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Quadri Partitioned Neutrosophic Pythagorean Set

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A B S T R A C T

The aim of this paper is to introduce the new concept of Quadripartitioned Neutrosophic Pythagorean set with T, C, U, F are dependent neutrosophic components and have also discussed some of its properties.

Keywords: Neutrosophic Set, Quadripartitioned Neutrosophic Set, Quadripartitioned Neutrosophic Pythagorean Set

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 in proposed neutrosophic sets [14]. 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. Although the hesitation margin of neutrosophic theory is independent of the truth or falsity membership, looks more general than intuitionistic fuzzy sets yet. Recently, in Atanassov et al. [3] studied the relations between inconsistent intuitionistic fuzzy sets, picture fuzzy sets, neutrosophic sets and intuitionistic fuzzy sets; however, it remains in doubt that whether the indeterminacy associated to a particular element occurs due to the belongingness of the element or the non-belongingness. This has been pointed out by Chattejee et al. [4] while introducing a more general structure of neutrosophic set viz. quadripartitioned single valued neutrosophic set (QSVNS). The idea of QSVNS is actually stretched from Smarandache' s four numerical-valued neutrosophic logic and Belnap' s four valued logic, where the indeterminacy is divided into two parts, namely, “unknown” i.e., neither true nor false and “contradiction” i.e., both true and false. In the context of neutrosophic study however, the QSVNS looks quite logical. Also, in their study, Chatterjee [4] et al. analyzed a real-life example for a better understanding of a QSVNS environment and showed that such situations occur very naturally.
In 2018 Smarandache [17] generalized the Soft Set to the Hyper Soft Set by transforming the classical uni-argument function F into a multi-argument function.
In 2016, F. Smarandache [14] introduced for the first time the degree of dependence between the components of fuzzy set and neutrosophic sets. The main idea of Neutrosophic sets is to characterize each value statement in a 3D – Neutrosophic space, where each dimension of the space represents respectively the truth membership, falsity membership and the indeterminacy, when two components T and F are dependent and I is independent then $T+I+F\leq 2$.
R. Jhansi [6] introduced the concept of pythagorean neutrosophic set with T and F as dependent neutrosophic components.
If T and F are dependent neutrosophic pythagorean components then $T^2 + F^2 \leq 1$. Similarly, for U and C as dependent neutrosophic pythagorean components then $C^2 + U^2 \leq 1$. When combining both we get Quadripartitioned pythagorean set with dependent components as $T^2 + F^2 + C^2 + U^2 \leq 2$

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In this we have to introduce the concept of introduced the concept of Quadripartitioned neutrosophic pythagorean set with dependent components and establish some of its properties.

The aim of this paper is to introduce the new concept of Quadripartitioned Neutrosophic Pythagorean soft set with T, C, U, F are dependent neutrosophic components and have also discussed some of its properties.

2. Preliminaries

Definition:2.1[14]

Let X be a universe. A Neutrosophic set A on X can be defined as follows:

$$A = \{< x, T_A(x), I_A(x), F_A(x) >: x \in X\}$$

Where $T_A\ , I_A, F_A: U \to [0,1]\ and 0 \leq T_A(x) + I_A(x) + F_A\ (x) \leq 3$

Here,$T_A(x)$ is the degree of membership, $I_A(x)$ is the degree of inderminancy and $F_A(x)$ is the degree of non-membership.

Here, $T_A(x)$ and $F_A(x)$are dependent neutrosophic components and $I_A(x)$ is an independent component.

Definition:2.2[6]

Let X be a universe. A Pythagorean neutrosophic set with T and F are dependent neutrosophic components A on X is an object of the form

$$A = \{< x, T_A(x), I_A(x), F_A(x) >: x \in X\}$$

Where $T_A\ , I_A, F_A: U \to [0,1]\ and 0 \leq (T_A(x))^2 + (I_A(x))^2 + (F_A\ (x))^2 \leq 2$

Here,$T_A(x)$ is the degree of membership, $I_A(x)$ is the degree of inderminancy and $F_A(x)$ is the degree of non-membership.

Definition:2.3[4]

Let X be a universe. A Quadripartitioned neutrosophic set A with independent neutrosophic components on X is an object of the form

$$A = \{< x, T_A(x), C_A(x), U_A(x), F_A(x) >: x \in X\}$$

$$and 0 \leq T_A(x) + C_A(x) + U_A(x) + F_A\ (x) \leq 4$$

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.

