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Quin-Terranean Fuzzy Soft Continuity

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ABSTRACT:

This paper introduces the novel concept of **Quin-Terranean fuzzy soft Continity building notion of quin –Terranean fuzzy soft topological spaces** and also the concept of continuity.Various characterizations,Definitions and basic properties of the **Quin-Terraneafuzzysoftinterior**,**Quin-Terraneanfuzzysoftclosure**,**Quin- Terranean fuzzy soft image and pre-image**, and **Quin-Terranean fuzzy soft continuity** are studied. The concept of Quin – Terranean fuzzy soft continuous mapping are studied.

KEYWORDS:

Quin-Terranean Fuzzy Soft Set, Quin-Terranean Fuzzy Soft Topological Space, Quin-Terranean Fuzzy Soft Interior, Quin-Terranean Fuzzy Soft Closure, Quin-Terranean Fuzzy Soft Mapping, Quin-Terranean Fuzzy Soft Continuity.

1. INTRODUCTION

A number of algebraic operations were presented by Maji et al. [15] in the context of soft set theory.Bysuggestingextraoperationswithinsoftsettheory,Alietal.[2]builtontheprevious research.SofttopologicalspaceswerefirstproposedbyShabirandNaz[25],whoalsodefined a number of concepts related to soft sets in these spaces. Maji et al. subsequently presented a unifiedframeworkbycombiningfuzzysettheoryandsoftsettheory.Fuzzysoftsetswerefirst proposed by Maji et al. [13], and Tanay and Kandemir [29] expanded on this idea to create fuzzy soft topology. Chang [6] expanded on this idea by providing fundamental precepts.A membership function and a non-membership function are two functions that Atanassov [3] added to fuzzy sets to create intuitionistic fuzzy sets (IFS), which are a classification of fuzzy sets. [0,1] is the closed unit interval into which both functions map. In addition to introducing intuitionisticfuzzytopology,Coker[7]investigatedanalogousformsoftraditionaltopological ideassuchascontinuityandcompactness.Theframeworkofsoftsetswasexpandedtointuitionistic fuzzy soft sets by Maji et al. [14]. Furthermore, thenotion of intuitionisticfuzzy soft topological spaces has been investigated by a number of writers [5, 11, 20, 32].The idea of thePythagorean fuzzy set was first presented byYager [30]. It is defined by amembership degree and a non-membership degree, where the square sum of these two degrees is less than or equal to one. Pythagorean fuzzy set theory has been studied by a number of authors [4, 9, 17,18,24,28,34].Olgunetal.[19]presentedtheideaofPythagoreanfuzzytopologicalspaces in2019and examinedtheircontinuityas wellas afewimportant characteristics.Pythagorean fuzzy soft set theory was defined and important properties were analyzed by Peng et al. [23]. Guleria and Bajaj [8] investigated the different feasible types of Pythagorean fuzzy soft matrices. In order to solve decision-making problems, M. Kirisci [12] proposed using a new kind of Pythagorean fuzzy soft set. Several properties of Pythagorean fuzzy soft topological spaceshavebeenstudiedbyAdemYolcuetal.[1].AccordingtoSenapatiand Yager's2020 [26]proposal,fermateanfuzzysetsarebetterabletomanageuncertaininformationduringthe decision-makingprocess.TheyusedFermateanfuzzysetstodefinebasicoperationsoverthem.

Fermatean fuzzy topological spaces were introduced and their properties were examined by HariwanandIbrahim[9].Usingtheirsetsinthepaper,RajarajeswariandThirunamakanni[25] introducedtheideaofQuinTerraneanfuzzysets ,Quin terranean fuzzy soft topological spaces which are supersetsof Fermateanfuzzysets. It is evident from a survey of the literature that we define Quin-Terranean fuzzy soft closure and Quin- Terranean fuzzy soft interior and discuss some of their key characteristics. Quin- Terraneanfuzzysoft continuous mappings areexamined,andintriguingfindings areobtained that may help us develop this area of study.

2. PRELIMINARIES

Definition 2.1

Let X be an universal set.X contains a fuzzy set $\mathcal{F}$,denoted by$\mathcal{F}$=$\{(\bar{x},\alpha\mathcal{F}(x\bar{x})):\bar{x}\in$Xwhere $\alpha\mathcal{F}$:X→[0,1]represents the membershipfunction.The membership of $\bar{x}$ ∈X in $\mathcal{F}$ is denoted by $\bar{\alpha}\mathcal{F}(x)\in[0,1]$. The notation $\mathcal{FS}$(X) will represent the set of all fuzzy sets over X.

Definition2.2

In X, an intuitionistic fuzzy set $\mathcal{I}$ is defined as $\mathcal{I}=\{(\bar{x},\alpha\mathcal{I}(\bar{x}),\beta\mathcal{I}(\bar{x})):\bar{x}\in$X},where $\bar{\alpha}\mathcal{I}$:X →[0,1],$\beta\mathcal{I}$:X →[0,1]are the degrees of membership and non-membership of x to $\mathcal{I}$ respectively which satisfies $0\leq\alpha\mathcal{I}(\bar{x})+\beta\mathcal{I}(\bar{x})\leq1,\forall xx\in$X. Let $\mathcal{IF}(\bar{x})$denotes the set of all intuitionistic fuzzy sets over X.

Definition2.3

Let Xbe an universal set and Vbe a set of parameters.Asoft set over Xis a pair $(\mathcal{F},V)$ where $\mathcal{F}$ isamapping $\mathcal{F}:V\rightarrow P$(X).Inotherwords,a soft set is a parameterized collection of subsets of the universal set X.

Definition 2.4

Let Xbe an universal set and Vbe a set of parameters.Afuzzy soft set over Xis a Pair $(\mathcal{F},V)$, If $\mathcal{F}:V\rightarrow\mathcal{FS}$(X) is a mapping from $V$to the set of all fuzzy sets in X, where $\mathcal{FS}$(X)is the set of all fuzzy subsets in X.

