International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Quadri Partitioned Neutrosophic Soft Topological Space

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A B S T R A C T

\The aim of this paper is to introduce the new concept of quadri partitioned neutrosophic soft topological space and discussed some of its properties.

Keywords: Soft set, quadri partitioned Neutrosophic set, quadric partitioned neutrosophic topological space.

1. Introduction

The fuzzy set was introduced by Zadeh [19] in 1965. The concept of Neutrosophic set was introduced by F. Smarandache which is a mathematical tool for handling problems involving imprecise, indeterminancy and inconsistent data. Smarandache is proposed neutrosophic set[13]. In neutrosophic sets, the indeterminacy membership function walks along independently of the truth membership or of the falsity membership. Neutrosophic theory has been widely explored by researchers for application purpose in handling real life situations involving uncertainty.The concept of Soft sets was first formulated by Molodtsov [7] as a completely new mathematical tool for solving problems dealing with uncertainties. Molodtsov [7] defines a soft set as a parameterized family of subsets of universe set where each element is considered as a set of approximate elements of the soft set. In the past few years, the fundamentals of soft set theory have been studied by various researchers.Also we introduced the concept of quadri partitioned neutrosophic soft set and establish some of its properties in our previous work. Now we have extended our work in this neutrosophic soft set as a topological space.

2. Preliminaries

Definition: 2.1 [13]

Let U be a universe. A Neutrosophic set A on U can be defined as follows: $A = \{< x, T_A(x), I_A(x), F_A(x) >: x \in X\}$ Where $T_A, I_A, F_A: U \rightarrow [0,1]$ *and* $0 \leq T_A(x) + I_A(x) + F_A(x) \leq 3$. Here,$T_A(x)$ is the degree of membership, $I_A(x)$ is the degree of indeterminancy and $F_A(x)$ is the degree of non-membership.

Definition: 2.2 [7]

Let U be an initial universe set and E be a set of parameters or attributes with respect to U. Let P(U) denote the power set of U and A ⊆ U. A pair (F, A) is called a soft set over U, where F is a mapping given by F : A → P(U).

Definition: 2.3 [4]

Let U be a universe. A quadri partitioned neutrosophic set A on U is defined as $A = \{< x, T_A(x), C_A(x), U_A(x), F_A(x) >: x \in U\}$, Where $T_A, F_A, C_A, U_A : X \longrightarrow [0,1]$ *and* $0 \leq T_A(x) + C_A(x) + U_A(x) + F_A(x) \leq 4$. Here $T_A(x)$ is the truth membership, $C_A(x)$ is contradiction membership,$U_A(x)$ is ignorance membership and $F_A(x)$ is the false membership.

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Definition: 2.4

Let X be an universe set and R be a set of parameters. Consider a non-empty set M and M ⊆ R. Let R(X) be the set of all quadri partitioned neutrosophic sets of X. The collection (K, M) is termed to be the quadri partitioned neutrosophic soft set (QNSS) over X, where K is a function from M to P(X). Where M= $\{< x, T_M(x), C_M(x), U_M(x), F_M(x) >: x \in X\}$ and $T_M, F_M, C_M, U_M : X \longrightarrow [0,1]$ *and* $0 \leq T_M(x), C_M(x), U_M(x), F_M(x) \leq 4$. Here $T_M(x)$ is the truth membership, $C_M(x)$ is contradiction membership, $U_M(x)$ is ignorance membership and $F_M(x)$ is the false membership

3. Quadri Partitioned Neutrosophic Soft Topological Space

Definition : 3.1

Let (K, M) be Quadri Partitioned Neutrosophic set on (X, R) and τ be a collection of quadric partitioned neutrosophic soft subsets of (K, M). Then (K, M) is called Quadri Partitioned Neutrosophic Soft Topology if the following conditions are satisfied.

i) $\phi_M, X_M \in \tau$

ii) The union of the elements of any sub collection of τ is in τ

iii) The intersection of the elements of any finite sub collection τ is in τ

The triplet (X, τ, M) is called an Quadri Partitioned Neutrosophic Soft Topological Space over X.

Note : 3.2

1. Every member of τ is called a Quadri Partitioned Neutrosophic Soft open set in X.
2. The set $A_M$is called a Quadri Partitioned Neutrosophic Soft closed set in X if $A_M \in \tau^c$, where $\tau^c = \{A_M{}^c : A_M \in \tau\}$.