3. Quadripartitioned Neutrosophic Pythagorean Set (QNPS or QNP set)

Definition:3.1

Let X be a universe. A Quadripartitioned neutrosophic pythagorean set A with dependent neutrosophic components A on X is an object of the form

$$A = \{< x, T_A(x), C_A(x), U_A(x), F_A(x) >: x \in X\}$$

Where $T_A\ + F_A \leq 1, C_A\ + U_A \leq 1\ and 0 \leq (T_A(x))^2 + (C_A(x))^2 + (U_A(x))^2 + (F_A\ (x))^2 \leq 2$

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.

Definition:3.2

A Quadripartitioned neutrosophic pythagorean set A is contained in another Quadripartitioned neutrosophic pythagorean set B (i.e) A$\subseteq B$ if $T_A(x) \leq T_B(x)$,$C_A(x) \leq C_B(x), U_A(x) \leq U_B(x)$ and $F_A(x) \leq F_B(x)$

Definition:3.3

The complement of a Quadripartitioned neutrosophic pythagorean set (F, A) on X Denoted by$(F, A)^c$ and is defined as

F^c(x)= $\{< x, F_A(x), U_A\ (x), C_A(x), T_A(x) >: x \in X\}$

Definition:3.4

Let X be a non-empty set, A = $< x, T_A(x), C_A(x), U_A(x), F_A(x) >$ and

B = $< x, T_B(x), C_B(x), U_B(x), F\ _B(x) >$ are Quadripartitioned neutrosophic pythagorean sets. Then

A ∪ B = $< x, max(T_A(x), T_B(x)), max(C_A(x), C_B(x)), min(U_A(x), U\ _B(x)), min(F_A(x), F\ _B(x)) >$

A ∩ B = $< x, min(T_A(x), T_B(x)), min(C_A(x), C_B(x)), max(U_A(x), U_B(x)), max(F_A(x), F\ _B(x)) >$

Definition:3.5

A Quadripartitioned neutrosophic pythagorean set (F, A) over the universe X is said to be empty neutrosophic pythagorean set with respect to the parameter A if

$T_{F(e)} = 0, C_{F(e)} = 0, U_{F(e)} = 1, F_{F(e)}$=1,$\forall x \in X, \forall e \in A$. It is denoted by $\emptyset$

Definition:3.6

A Quadripartitioned neutrosophic pythagorean set (F, A) over the universe X is said to be universe neutrosophic pythagorean set with respect to the parameter A if

$T_{F(e)} = 1, C_{F(e)} = 1, U_{F(e)} = 0, F_{F(e)}=0, \forall x \in X, \forall e \in A$. It is denoted by θ

Definition:3.7

Let A and B be two Quadripartitioned neutrosophic pythagorean sets on X then A\B may be defined as

A\B = $< x, min(T_A(x), F_B(x)), min(C_A(x), U_B(x)), max(U_A(x), C_B(x)), max(F_A(x), T_B(x)) >$

Definition:3.8

F_E is called absolute Quadripartitioned neutrosophic pythagorean set over X if F(e) = θ for any $e \in E$. We denote it by X_E

Definition:3.9

F_E is called relative null Quadripartitioned neutrosophic pythagorean set over X if F(e) = $\emptyset$ for any $e \in E$. We denote it by $\emptyset_E$

Definition:3.10

The complement of a Quadripartitioned neutrosophic pythagorean set (F, A) over X can also be defined as $(F, A)^c = U_E \backslash F(e)$ for all $e \in A$.

Note: We denote X_E by X in the proofs of proposition.

Definition:3.11

If (F, A) and (G, B) be two Quadripartitioned neutrosophic pythagorean set then "(F, A) AND (G, B)" is a denoted by

(F, A) ∧(G, B) and is defined by (F, A)∧ (G, B) = (H, A ×B)

where H (a, b) = F(a) ∩ G(b) $\forall a \in A$ and $\forall b \in B$, where ∩ is the operation intersection of Quadripartitioned neutrosophic pythagorean set.

Definition:3.12

If (F, A) and (G, B) be two Quadripartitioned neutrosophic pythagorean set then "(F, A) OR (G, B)" is a denoted by (F, A) ∨(G, B) and is defined by (F, A)∨ (G, B) = (K, A ×B)

where K (a, b) = F(a) ∪ G(b) $\forall a \in A$ and $\forall b \in B$, where ∪ is the operation union of Quadripartitioned neutrosophic pythagorean set.

Theorem :3.13

Let (F, A) and (G, A) be Quadripartitioned neutrosophic pythagorean set over the universe X. Then the following are true.

