

2. 2. Definition. [2,3]. Assume X be a universal set and $Q \neq \emptyset$. A Q –fuzzy subset N of X is a function $X \times X \rightarrow [0,1]$." The union of two Q –fuzzy subsets N and M is defined as

$$N \cup M = \{\max(\mu_N(\hat{\theta}, \hat{u}), \mu_M(\hat{\theta}, \hat{u})): \hat{\theta} \in X, \hat{u} \in Q\}$$

The intersection of two Q –fuzzy subsets N and M is defined as

$$N \cap M = \{\min(\mu_N(\hat{\theta}, \hat{u}), \mu_M(\hat{\theta}, \hat{u})): \hat{\theta} \in X, \hat{u} \in Q\}$$

2. 3. Definition[3]. Let I be unit interval $[0,1]$, $k \in Z^+$ (positive integer), X be universal set and $Q \neq \emptyset$. A multi Q –fuzzy set N_Q in X and Q is a set of ordered sequences,

$$N_Q = \{\max(\mu_j(\hat{\theta}, \hat{u})): \hat{\theta} \in X, \hat{u} \in Q\}$$

Where $\mu_j: X \times Q \rightarrow I^k$ The function $\mu_j(\theta, \hat{u})$ is termed as membership function of multi Q -fuzzy set N_Q , and $\sum_{j=0}^k \mu_j(\hat{\theta}, \hat{u}) \leq 1$, for $j = 1,2,3, \dots, k$. k is the dimension of multi Q fuzzy set N_Q . The set of all multi- Q – fuzzy set of dimension k in X and Q is denoted by $M^k FQ(X)$."

2. 4. Definition[4]. Let X be a universal set, E be the set of parameters, $Q \neq \emptyset$. Let $M^k FQ(X)$ is the power set of all multi Q –fuzzy subsets of X with dimension $k = 1$. Let $D \subseteq E$. A pair (F_Q, D) is referred as Q –fuzzy soft set (in short QF –soft set)over X where F_Q , is defined by

$$F_Q: D \rightarrow M^k FQ(X) \text{ such that } (F_Q(\hat{\theta})) = \emptyset \text{ if } \hat{\theta} \notin D$$

Here a Q –fuzzy soft set can be represented by the set of ordered pairs

$$(F_Q, D) = \{\hat{\theta}, F_Q(\hat{\theta}): \hat{\theta} \in X, F_Q(\hat{\theta}) \in M^k FQ(X)\}$$

The set of all Q –fuzzy soft sets over X will be denoted by $QFS(X)$

2. 5. Definition. [22] Let X be a space of points (objects), with a generic element in X denoted by $\hat{\theta}$. A SVNS N in X has the features truth-membership function T_N , indeterminacy-membership function I_N , and falsity-membership function F_N . For each

point $\tilde{\theta}$ in $X, T_N(\tilde{\theta}), I_N(\tilde{\theta}), F_N(\tilde{\theta}) \in [0,1]$.

Mathematically single valued neutrosophic is expressed as follows:

$$N = \{(\tilde{\theta}, (T_N(\tilde{\theta}), I_N(\tilde{\theta}), F_N(\tilde{\theta}))) | \tilde{\theta} \in X\}$$

3 Q –Single Valued Neutrosophic Sets

3.1. Definition. Let X be a universal set and $Q \neq \emptyset$. A Q –SVNS \tilde{N}_Q in X and Q is an object of the form

$$\tilde{N}_Q = \{(\tilde{\theta}, \hat{u}), \mu_{\tilde{N}_Q}(\tilde{\theta}, \hat{u}), \nu_{\tilde{N}_Q}(\tilde{\theta}, \hat{u}), \lambda_{\tilde{N}_Q}(\tilde{\theta}, \hat{u}) : \tilde{\theta} \in X, \hat{u} \in Q\}$$

Where $\mu_{\tilde{N}_Q} : X \times Q \rightarrow [0,1]$, $\nu_{\tilde{N}_Q} : X \times Q \rightarrow [0,1]$, $\lambda_{\tilde{N}_Q} : X \times Q \rightarrow [0,1]$, are respectively truth-membership, indeterminacy-membership and falsity membership functions for every $\tilde{\theta} \in X$ and $\hat{u} \in Q$ and satisfy the condition $0 \leq \mu_{\tilde{N}_Q}(\tilde{\theta}, \hat{u}) + \nu_{\tilde{N}_Q}(\tilde{\theta}, \hat{u}) + \lambda_{\tilde{N}_Q}(\tilde{\theta}, \hat{u}) \leq 3$.

3.2. Example. Let $X = \{p_1, p_1, p_3\}$ and $Q = \{\hat{u}, \hat{v}\}$, then Q –SVNS \tilde{N}_Q is defined below,

$$\tilde{N}_Q = \{< (p_1, \hat{u}), (0.4,0.3,0.5), (p_1, \hat{v}), (0.2,0.4,0.6), (p_2, \hat{u}), (0.6,0.1,0.3), (p_2, \hat{v}), (0.7,0.2,0.1), (p_3, \hat{u}), (0.3,0.6,0.4), (p_3, \hat{v}), (0.5,0.4,0.6) >\}$$

Now we define some basic operations for Q –SVNS.

3.3. Definition. Let X be a universal set, $Q \neq \emptyset$ and \tilde{N}_Q be a Q –SVNS. The complement of \tilde{N}_Q is denoted and defined as follows

$$\tilde{N}_Q^c = \{(\tilde{\theta}, \hat{u}), \lambda_{\tilde{N}_Q}(\tilde{\theta}, \hat{u}), 1 - \nu_{\tilde{N}_Q}(\tilde{\theta}, \hat{u}), \mu_{\tilde{N}_Q}(\tilde{\theta}, \hat{u}) : \tilde{\theta} \in X, \hat{u} \in Q\}$$

