, $[T,J](a_1a_2, q) = 0, \forall a_1, a_2 \in R$ and $q \in Q$.

Therefore we get $a_1a_2 \in L$

Therefore, L is a subhemiring of R.

Hence L is either void or is a subhemiring of R.

3.2. Theorem: Let $[T,J]$ be an interval valued Q − fuzzy soft subhemiring of a hemiring $(R,+,.)$

(i) If $\lambda_{[T,J]}(a_1 + a_2, q) = 1$then either $\lambda_{[T,J]}(a_1,q) = 1$ or$\lambda_{[T,J]}(a_2,q) = 1$, $\forall\, a_1, a_2 \in R$ and $q \in Q$.

(ii)) If $\lambda_{[T,J]}(a_1a_2, q) = 1$then either $\lambda_{[T,J]}(a_1,q) = 1$ or$\lambda_{[T,J]}(a_2,q) = 1$, $\forall\, a_1, a_2 \in R$ and $q \in Q$.

Proof: Let$a_1, a_2 \in R$, then by definition $\lambda_{[T,J]}(a_1 + a_2, q) \geq \inf\{\lambda_{[T,J]}(a_1,q), \lambda_{[T,J]}(a_2,q)\}$,

$\Rightarrow 1 \geq inf\{\lambda_{[T,J]}(a_1,q), \lambda_{[T,J]}(a_2,q)\}$.

Hence, either $\lambda_{[T,J]}(a_1,q) = 1$ or$\lambda_{[T,J]}(a_2,q) = 1$, $\forall\, a_1, a_2 \in R$ and $q \in Q$.

3.3. Theorem: Let$[T,J]$ and $[I,O]$ be two interval valued Q −fuzzy soft subhemiring of a hemiring $(R,+,.)$ then their $[T,J] \sqcap [[I,O]$ is a Q −fuzzy soft subhemiring of R.

Proof: Leta_1,$a_2 \in R$,$[T,J] = \{(a_1,q), \lambda_{[T,J]}(a_1,q)/a_1 \in R, q \in Q\}$ and

$[I,O] = \{(a_2,q), \lambda_{[I,O]}(a_2,q)/a_2 \in R, q \in Q\}$.

Let$[L,H] = \{(a_1,q), \lambda_{[L,H]}(a_1,q)/a_1 \in R, q \in Q\}$,

Where $\lambda_{[L,H]}(a_1,q) = \inf\{\lambda_{[L,H]}(a_1,q), \lambda_{[L,H]}(a_2,q)\}$.

(iii) $\lambda_{[L,H]}(a_1 + a_2, q) = inf\{\lambda_{[L,H]}(a_1 + a_2, q), \lambda_{[I,O]}(a_1 + a_2, q)\}$

$\geq inf\{\{inf\{(\lambda_{[T,J]}(a_1,q), \lambda_{[T,J]}(a_2,q)\}, inf\{\lambda_{[I,O]}(a_1,q), \lambda_{[I,O]}(a_2,q)\}\}$

$\geq inf\{inf\{(\lambda_{[T,J]}(a_1,q), \lambda_{[I,O]}(a_2,q)\}, inf\{\lambda_{[T,J]}(a_2,q), \lambda_{[I,O]}(a_2,q)\}\}\}$

$= inf\{\lambda_{[L,H]}((a_1,q), \lambda_{[L,H]}(a_2,q)\}$.

(iv) $\lambda_{[L,H]}(a_1a_2, q) = inf\{\lambda_{[L,H]}(a_1a_2,q), \lambda_{[I,O]}(a_1a_2,q)\}$

$\geq inf\{\{inf\{(\lambda_{[T,J]}(a_1,q), \lambda_{[T,J]}(a_2,q)\}, inf\{\lambda_{[I,O]}(a_1,q), \lambda_{[I,O]}(a_2,q)\}\}$

$$\geq inf\left\{inf\left\{\left(\lambda_{[T,J]}(a_1,q),\lambda_{[I,O]}(a_2,q)\right\},inf\left\{\lambda_{[T,J]}(a_2,q),\lambda_{[I,O]}(a_2,q)\right\}\right\}\right.$$
$$= inf\left\{\lambda_{[L,H]}\left((a_1,q),\lambda_{[L,H]}(a_2,q)\right\}.\right.$$

Therefore, $\lambda_{[L,H]}(a_1a_2,q) \geq \inf\left\{\lambda_{[L,H]}(a_1,q),\lambda_{[L,H]}(a_2,q)\right\}, \forall\, a_1,a_2 \in R$ and $q \in Q$.

Hence $[T,J] \sqcap [I,O]$ be an interval valued $Q-$ fuzzy soft subhemiring of a hemiring R.