Example : 3.3

Let X = {b_1, b_2, b_3, b_4}, M = {m_1, m_2} and Let A_M, B_M, C_M, D_M be Quadri Partitioned Neutrosophic Soft sets where

A(m_1) = $\{< b_1, 0.5,0.6,0.7,0.2 > < b_2, 0.7,0.5,0.4,0.1 > < b_3, 0.6,0.5,0.4,0.3 > < b_4, 0.3,0.2,0.6,0.1 >\}$

A(m_2) = $\{< b_1, 0.8,0.7,0.6,0.3 > < b_2, 0.2,0.3,0.6,0.7 > < b_3, 0.9,0.8,0.7,0.1 > < b_4, 0.7,0.5,0.4,0.3 >\}$

B(m_1) = $\{< b_1, 0.2,0.3,0.5,0.1 > < b_2, 0.6,0.4,0.3,0.2 > < b_3, 0.2,0.3,0.6,0.5 > < b_4, 0.1,0.8,0.9,0.5 >\}$

B(m_2) = $\{< b_1, 0.5,0.8,0.2,0.4 > < b_2, 0.5,0.8,0.7,0.9 > < b_3, 0.4,0.5,0.8,0.6 > < b_4, 0.5,0.6,0.8,0.9 >\}$

C(m_1) = $\{< b_1, 0.5,0.6,0.5,0.1 > < b_2, 0.7,0.5,0.3,0.1 > < b_3, 0.6,0.5,0.4,0.3 > < b_4, 0.3,0.8,0.6,0.1 >\}$

C(m_2) = $\{< b_1, 0.8,0.8,0.2,0.3 > < b_2, 0.5,0.8,0.6,0.7 > < b_3, 0.9,0.8,0.7,0.1 > < b_4, 0.7,0.5,0.4,0.3 >\}$

$\tau = \{A_M, B_M, C_M, \phi_M, X_M\}$ is an Quadri Partitioned Neutrosophic Soft topology on X.

Preposition 3.4

Let (X, τ_1, M) and (X, τ_2, M) be two Quadri Partitioned Neutrosophic Soft topological space on X. Then $\tau_1 \cap \tau_2$ is an Quadri Partitioned Neutrosophic Soft topology on X. where $\tau_1 \cap \tau_2 = \{A_M : A_M \in \tau_1$ and $A_M \in \tau_2\}$

Proof :

Obviously $\phi_M, X_M \in \tau$.Let $A_M, B_M \in \tau_1 \cap \tau_2$

Then $A_M, B_M \in \tau_1$ and $A_M, B_M \in \tau_2$

We know that τ_1 and τ_2 are two Quadri Partitioned Neutrosophic Soft topological spaces on X.

Then $A_M \cap B_M \in \tau_1$ and $A_M \cap B_M \in \tau_2$

Hence $A_M \cap B_M \in \tau_1 \cap \tau_2$.

Let $\{(A_\alpha)_M : \alpha \in \Gamma\} \subseteq \tau_1 \cap \tau_2$.

Then $(A_\alpha)_M \in \tau_1$ and $(A_\alpha)_M \in \tau_2$for any $\alpha \in \tau$

Since τ_1 and τ_2 are two Quadri Partitioned Neutrosophic Soft topological space on X, $\sqcup \{(A_\alpha)_M : \alpha \in \Gamma\} \in \tau_1$ and $\sqcup \{(A_\alpha)_M : \alpha \in \Gamma\} \in \tau_2$

Then $\sqcup \{(A_\alpha)_M : \alpha \in \Gamma\} \in \tau_1 \cap \tau_2$

Let τ_1 and τ_2 are two Quadri Partitioned Neutrosophic Soft topological spaces on X.

Denote $\tau_1 \vee \tau_2 = \{A_M \sqcup B_M : A_M \in \tau_1$ and $A_M \in \tau_2\}$ $\tau_1 \wedge \tau_2 = \{A_M \sqcap B_M : A_M \in \tau_1$ and $A_M \in \tau_2\}$

Example : 3.5

Let A_M *and* B_M be two Quadri Partitioned Neutrosophic Soft sets on X.