3.4. Definition. Let \tilde{A}_Q and \tilde{N}_Q be two Q –SVNS. Then the union and intersection is denoted and defined by

$$\tilde{A}_Q \cup \tilde{N}_Q = \{(\tilde{\theta}, \hat{u}), \max(\mu_{\tilde{A}_Q}(\tilde{\theta}, \hat{u}), \mu_{\tilde{N}_Q}(\tilde{\theta}, \hat{u})), \min(\nu_{\tilde{A}_Q}(\tilde{\theta}, \hat{u}), \nu_{\tilde{N}_Q}(\tilde{\theta}, \hat{u})), \min(\lambda_{\tilde{A}_Q}(\tilde{\theta}, \hat{u}), \lambda_{\tilde{N}_Q}(\tilde{\theta}, \hat{u})) : \tilde{\theta} \in X, \hat{u} \in Q\}$$

$$\tilde{A}_Q \cap \tilde{N}_Q = \{(\tilde{\theta}, \hat{u}), \min(\mu_{\tilde{A}_Q}(\tilde{\theta}, \hat{u}), \mu_{\tilde{N}_Q}(\tilde{\theta}, \hat{u})), \max(\nu_{\tilde{A}_Q}(\tilde{\theta}, \hat{u}), \nu_{\tilde{N}_Q}(\tilde{\theta}, \hat{u})), \max(\lambda_{\tilde{A}_Q}(\tilde{\theta}, \hat{u}), \lambda_{\tilde{N}_Q}(\tilde{\theta}, \hat{u})) : \tilde{\theta} \in X, \hat{u} \in Q\}$$

$$\max(\lambda_{\tilde{A}_Q}(\tilde{\theta}, \hat{u}), \lambda_{\tilde{N}_Q}(\tilde{\theta}, \hat{u}))\}$$

3.5. Definition. Let \tilde{A}_Q and \tilde{N}_Q be two Q –SVNSs over two non-empty universal sets G and H respectively and Q be any non-empty set. Then the product of \tilde{A}_Q and \tilde{N}_Q is denoted by $\tilde{A}_Q \times \tilde{N}_Q$ and defined as

$$\tilde{A}_Q \times \tilde{N}_Q = \{ \langle ((\tilde{\theta}, b), \hat{u}), \mu_{\tilde{A}_Q \times \tilde{N}_Q}((\tilde{\theta}, b), \hat{u}), \nu_{\tilde{A}_Q \times \tilde{N}_Q}((\tilde{\theta}, b), \hat{u}), \lambda_{\tilde{A}_Q \times \tilde{N}_Q}((\tilde{\theta}, b), \hat{u}) \rangle : \tilde{\theta} \in G, b \in H, \hat{u} \in Q \}$$

Where

$$\begin{aligned} \mu_{\tilde{A}_Q \times \tilde{N}_Q}((\tilde{\theta}, b), \hat{u}) &= \min\{\mu_{\tilde{A}_Q}(\tilde{\theta}, \hat{u}), \mu_{\tilde{N}_Q}(b, \hat{u})\} \\ \nu_{\tilde{A}_Q \times \tilde{N}_Q}((\tilde{\theta}, b), \hat{u}) &= \max\{\nu_{\tilde{A}_Q}(\tilde{\theta}, \hat{u}), \nu_{\tilde{N}_Q}(b, \hat{u})\} \\ \lambda_{\tilde{A}_Q \times \tilde{N}_Q}((\tilde{\theta}, b), \hat{u}) &= \max\{\lambda_{\tilde{A}_Q}(\tilde{\theta}, \hat{u}), \lambda_{\tilde{N}_Q}(b, \hat{u})\} \end{aligned}$$

For all $\tilde{\theta}, b$ in G and $\hat{u} \in Q$.

3.6. Definition. Let \tilde{A}_Q a Q –single valued neutrosophic subset in a set G , the strongest Q –single valued neutrosophic relation on G , that is a Q –single valued neutrosophic relation on \tilde{A}_Q is H given by

$$\begin{aligned} \mu_H((\tilde{\theta}, b), \hat{u}) &= \min\{\mu_{\tilde{A}_Q}(\tilde{\theta}, \hat{u}), \mu_{\tilde{N}_Q}(b, \hat{u})\} \\ \nu_H((\tilde{\theta}, b), \hat{u}) &= \max\{\nu_{\tilde{A}_Q}(\tilde{\theta}, \hat{u}), \nu_{\tilde{N}_Q}(b, \hat{u})\} \\ \lambda_H((\tilde{\theta}, b), \hat{u}) &= \max\{\lambda_{\tilde{A}_Q}(\tilde{\theta}, \hat{u}), \lambda_{\tilde{N}_Q}(b, \hat{u})\} \end{aligned}$$

For all $\tilde{\theta}, b$ in G and $\hat{u} \in Q$.

4. Multi Q –Single Valued Neutrosophic Sets

4.1. Definition. Let X be a non-empty set and Q be any non-empty set, l be any positive integer and I be a unit interval $[0,1]$. A multi Q –SVNS \tilde{A}_Q in X and Q is a set of ordered sequences

$$\tilde{A}_Q = \{((\tilde{\theta}, \hat{u}), \mu_j(\tilde{\theta}, \hat{u}), \nu_j(\tilde{\theta}, \hat{u}), \lambda_j(\tilde{\theta}, \hat{u})) : \tilde{\theta} \in X, \hat{u} \in Q \text{ for all } j = 1, 2, \dots, l\}$$

Where $\mu_j: X \times Q \rightarrow I^K$, $\nu_j: X \times Q \rightarrow I^K$, $\lambda_j: X \times Q \rightarrow I^K$, for all $j = 1, 2, \dots, l$

and are respectively truth-membership, indeterminacy-membership and falsity membership functions for each $\tilde{\theta} \in X$ and $\hat{u} \in Q$ and satisfy the condition

$$0 \leq \mu_j(\tilde{\theta}, \hat{u}) + \nu_j(\tilde{\theta}, \hat{u}) + \lambda_j(\tilde{\theta}, \hat{u}) \leq 3, \text{ for all } j = 1, 2, \dots, l$$

The functions $\mu_j(\tilde{\theta}, \hat{u}), \nu_j(\tilde{\theta}, \hat{u}), \lambda_j(\tilde{\theta}, \hat{u})$ for all $j = 1, 2, \dots, l$ are called the "truth-membership, indeterminacy-membership and falsity-membership" functions respectively of the multi Q –SVNS \tilde{A}_Q and satisfy the condition

$$0 \leq \mu_j(\tilde{\theta}, \hat{u}) + \nu_j(\tilde{\theta}, \hat{u}) + \lambda_j(\tilde{\theta}, \hat{u}) \leq 3, \text{ for all } j = 1, 2, \dots, l$$

l is called the dimension of the Q –SVNS \tilde{A}_Q . The set of all Q –SVNS is denoted by $Z^k QSVN(X)$.