(i) (F, A)⊆ (G, A) iff (F, A) ∩ (G, A) = (F, A)

(ii) (F, A)⊆ (G, A) iff (F, A) ∪ (G, A) = (F, A)

Proof:

(i)Suppose that (F, A)⊆ (G, A), then F(e) ⊆G(e) for all e ∈ A. Let (F, A) ∩ (G, A) = (H, A).

Since H(e) = F(e) ∩ G(e) =F(e) for all e ∈ A, by definition (H, A) = (F, A).

Suppose that (F, A) ∩ (G, A) = (F, A). Let (F, A) ∩ (G, A) = (H, A).

Since H(e) = F(e) ∩ G(e) =F(e) for all e ∈ A, we know that F(e) ⊆ G(e) for all e ∈ A.

Hence (F, A)⊆ (G, A).

(ii)The proof is similar to (i).

Theorem :3.14

Let (F, A), (G, A), (H, A), and (S, A) are Quadripartitioned neutrosophic pythagorean set over the universe X. Then the following are true.

(i) If (F, A) ∩ (G, A) =$\emptyset_A$, then (F, A)⊆ (G, A)^c

(ii) If (F, A)⊆ (G, A) and (G, A)⊆ (H, A) then (F, A)⊆ (H, A)

(iii) If (F, A)⊆ (G, A) and (H, A)⊆ (S, A) then (F, A) ∩ (H, A) ⊆ (G, A) ∩ (S, A)

(iv) (F, A)⊆ (G, A) iff (G, A)^c ⊆ (F, A)^c

Proof:

(i)Suppose that (F, A) ∩ (G, A) =$\emptyset_A$.Then F(e)∩ G(e) = $\emptyset$.

So, F(e) ⊆ U\G(e)=$G^c(e)$ for all e ∈ A.

Therefore, we have (F, A)⊆ (G, A)^c

Proof of (ii) and (iii) are obvious.

(iv) (F, A)⊆ (G, A)⟺ F(e) ⊆ G(e) for all e ∈ A.

⟺ (G(e))^c ⊆ (F(e))^c for all e ∈ A.

$$\Leftrightarrow G^c(e) \subseteq F^c(e) \; for \; all \; e \in A.$$

⟺(G, A)^c ⊆ (F, A)^c

Definition:3.15

Let I be an arbitrary index $\{(F_i, A)\}_{i\in I}$ be a subfamily of Quadripartitioned neutrosophic pythagorean set over the universe X.

(i)The union of these Quadripartitioned neutrosophic pythagorean set is the Quadripartitioned neutrosophic pythagorean set (H, A) where H(e) = $\cup_{i\in I} F_i\,(e)$ for each e $\in A$.

$We\ write\ \cup_{i\in I}(F_i\,, A)$= (H, A)

(ii)The intersection of these Quadripartitioned neutrosophic pythagorean set is the Quadripartitioned neutrosophic pythagorean set (M, A) where M(e) = $\cap_{i\in I}\, F_i(e)$ for each e $\in A$.

$We\ write\ \cap_{i\in I}\,(F_i, A)$= (M, A)

Theorem:3.16

Let I be an arbitrary index set and $\{(F_i, A)\}_{i\in I}$ be a subfamily of Quadripartitioned neutrosophic pythagorean set over the universe X. Then

(i) $(\cup_{i\in I}(F_i\,, A))^C = \cap_{i\in I}\,(F_i, A)^C$

(ii) $(\cap_{i\in I}\,(F_i, A))^C = \cup_{i\in I}(F_i\,, A)^C$

Proof:

(i) $(\cup_{i\in I}(F_i\,, A))^C$ = (H, A) ^{C}, By definition $H^C(e) = X_E \backslash H(e) = X_E \backslash \cup_{i\in I} F_i\,(e) = \cap_{i\in I}\,(X_E \backslash F_i(e))$ for all e $\in A$.

On the other hand, $(\cap_{i\in I}\,(F_i, A))^C$ = (K, A).

By definition, K(e)=$\cap_{i\in I}\, F_i^C(e) = \cap_{i\in I}\,(X - F_i(e))$ for all e $\in A$.

(ii) It is obvious.

Note: We denote $\emptyset_E\ by\ \emptyset$ and $X_E\ by\ X$.

Theorem:3.17

Let (F, A) be Quadripartitioned neutrosophic pythagorean set over the universe X. Then the following are true.

