







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:

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

### 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  $\theta \in X$ .

**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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