4. 2. Example. Let $X = \{p_1, p_2, p_3\}$ be a universal set and $Q = \{\hat{u}, v\}$ be a non-empty set and $l = 2$ be a positive integer. If $\tilde{A}_Q: X \times Q \rightarrow I^2$, Then the set

$$\tilde{A}_Q = \{ < ((p_1, \hat{u}), (0.2, 0.3, 0.6), (0.6, 0.2, 0.3)), ((p_1, \hat{v}), (0.5, 0.1, 0.3), (0.4, 0.4, 0.5)), ((p_2, \hat{u}), (0.4, 0.3, 0.5), (0.6, 0.1, 0.3)), ((p_2, \hat{v}), (0.7, 0.2, 0.1), (0.2, 0.4, 0.8)) > \}$$

is a multi Q –SVNS in X and Q .

4. 3. Remark. Note that if $\nu_j(\tilde{\theta}, \hat{u}) = 0$ and $\lambda_j(\tilde{\theta}, \hat{u}) = 0$ then multi Q –SVNS reduces to multi Q –fuzzy set.

4. 4. Definition. Let \tilde{A}_Q be a Q –SVNS. The the complement of \tilde{A}_Q is denoted and defined as follows

$$\tilde{A}_Q^c = \{(\tilde{\theta}, \hat{u}), \lambda_j(\tilde{\theta}, \hat{u}), 1 - \nu_j(\tilde{\theta}, \hat{u}), \mu_j(\tilde{\theta}, \hat{u}): \tilde{\theta} \in X \text{ and } \hat{u} \in Q, \text{ for all } j = 1, 2, \dots, l\}$$

4. 5. Definition. Let \tilde{A}_Q and A_Q and B_Q be two Q –SVNSs, and l be a positive integer such that

$$A = \{(\tilde{\theta}, \hat{u}), \mu_j(\tilde{\theta}, \hat{u}), \nu_j(\tilde{\theta}, \hat{u}), \lambda_j(\tilde{\theta}, \hat{u}): \tilde{\theta} \in X \text{ and } \hat{u} \in Q \text{ for all } j = 1, 2, \dots, l\} \text{ and}$$

$$B = \{(\tilde{\theta}, \hat{u}), \mu_j^*(\tilde{\theta}, \hat{u}), \nu_j^*(\tilde{\theta}, \hat{u}), \lambda_j^*(\tilde{\theta}, \hat{u}): \tilde{\theta} \in X \text{ and } \hat{u} \in Q \text{ for all } j = 1, 2, \dots, l\}$$

Then we define the following basic operations for Q –SVNSs.

1. $A \subset B$ iff $\mu_j(\hat{\theta}, \hat{u}) \leq \mu_j^*(\hat{\theta}, \hat{u}), \nu_j(\hat{\theta}, \hat{u}) \geq \nu_j^*(\hat{\theta}, \hat{u})$ and $\lambda_j(\hat{\theta}, \hat{u}) \geq \lambda_j^*(\hat{\theta}, \hat{u})$ for all $j = 1, 2, \dots, l$.
2. $A = B$ iff $\mu_j(\hat{\theta}, \hat{u}) = \mu_j^*(\hat{\theta}, \hat{u}), \nu_j(\hat{\theta}, \hat{u}) = \nu_j^*(\hat{\theta}, \hat{u})$ and $\lambda_j(\hat{\theta}, \hat{u}) = \lambda_j^*(\hat{\theta}, \hat{u})$ for all $j = 1, 2, \dots, l$.
3. $A \cup B = \{(\hat{\theta}, \hat{u}), \max(\mu_j(\hat{\theta}, \hat{u}), \mu_j^*(\hat{\theta}, \hat{u})), \min(\nu_j(\hat{\theta}, \hat{u}), \nu_j^*(\hat{\theta}, \hat{u})), \min(\lambda_j(\hat{\theta}, \hat{u}), \lambda_j^*(\hat{\theta}, \hat{u}))\}$
4. $A \cap B = \{(\hat{\theta}, \hat{u}), \min(\mu_j(\hat{\theta}, \hat{u}), \mu_j^*(\hat{\theta}, \hat{u})), \max(\nu_j(\hat{\theta}, \hat{u}), \nu_j^*(\hat{\theta}, \hat{u})), \max(\lambda_j(\hat{\theta}, \hat{u}), \lambda_j^*(\hat{\theta}, \hat{u}))\}$

5. Q –Single Valued Neutrosophic Soft Sets

In this section we introduce the concept of Q –SVNSSs by combining soft sets and Q –SVNS. We also define some basic operations and properties of Q –SVNSSs.

5.1. Definition. Let X be a universal set, Q be any non-empty set and E be the set of parameters. Let $Z^1QSVN(X)$ denote the set of all multi Q –single valued neutrosophic subsets of X with dimension $l = 1$. Let $K \subset E$. A pair (F_Q, K) is called Q –SVNSS over X where F_Q is a mapping given

$$F_Q: K \rightarrow Z^1QSVN(X) \text{ such that } (F_Q, (\hat{\theta})) = \emptyset \text{ if } \hat{\theta} \notin K$$

A Q –SVNSS can be represented by the set of ordered pairs

$$(F_Q, K) = \{(\hat{\theta}, F_Q(\hat{\theta})) : \hat{\theta} \in X, F_Q(\hat{\theta}) \in Z^1QSVN(X)\}$$

5.2. Example. Let $X = \{p_1, p_2, p_3, p_4\}$ be a universal set, $E = \{k_1, k_2, k_3, k_4\}$ and $Q = \{\hat{u}, \hat{v}\}$ be a non-empty set. If $K = \{k_1, k_2, k_3\} \subset E$,

$$F_Q(k_1) = \{((p_1, \hat{u}), (0.3, 0.4, 0.6)), ((p_1, \hat{v}), (0.2, 0.3, 0.5)), ((p_2, \hat{u}), (0.6, 0.2, 0.4))\}$$

$$F_Q(k_2) = \{((p_1, \hat{u}), (0.5, 0.3, 0.4)), ((p_1, \hat{v}), (0.4, 0.1, 0.7)), ((p_3, \hat{u}), (0.8, 0.1, 0.2))\}$$

$$F_Q(k_3) = \{((p_1, \hat{u}), (0.9, 0.1, 0.1)), ((p_1, \hat{v}), (0.8, 0.2, 0.3)), ((p_3, \hat{v}), (0.4, 0.3, 0.6))\}$$

