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Intuitionistic Fuzzy γ Supra Open Mappings And Intuitionistic Fuzzy γ Supra Closed Mappings

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Abstract-Necla Turanl introduced the concept of Intuitionistic fuzzy supra topological space which is a special case of Intuitionistic fuzzy topological space. Aim of this paper is we introduced in IF γ supra open sets in Intuitionistic fuzzy supra topological space.and also we studied about Intuitionistic Fuzzy γ Supra Open Mappings And Intuitionistic Fuzzy γ Supra Closed Mappings in Intuitionistic fuzzy supra topological spaces

Index Terms-*IFγ supra open set, IFγ supra closed set, Intuitionistic fuzzy γ supra Open Mappings, Intuitionistic fuzzyi γ supra Closed Mappings*

1. INTRODUCTION

Topology is a classical subjects,as a generalization topological spaces many type of topological spaces introduced over the year. C.L. Chang [4] was introduced and developed fuzzy topological space by using L.A. Zadeh's[23] fuzzy sets. Coker[5] introduced the notion of Intuitionistic fuzzy topological spaces by using Atanassov's[2] Intuitionistic fuzzy sets

A.S. Mashhour [13] et al. Introduced and studied the supra topological spaces in the year 1983. M. E. AbdEl-Monsef et al. [1] introduced the fuzzy supra topological spaces and studied fuzzy supra-continuous functions and obtained some properties and characterizations. In 2003 Necla Turanl [21] introduced the concept of Intuitionistic fuzzy supra topological space

In 1996 D. Andrijevic[2] introduced b open sets in topological space,In this paper we introduced and studied about Intuitionistic Fuzzy γ Supra Open Mappings And Intuitionistic Fuzzy γ Supra Closed Mappings in Intuitionistic fuzzy supra topological spaces

2. PRELIMINARIES

Definition 2.1: [3]
An Intuitionistic fuzzy set (IF for short) A is an object having the form

$$A = \{\langle x, \mu_A(x), \nu_A(x)\rangle : x \in X\}$$

where the functions μ_A:X⟶[0,1] and ν_A:X⟶ [0,1] denote the degree of membership (namely $\mu_A(x)$) and the degree of non-membership (namely $\nu_A(x)$) of each element x ∈ X to the set A respectively, and $0 \le \mu_A(x) + \nu_A(x) \le 1$ for each x ∈ X.
Obviously, every fuzzy set A on a nonempty set X is an IFS of the following form

$$A =\{\langle x, \mu_A(x), 1- \mu_A(x)\rangle: x \in X\}.$$

Definition 2.2[3]
Let A and B be two IFSs of the form
$A = \{\langle x, \mu_A(x), \nu_A(x)\rangle: x \in X\}$ and $B = \{\langle x, \mu_B(x), \nu_B(x)\rangle : x\in X\}$. Then,
(i) $A \subseteq B$ if and only if $\mu_A(x)\le\mu_B(x)$ and $\nu_A(x)\ge \nu_B(x)$ for all x ∈ X,
(ii) A = B if and only if $A \subseteq B$ and $A \supseteq B$,
(iii) $A^C = \{\langle x, \nu_A(x), \mu_A(x)\rangle: x \in X\}$,
(iv) $A\cup B = \{\langle x, \mu_A(x) \vee \mu_B(x), \nu_A(x) \wedge \nu_B(x)\rangle: x \in X\}$,
(v) $A\cap B = \{\langle x, \mu_A(x) \wedge \mu_B(x), \nu_A(x) \vee \nu_B(x)\rangle: x \in X\}$.
(vi) $[]A = \{\langle x, \mu_A(x), 1 - \mu_A(x)\rangle , x \in X\}$;
(vii) $\langle\rangle A = \{\langle x, 1 - \nu_A(x), \nu_A(x)\rangle , x \in X\}$;
The Intuitionistic fuzzy sets 0~ = ⟨x, 0, 1⟩ and 1~ = ⟨x, 1, 0⟩ are respectively the empty set and the whole set of X

Definition 2.3. [3]
Let {Ai : i ∈ J } be an arbitrary family oIFS Intuitionistic fuzzy sets in X. Then
(i) $\cap A_i = \{\langle x,\wedge \mu_{Ai}(x),\vee \nu_{Ai}(x) \rangle : x \in X\}$;
(ii) $\cup A_i = \{\langle x,\vee \mu_{Ai}(x),\wedge \nu_{Ai}(x) \rangle : x \in X\}$.