Definition 2.5

Assume that X is an universal set. Let V be a collection of parameters. An intuitionistic fuzzy soft set over X is a pair $(\mathcal{F},)$ where $\mathcal{F}$is a mapping denoted by $\mathcal{F}:V\rightarrow\mathcal{IFS}$(X), where $\mathcal{IFS}$(X) is the set of all intuitionistic fuzzy subsets in X.

In general, for every $v\ \epsilon\ V$, $\mathcal{F}(v)$ is an intuitionistic fuzzy set of X referred to as the intuitionistic fuzzy value set corresponding to the parameter v. It is evident that $\mathcal{F}(v)$ can be expressed as an intuitionistic fuzzy set as follows $\mathcal{F}(v)=\{(\bar{x},\alpha\mathcal{I}(\bar{x}),\beta\mathcal{I}(\bar{x})):\bar{x}\in$X}.

Definition2.6

Let$V$ be a set of parameters and X be the universal set.Quin-Terranean fuzzy softest is defined as the pair $(\mathcal{F}$,V), where $\mathcal{F}$: $V\rightarrow\mathcal{QTFS}$(X) and $\mathcal{QTFS}$(X) represents the Quin-Terranean fuzzysubsetsofX.Quin-Terraneanfuzzy soft sets degenerate into Pythagoreanfuzzysoftsets.

Definition 2.7

Let V be a set of parameters and X be the universal set and let M, N⊆ V. Considertwo Quin-Terranean fuzzy soft sets $(\mathcal{F},M)$,(S,N) over X. $(\mathcal{F},M)$ is aQuin-Terranean fuzzy soft subset of (S,N) denoted by $(\mathcal{F},M)\subseteq(S,N)$ if,

(1) $M\subseteq N$

(2) $\forall v\in M$,$\mathcal{F}(v)$is the Quin-Terranean fuzzy subset of $S(v)$that is,$\forall\ \bar{x}\in$Xand $\forall v\in M,\alpha\mathcal{F}(v)(\bar{x})\leq\alpha S(v)(\bar{x})and\beta\mathcal{F}(v)(\bar{x})\geq\beta S(v)(\bar{x})$.If$(\mathcal{F},M)\subseteq(S,N)$and $(S,N)\subseteq(\mathcal{F},M)$,then$(\mathcal{F},M)$and $(S,N)$are said to be equal.

Definition2.8

Let $(\mathcal{F}$,V) be a Quin-Terranean fuzzy soft sets over X. Then $(\mathcal{F}$,V) ^{C}is the notation for the complement of $(\mathcal{F},V)$ which is defined by

$(\mathcal{F},V)^{C}=\{(v,(\bar{x},\beta\mathcal{F}(v)(\bar{x}),\alpha\mathcal{F}(v)(\bar{x})):\bar{x}\in$X$):v\in V\}$

Definition 2.9

If$\alpha\mathcal{F}(v)(\bar{x})=0and\beta\mathcal{F}(v)(\bar{x})=1:\forall v\in V,\forall\ \bar{x}\in$X.Then a Quin-Terranean fuzzy soft set$(\mathcal{F},V)$ over the universe X is considered null Quin-Terranean fuzzy soft set.It is representedby$\bar{0}_{(X,V)}$.If $\alpha\mathcal{F}(v)(\bar{x})=1$and $\beta\mathcal{F}(v)(\bar{x})=0$: $\forall v\in V$, $\forall\ \bar{x}\in$X.Then a Quin-Terranean fuzzy soft set $(\mathcal{F},V)$ over the universe X is an absolute Quin-Terranean fuzzy soft set.It is represented by $\bar{1}(X,V)$.

Definition2.10

i. Consider two Quin-Terranean fuzzy soft sets over the universe setX,$(\mathcal{F}1,V)$and $(\mathcal{F}2,V)$.Then,the restricted unionof$(\mathcal{F}1,V)$and$(\mathcal{F}2,V)$ which is denoted by $(\mathcal{F}1,V)$ $\cup(\mathcal{F}2,V)=(\mathcal{F}3,V)$and is defined by

$(\mathcal{F}_3$,V$)=\{(v,(\bar{x},\alpha_{\mathcal{F}3}(v)(\bar{x}),\beta_{\mathcal{F}3}(v)(\bar{x})):\bar{x}\in$X$):v\in V\}$

where$\alpha_{\mathcal{F}3}(v)(\bar{x})=\max\{\alpha_{\mathcal{F}1}(v)(\bar{x}),\alpha_{\mathcal{F}2}(v)(\bar{x})\}and\beta_{\mathcal{F}3}(v)(\bar{x})=\min\{\beta_{\mathcal{F}1}(v)(\bar{x}),\beta_{\mathcal{F}2}(v)(\bar{x})\}$.

ii. The notation $(\mathcal{F}1,V)\cap R(\mathcal{F}2,V)=(\mathcal{F}3,V)$,indicates there stricted intersection of $(\mathcal{F}1,V)$ and $(\mathcal{F}2,V)$ which is defined by

$(\mathcal{F}_3$,V$)=\{(v,(\bar{x},\alpha_{\mathcal{F}3}(v)(\bar{x}),\beta_{\mathcal{F}3}(v)(\bar{x})):\bar{x}\in$X$):v\in V\}$

Where$\alpha_{\mathcal{F}3}(v)(\bar{x})=\min\{\alpha_{\mathcal{F}1}(v)(\bar{x}),\alpha_{\mathcal{F}2}(v)(\bar{x})\}and\beta_{\mathcal{F}3}(v)(\bar{x})=\max\{\beta_{\mathcal{F}1}(v)(\bar{x}),\beta_{\mathcal{F}2}(v)(\bar{x})\}$.