Then

$$(F_Q, K) = \{(\mathbf{k}_1, ((\mathbf{p}_1, \hat{u}), (0.3, 0.4, 0.6)), ((\mathbf{p}_1, \hat{v}), (0.2, 0.3, 0.5)), ((\mathbf{p}_2, \hat{u}), (0.6, 0.2, 0.4)), \\ \mathbf{k}_2, ((\mathbf{p}_1, \hat{u}), (0.5, 0.3, 0.4)), ((\mathbf{p}_1, \hat{v}), (0.4, 0.1, 0.7)), ((\mathbf{p}_3, \hat{u}), (0.8, 0.1, 0.2)), \\ \mathbf{k}_3, ((\mathbf{p}_1, \hat{u}), (0.9, 0.1, 0.1)), ((\mathbf{p}_1, \hat{v}), (0.8, 0.2, 0.3)), ((\mathbf{p}_3, \hat{v}), (0.4, 0.3, 0.6))\}$$

is a Q -SVNSS.

5.3. Definition. Let $(F_Q, K) \in QSVNSS(X)$. If $F_Q(\hat{\theta}) = \emptyset$ for all $\hat{\theta} \in E$ then (F_Q, K) is called a null Q -SVNSS denoted by (\emptyset, K) .

5.4. Example. Let X, E and Q be defined in the above example 5.2 then

$$(\emptyset, K) = \{(\mathbf{k}_1, ((\mathbf{p}_1, \hat{u}), (0, 1, 1)), ((\mathbf{p}_1, \hat{v}), (0, 1, 1)), ((\mathbf{p}_2, \hat{u}), (0, 1, 1)), \mathbf{k}_2, \\ ((\mathbf{p}_1, \hat{u}), (0, 1, 1)), ((\mathbf{p}_1, \hat{v}), (0, 1, 1)), ((\mathbf{p}_3, \hat{u}), (0, 1, 1)), \\ \mathbf{k}_3, ((\mathbf{p}_1, \hat{u}), (0, 1, 1)), ((\mathbf{p}_1, \hat{v}), (0, 1, 1)), ((\mathbf{p}_3, \hat{v}), (0, 1, 1))\}$$

5.5. Definition. Let $(F_Q, K) \in QSVNSS(X)$, If $F_Q(\hat{\theta}) = X$ for all $\hat{\theta} \in E$ then (F_Q, K) is called a null Q -SVNSS denoted by (X, K) .

5.6. Example. Let X, E and Q be defined in the above example 5.2 then

$$(X, K) = \{(\mathbf{k}_1, ((\mathbf{p}_1, \hat{u}), (1, 0, 0)), ((\mathbf{p}_1, \hat{v}), (1, 0, 0)), ((\mathbf{p}_2, \hat{u}), (1, 0, 0)), \\ \mathbf{k}_2, ((\mathbf{p}_1, \hat{u}), (1, 0, 0)), ((\mathbf{p}_1, \hat{v}), (1, 0, 0)), ((\mathbf{p}_3, \hat{u}), (1, 0, 0)), \\ \mathbf{k}_3, ((\mathbf{p}_1, \hat{u}), (1, 0, 0)), ((\mathbf{p}_1, \hat{v}), (1, 0, 0)), ((\mathbf{p}_3, \hat{v}), (1, 0, 0))\}$$

5.7. Definition. Let $(F_Q, K), (G_Q, L) \in QSVNS(X)$. Then (F_Q, K) is Q -SVNSS subset of (G_Q, L) , denoted by $(F_Q, K) \subset (G_Q, L)$ if $K \subset L$ and $F_Q(\hat{\theta}) \subset G_Q(\hat{\theta})$ for all $\hat{\theta} \in X$.

5.8. Proposition. Let $(F_Q, K), (G_Q, L), (M_Q, N) \in QSVNS(X)$. Then

1. $(F_Q, K) \subset (G_Q, E)$
2. $(\emptyset, K) \subset (G_Q, L)$
3. $(F_Q, K) \subset (G_Q, L)$ and $(G_Q, L) \subset (M_Q, N)$ then $(F_Q, K) \subset (M_Q, N)$.
4. If $(F_Q, K) = (G_Q, L)$ and $(G_Q, L) = (M_Q, N)$ then $(F_Q, K) = (M_Q, N)$

Proof: Straightforward.

5. 9. Definition. Let $(F_Q, K) \in QSVNS(X)$, Then the complement of $Q - SVNSS$ set is written as $(F_Q, K)^c$ and is defined by $(F_Q, K)^c = (F_Q^c, \neg K)$ where

$$F_Q^c: \neg K \rightarrow QSVNS(X)$$

is the mapping given by $F_Q^c(e)$ $Q -$ single valued neutrosophic complement for each $e \in K$.

5. 10. Proposition. Let $(F_Q, K) \in QSVNS(X)$, Then

1. $((F_Q, K)^c)^c = (F_Q, K)$
2. $(\emptyset, K)^c = (X, E)$
3. $(X, E)^c = (\emptyset, E)$

Proof. 1. Let $k \in K$. Then

$$(F_Q, K) = F_Q(k) = \{(\mathbf{p}_1, \hat{u}), (\mu_{F_Q(k)}(\mathbf{p}_1, \hat{u}), \nu_{F_Q(k)}(\mathbf{p}_1, \hat{u}), \lambda_{F_Q(k)}(\mathbf{p}_1, \hat{u})) : \hat{u} \in Q, \mathbf{p}_1 \in X\}$$

$$(F_Q, K)^c = (F_Q(k))^c = \{(\mathbf{p}_1, \hat{u}), (\lambda_{F_Q(k)}(\mathbf{p}_1, \hat{u}), 1 - \nu_{F_Q(k)}(\mathbf{p}_1, \hat{u}), \mu_{F_Q(k)}(\mathbf{p}_1, \hat{u}))\}$$

$$((F_Q, K)^c)^c = \{(\mathbf{p}_1, \hat{u}), (\mu_{F_Q(k)}(\mathbf{p}_1, \hat{u}), 1 - (1 - \nu_{F_Q(k)}(\mathbf{p}_1, \hat{u})), \lambda_{F_Q(k)}(\mathbf{p}_1, \hat{u}))\}$$