3.4. Theorem: The $\sqcap$ of a family of an inteval valued $Q-$fuzzy soft subhemiring of a hemiring $(R,+,.)$ is a $Q-$fuzzy soft subhemiring of R.

Proof : Let $\left\{\lambda_{[T,J]_i}\right\} i \in I$ be a family of a interval valued $Q-$fuzzy soft subhemiring of a hemiring R and $\lambda_{[T,J]} = \underset{i\in I}{\sqcap}\lambda_{[T,J]i}$

Then $\forall\, a_1,a_2 \in R$, we have

(iii) $\lambda_{[T,J]}(a_1+a_2,q) = \min\limits_{i\in I}\left(\lambda_{[T,J]}\right) i\,((a_1+a_2,q)$

$$\geq \min_{i\in I} inf\,\{(\lambda_{[T,J]i}(a_1,q),\lambda_{[T,J]i}(a_2,q)$$
$$\geq \inf\{\min_{i\in I}((\lambda_{[T,J]i}(a_1,q)),\min_{i\in I}(\lambda_{[T,J]i}(a_2,q)\}$$
$$= \inf\left\{\lambda_{[T,J]}(a_1,q),\lambda_{[T,J]}(a_2,q)\right\}.$$

Therefore, $\lambda_{[T,J]}(a_1+a_2,q) \geq \inf\left\{\lambda_{[T,J]}(a_1,q),\lambda_{[T,J]}(a_2,q)\right\}, \forall\, a_1,a_2 \in R$ and $q \in Q$.

(iv) $\lambda_{[T,J]}(a_1a_2,q) = \min\limits_{i\in I}\left(\lambda_{[T,J]}\right) i\,((a_1a_2,q)$

$$\geq \min_{i\in I} inf\,\{(\lambda_{[T,J]i}(a_1,q),\lambda_{[T,J]i}(a_2,q)$$
$$\geq \inf\{\min_{i\in I}((\lambda_{[T,J]i}(a_1,q)),\min_{i\in I}(\lambda_{[T,J]i}(a_2,q)\}$$
$$= \inf\left\{\lambda_{[T,J]}(a_1,q),\lambda_{[T,J]}(a_2,q)\right\}.$$

Therefore, $\lambda_{[T,J]}(a_1a_2,q) \geq \inf\left\{\lambda_{[T,J]}(a_1,q),\lambda_{[T,J]}(a_2,q)\right\}, \forall\, a_1,a_2 \in R$ and $q \in Q$.

Hence the theorem//

3.5 Theorem: If $[T,J]$ and $[I,O]$ are any two interval valued $Q-$fuzzy soft subhemiring of a hemiring $(R,+,.)$, Then their $[T,J] \sqcup [I,O]$ is a IVQFSSHR of R.

Proof: $a_1,a_2 \in R$ and $q \in Q$.

$[T,J] = \{\left((a_1,q),\lambda_{[T,J]}(a_1q)\right)/a_1 \in R, q \in Q\}$ and

$[I,O] = \{\left((a_1,q),\lambda_{[I,O]}(a_1q)\right)/a_1 \in R, q \in Q\}.$

Let $[L,H] = [T,J] \sqcup [I,O]$ and $[L,H = \{\left((a_1,q),\lambda_{[L,H]}(a_1q)\right)/a_1 \in R, q \in Q\}$, where

$\lambda_{[L,H]}(a_1,q) = sup\left\{\lambda_{[T,J]}(a_1,q),\lambda_{[I,O]}(a_1,q)\right\}.$

(iii) $\lambda_{[L,H]} = (a_1+a_2,q) = sup\left\{\lambda_{[T,J]}(a_1+a_2,q),\lambda_{[I,O]}(a_1+a_2,q)\right\}$

$$\geq sup\left\{inf\left\{\lambda_{[T,J]}(a_1,q),\lambda_{[T,J]}(a_2,q)\right\},inf\left\{\lambda_{[I,O]}(a_1,q),\lambda_{[I,O]}(a_2,q)\right\}\right\}$$
$$\geq inf\left\{inf\left\{\lambda_{[T,J]}(a_1,q),\lambda_{[I,O]}(a_1,q)\right\},inf\left\{\lambda_{[T,J]}(a_2,q),\lambda_{[I,O]}(a_2,q)\right\}\right\}$$
$$= inf\left\{\lambda_{[L,H]}(a_1,q),\lambda_{[L,H]}(a_2,q)\right\}.$$

Therefore, $\lambda_{[L,H]}(a_1+a_2,q) \geq inf\{\lambda_{[L,H]}(a_1,q),\lambda_{[L,H]}(a_2,q), \forall\, a_1,a_2 \in R$ and $q \in Q$.