Definition 2.11

Let Vbe a parameter set, M,N⊆ $V$and $(\mathcal{F},M)$ *and* (S,N) be two Quin-Terranean fuzzy soft sets over the universe set X. Then,

a) The expression$(\mathcal{F},M)\cup\mathcal{E}(S,N)=(T,O)$represents the extended union of $(\mathcal{F},M)(S,)$,where$O=M\cup N$and(T,O)isdefinedby;

$$(T,O)=\{(v,(\bar{x},\alpha T(v)(\bar{x}),\beta T(v)(\bar{x})):\bar{x}\in\text{X}):v\in V\}$$

where

$\alpha\mathcal{F}(v)(\bar{x}),if\,v\in M-N$

$\alpha T(v)(x) =$

$\alpha\, s(x), if\, v \in N-M \{$ $\}$

$\max\{\ \alpha\mathcal{F}(v)(x), \alpha S(v)(x)\ \}, if\, v \in M \cap$

$\beta\mathscr{F}(v)(x), if\, v \in M-N$

$\bar{\beta} T(v)(x) = \Bigg\{$ $\Bigg\}$

$\beta\, s(v)(x), if\, v \in N-M$

$\min\{\beta\mathcal{F}(v)(\bar{x}),\beta S(v)(\bar{x})\}, if\ v\in M\cap N$

b) The extended intersection of $(\mathcal{F},M)$ and (S,N) is represented by $(\mathcal{F},v)\cap\mathcal{E}(S,N)=(T,O)$ when $O=M\cup N$ and (T,O) is defined by

$$(T,O)=\{(v,(\bar{x},\alpha T(v)(\bar{x}),\beta T(v)(\bar{x}),):\bar{x}\in X):v\in V\}$$

where

$$\alpha T(v)(\bar{x})=\begin{cases}\alpha\mathcal{F}(v)(\bar{x}), if\ v\in M-N\\ \alpha S(v)(\bar{x}), if\ v\in N-M\\ \min\{\alpha\mathcal{F}(v)(\bar{x}),\alpha S(v)(\bar{x})\}, if\ v\in M\cap N\end{cases}$$

$$\beta T(v)(\bar{x})=\begin{cases}\beta\mathcal{F}(v)(\bar{x}), if\ v\in M-N\\ \beta S(v)(\bar{x}), if\ v\in N-M\\ \max\{\beta\mathcal{F}(v)(\bar{x}),\beta S(v)(\bar{x})\}, if\ v\in M\cap N\end{cases}$$

Definition2.12

a) Let V be a parameter set $M,N\subseteq V$ and let $(\mathcal{F},M)$ *and* (S,N) be two Quin-Terranean fuzzysoftsetsovertheuniversesetX.Thenthe"and"operationonthemisdenotedby $(\mathcal{F},M)\wedge(S,N)=(T,M\times N)$ and is defined by,

$$(T,M\times N)=\{((v_1,v_2),(\bar{x},\alpha_{T(v_1,v_2)}(\bar{x}),\beta_{T(v_1,v_2)}(\bar{x})):\bar{x}\in X):(v_1,v_2)\in M\times N\}$$

where

$$(v_1,v_2)(\bar{x})=\min\{\alpha_{\mathcal{F}(v_1)}(\bar{x}),\alpha_{S(v_2)}(\bar{x})\}$$
$$(v_1,v_2)(\bar{x})=\max\{\beta_{\mathcal{F}(v_1)}(\bar{x}),\beta_{S(v_2)}(\bar{x})\}$$

b) Given a parameter set V, two Quin-Terranean fuzzy soft sets $(\mathcal{F},M)$ *and* (S,N) over the universe setX and $M,N \subseteq V$.Then the"or"operation on them,which is represented by $(\mathcal{F},M) \vee (S,N) = (T,M \times N)$ and is defined by,

$$(T,M\times N)=\{((v_1,v_2),(\bar{x},\alpha_{T(v_1,v_2)}(\bar{x}),\beta_{T(v_1,v_2)}(\bar{x})): \bar{x}\in X):(v_1,v_2)\in M\times N\}$$

where

$$\overline{(v_{1,2})}(x)=\max\{\alpha_{\mathcal{F}(v_1)}(\bar{x}),\alpha_{S(v_2)}(\bar{x})\}$$

$$\beta_{T(v_1,v_2)}(\bar{x})=\min\{\beta_{\mathcal{F}(v_1)}(\bar{x}),\beta_{S(v_2)}(\bar{x}).\}$$

Definition 2.13

LetX andY betwonon-emptysets.LetM andN beQuin-TerraneanfuzzysubsetsofX andY, respectively,and let f:X→Y be a function.The image of $M$with respect to$f$,represented by [M],with membership and non-membership functions that are defined by,

$$\alpha_{f[M]}(\bar{y}) = \begin{cases} \sup_{\bar{z}\in f^{-1}(\bar{y})} \alpha_M(\bar{z}), & if\, f^{-1}(\bar{y})\neq\emptyset \\ 0, & otherwise \end{cases}$$

$$\beta_{f[M]}(\bar{y}) = \begin{cases} \inf_{\bar{z}\in f^{-1}(\bar{y})} \beta_M(\bar{z}), & \text{if } f^{-1}(\bar{y}) \neq\emptyset \\ 0 & \text{otherwise} \end{cases}$$

The pre-image of N with respect to f, represented by $f^{-1}[N]$, has membership and non membership functions that are defined by $\alpha_{f^{-1}[N]}(x)=\alpha N(f x)$ and $\bar{\beta}_{f^{-1}[N]}(x)=\beta N(f(\bar{x}))$, respectively. In this study they proved that demonstrated that

$\alpha^{4}_{f}[M](x)+\beta^{5/4}_{f}[\bar{M}](x)\leq 1$ QuinTerranean fuzzy membership condition is provided for Quin-Terraneanfuzzyimagesandpre-images.

Definition 2.14

Let $X\neq\emptyset$ be an universal set then the collection $\bar{\tau}$ of Quin-TerraneanfuzzysoftsetsoverX Represented by $\tau \not\subset \mathcal{QTFSS}$(X,),is said to be a Quin-Terranean fuzzy soft topology on X if,

(1) $\bar{0}_{(X,)}, \bar{1}_{(X,)} \in \tau x$,

(2) Arbitrary unionofanyQuin-Terraneanfuzzysoftsetsin τ belongsto $\bar{\tau} x$.