(i) $(\emptyset, A)^c$ = (X, A)

(ii) $(X, A)^c = (\emptyset, A)$

Proof:

(i) Let ($\emptyset$, A) = (F, A)

Then $\forall$e $\in$ A,

F(e) = $\{< x, T_{F(e)}(x), C_{F(e)}(x), U_{F(e)}(x), F_{F(e)}(x) >: x \in X\}$

= $\{(x,0,0,1,1): x \in X\}$

$(\emptyset, A)^c = (F, A)^c$

Then $\forall$e $\in$ A,

$(F(e))^c = \{< x, T_{F(e)}(x), C_{F(e)}(x), U_{F(e)}(x), F_{F(e)}(x) >: x \in X\}^c$

= $\{< x, F_{F(e)}(x), U_{F(e)}(x), C_{F(e)}(x), T_{F(e)}(x) >: x \in X\}$

=$\{(x1,1,0,0): x \in X\}$ = X

Thus $(\emptyset, A)^c$ = (X, A)

(ii) Proof is similar to (i)

Theorem:3.18

Let (F, A) be Quadripartitioned neutrosophic pythagorean set over the universe X. Then the following are true.

(i) (F, A)$\cup$ ($\emptyset$, A) = (F, A)

(ii) (F, A)$\cup$ (X ,A) = (X, A)

Theorem:3.19

Let (F, A) be Quadripartitioned neutrosophic pythagorean set over the universe X. Then the following are true.

(i) (F, A)$\cap$ ($\emptyset$, A) = ($\emptyset$, A)

(ii) (F, A)$\cap$ (X, A) = (F, A)

Proof:

(i) (F, A) = {e, $(x, T_{F(e)}(x), C_{F(e)}(x), U_{F(e)}(x), F_{F(e)}(x)): x \in X\}\forall$e $\in$ A

($\emptyset$, A) = {e, (x,0,0,1,1): x $\in$ X} $\forall$e $\in$ A

(F,A)$\cap$($\emptyset$,A)= {e, , $(x, 0,0,1,1): x \in X\}\forall$e $\in$ A

= ($\emptyset$, A)

(ii) Proof is similar to (i).

Note: We denote T_F(x), $C_F(x), U_F(x)\ and\ F_F(x)$ by $T_F C_F, U_F and\ F_F$

Theorem:3.20

Let (F, A) and (G, A) be Quadripartitioned neutrosophic pythagorean set over the universe X. Then the following are true.

(i) (F, A)∪ (∅, B) = (F, A) iff B⊆A

(ii) (F, A)∪ (X, B) = (X, A) iff A⊆ B

Theorem:3.21

Let (F, A) and (G, B) be Quadripartitioned neutrosophic pythagorean set over the universe X. Then the following are true.

(i) (F, A)∩ (∅, B) = (∅, A∩B)

(ii) (F, A)∩ (X, B) = (F, A∩B)

Proof:

(i) We have for (F, A)

F(e) = $\{(x, T_{F(e)}, C_{F(e)}, U_{F(e)}, F_{F(e)}): x \in X\}$∀e ∈ A

Also let (∅, B) = (G, B) then

G(e) = {(x,0,0,1,1): $x \in$ U} ∀e ∈ B

Let (F, A) ∩ (∅,B) = (F, A) ∩(G, B) = (H, C) where C = A ∩B and ∀e ∈ C

H(e) = $\{(x, min(T_{F(e)}, T_{G(e)}), min(C_{F(e)}, C_{G(e)}), max(U_{F(e)}, U_{G(e)}) max(F_{F(e)}, F_{G(e)})): x \in X\}$

= $\{ (x, min(T_{F(e)}, 0), min(C_{F(e)}, 0), max(U_{F(e)}, 1) max(F_{F(e)}, 1)): x \in X\}$

= $\{(x, 0,0,1,1): x \in X\}$

= (G, B) = (∅, B)

Thus (F, A)∩ (∅, B) = (∅, B) =(∅, A∩B)

(ii) Proof is similar to (i).

Theorem:3.22

Let (F, A) and (G, B) be Quadripartitioned neutrosophic pythagorean set over the universe X. Then the following are true.