Define $\tau_1 = \{\phi_M, X_M, A_M\}$ $\tau_2 = \{\phi_M, X_M, B_M\}$

Then $\tau_1 \cap \tau_2 = \{\phi_M, X_M\}$ is a Quadri Partitioned Neutrosophic Soft topological space on X.

But $\tau_1 \cup \tau_2 = \{\phi_M, A_M, B_M, X_M\}$, $\tau_1 \vee \tau_2 = \{\phi_M, A_M, B_M, X_M, A_M \sqcup B_M\}$ *and*

$\tau_1 \wedge \tau_2 = \{\phi_M, A_M, B_M, X_M, A_M \sqcap B_M\}$ are not Quadri Partitioned Neutrosophic Soft topological space on X.

Theorem : 3.6

Let (X, τ, M) be a Quadri Partitioned Neutrosophic Soft topological space on X and let m ∈ M, $\{\tau(m) = \{A(m): A_M \in \tau\}$ is an Quadri Partitioned Neutrosophic Soft topological space on X.

Proof:

Let m ∈ M.

i) $\phi_M, X_M \in \tau$ $0_N^c = \phi(m)$ and 1_N^c = X(m)

we have $0_N^c, 1_N^c \in \tau(m)$

ii) Let V, W ∈ $\tau(m)$. Then there exist $A_M, B_M \in \tau$ such that V =A(m) and W =G(m)

By τ is an Quadri Partitioned Neutrosophic Soft topological space on X, $A_M \sqcap B_M \in \tau$

Take $C_M = A_M \sqcap B_M$ Then $C_M \in \tau$

Note that V∩ W = $A_M \cap B_M = C_M$ and $\{\tau(m) = \{A(m): A_M \in \tau\}$

Then V∩ W = $\tau(m)$

Definition : 3.7

Let (X, τ, M) be a Quadri Partitioned Neutrosophic Soft topological space on X and let $\mathfrak{B} \subseteq \tau, \mathfrak{B}$ is a basis on τ if for each $A_M \in \tau$, there exist $\mathfrak{B}' \subseteq \mathfrak{B}$ such that $A_M \subseteq \mathfrak{B}'$

Example : 3.8

Let (X, τ, M) be a Quadri Partitioned Neutrosophic Soft topological space on X as in Example:3.3
Then $\mathfrak{B} = \{A_M, B_M, C_M, \phi_M, X_M\}$ is a basis for τ.

Theorem : 3.9

Let $\mathfrak{B}$ be a basis for Quadri Partitioned Neutrosophic Soft topological space on τ. Define $\mathfrak{B}_m = \{A(m): A_M \in \mathfrak{B}\}$and $\tau(m) = \{A(m): A_M \in \tau\}$ for and m ∈ M. Then $\mathfrak{B}_m$ is a basis for Quadri Partitioned Neutrosophic Soft topology $\tau(m)$.

Proof :

Let m ∈ M. For any V= $\tau(m)$, V= B(m) , for $B_M \in \tau$.
Now $\mathfrak{B}$ is a basis for τ.
Then there exists $\mathfrak{B}' \subseteq \mathfrak{B}$ such that $B_M = \sqcup \mathfrak{B}'$ where $\mathfrak{B}_m' = \{A(m): A_M \in \mathfrak{B}''\} \subseteq \mathfrak{B}_m$.
Thus $\mathfrak{B}_m$is a basis for Quadri Partitioned Neutrosophic Soft topology $\tau(m)$.

4. SOME PROPERTIES OF QUADRI PARTITIONED NEUTROSOPHIC SOFT TOPOLOGICAL SPACE

Definition : 4.1

Let (X, τ, M) be a Quadri Partitioned Neutrosophic Soft topological space on X and let A_M belongs to Quadri Partitioned Neutrosophic Soft set on X_M. Then the interior of A_M is denoted as QNSint (A_M). It is defined by QNSint (A_M) = $\sqcup \{B_M \in \tau: B_M \subseteq A_m\}$

Definition : 4.2

Let (X, τ, M) be a Quadri Partitioned Neutrosophic Soft topological space on X and let A_M belongs to Quadri Partitioned Neutrosophic Soft set on X_M. Then the closure of A_M is denoted as QNScl (A_M). It is defined by QNScl (A_M) = $\sqcap \{B_M \in \tau^c : A_M \subseteq B_m\}$

Theorem : 4.3

Let (X, τ, M) be a Quadri Partitioned Neutrosophic Soft topological space over X. Then the following properties are hold.

i) ϕ_M *and* X_M are Quadri Partitioned Neutrosophic Soft closed sets over X

ii) The intersection of any number of Quadri Partitioned Neutrosophic Soft closed set is a Quadri Partitioned Neutrosophic Soft closed set over X.

iii) The union of any two Quadri Partitioned Neutrosophic Soft closed set is an Quadri Partitioned Neutrosophic Soft closed set over X.