(3) theintersectionofanytwoQuin-Terraneanfuzzysoftsetsin τ belongsto τx.

AQuin-TerraneanfuzzysofttopologicalspaceoverXisdenotedbythetriple(X, $\bar{\tau}$,)$\mathcal{QT}$. Every element of $\bar{\tau}$ is called as a Quin-Terranean fuzzy soft open set in X.

Definition 2.15

a) LetXbe an universal set, Vbe the parameter set and $\tau x = \{\bar{0}_{(X,)}, \bar{1}_{((X,)}\}$.Then is referredtoasaQuin-TerraneanfuzzysoftindiscretetopologyonX and((X, v $\bar{\tau}$, V)$\mathcal{QT}$is a Quin-Terranean fuzzy soft indiscrete space over X.

b) LetXbeanuniversalset,betheparametersetandthecollectionofallQuin-Terranean fuzzysoftsets that can be defined over X are denoted by $\bar{\tau}$. Then is referred to as a Quin-TerraneanfuzzysoftdiscretetopologyonX and(X, $\bar{\tau}$,)$\mathcal{QT}$is a Quin-Terranean fuzzy soft discrete space over X.

Definition 2.16

Supposethat(X, $\bar{\tau}$,)$\mathcal{QT}$isaQuin-TerraneanfuzzysofttopologicalspaceoverX,andthat $(T,V)\in\mathcal{QTFSS}$(X,).TheunionofallQuin-Terraneanfuzzysoftopensetsthatarecontained in (T, V) is the Quin-Terranean fuzzy soft interior of (T, V), representing Qtint (T, V).

3. Quin-TerraneanFuzzySoftContinuity

Let X and Y be non-empty initial universes with parameter sets V,V,′and$M\subseteq V$,$N\subseteq V'$.

Definition 3.1

Let(X, $\bar{\tau}_1$,)and(Y, $\bar{\tau}_2$,V')$\mathcal{QT}$be twoQuin-Terraneanfuzzysofttopologicalspaces,andlet $\theta\theta$:X→Y,:$V\to V'$bemappings.Then,amapping$f=(\theta\theta,\rho)$: $\mathcal{QTFSS}$(X,V)→$\mathcal{QTFSS}$(Y,V') is defined as for $(T,M)\in\mathcal{QTFSS}$(X,V), $f(T,M)\in\mathcal{QTFSS}(Y,V')$ is the image of (T,M) under $f$is a Quin-Terranean fuzzy soft set in $\mathcal{QTFSS}(Y,V')$ provided by sup

$(T)(v')(y)=\{v\in\rho^{-1}(v')\cap M, \in\theta\theta^{-1}(\bar{y})$ $\quad - \quad (v)(\bar{x}) \quad$ $if\theta\theta^{-1}(\bar{y})\neq\emptyset$

0, $\quad otherwise$

inf

(T) $\quad (\bar{v}')(y)=\{v\in\rho^{-1}(v')\cap M, x\,\theta\theta^{-1}(\bar{y})$ $\quad \beta T(v)(x),\ if\theta\theta^{-1}(\bar{y})\neq\emptyset$

1, $\quad otherwise$

The inverse image of $(\mathcal{F},)$under $f$represented by $f^{-1}(\mathcal{F},N)$for $(\mathcal{F},N)\in \mathcal{QTFSS}(Y,V')$ is a Quin-Terranean fuzzy soft set in $\mathcal{QTFSS}(\mathrm{X},V)$ given by:

$$\alpha_{\theta^{-1}(\mathcal{F})}\, v(\bar{x}x)=\alpha_{\mathcal{F}(\rho(v))}\theta\theta(\bar{x})$$

$$\beta_{\theta^{-1}(\mathcal{F})}\, v(\bar{x})=\beta_{\mathcal{F}(\rho(v))}\theta\theta(\bar{x})$$

Forevery $v\in V$and $\bar{x}\in$X.

Remark3.2

Quin-Terraneanfuzzysoftsubsetsare(T,M) and$f^{-1}(\mathcal{F},N)$.We are able toget

$$\sup \alpha^{45}_{\theta(T)}(v')(y)+\beta^{5/4}_{\theta(T)}(v')(y)=\alpha_{(v\in\rho^{-1}(v')\cap M,\ \bar{x}\in\theta\theta^{-1}(\bar{y}))}(T(v)(\bar{x}))^{45}+\inf \beta_{(v\in\rho^{-1}(v')\cap M,\ \bar{x}\in\theta\theta^{-1}(\bar{y}))}(T(v)(\bar{x}))^{5/4}$$

$$=\sup_{v\in\rho^{-1}(v')\cap M,\ x\in\theta\theta^{-1}(\bar{y})} \alpha^{45}\ T(v)(\bar{x})+\inf_{v\in\rho^{-1}(v')\cap M,\ x\in\theta\theta^{-1}(\bar{y})}\beta^{5/4}\ T(v)(\bar{x})$$

$$\sup_{v\in\rho^{-1}(v')\cap M,\ x\in\theta\theta^{-1}(\bar{y})} \left(1-\beta^{\frac{5}{4}}_{T(v)}(\bar{x})\right)+\inf_{v\in\rho^{-1}(v')\cap M,\ x\in\theta\theta^{-1}(\bar{y})}\beta^{5/4}_{T(v)}(\bar{x})$$

=1.

Whenever $\theta\theta^{-1}(\bar{y})\neq\emptyset$is not empty.Alternatively,if $\theta\theta^{-1}(\bar{y})=\emptyset$ then $\alpha^{45}_{\theta(T)}(v')(y)+\beta^{5/4}_{(\theta T)}(v')(y)=1$. Consequently, we demonstrated that the Quin-Terranean fuzzy membershipgradeconditionisprovidedforboththeQuin-Terraneanfuzzysoftpre-imageand image. Similarly, the proof follows for $f^{-1}(\mathcal{F},N)$.