$$((F_Q, K)^c)^c = \{(\mathbf{p}_1, \hat{u}), (\mu_{F_Q(k)}(\mathbf{p}_1, \hat{u}), \nu_{F_Q(k)}(\mathbf{p}_1, \hat{u}), \lambda_{F_Q(k)}(\mathbf{p}_1, \hat{u}))\}$$

$$((F_Q, K)^c)^c = (F_Q, K)$$

2. Let $(\emptyset, K) = (F_Q, K)$, Than for all $k \in K$

$$F_Q(k) = \{(\mathbf{p}_1, \hat{u}), (\mu_{F_Q(k)}(\mathbf{p}_1, \hat{u}), \nu_{F_Q(k)}(\mathbf{p}_1, \hat{u}), \lambda_{F_Q(k)}(\mathbf{p}_1, \hat{u})) : \hat{u} \in Q, \mathbf{p}_1 \in X\}$$

$$= \{(\mathbf{p}_1, \hat{u}), (0, 1, 1) : \hat{u} \in Q, \mathbf{p}_1 \in X\}$$

$$(\emptyset, K)^c = (F_Q, K)^c = (F_Q(k))^c = \{(\mathbf{p}_1, \hat{u}), (1, 1 - 1, 0) : \hat{u} \in Q, \mathbf{p}_1 \in X\}$$

$$= \{(\mathbf{p}_1, \hat{u}), (1, 0, 0) : \hat{u} \in Q, \mathbf{p}_1 \in X\}$$

$$= (X, E)$$

3. Let $(X, E) = (F_Q, E)$, Then for all $k \in K$

$$F_Q(k) = \{(\mathbf{p}_1, \hat{u}), (\mu_{F_Q(k)}(\mathbf{p}_1, \hat{u}), \nu_{F_Q(k)}(\mathbf{p}_1, \hat{u}), \lambda_{F_Q(k)}(\mathbf{p}_1, \hat{u})) : \hat{u} \in Q, \mathbf{p}_1 \in X\}$$

$$= \{(\mathbf{p}_1, \hat{u}), (1,0,0) : \hat{u} \in Q, \mathbf{p}_1 \in X\}$$

$$\begin{aligned} (X, E)^c &= (F_Q, E)^c = (F_Q(k))^c = \{(\mathbf{p}_1, \hat{u}), (0,1 - 0,1) : \hat{u} \in Q, \mathbf{p}_1 \in X\} \\ &= \{(\mathbf{p}_1, \hat{u}), (0,1,1) : \hat{u} \in Q, \mathbf{p}_1 \in X\} \\ &= (\emptyset, E) \end{aligned}$$

5.11. Definition. Let (F_Q, K) and $(G_Q, L) \in QSVNS(X)$. Then the union of two Q -SVNSSs (F_Q, K) and (G_Q, L) is the Q -SVNSS, (M_Q, N) written as $(F_Q, K) \cup (G_Q, L) = (M_Q, N)$ where $N = K \cup L$ for all $l \in N$ and

$$(M_Q, N) = \begin{cases} F_Q(l) & \text{if } l \in K - L \\ G_Q(l) & \text{if } l \in L - K \\ F_Q(l) \cup G_Q(l) & \text{if } l \in K \cap L \end{cases}$$

5.12. Example. Let $X = \{\mathbf{p}_1, \mathbf{p}_2, \mathbf{p}_3, \mathbf{p}_4, \mathbf{p}_5\}$ be a universal set, $E = \{\mathbf{a}_1, \mathbf{a}_2, \mathbf{a}_3, \mathbf{a}_4, \mathbf{a}_5\}$ be a set of parameters and $Q = \{\hat{u}, \hat{v}, w\}$ be a non-empty set. Let $N = \{\mathbf{a}_1, \mathbf{a}_3, \mathbf{a}_4\} \subset E$, and $M = \{\mathbf{a}_1, \mathbf{a}_2, \mathbf{a}_3\}$

$$\begin{aligned} (F_Q, N) &= \{(\mathbf{a}_1, ((\mathbf{p}_1, \hat{u}), (0.3,0.4,0.5)), ((\mathbf{p}_1, \hat{v}), (0.5,0.3,0.4)), ((\mathbf{p}_1, w), (0.6,0.1,0.2))) \\ &(\mathbf{a}_3, ((\mathbf{p}_1, \hat{u}), (0.2,0.3,0.4)), ((\mathbf{p}_1, \hat{v}), (0.4,0.2,0.3)), ((\mathbf{p}_1, w), (0.6,0.2,0.4)), ((\mathbf{p}_3, \hat{u}), (0.7,0.1,0.2)), \\ &((\mathbf{p}_3, \hat{v}), (0.8,0.2,0.2)), ((\mathbf{p}_3, w), (0.2,0.4,0.6)))\}, (\mathbf{a}_4, \{((\mathbf{p}_2, \hat{u}), (0.6,0.2,0.1)), ((\mathbf{p}_2, \hat{v}), (0.4,0.2,0.5)) \\ &, ((\mathbf{p}_2, w), (0.5,0.4,0.4))\}, \end{aligned}$$

and

$$\begin{aligned} (G_Q, M) &= \{(\mathbf{a}_1, ((\mathbf{p}_1, \hat{u}), (0.4,0.3,0.5)), ((\mathbf{p}_1, \hat{v}), (0.3,0.3,0.4)), ((\mathbf{p}_1, w), (0.4,0.2,0.3))), \\ &(\mathbf{a}_2, ((\mathbf{p}_2, \hat{u}), (0.4,0.5,0.2)), ((\mathbf{p}_2, \hat{v}), (0.7,0.1,0.1)), ((\mathbf{p}_2, w), (0.6,0.2,0.3)), \\ &(\mathbf{a}_3, \{((\mathbf{p}_1, \hat{u}), (0.4,0.3,0.5)), ((\mathbf{p}_1, \hat{v}), (0.2,0.2,0.4)), ((\mathbf{p}_1, w), (0.4,0.1,0.4)) \\ &, ((\mathbf{p}_3, \hat{v}), (0.6,0.1,0.2)), ((\mathbf{p}_3, w), (0.7,0.2,0.3))\}, \end{aligned}$$