Proof:

It is obviously true.

Theorem 4.4:

Let (X, τ, M) be a be a Quadri Partitioned Neutrosophic Soft topological space over X.and Let A_M be a Quadri Partitioned Neutrosophic Soft topological space .Then the following properties hold.

(i) QNSInt (A_M) ⊆ A_M

(ii) $A_M \subseteq B_M$ implies QNSInt (A_M) ⊆ QNSInt (B_M) .

(iii) QNSInt (A_M) ∈ τ.

(iv) A_M is a QNS open set implies QNSInt (A_M) = A_M.

(v) QNSInt (QNSInt (A_M)) = QNSInt (A_M)

(vi) QNSInt (ϕ_M) = ϕ_M, QNSInt (X_M) = X_M.

Proof:

(i) and (ii) are obviously true.

(iii) obviously $\sqcup \{B_M \in \tau : B_M \subseteq A_m\} \in \tau$

Note that $\sqcup \{B_M \in \tau : B_M \subseteq A_m\}$ = QNSInt (A_M)

$\therefore$ QNSInt (A_M) $\in \tau$

(iv) Necessity: Let A_M be a QNS open set. ie., $A_M \in \tau$. By (i) and (ii) QNSInt (A_M) $\subseteq A_m$.

Since $A_M \in \tau$ and $A_M \subseteq A_m$

Then $A_M \subseteq \sqcup \{B_M \in \tau : B_M \subseteq A_m\}$= QNSInt ($A_M$) $A_M \subseteq$ QNSInt (A_M)

Thus QNSInt = A_m.

Sufficiency: Let QNSInt(A_m) = A_m

By (iii) QNSInt(A_m) $\in \tau$, ie., A_m is a QNS open set.

(v) To prove QNSInt (QNSInt (A_m)) = QNSInt(A_m)

By (iii) QNSInt (A_m) $\in \tau$. By (iv) QNSInt (QNSInt (A_m)) = QNSInt (A_m).

(vi) We know that ϕ_M and X_M are in τ

By (iv) QNSInt (ϕ_M) = ϕ_M , QNSInt (X_M) = X_M.

Theorem 4.5:

Let (X, τ, M) be a be a Quadri Partitioned Neutrosophic Soft topological space over X and Let A_M is in the Quadri Partitioned Neutrosophic Soft topological space .Then the following properties hold.

(i) $A_M \subseteq$ QNSCl(A_M)

(ii) $A_M \subseteq B_M$ implies QNSCl (A_M) $\subseteq$ QNSCl (B_M) .

(iii) QNSCl $(A_M)^c \in \tau$.

(iv) A_M is a QNS closed set implies QNSCl (A_M) = A_M.

(v) QNSCl (QNSCl (A_M)) = QNSCl (A_M)

(vi) \QNSCl (ϕ_M) = ϕ_M, QNSCl (X_M) = X_M.

Proof:

(i) and (ii) are obviously true.

(iii) By theorem, QNSInt ($A_M{}^c$) $\in \tau$

Therefore [QNSCl (A_M)]^c = $(\sqcap \{B_M \in \tau^c : B_M \subseteq A_m\})^c$

$= \sqcup \{B_M \in \tau : B_M \subseteq A_m{}^c\}$ = QNSInt ($A_M{}^c$)

$\therefore$ [QNSCl (A_M)]$^c \in \tau$

(iv) Necessity:

By theorem, $A_M \subseteq$ QNSCl(A_M)

Let A_M be a QNS closed set. ie., $A_M \in \tau^c$.