(iv) $\lambda_{[L,H]} = (a_1a_2,q) = sup\left\{\lambda_{[T,J]}(a_1a_2,q),\lambda_{[I,O]}(a_1a_2,q)\right\}$

$$\geq sup\left\{inf\left\{\lambda_{[T,J]}(a_1,q),\lambda_{[T,J]}(a_2,q)\right\},inf\left\{\lambda_{[I,O]}(a_1,q),\lambda_{[I,O]}(a_2,q)\right\}\right\}$$

$$\geq inf\left\{inf\{\lambda_{[T,J]}(a_1,q),\lambda_{[I,O]}(a_1,q)\},inf\{\lambda_{[T,J]}(a_2,q),\lambda_{[I,O]}(a_2,q)\}\right\}$$
$$= inf\{\lambda_{[L,H]}(a_1,q),\lambda_{[L,H]}(a_2,q)\}.$$

Therefore, $\lambda_{[L,H]}(a_1+a_2,q) \geq inf\{\lambda_{[L,H]}(a_1,q),\lambda_{[L,H]}(a_2,q), \forall\, a_1,a_2 \in R$ and $q \in Q$.

3.6 Theorem: The family of union of a IVQFSSHR $(R,+,.)$ is a IVAFSSHR of R.

Proof: Let $\{\lambda_{[T,J]i}\}_{i\in I}$ be a family of IVQFSSHR and $\lambda_{[T,J]} = \sqcup_{i\in I}\lambda_{[T,J]i}$, then $\forall\, a_1,a_2 \in R, q \in Q$, we have

(iii) $\lambda_{[T,J]}(a_1+a_2,q) = \max_{i\in I}\lambda_{[T,J]i}(a_1+a_2,q)$
$$\geq \max_{i\in I}\{inf\{\lambda_{[T,J]i}(a_1,q),\lambda_{[T,J]i}(a_2,q)\}$$
$$\geq inf\left\{\max_{i\in I}(\lambda_{[T,J]i}(a_1,q),\lambda_{[T,J]i}(a_2,q)\right\}$$
$$= inf\{\lambda_{[T,J]}(a_1,q),\lambda_{[T,J]}(a_2,q)\}.$$

Therefore, $\lambda_{[T,J]}(a_1+a_2,q) \geq inf\{\lambda_{[T,J]}(a_1,q),\lambda_{[T,J}(a_2,q)\}, \forall\, a_1,a_2 \in R, q \in Q.$

(iv) $\lambda_{[T,J]}(a_1a_2,q) = \max_{i\in I}\lambda_{[T,J]i}(a_1a_2,q)$
$$\geq \max_{i\in I}\{inf\{\lambda_{[T,J]i}(a_1,q),\lambda_{[T,J]i}(a_2,q)\}$$
$$\geq inf\left\{\max_{i\in I}(\lambda_{[T,J]i}(a_1,q),\lambda_{[T,J]i}(a_2,q)\right\}$$
$$= inf\{\lambda_{[T,J]}(a_1,q),\lambda_{[T,J]}(a_2,q)\}.$$

Therefore, $\lambda_{[T,J]}(a_1a_2,q) \geq inf\{\lambda_{[T,J]}(a_1,q),\lambda_{[T,J}(a_2,q)\}, \forall\, a_1,a_2 \in R, q \in Q.$

Hence the proof is complete //

4. INTERVAL VALUED Q –FUZZY SOFT SUBHEMIRING OF A HEMIRING

4.1 Theorem: *Let* $[T,J]$ *be a fuzzy soft sub subset of a hemiring* $(R,+,.)$ *and* $[W,G]$ *be the strongest fuzzy soft relation* R.*Then* $[T,J]$ *is a IVQFSSHR of* $R \Leftrightarrow [W,G]$ *is a IVQFSSHR of* $R \times R$.

Proof: *Suppose that* $[T,J]$ *is an IVQFSSHR of*R.

Then for any $a = (a_1,a_2)$ *and* $b = (b_1,b_2)$ *are in* $R \times R$.