Then

$$\begin{aligned} (K_Q, L) &= \{(\mathbf{a}_1, \{((\mathbf{p}_1, \hat{u}), (0.4,0.3,0.5)), ((\mathbf{p}_1, \hat{v}), (0.5,0.3,0.4)), ((\mathbf{p}_1, w), (0.6,0.1,0.2))\}), \\ &\mathbf{a}_2, ((\mathbf{p}_2, \hat{u}), (0.4,0.5,0.2)), ((\mathbf{p}_2, \hat{v}), (0.7,0.1,0.1)), ((\mathbf{p}_2, w), (0.6,0.2,0.3)), \\ &\mathbf{a}_3, ((\mathbf{p}_1, \hat{u}), (0.4,0.3,0.4)), ((\mathbf{p}_1, \hat{v}), (0.4,0.2,0.3)), ((\mathbf{p}_1, w), (0.6,0.1,0.4)), (\mathbf{p}_3, \hat{u}), (0.8,0.1,0.1), \\ &(\mathbf{p}_3, \hat{v}), (0.8,0.1,0.2), \end{aligned}$$

$$(\mathbf{p}_3, w), (0.7, 0.2, 0.3))\}, \mathbf{a}_4, \{((\mathbf{p}_2, \hat{u}), (0.6, 0.2, 0.1)), ((\mathbf{p}_2, \hat{v}), (0.4, 0.2, 0.5)), ((\mathbf{p}_2, w), (0.5, 0.4, 0.4))\}.$$

5. 13. Definition. Let (F_Q, K) and $(G_Q, L) \in QSVNSS(X)$. Then the intersection of two Q –SVNSSs, (F_Q, K) and (G_Q, L) is the Q – SVNSS (M_Q, N) written as $(F_Q, K) \cap (G_Q, L) = (M_Q, N)$ where $N = K \cap L$ for all $l \in N$ and

$$(M_Q, N) = \{e, \min(\mu_{F_Q}(\hat{\theta}, \hat{u}), \mu_{G_Q}(\hat{\theta}, \hat{u})), \max(\nu_{F_Q}(\hat{\theta}, \hat{u}), \nu_{G_Q}(\hat{\theta}, \hat{u})), \max(\lambda_{F_Q}(\hat{\theta}, \hat{u}), \lambda_{G_Q}(\hat{\theta}, \hat{u})) : \hat{\theta} \in X, \hat{u} \in Q \text{ and } j = 1, 2, \dots, l\}$$

5. 14. Example. Let $X = \{\mathbf{p}_1, \mathbf{p}_2, \mathbf{p}_3, \mathbf{p}_4, \mathbf{p}_5\}$ be a universal set, $E = \{\mathbf{a}_1, \mathbf{a}_2, \mathbf{a}_3, \mathbf{a}_4, \mathbf{a}_5\}$ be a set of parameters and $Q = \{\hat{u}, \hat{v}, w\}$ be a non-empty set. Let $N = \{\mathbf{a}_1, \mathbf{a}_3, \mathbf{a}_4\} \subset E$, and $M = \{\mathbf{a}_1, \mathbf{a}_2, \mathbf{a}_3\}$

$$(F_Q, N) = \{(\mathbf{a}_1, ((\mathbf{p}_1, \hat{u}), (0.3, 0.4, 0.5)), ((\mathbf{p}_1, \hat{v}), (0.5, 0.3, 0.4)), ((\mathbf{p}_1, w), (0.6, 0.1, 0.2))), (\mathbf{a}_3, ((\mathbf{p}_1, \hat{u}), (0.2, 0.3, 0.4)), ((\mathbf{p}_1, \hat{v}), (0.4, 0.2, 0.3)), ((\mathbf{p}_1, w), (0.6, 0.2, 0.4)), ((\mathbf{p}_3, \hat{u}), (0.7, 0.1, 0.2)), ((\mathbf{p}_3, \hat{v}), (0.8, 0.2, 0.2)), ((\mathbf{p}_3, w), (0.2, 0.4, 0.6))), (\mathbf{a}_4, \{((\mathbf{p}_2, \hat{u}), (0.6, 0.2, 0.1)), ((\mathbf{p}_2, \hat{v}), (0.4, 0.2, 0.5)), ((\mathbf{p}_2, w), (0.5, 0.4, 0.4))\},$$

and

$$(G_Q, M) = \{(\mathbf{a}_1, ((\mathbf{p}_1, \hat{u}), (0.4, 0.3, 0.5)), ((\mathbf{p}_1, \hat{v}), (0.3, 0.3, 0.4)), ((\mathbf{p}_1, w), (0.4, 0.2, 0.3))), (\mathbf{a}_2, ((\mathbf{p}_2, \hat{u}), (0.4, 0.5, 0.2)), ((\mathbf{p}_2, \hat{v}), (0.7, 0.1, 0.1)), ((\mathbf{p}_2, w), (0.6, 0.2, 0.3))), (\mathbf{a}_3, \{((\mathbf{p}_1, \hat{u}), (0.4, 0.3, 0.5)), ((\mathbf{p}_1, \hat{v}), (0.2, 0.2, 0.4)), ((\mathbf{p}_1, w), (0.4, 0.1, 0.4)), ((\mathbf{p}_3, \hat{v}), (0.6, 0.1, 0.2)), ((\mathbf{p}_3, w), (0.7, 0.2, 0.3))\},$$

Then

$$(K_Q, L) = \{(\mathbf{a}_1, \{((\mathbf{p}_1, \hat{u}), (0.3, 0.4, 0.5)), ((\mathbf{p}_1, \hat{v}), (0.3, 0.3, 0.4)), ((\mathbf{p}_1, w), (0.4, 0.2, 0.3))\}), (\mathbf{a}_3, \{((\mathbf{p}_1, \hat{u}), (0.2, 0.3, 0.5)), ((\mathbf{p}_1, \hat{v}), (0.2, 0.2, 0.4)), ((\mathbf{p}_1, w), (0.4, 0.2, 0.4)), ((\mathbf{p}_3, \hat{u}), (0.7, 0.2, 0.2)), ((\mathbf{p}_3, \hat{v}), (0.6, 0.2, 0.2)), ((\mathbf{p}_3, w), (0.2, 0.4, 0.6))\})$$