Since $A_M \in \tau$ *and* $A_M \subseteq A_m$

[QNSCl (A_M)] = $\sqcap \{B_M \in \tau^c : A_M \subseteq B_m\} \subseteq \{B_M \in \tau^c : A_M \subseteq A_m\}$

QNSCl (A_M) $\subseteq A_m$

Thus A_m =QNSCl(A_m)

Sufficiency: This is obviously true by (iii)

(v) and (vi) can be proved by (iii) and (iv)

Theorem 4.6*:*

Let (X, τ, M) be a be a Quadri Partitioned Neutrosophic Soft topological space over X and Let A_M, B_M are in Quadri Partitioned Neutrosophic Soft topological space X_M .Then the following properties hold.

(i) QNSInt (A_M) $\sqcap$ QNSInt (B_M) = QNSInt ($A_M \sqcap B_M$)

(ii) QNSInt (A_M) $\sqcup$ QNSInt (B_M) $\subseteq$ QNSInt ($A_M \sqcup B_M$)

(iii) QNSCl (A_M) $\sqcup$ QNSCl (B_M) $\subseteq$ QNSCl ($A_M \sqcup B_M$)

(iv) QNSCl ($A_M \sqcup B_M$) ⊆ QNSCl (A_M) ⊓ QNSCl (B_M)

(v) (QNSInt (F_E))^c = QNSCl ($F_E{}^c$)

(vi) (QNSCl (F_E))^c = QNSInt ($F_E{}^c$)

Proof:

(i) Since $A_M \sqcap B_M \subseteq A_m$ for any m in M

By theorem, QNSInt ($A_M \sqcap B_M$) ⊆ QNSInt (A_M)

Similarly, QNSInt ($A_M \sqcap B_M$) ⊆ QNSInt (B_M), QNSInt ($A_M \sqcap B_M$) ⊆ QNSInt (A_M) ⊓ QNSInt(B_M)

By theorem, QNSInt (A_M) ⊆ A_M and QNSInt (B_M) ⊆ B_M

Thus QNSInt ($A_M \sqcap B_M$) ⊆ $A_M \sqcap B_M$

Therefore, QNSInt (A_M) ⊓ QNSInt (B_M) = QNSInt ($A_M \sqcap B_M$)

Similarly we can prove (ii),(iii) and (iv).

v) (QNSInt (F_E))^c = ($\sqcup$ $\{B_M \in \tau : B_M \subseteq A_m\}$)^c

= ⊓ $\{B_M \in \tau^c : A_M{}^c \subseteq B_m\}$

= QNSCl ($A_M{}^c$)

Similarly we can prove (vi)

Theorem 4.7*:*

Prove that i) QNSInt (B_M) ⊔ QNSInt (C_M) ≠ QNSInt ($B_M \sqcup C_M$)

ii) QNSCl ($B_M{}^c \sqcap C_M{}^c$) ≠ QNSCl (B_M)^c ⊓ (QNSCl (B_M)]^c

Proof **:**

i) QNSInt (B_M) = ϕ_M= QNSInt(C_M)

Then $B_M \sqcup C_M = A_M$

QNSInt (B_M) ⊔ QNSInt (C_M) =$\phi_M \sqcup \phi_M$=ϕ_M And QNSInt ($B_M \sqcup C_M$) = QNSInt (A_M)= A_M

QNSInt (B_M) ⊔ QNSInt (C_M) ≠ QNSInt ($B_M \sqcup C_M$)

ii) QNSCl (B_M)^c = (QNSCl (B_M))^c = $\phi_M{}^c = X_M$

Similarly QNSCl (C_M)^c= X_M

QNSCl (B_M)^c ⊓ QNSCl (C_M)^c= $X_M \sqcap X_M = X_M$, Similarly QNSCl ($B_M{}^c \sqcap C_M{}^c$) = QNSCl ($B_M \sqcap C_M$)^c = QNSInt ($B_M \sqcup C_M$)^c= $A_M{}^c$

QNSCl ($B_M{}^c \sqcap C_M{}^c$) ≠ QNSCl (B_M)^c ⊓ (QNSCl (B_M)]^c

5. CONCLUSION

We have introduced the concept of Quadri partitioned Neutrosophic soft set and topological space and studied some of its properties. We have put forward some proposition based on this new notion. We have introduced topological structure on Quadri partitioned Neutrosophic soft set, topological space and characterized some of its properties. We hope that this paper will promote the future study on QNSS and QNSTS to carry out a general framework for their application in practical life.

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