

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

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

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 $\theta \in X$.

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.

Acknowledgements

The authors are thankful to the referees and reviewers for their valuable comments and suggestions for the improvement of this article. The authors are also thankful to editors for their co-operation.

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