The following proposition studies some fundamental characteristic so f-image$f$.

Proposition3.3

Let f : $\mathcal{QTFSS}(\mathrm{X},V)\rightarrow \mathcal{QTFSS}(Y,V')$ be a Quin-Terranean fuzzy soft mapping. Then, for Quin-Terranean fuzzy soft sets $(T,)$ and $(S,)$ in $\mathcal{QTFSS}(\mathrm{X},)$ we have,

(1)$(\bar{0}_{(X,V)})=\bar{0}_{(Y,V')}$,

(2) $f(1_{(X,V)}) \subseteq 1_{(Y,V')}$,
(3) $f((T,M) \cup \mathcal{E}(S,N)) = f(T,M) \cup \mathcal{E} f(S,N)$,
(4) $f((T,M) \cap \mathcal{E}(S,N)) \subseteq f(T,M) \cap \mathcal{E} f(S,N)$,
(5) $f((T,M) \cup R(S,N)) = f(T,M) \cup R f(S,N)$,
(6) $f((T,M) \cap R(S,N)) \subseteq f(T,M) \cap R f(S,N)$,
(7) If $(T,M) \subseteq (S,N)$ then $f(T,M) \subseteq f(S,N)$.

Proof:

We just provide proofs of (3),(4), and(7).The others can be proved similarly.

(3) We consider, $(T,M) \cup \mathcal{E}(S,N) = (B,(M \cup N))$ and

$f((T,M)\cup\mathcal{E}(S,N))=(\theta\theta(T),\rho(M))\cup\mathcal{E}(\theta\theta(S),\rho(N))=(A,\rho(M)\cup\rho(N))$.Then $f((T,M)\cup\mathcal{E}(S,N))=(\theta\theta(B),\rho(M\cup N))=(\theta\theta(B),\rho(M)\cup\rho(N))$.Foranyyy $\in Y$and$v'\in\rho(M)\cup\rho(N)$,if$\theta\theta^{-1}(\bar{y})\neq\emptyset$,then$\alpha A(v')(\bar{y})=\alpha\theta(B)(v')(\bar{y})=0and\beta A(v')(\bar{y})=\beta\theta(B)(v')(\bar{y})=1$. Otherwise,

i. If$v'\in\rho(M)$-$\rho(N)$,then$A(v')=\theta\theta(T)(v')$.However,$v'\in\rho(M)$-$\rho(N)$impliesthat thereisn'tan$v\in N$suchthat$\rho(v)=v'$.Inotherwords,forany$v\in\rho^{-1}(v')\cap(M\cup N)$ wehave$v\in\rho^{-1}(v')\cap(M-N)$.Therefore, accordingtoDefinition4.1,wehave

$$\alpha\theta(B)(v')(\bar{y})=\sup_{v\in\rho^{-1}(v')\cap(M\cup N),\ \bar{x}\in\theta\theta^{-1}(\bar{y})}\alpha B(v)(\bar{x})$$

$$=\sup_{v\in\rho^{-1}(v')\cap(M-N),\ \bar{x}\in\theta\theta^{-1}(\bar{y})}\alpha B(v)(\bar{x})$$

$$=\sup_{v\in\rho^{-1}(v')\cap(M\cup N),\ \bar{x}\in\theta\theta^{-1}(\bar{y})}\alpha T(v)(\bar{x})$$

$= (v')(y)$ Similarly,we get $\beta\theta(B)(v')\bar{y}=\beta A(v')\bar{y})$.

ii. Similar to (i),if$v'\in\rho(N)$-$\rho(M)$,thenwehave$\alpha\theta(B)(v')(\bar{y})=\alpha A(v')(\bar{y})$, $(B)(v')(\bar{y})=\beta A(v')(\bar{y})$.

iii. If $v'\in\rho(M)\cap\rho(N)$,then

$$\alpha\theta(B)(v')(\bar{y})=\sup_{v\in\rho^{-1}(v')\cap(M\cup N),\ \bar{x}\in\theta\theta^{-1}(\bar{y})}\alpha B(v)(\bar{x})$$

$$=\sup_{v\in(\rho^{-1}(v')\cap M)\cup(\rho^{-1}(v')\cap N),\ \bar{x}\in\theta\theta^{-1}(\bar{y})}\alpha B(v)(\bar{x})$$

$$=(\sup_{v\in(\rho^{-1}(v')\cap M)-(\rho^{-1}(v')\cap N),\ \bar{x}\in\theta\theta^{-1}(\bar{y})}\alpha T(v)(\bar{x}))$$

$$Ç(\sup_{v\in(\rho^{-1}(v')\cap M)\cap(\rho^{-1}(v')\cap N),\ \bar{x}\in\theta\theta^{-1}(\bar{y})}\max\{\alpha T(v)(\bar{x}),\alpha S(v)(\bar{x})\})$$

$$Ç(\sup_{v\in(\rho^{-1}(v')\cap N)-(\rho^{-1}(v')\cap M),\ \bar{x}\in\theta\theta^{-1}(\bar{y})}\alpha S(v)(\bar{x}))$$

$$=\max\{\sup_{v\in(\rho^{-1}(v')\cap M),\ \bar{x}\in\theta\theta^{-1}(\bar{y})}\alpha T(v)(\bar{x}),\sup_{v\in(\rho^{-1}(v')\cap N),\ \bar{x}\in\theta\theta^{-1}(\bar{y})}\alpha S(v)(\bar{x})\}$$

$$=\max\{\alpha\theta(T)(v')(\bar{y}),\alpha\theta(S)(v')(\bar{y})\}=\alpha A(v')(\bar{y})$$

.Similarly,weget$\beta\theta(B)(v')(\bar{y})=\beta A(v')(\bar{y})$. Consequently,$((T,M)\cup\mathcal{E}(S,N))=f(T,M)\cup\mathcal{E}f(S,N)$.