5. 15 Proposition. Let $(F_Q, K), (M_Q, N)$ and $(G_Q, L) \in QSVNSS(X)$. Then

1. $(F_Q, K) \cup (\emptyset, K) = (F_Q, K)$
2. $(F_Q, K) \cup (X, K) = (X, K)$
3. $(F_Q, K) \cup (F_Q, K) = (F_Q, K)$

$$4. (F_Q, K) \cup (G_Q, L) = (G_Q, L) \cup (F_Q, K)$$

$$5. (F_Q, K) \cup ((G_Q, L) \cup (M_Q, N)) = ((G_Q, L) \cup (F_Q, K)) \cup (M_Q, N)$$

Proof. 1. We have

$$(F_Q, K) = \{(\mathbf{p}_1, \hat{u}), (\mu_{F_Q(k)}(\mathbf{p}_1, \hat{u}), \mathbf{v}_{F_Q(k)}(\mathbf{p}_1, \hat{u}), \lambda_{F_Q(k)}(\mathbf{p}_1, \hat{u})) : \hat{u} \in Q, \mathbf{p}_1 \in X\}$$

$$(\emptyset, K) = \{(\mathbf{p}_1, \hat{u}), (0, 1, 1) : \hat{u} \in Q, \mathbf{p}_1 \in X\}$$

$$(F_Q, K) \cup (\emptyset, K)$$

$$= \{k, \left\{ (\mathbf{p}_1, \theta \hat{u}), \max(\mu_{F_Q(k)}(\mathbf{p}_1, \hat{u}), 0), \min(\mathbf{v}_{F_Q(k)}(\mathbf{p}_1, \hat{u}), 1), \min(\lambda_{F_Q(k)}(\mathbf{p}_1, \hat{u}), 1) \right\}\}$$

$$= \{(\mathbf{p}_1, \hat{u}), (\mu_{F_Q(k)}(\mathbf{p}_1, \hat{u}), \mathbf{v}_{F_Q(k)}(\mathbf{p}_1, \hat{u}), \lambda_{F_Q(k)}(\mathbf{p}_1, \hat{u})) : \hat{u} \in Q, \mathbf{p}_1 \in X\}$$

$$= (F_Q, K)$$

2. Let $(X, K) = (G_Q, K)$ then

$$(F_Q, K) = \{(\mathbf{p}_1, \hat{u}), (\mu_{F_Q(k)}(\mathbf{p}_1, \hat{u}), \mathbf{v}_{F_Q(k)}(\mathbf{p}_1, \hat{u}), \lambda_{F_Q(k)}(\mathbf{p}_1, \hat{u})) : \hat{u} \in Q, \mathbf{p}_1 \in X\}$$

$$(G_Q, L) = \{(\mathbf{p}_1, \hat{u}), (1, 0, 0) : \hat{u} \in Q, \mathbf{p}_1 \in X\}$$

$$(F_Q, K) \cup (G_Q, K)$$

$$= \{k, \left\{ (\mathbf{p}_1, \hat{u}), \max(\mu_{F_Q(k)}(\mathbf{p}_1, \hat{u}), 1), \min(\mathbf{v}_{F_Q(k)}(\mathbf{p}_1, \hat{u}), 0), \min(\lambda_{F_Q(k)}(\mathbf{p}_1, \hat{u}), 0) \right\}\}$$

$$= \{(\mathbf{p}_1, \hat{u}), (1, 0, 0) : \hat{u} \in Q, \mathbf{p}_1 \in X\}$$

$$= (G_Q, K) = (X, K)$$

3. Let

$$(F_Q, K) = \{(\mathbf{p}_1, \hat{u}), (\mu_{F_Q(k)}(\mathbf{p}_1, \hat{u}), \mathbf{v}_{F_Q(k)}(\mathbf{p}_1, \hat{u}), \lambda_{F_Q(k)}(\mathbf{p}_1, \hat{u})) : \hat{u} \in Q, \mathbf{p}_1 \in X\}$$

$$(F_Q, K) \cup (F_Q, K)$$

$$= \left\{ k, \left(\left((\mathbf{p}_1, \hat{u}), \max(\mu_{F_Q(k)}(\mathbf{p}_1, \hat{u}), \mu_{F_Q(k)}(\mathbf{p}_1, \hat{u})), \min(\mathbf{v}_{F_Q(k)}(\mathbf{p}_1, \hat{u}), \mathbf{v}_{F_Q(k)}(\mathbf{p}_1, \hat{u})), \right) \right. \right. \\ \left. \left. \min(\lambda_{F_Q(k)}(\mathbf{p}_1, \hat{u}), \lambda_{F_Q(k)}(\mathbf{p}_1, \hat{u})) : \hat{u} \in Q, \mathbf{p}_1 \in X \right) \right\}$$

$$= \{(\mathbf{p}_1, \hat{u}), (\mu_{F_Q(k)}(\mathbf{p}_1, \hat{u}), \mathbf{v}_{F_Q(k)}(\mathbf{p}_1, \hat{u}), \lambda_{F_Q(k)}(\mathbf{p}_1, \hat{u})) : \hat{u} \in Q, \mathbf{p}_1 \in X\}$$

$$= (F_Q, K)$$

4 and 5 can be proved easily in a similar way.

5. 16. Proposition. Let $(F_Q, K), (M_Q, N)$ and $(G_Q, L) \in QSVNSS(X)$. Then

1. $(F_Q, K) \cap (\emptyset, K) = (\emptyset, K)$
2. $(F_Q, K) \cap (X, K) = (F_Q, K)$
3. $(F_Q, K) \cap (F_Q, K) = (F_Q, K)$
4. $(F_Q, K) \cap (G_Q, L) = (G_Q, L) \cap (F_Q, K)$
5. $(F_Q, K) \cap ((G_Q, L) \cap (M_Q, N)) = ((G_Q, L) \cap (F_Q, K)) \cap (M_Q, N)$

Proof. 1. We have

$$\begin{aligned} (F_Q, K) &= \{(\mathbf{p}_1, \hat{u}), (\mu_{F_Q(k)}(\mathbf{p}_1, \hat{u}), \nu_{F_Q(k)}(\mathbf{p}_1, \hat{u}), \lambda_{F_Q(k)}(\mathbf{p}_1, \hat{u})) : \hat{u} \in Q, \mathbf{p}_1 \in X\} \\ (\emptyset, K) &= \{(\mathbf{p}_1, \hat{u}), (0, 1, 1) : \hat{u} \in Q, \mathbf{p}_1 \in X\} \\ (F_Q, K) \cap (\emptyset, K) &= \{k, (\{(\mathbf{p}_1, \hat{u}), \min(\mu_{F_Q(k)}(\mathbf{p}_1, \hat{u}), 0), \max(\nu_{F_Q(k)}(\mathbf{p}_1, \hat{u}), 1), \max(\lambda_{F_Q(k)}(\mathbf{p}_1, \hat{u}), 1)\})\} \\ &= \{(\mathbf{x}_1, \hat{u}), (0, 1, 1) : \hat{u} \in Q, \mathbf{p}_1 \in X\} \\ &= (\emptyset, K) \end{aligned}$$