(i) ((F, A)∪ (G, B)) ^{C}⊆ (F, A) ^{C}∪(G, B) ^{C}

(ii) (F, A) ^{C} ∩(G, B) ^{C}⊆((F, A)∩ (G, B)) ^{C}

Proof:

Let (F, A)∪(G, B) = (H, C) Where C = A∪B and∀ e∈ C

H(e) may be defined as
$$\begin{cases} \{(x, T_{F(e)}, C_{F(e)}, U_{F(e)}, F_{F(e)}): x \in X\} \ if \ e \in A - B \\ \{(x, T_{G(e)}, C_{G(e)}, U_{G(e)}, F_{G(e)}): x \in X\} \ if \ e \in B - A \\ \{(x, max(T_{F(e)}, T_{G(e)}), max(C_{F(e)}, C_{G(e)}), min(U_{F(e)}, U_{G(e)}), min(F_{F(e)}, F_{G(e)})): x \in X\} \ if \ e \in A \cap B \end{cases}$$

Thus (F, A)∪(G, B))^C = (H, C)^C Where C = A∪B and∀ e∈ C

$$(H(e))^C = \begin{cases} (F(e))^C \ if \ e \in A - B \\ (G(e))^C \ if \ e \in B - A \\ (F(e) \cup G(e))^C if \ e \in A \cap B \end{cases}$$

$$= \begin{cases} \{(x, F_{F(e)}, U_{F(e)}, C_{F(e)}, T_{F(e)}): x \in X\} \ if \ e \in A - B \\ \{(x, F_{G(e)}, U_{G(e)}, C_{G(e)}, T_{G(e)}): x \in X\} \ if \ e \in B - A \\ \{(x, min(F_{F(e)}, F_{G(e)}), min(U_{F(e)}, U_{G(e)}), max(C_{F(e)}, C_{G(e)}), max(T_{F(e)}, T_{G(e)}): x \in X\} \ if e \in A \cap B \end{cases}$$

Again (F, A)^C∪(G, B)^C = (I, J) say J = A∪B and ∀ e∈ J

$$I(e) = \begin{cases} (F(e))^C \ if \ e \in A - B \\ (G(e))^C \ if \ e \in B - A \\ (F(e) \cup G(e))^C if \ e \in A \cap B \end{cases}$$

$$= \begin{cases} \{(x, F_{F(e)}, U_{F(e)}, C_{F(e)}, T_{F(e)}): x \in X\} if e \in A - B \\ \{(x, F_{G(e)}, U_{G(e)}, C_{G(e)}, T_{G(e)}): x \in X\} if e \in B - A \\ \{(x, min(F_{F(e)}, F_{G(e)}), min(U_{F(e)}, U_{G(e)}), max(C_{F(e)}, C_{G(e)}), max(T_{F(e)}, T_{G(e)})): x \in X\} if \ e \in A \cap B \end{cases}$$

So, C⊆ J ∀ e∈ J, $(H(e))^C$ ⊆I(e)

Thus (F, A)∪(G, B)) ^{C}⊆ (F, A) ^{C}∪(G, B) ^{C}

Theorem :3.23

Let (F, A) and (G, A) are two Quadripartitioned neutrosophic pythagorean sets over the same universe X. We have the following

(i) ((F, A)∪ (G, A)) ^{C} = (F, A) ^{C} ∩(G, A) ^{C}

(ii) ((F, A)∩ (G, A)) ^{C} = (F, A) ^{C}∪(G, A) ^{C}

Proof:

(i) Let (F, A) ∪ (G, A) = (H, A) ∀ e∈ A

H(e) = F(e)∪G(e)

=$\{(x, max(T_{F(e)}, T_{G(e)}), max(C_{F(e)}, C_{G(e)}), min(U_{F(e)}, U_{G(e)}), min(F_{F(e)}, F_{G(e)})\}$

Thus (F, A) ∪ (G, A))^C = (H, A)^C∀ e∈ A

(H(e)) ^{C} = (F(e)∪G(e)) ^{C}

=$\{(x, max(T_{F(e)}, T_{G(e)}), max(C_{F(e)}, C_{G(e)}), min(U_{F(e)}, U_{G(e)}), min(F_{F(e)}, F_{G(e)})\}^C$

=$\{(x, min(F_{F(e)}, F_{G(e)}), min(U_{F(e)}, U_{G(e)}), max(C_{F(e)}, C_{G(e)}), max(T_{F(e)}, T_{G(e)})\}$

Again (F, A) ^{C}∩ (G, A) ^{C} = (I, A) where∀ $e \in A$

I(e) = (F(e)) ^{C}∩ (G(e)) ^{C}

=$\{(x, min(F_{F(e)}, F_{G(e)}), min(U_{F(e)}, U_{G(e)}), max(C_{F(e)}, C_{G(e)}), max(T_{F(e)}, T_{G(e)})\}$

Thus ((F, A)∪ (G, A)) ^{C} = (F, A) ^{C} ∩(G, A) ^{C}

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