Definition 2.4. [3]
Since our main purpose is to construct the tools for developing Intuitionistic fuzzy topological spaces, we must introduce the Intuitionistic fuzzy sets 0~ and 1~ in X as follows:

0~ = {⟨x, 0, 1⟩: x ∈ X} and 1~ = {⟨x, 1, 0⟩ : x ∈ X}.

Definition 2.5[3]

Let A,B,C be Intuitionistic fuzzy sets in X. Then

(i) A ⊆ B and C ⊆ D ⇒A ∪ C ⊆ B ∪ D and A ∩ C ⊆ B ∩ D,
(ii) A ⊆ B and A ⊆ C ⇒A ⊆ B ∩ C,
(iii) A ⊆ C and B ⊆ C ⇒A ∪ B ⊆ C,
(iv) A ⊆ B and B ⊆ C ⇒A ⊆ C,
(v) $\overline{A \cup B} = \bar{A} \cap \bar{B}$
(vi) $\overline{A \cap B} = \bar{A} \cup \bar{B}$,
(vii) A ⊆ B ⇒$\bar{B} \subseteq \bar{A}$,
(viii) $\overline{(\bar{A})}$ = A,
(ix) $\bar{1}$∼ = 0∼,
(x) $\bar{0}$∼ = 1∼.

Definition 2.6[3]

Let f be a mapping from an ordinary set X into an ordinary set Y ,

If B ={⟨y, $\mu_B(y)$, $\nu_B(y)$ ⟩ : y ∈ Y } is an IFST in Y , then the inverse image of B under f is an IFST defined by $f^{-1}(B)$={⟨x, $f^{-1}(\mu_B)(x)$, $f^{-1}(\nu_B)(x)$ ⟩ : x ∈ X}

The image of IFST A = {⟨y, $\mu_A(y)$, $\nu_A(y)$ ⟩ : y ∈ Y } under f is an IFST defined by

f(A) = {⟨y, $f(\mu_A)(y)$, $f(\nu_A)(y)$ ⟩ : y ∈ Y }.

Definition 2.7[3]

Let A, Ai (i ∈ J) be Intuitionistic fuzzy sets in X, B, Bi (i ∈ K) be Intuitionistic fuzzy sets in Y and f:X →Y is a function. Then

(i) $A_1 \subseteq A_2 \Rightarrow f(A_1) \subseteq f(A_2)$,
(ii) $B_1 \subseteq B_2 \Rightarrow f^{-1}(B_1) \subseteq f^{-1}(B_2)$,
(iii) A ⊆ f^{-1}(f (A)) { If f is injective, then A = f^{-1}(f (A))},
(iv) f (f^{-1}(B))⊆ B{If f is surjective, then f(f^{-1}(B))=B},
(v) $f^{-1}(\cup B_j) = \cup f^{-1}(B_j)$
(vi) $f^{-1}(\cap B_j) = \cap f^{-1}(B_j)$
(vii) $f(\cup B_j) = \cup f(B_j)$
(viii) $f(\cap B_j) \subseteq \cap f(B_j)$ { If f is injective, then $f(\cap B_j) = \cap f(B_j)$}
(ix) f^{-1}(1∼) = 1∼ ,
(x) f^{-1}(0∼) = 0∼,
(xi) f (1∼) = 1∼ , if f is surjective
(xii) f (0∼) = 0∼,
(xiii) $\overline{f(A)} \subseteq f(\bar{A})$, if f is surjective,
(xiv) $f^{-1}(\bar{B}) = \overline{f^{-1}(B)}$.