2. Let $(X, K) = (G_Q, L)$ then

$$\begin{aligned} (F_Q, K) &= \{(\mathbf{p}_1, \hat{u}), (\mu_{F_Q(k)}(\mathbf{p}_1, \hat{u}), \nu_{F_Q(k)}(\mathbf{p}_1, \hat{u}), \lambda_{F_Q(k)}(\mathbf{p}_1, \hat{u})) : \hat{u} \in Q, \mathbf{p}_1 \in X\} \\ (G_Q, L) &= \{(\mathbf{p}_1, \hat{u}), (1, 0, 0) : \hat{u} \in Q, \mathbf{p}_1 \in X\} \\ (F_Q, K) \cap (G_Q, L) &= \{k, (\{(\mathbf{p}_1, \hat{u}), \min(\mu_{F_Q(k)}(\mathbf{p}_1, \hat{u}), 1), \max(\nu_{F_Q(k)}(\mathbf{p}_1, \hat{u}), 0), \max(\lambda_{F_Q(k)}(\mathbf{p}_1, \hat{u}), 0)\})\} \\ &= \{(\mathbf{p}_1, \hat{u}), (\mu_{F_Q(k)}(\mathbf{p}_1, \hat{u}), \nu_{F_Q(k)}(\mathbf{p}_1, \hat{u}), \lambda_{F_Q(k)}(\mathbf{p}_1, \hat{u})) : \hat{u} \in Q, \mathbf{p}_1 \in X\} \\ &= (F_Q, K) \end{aligned}$$

3. Let

$$\begin{aligned} (F_Q, K) &= \{(\mathbf{p}_1, \hat{u}), (\mu_{F_Q(k)}(\mathbf{p}_1, \hat{u}), \nu_{F_Q(k)}(\mathbf{p}_1, \hat{u}), \lambda_{F_Q(k)}(\mathbf{p}_1, \hat{u})) : \hat{u} \in Q, \mathbf{p}_1 \in X\} \\ (F_Q, K) \cap (F_Q, K) &= \{(\mathbf{p}_1, \hat{u}), (\min(\mu_{F_Q(k)}(\mathbf{p}_1, \hat{u}), \mu_{F_Q(k)}(\mathbf{p}_1, \hat{u})), \\ &\min(\nu_{F_Q(k)}(\mathbf{p}_1, \hat{u}), \nu_{F_Q(k)}(\mathbf{p}_1, \hat{u})), \min(\lambda_{F_Q(k)}(\mathbf{p}_1, \hat{u}), \lambda_{F_Q(k)}(\mathbf{p}_1, \hat{u})) : \hat{u} \in Q, \mathbf{p}_1 \in X\} \\ &= \{(\mathbf{p}_1, \hat{u}), (\mu_{F_Q(k)}(\mathbf{p}_1, \hat{u}), \nu_{F_Q(k)}(\mathbf{p}_1, \hat{u}), \lambda_{F_Q(k)}(\mathbf{p}_1, \hat{u})) : \hat{u} \in Q, \mathbf{p}_1 \in X\} \\ &= (F_Q, K) \end{aligned}$$

4 and 5 can be proved easily in a similar way.

5. 17. Proposition. Let (F_Q, K) and $(G_Q, L) \in QSVNSS(X)$. Then

1. $((F_Q, K) \cup (G_Q, L))^c = (F_Q, K)^c \cap (G_Q, L)^c$
2. $((F_Q, K) \cap (G_Q, L))^c = (F_Q, K)^c \cup (G_Q, L)^c$

Proof. Straightforward

5. 18. Proposition. Let $(F_Q, K), (M_Q, N)$ and $(G_Q, L) \in QSVNSS(X)$. Then

$$(F_Q, K) \cap ((G_Q, L) \cup (M_Q, N)) = ((F_Q, K) \cap (G_Q, L)) \cup ((F_Q, K) \cap (M_Q, N))$$

$$(F_Q, K) \cup ((G_Q, L) \cap (M_Q, N)) = ((F_Q, K) \cup (G_Q, L)) \cap ((F_Q, K) \cup (M_Q, N))$$

Proof. Straightforward.

5. 19. Definition. Let $(F_Q, K), (M_Q, N)$ and $(G_Q, L) \in QSVNSS(X)$. Then the "AND" operation of two $Q - SVNSSs$ (F_Q, K) and (G_Q, L) is the $Q - SVNSS$ denoted by $(F_Q, K) \wedge (G_Q, L)$ and is defined by

$$(F_Q, K) \wedge (G_Q, L) = (M_Q, K \times L)$$

Where $M_Q(\gamma, \delta) = F_Q(\gamma) \cap G_Q(\delta)$ for all $\gamma \in K, \delta \in L$ is the intersection of two $Q - SVNSSs$.

5. 20. Definition. Let $(F_Q, K), (M_Q, N)$ and $(G_Q, L) \in QSVNSS(X)$. Then the "OR" operation of two $Q - SVNSSs$ (F_Q, K) and (G_Q, L) is the $Q - SVNSS$ denoted by $(F_Q, K) \vee (G_Q, L)$ and is defined by

$$(F_Q, K) \vee (G_Q, L) = (M_Q, K \times L)$$

Where $M_Q(\gamma, \delta) = F_Q(\gamma) \cup G_Q(\delta)$ for all $\gamma \in K, \delta \in L$ is the union of two $Q - SVNSSs$.

Conclusion

In this paper we have inaugurated the concept of Q-SVNS, Multi Q-SVNS. We also gave the concept of Q- SVNSS and studied some related properties with associate proofs. The equality, subset, complement, union, intersection, AND or OR operations have been defined on the Q- SVNSS. This new wing will be more useful than Q-fuzzy soft set, Q-intuitionistic fuzzy soft set and provide a substantial addition to existing theories for handling uncertainties, and pass to possible areas of further research and relevant applications.

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