(4) Let$((T,M)\cap\mathcal{E}(S,N))=(T,M\cup N)andf((T,M)\cap\mathcal{E}(S,N))=(\theta\theta(T),\rho(M))\cap\mathcal{E}(\theta\theta(S),\rho(N))=(A,\rho(M)\cup\rho(N))$.Consequently,$f((T,M)\cap\mathcal{E}(S,N))=(\theta\theta(B),\rho(M\cup N))=(\theta\theta(B),\rho(M)\cup\rho(N))$.Assumingthat$\theta\theta^{-1}(\bar{y})\neq\emptyset$,forany $\bar{y}\in Y$and$v'\in\rho(M)\cup\rho(N)$then,

$\alpha A(v')(yy)=\alpha\theta(B)(v')(yy)=0and\beta A(v')(y)=\beta\theta(B)(v')(y)=1$.Otherwise,

i. If $v' \in \rho(M)-\rho(N)$then,$A(v')= \theta\theta(T)(v')$.Conversely, $v' \in \rho(M)-\rho(N)$,implies that theredoesn't exist$v\in N$such that $\rho(v)=v'$. In otherwords, forany $v\in \rho^{-1}(v')$ $\cap (M \cup N)$, we have $v \in \rho^{-1}(v') \cap (M - N)$. Therefore, according to Definition 4.1, we have

$$\alpha_{\theta(B)(v')}(\bar{y}) = \sup_{v\in\rho^{-1}(v')\cap(M\cap N),\ \bar{x}\in\theta\theta^{-1}(\bar{y})} \alpha_{B(v)}(\bar{x})$$

$$= \sup_{v\in\rho^{-1}(v')\cap(M-N),\ \bar{x}\in\theta\theta^{-1}(\bar{y})} \alpha_{B(v)}(\bar{x})$$

$$= \sup_{v\in\rho^{-1}(v')\cap(M-N),\ \bar{x}\in\theta\theta^{-1}(\bar{y})} \alpha_{T(v)}(\bar{x})$$

$$\leq \min\{\sup_{v\in\rho^{-1}(v')\cap(M),\ \bar{x}\in\theta\theta^{-1}(\bar{y})} \alpha_{T(v)}(\bar{x}), \sup_{v\in\rho^{-1}(v')\cap(N),\ \bar{x}\in\theta\theta^{-1}(\bar{y})} \alpha_{S(v)}(\bar{x})\}$$

$$=\min\{\alpha_{\theta(T)(v')}(\bar{y}),\alpha_{\theta(S)(v')}(\bar{y})\}$$

$$= \alpha_{A(v')}(\bar{y})$$

Similarly,we get $\beta_{\theta(B)(v')}(\bar{y})\geq\beta_{A(v')}(\bar{y})$

Similar to (i), if$v'\in\rho(N)$-$\rho(M)$, then

wehave$\alpha_{\theta(B)(v')}(\bar{y})=\alpha_{A(v')}(\bar{y})$,

$\beta_{\theta(B)(v')}(\bar{y})=\beta_{A(v')}(\bar{y})$.

ii. If$v'\in\rho(M)\cap\rho(N)$,then

$$\alpha_{\theta(B)(v')}(\bar{y}) = \sup_{v\in\rho^{-1}(v')\cap(M\cap N),\ \bar{x}\in\theta\theta^{-1}(\bar{y})} \alpha_{B(v)}(\bar{x})$$

$$= \sup_{v\in\rho^{-1}(v')\cap(M\cap N),\ \bar{x}\in\theta\theta^{-1}(\bar{y})} \max\{\alpha_{T(v)}(\bar{x}),\alpha_{S(v)}(\bar{x})\}$$

$$\leq \max\{\sup_{v\in\rho^{-1}(v')\cap(M),\ \bar{x}\in\theta\theta^{-1}(\bar{y})} \alpha_{T(v)}(\bar{x}), \sup_{v\in\rho^{-1}(v')\cap(N),\ \bar{x}\in\theta\theta^{-1}(\bar{y})} \alpha_{S(v)}(\bar{x})\}$$

$$=\max\{\alpha_{\theta(T)(v')}(\bar{y}),\alpha_{\theta(S)(v')}(\bar{y})\}$$

$= \alpha \mathrm{A}\ (v')(\ y\ )$

Similarly,we get $\beta\theta(B)(v')(yy\ ) = \beta A(v')(\ y\ )$.Therefore$f((T,M)\cap\mathcal{E}(S,N))\subseteq f(T,M)\cap\mathcal{E}$ $f(S,N)$.

(7)Let us assume that,$(T,M)\subseteq(S,N)$.Then,$M\subseteq N$andfor any $v\in M$ and $x\in$Xwe get $(M)\subseteq(N)$.We have,

$\alpha\theta(T)(v')(y) = \begin{cases} \sup_{v\in\rho^{-1}(v')\cap(M),\ x\in\theta\theta^{-1}(y)} \alpha T(v)(x), & \text{if } \theta\theta^{-1}(y)\neq\emptyset \\ 0, & otherwise \end{cases}$

$\geq \begin{cases} \sup_{v\in\rho^{-1}(v')\cap(N),\ x\in\theta\theta^{-1}(y)} \alpha S(v)(x), & \text{if } \theta\theta^{-1}(y)\neq\emptyset \\ 0, & otherwise \end{cases}$

$= \alpha\theta(S)(v')(y)$

Similarly,wehave,$\beta\theta(T)(v')(y)\geq\beta\theta(S)(v')(y)$.Therefore,$f(T,M)\subseteq f(S,N)$.