Definition 2.8[21]

A family τ_μ Intuitionistic fuzzy sets on X is called an Intuitionistic fuzzy supra topology(in short,IFST) on X if 0~∈τ_μ,1~∈τ_μ and τ_μ is closed under arbitrary suprema.

Then we call the pair (X,τ_μ) an Intuitionistic fuzzy supra topological space (in short,IFSTS).

Each member of τ_μ is called an Intuitionistic fuzzy supra open set and the complement of an Intuitionistic fuzzy supra open set is called an Intuitionistic fuzzy supra closed set.

Definition 2.9[21]

The Intuitionistic fuzzy supra closure of a set A is denoted by S-cl(A) and is defined as

S-cl (A) = ∩{B : B is Intuitionistic fuzzy supra closed and A ⊆ B} .

The Intuitionistic fuzzy supra interior of a set A is denoted by S-int(A) and isdefined as

S-int(A) = ∪{B : B is Intuitionistic fuzzy supra open and A ⊇ B}

Definition 2.10[21]

(i). ¬ (AqB) ⇔ A ⊆ B^C .
(ii). A is an Intuitionistic fuzzy supra closed set in X ⇔ S-cl(A) = A.
(iii). A is an Intuitionistic fuzzy supra open set in X ⇔ S-int (A) = A.
(iv). S-cl(A^C) = $(\text{S-int}(A))^C$.
(v). S-int(A^C) = $(\text{S-cl}(A))^C$.
(vi). A ⊆ B ⇒ S-int(A) ⊆ S-int(B).
(vii). A ⊆ B ⇒ S-cl(A) ⊆ S-cl(B).
(viii). S-cl(A ∪ B) =S-cl(A)∪ S-cl(B).
(ix). S-int(A ∩ B) = S-int(A)∩S-int(B).

Definition 2.11

Let (X, τμ) is a Intuitionistic fuzzy supra topological space and A ⊆ X .Then A is said to be Intuitionistic fuzzy γ supra open(briefly IFγs -open) set if A⊆ s-cl(s-int(A))∪ s-int(s-cl(A)).

The complement of Intuitionistic fuzzy γ supra open set is called Intuitionistic fuzzy γ supra closed set (briefly IFγs closed).

Definition 2.12

The Intuitionistic fuzzy γ supra closure of a set A is denoted by IFγS-cl(A) and isdefined as

IFγS -cl (A) = ∩{B : B is Intuitionistic fuzzy γ supra closed and A ⊆ B} .

The Intuitionistic fuzzy γ supra interior of a set A is denoted by IFγS -int(A) and is defined as

IFγS -int(A) = ∪{B : B is Intuitionistic fuzzy γ supra open and A ⊇ B}

Definition 2.13[21]

Let (X, τμ) and (Y, σμ) be two Intuitionistic fuzzy supra topological spaces and let f: X→Y be a function. Then f is said to be

(i) Intuitionistic fuzzy supra continuous if the pre image of each Intuitionistic fuzzy supra open set of Y is an Intuitionistic fuzzy supra open set in X.
(ii) Intuitionistic fuzzy supra closed if the image of each Intuitionistic fuzzy supra closed set in X is an Intuitionistic fuzzy supra closed set in Y.
(iii) Intuitionistic fuzzy supra open if the image of each Intuitionistic fuzzy supra open set in X is an Intuitionistic fuzzy supra open set in Y.

3.INTUITIONISTIC FUZZY γ SUPRA OPEN MAPPINGS

Definition 3.1

A mapping f : (X, τμ) → (Y, σμ) is Intuitionistic fuzzy γ supra open if the image of every Intuitionistic fuzzy supra open set of X is Intuitionistic fuzzy γ supra open set in Y.