We, have $\lambda_{[W,G]}\left((a+b,q) = \lambda_{[W,G]}((a_1,a_2)+(b_1,b_2),q)\right)$

$= \lambda_{[W,G]}((a_1+b_1,a_2+b_2),q)$

$= inf\{\lambda_{[T,J]}((a_1+b_1),q),\lambda_{[T,J]}((a_2+b_2),q)\}$

$\geq inf\left\{\inf\{\lambda_{[T,J]}(a_1,q),\lambda_{[T,J]}(b_1,q)\},\inf\left\{\lambda_{[T,J]}(a_2,q),\lambda_{[T,J]}(b_2,q)\right)\right\}$

$\geq inf\{\inf\{\lambda_{[T,J]}(a_1,q),\lambda_{[T,J]}(a_2,q)\},\inf\{\lambda_{[T,J]}(b_1,q),\lambda_{[T,J]}(b_2,q)\}\}$

$= inf\{\lambda_{[W,G]}\{((a_1,a_2),q),\lambda_{[W,G]}((b_1,b_2),q)\}$

$= inf\{\lambda_{[W,G]}(a,q),\lambda_{[W,G]}(b,q)\}.$

Therefore,

$\lambda_{[W,G]}(a+b),q) \geq \inf\{\lambda_{[W,G]}(a,q),\lambda_{[W,G]}(b,q)\}, \forall\, a,b \in R \times R, q \in Q.$ And

$$\lambda_{[W,G]}\big((ab,q) = \lambda_{[W,G]}\big((a_1,a_2)(b_1,b_2),q)\big)$$
$$= \lambda_{[W,G]}\big((a_1+b_1, a_2+b_2),q\big)$$
$$= inf\{\lambda_{[T,J]}\big((a_1b_1),q\big),\lambda_{[T,J]}\big((a_2b_2),q\big)\}$$
$$\geq inf\Big\{\inf\{\lambda_{[T,J]}(a_1,q),\lambda_{[T,J]}(b_1,q)\},\inf\Big\{\lambda_{[T,J]}(a_2,q),\lambda_{[T,J]}(b_2,q)\Big)\Big\}$$
$$\geq inf\{\inf\{\lambda_{[T,J]}(a_1,q),\lambda_{[T,J]}(a_2,q)\},\inf\{\lambda_{[T,J]}(b_1,q),\lambda_{[T,J]}(b_2,q)\}\}$$
$$= inf\{\lambda_{[W,G]}\{\big((a_1,a_2),q\big),\lambda_{[W,G]}\big((b_1,b_2),q\big)\}$$
$$= inf\{\lambda_{[W,G]}(a,q),\lambda_{[W,G]}(b,q)\}.$$

Therefore, $\lambda_{[W,G]}(ab),q) \geq \inf\{\lambda_{[W,G]}(a,q),\lambda_{[W,G]}(b,q)\}, \forall\, a,b \in R\times R, q\in Q.$

And

Hence $[W,G]$ is a $Q-$ fuzzy subhemiring of $R\times R.$

Assume conversely that $[W,G]$ is a $Q-$fuzzy subhemiring of $R\times R$ then for any $a=(a_1,a_2)$ and $b=(b_1,b_2)$ are in $R\times R$. We have

$$\inf\{\lambda_{[T,J]}\big((a_1+b_1),q\big),\lambda_{[T,J]}(a_2,b_2),q)\} = \lambda_{[W,G]}\big((a_1+b_1,a_2+b_2),q\big)$$
$$= inf\{\lambda_{[T,J]}\big((a_1b_1),q\big),\lambda_{[T,J]}\big((a_2b_2),q\big)\}$$
$$\geq inf\Big\{\inf\{\lambda_{[T,J]}(a_1,q),\lambda_{[T,J]}(b_1,q)\},\inf\Big\{\lambda_{[T,J]}(a_2,q),\lambda_{[T,J]}(b_2,q)\Big)\Big\}$$
$$\geq inf\{\inf\{\lambda_{[T,J]}(a_1,q),\lambda_{[T,J]}(a_2,q)\},\inf\{\lambda_{[T,J]}(b_1,q),\lambda_{[T,J]}(b_2,q)\}\}$$
$$= inf\{\lambda_{[W,G]}\{\big((a_1,a_2),q\big),\lambda_{[W,G]}\big((b_1,b_2),q\big)\}$$
$$= inf\{\lambda_{[W,G]}(a,q),\lambda_{[W,G]}(b,q)\}.$$

Therefore, $\lambda_{[W,G]}(ab),q) \geq \inf\{\lambda_{[W,G]}(a,q),\lambda_{[W,G]}(b,q)\}, \forall\, a,b \in R\times R, q\in Q.$

And

Hence $[W,G]$ is a $Q-$ fuzzy subhemiring of $R\times R.$

Hence complete the proof.

Conclusion: *In this papar we have give the definition of hemiring and subhemiring intuitionistic interval valued fuzzy soft set based on some theorem, and also we have to develope intuitionistic interval valued fuzzy soft set, soft subhemiring of a hemiring under homomorphism and anti homomorphism.*

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