Proposition3.4

Assumethat f: $\mathcal{QTF}$SS(X,) $\rightarrow$ $\mathcal{QTF}(Y,V')$ is a Quin-Terranean fuzzy soft mapping.Then for Quin-Terranean fuzzy soft sets (T,M) and (S,N) in $\mathcal{QTF}$SS(X,V), we obtain

(1) $f^{-1}(0_{(X,V)})=0_{(Y,V')}$,
(2) $f^{-1}(1_{(X,V)})\subseteq 1_{(Y,V')}$,
(3) $f^{-1}((T,M)\cup\mathcal{E}(S,N))=f^{-1}(T,M)\cup\mathcal{E}f^{-1}(S,N)$,
(4) $f^{-1}((T,M)\cap\mathcal{E}(S,N))\subseteq f^{-1}(T,M)\cap\mathcal{E}f^{-1}(S,N)$,
(5) If$(T,M)\subseteq(S,N)$then$f^{-1}(T,M)\subseteq f^{-1}(S,N)$,
(6) $(T,M)\subseteq f^{-1}(f(T,M))$, then $f^{-1}(f(S,N)) = (S,N)\cap\mathcal{E}f(1X)$ Proof : Simple and direct.

Definition 3.5

Let$(X,\tau_1, V)\mathcal{QT}and(Y,\tau_2, V')\mathcal{QT}$betwoQuin-Terranean fuzzy soft topological spaces,a Quin-Terranean fuzzy soft mapping $f = (\theta\theta,\rho)$: $\mathcal{QTF}$SS(X,V) $\rightarrow$ $\mathcal{QTF}$SS(Y,V') is calleda "Quin-Terranean fuzzy soft continuous"if$f^{-1}(S,N)\in\tau_1$ forall$(S,N)\in\tau_2$.

Example 3.6

LetX=$\{x_1, x_2\}$,$Y=\{y_1, y_2\}$,$V=\{v_1,v_2\}$ and $V'=\{v'_1,v'_2\}$.$\tau_1=\{0_X,1_X,(T_1,V),(T_2,V)\}$ where(T_1,V),(T_2,V)Quin-Terranean fuzzy soft sets over X,defined as follows,

$(T1,V) = \{(v_1,\{(x_1,0.78,0.80),(x_2,0.80,0.70)\}), (v_2,\{(x_1,0.80,0.70),(x_2,0.90,0.80)\})\}$

$(T2,V)= \{(v_1,\{(x_1,0.65,0.85),(x_2,0.80,0.90)\}), (v_2,\{(x_1,0.80,0.70),(x_2,0.65,0.85)\})\}$

Then τ_1 is a Quin-Terranean fuzzy soft topology over Xand hence(X,τ_1, $V)\mathcal{QT}$is a Quin-Terranean fuzzy soft topological space.

$\tau_2=\{0_F,1_F,(S_1,V'),(S_2,V')\}$where$(S_1,V')$,$(S_2,V')$Quin-Terraneanfuzzysoftsets over$Y$, definedas follows,

$$\overline{(}S1,V) \quad \{ (v'1,\{(\underline{\ }y\ 1\ ,0.80,0.70),(\underline{\ }y\ 2\ ,0.90,0.80)\}) \\ (v'2,\{(y\ 1\ ,0.78,0.80),(\ y\ 2\ ,0.80,0.70)\})\}$$

(S2,V) = $\{(v'1,\{(\bar{y}1,0.80,0.70),(\bar{y}2,0.65,0.85)\})$ $(v'2,\{(\bar{y}1,0.65,0.85),(\bar{y}2,0.80,0.90)\})\}$

Then $\bar{\tau}2$ is a Quin-Terranean fuzzy soft topology over X and hence $(Y, \bar{\tau}2,)$is a Quin-Terranean fuzzy soft topological space.If $f = (\theta\theta,\rho)$:$\mathcal{QTF}$SS(X,V) → $\mathcal{QTF}$SS(Y,V') defined as follow:

$(\bar{x})= \bar{y}2$ $\rho(v1)=v'1$

$(\bar{x})=\bar{y}1$ $\rho(v2)=v'2$

Then it is easy to verify that $f^{-1}(S,V') \in \bar{\tau}1$ for all $(S,V') \in \bar{\tau}2$. Thus $f= (\theta\theta,\rho)$ is a Quin-Terranean fuzzy soft continuous mapping.

Theorem 3.7

Let(X, $\bar{\tau}1$,)and $(Y, \bar{\tau}2, V')\mathcal{QT}$betwoQuin-Terraneanfuzzysofttopologicalspaces, f=($\theta\theta$,ρ):$\mathcal{QTF}$SS(X,V)→$\mathcal{QTF}$SS(Y,V')isaQuin-Terranean fuzzy soft continuous mapping. If $(S,')$ ∈ $\mathcal{QTF}$SS(Y,V') is a Quin-Terranean fuzzy soft closed set, then $f^{-1}(S,V')$ ∈ $\mathcal{QTF}$SS(X,V)is a Quin-Terranean fuzzy soft closed set.

Proof

Assume that f : $\mathcal{QTF}$SS(X,V) → $\mathcal{QTF}$SS(Y,V')is a Quin-Terranean fuzzy soft continuous mapping on the Quin-Terraneanfuzzy soft topological space(X, $\bar{\tau}1$, $V)\mathcal{QT}$andlet(S,V')beany Quin-Terranean fuzzy soft closed set in$Y$.Then$f^{-1}((S,V')^{C})=(f^{-1}(S,V'))^{C}and(S,V')^{C}$is a Quin-Terranean fuzzy soft open set, the following results are obtained. Consequently, $(f^{-1}(S,V'))^{C}$isaQuin-Terranean fuzzy soft open set in X which implies,$f^{-1}(S,V')$ is a Quin-Terranean fuzzy soft closed set in X.

Conversely, let's assume that$f^{-1}(S,V')$ is a Quin-Terranean fuzzy soft closed set in X whenever$(S,V')$is a Quin-Terranean fuzzy soft closed set in Y.InY,Forevery Quin-Terranean fuzzy soft open set(T,V'),$f^{-1}((T,V')^{C})=(f^{-1}(T,V'))^{C}$.According to the hypothesis, $f^{-1}((T,V')^{C})$ is a Quin-Terranean fuzzy soft closed set in X. Therefore$f^{-1}(T,V')$ is a Quin-Terranean fuzzy soft continuous mapping on a Quin-Terranean fuzzy soft topological space (X, τ 1 , $V)\mathcal{QT}$.

Theorem4.2

Let(X,1 ,$V)\mathcal{QT}$and$(Y, \bar{\tau}2, V')\mathcal{QT}$betwoQuin-Terraneanfuzzysofttopologicalspacesand

$f = (\theta\theta,\rho) : \mathcal{QTF}SS(X,V) \rightarrow \mathcal{QTF}SS(Y,V')$ be a Quin-Terranean fuzzy soft continuous mapping.Then f is a Quin-Terranean fuzzy soft continuous mapping on Quin-Terraneanfuzzy soft topological space $(X, \tau\bar{1}, V)\mathcal{QT}$if and only if$f^{-1}$(Qtint (S,V')) ⊆ Qtint($f^{-1}(T,V')$) for each $(S, V') \in \mathcal{QTF}SS(Y, V')$.

Proof

Let(S,V')∈$\mathcal{QTF}SS(Y,V')$and$f$ be a Quin-Terranean fuzzy soft continuous mapping. Accordingly,f^{-1}(Qtint(S,V'))∈ τ 1 and$\bar{\text{fr}}$omQtint(S,V')⊆(S,V')wehavef^{-1}(Qtint

$(S,V')) \subseteq f^{-1}(S,V')$. Since Qtint $(f^{-1}(S,V'))$ is the largest Quin-Terranean fuzzy soft open set that contains $f^{-1}(S,V')$.f^{-1}(Qtint $(S,V')) \subseteq$ Qtint $(f^{-1}(S,V'))$.

Conversely,assuming that for every $(S,V') \in \mathcal{QTFSS}(Y,V')$,$f^{-1}$(Qtint$(S,V')) \subseteq$ Qtint$(f^{-1}(S,V'))$.Assuming$(S,V')) \in \bar{\tau}_2$, we obtain$f^{-1}(S,V')=f^{-1}$(Qtint$(S,V')) \subseteq$ Qtint$(f^{-1}(S,V')) \subseteq f^{-1}(S,V')$. Therefore, $f^{-1}(S,V') \in \tau_1$. This implies that f is a Quin-Terranean fuzzy soft continuous mapping.

Theorem 3.8

Let(X, $\bar{\tau}_1$,)and(Y, $\bar{\tau}_2$, V')$\mathcal{QT}$ be two Quin-Terranean fuzzy soft topological spaces and let f : $\mathcal{QTF}$SS(X,) → $\mathcal{QTF}$S(Y,V') be a Quin-Terranean fuzzy soft continuous mapping. Then,f=($\theta\theta$,ρ)is a Quin-Terraneanfuzzy soft continuous mapping on a Quin-Terraneanfuzzy soft topological space(X, $\bar{\tau}_1$, V)$\mathcal{QT}$ if and only if $f(\mathcal{QT}Cl(T,V)) \subseteq \mathcal{QT}Cl(f(T,V))for(T,V)$ $\in \mathcal{QTF}$SS(X, V).

Proof

Let f be a Quin-Terranean fuzzy soft continuous mapping on Quin-Terranean fuzzy soft topological space (X, $\bar{\tau}_1$,)and $(T,V) \in \mathcal{QTF}$SS(X,V). Since $\mathcal{QT}Cl$ ((T,)) is a Quin- Terranean fuzzy soft closed set in Y, $f^{-1}(\mathcal{QT}Cl\,(f(T,V)))$ is a Quin-Terranean fuzzy soft closed set in X.
Hence, $(f^{-1}(\mathcal{QT}Cl(f(T,V))))) = f^{-1}(\mathcal{QT}Cl(f(T,V)))$ and
$f(T,V) \subseteq \mathcal{QT}Cl(f(T,V))$.
Consequently,weobtain$(T,V) \subseteq f^{-1}(f(T,V)) \subseteq f^{-1}(\mathcal{QT}Cl(f(T,V)))$thenwehave,
$(T,V) \subseteq \mathcal{QT}Cl(f^{-1}(\mathcal{QT}Cl(f(T,V))))) \subseteq f^{-1}(\mathcal{QT}Cl(f(T,V)))$.Accordingly,
$f(\mathcal{QT}Cl(T,V)) \subseteq \mathcal{QT}Cl(f(T,V))$.
Conversely, assume that $(\mathcal{QT}Cl\ (T,)) \subseteq \mathcal{QT}Cl\ ((T,))$ for every $(T,) \in \mathcal{QTF}$SS(X,) and $(S,')$ is any Quin-Terranean fuzzy soft closed set in Y. Hence, $\mathcal{QT}Cl$ $(S,')$ = (S,V'). Fromtheresultofthehypothesis,$f(\mathcal{QT}Cl(f^{-1}(S,V'))) \subseteq \mathcal{QT}Cl(f(f^{-1}(S,V'))) \subseteq \mathcal{QT}Cl$ (S,V') = (S,V'). Thus, $\mathcal{QT}Cl$ $(f^{-1}(S,V')) = f^{-1}(S,V')$ and $f^{-1}(S,V') \subseteq \mathcal{QT}Cl$ $(f^{-1}(S,V'))$. This means that $\mathcal{QT}Cl$ $(f^{-1}(S,V'))$ = $f^{-1}(S,V')$ and hence, $f^{-1}(S,V')$ is a Quin-Terranean fuzzysoftclosedsetinX.Consequently,f isaQuin-Terraneanfuzzysoftcontinuousmapping on a Quin-Terranean fuzzy soft topological space (X,$\bar{\tau}_1$, V)$\mathcal{QT}$.

4. CONCLUSION

The concept of Quin-Terranean fuzzy set which is extension of fuzzy set, intuitionistic fuzzy set, Pythagorean fuzzy set and soft set theories are all crucial mathematical instruments for handling uncertainties. Presented in this study are Quin-Terranean fuzzy soft continuous spaces. Next, we looked into the concepts of Quin-Terranean fuzzy soft closure and Quin-Terraneanfuzzysoftinterior.Wealsodefinethepre-imageandimageofQuin-Terraneanfuzzy softsets.

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