Remark 3.2

Every Intuitionistic fuzzy supra open map is Intuitionistic fuzzy γ supra open but converse may not be true. For,

Example 3.3 Let X = {a, b} , Y = {x , y} and the Intuitionistic fuzzy set U and V are defined as follows :A_1 = { x,< 0.7, 0.4 > , < 0.5, 0.6 >},
A_2 = { x ,< 0.5, 0.6> , < 0.8, 0.7 >}
B_1 = { y,< 0.7, 0.6 >, < 0.5, 0.6 >},
B_2 = { y,< 0.5, 0.6>, >, < 0.8, 0.7 >},
Then τμ ={0~, 1~, A_1, A_2, $A_1 \cup A_2$} and σμ ={0~, 1~, B_1, B_2, $B_1 \cup B_2$} be Intuitionistic fuzzy supra topologies on X and Y respectively . Then the mapping f : (X, τμ) → (Y, σμ) defined by f(a) = x and f(b) =y is Intuitionistic fuzzy γ supra open but it is not Intuitionistic fuzzy supra open.

Theorem 3.4

A mapping f : (X, τμ) → (Y, σμ) is Intuitionistic fuzzy γ supra open if and only if for every Intuitionistic fuzzy set U of X f(S-int(U)) ⊆IFγS-int(f(U)).

Proof:

Necessity Let f be an Intuitionistic fuzzy γ supra open mapping and U is an Intuitionistic fuzzy supra open set in X. Now S-int(U)⊆U which implies that f(S-int(U)⊆f(U). Since f is an Intuitionistic fuzzy γ supra open mapping,f(S-int(U) is Intuitionistic fuzzy γ supra open set in Y such that f(S-int(U) ⊆f(U) therefore f(S-int(U) ⊆IFγS-int f(U).

Sufficiency: For the converse suppose that U is an Intuitionistic fuzzy supra open set of X. Then
f (U)=f(S-int(U)⊆IFγS-intf(U). But IFγS-int(f (U))⊆f (U). Consequently f (U)=IFγS-int(U) which implies that f(U) is an Intuitionistic fuzzy γ supra open set of Y and hence f is an Intuitionistic fuzzy γ supra open .

Theorem 3.5

If f :(X, τμ)→(Y, σμ) is an Intuitionistic fuzzy γ supra open map then S-int(f^{-1}(G)⊆f^{-1}(IFγS-int(G) for every Intuitionistic fuzzy set G of Y.

Proof:

Let G is an Intuitionistic fuzzy set of Y. Then S-int f^{-1}(G) is an Intuitionistic fuzzy supra open set in X. Since f is Intuitionistic fuzzy γ supra open f(S-int f^{-1}(G)) is Intuitionistic fuzzy γ supra open in Y and hencef(S-intf^{-1}(G))⊆IFγS-int(f(f^{-1}(G))⊆IFγS-int(G). ThusS-intf^{-1}(G)⊆f^{-1}(IFγS-int (G).

Theorem 3.6

A mapping f : (X, τμ) → (Y, σμ) is Intuitionistic fuzzy γ supra open if and only if for each Intuitionistic fuzzy set S of Y and for each Intuitionistic fuzzy supra closed set U of X containing f^{-1}(S) there is a Intuitionistic fuzzy γ supra closed V of Y such that S ⊆V and f^{-1}(V) ⊆U .

Proof:

Necessity: Suppose that f is an Intuitionistic fuzzy supra γ open map. Let S be the Intuitionistic fuzzy supra closed set of Y and U is an Intuitionistic fuzzy supra closed set of X such that f^{-1}(S) ⊆U . Then V = (f^{-1}(U^C))^C is Intuitionistic fuzzy γ supra closed set of Y such that f^{-1}(V) ⊆U .

Sufficiency: For the converse suppose that F is an Intuitionistic fuzzy supra open set of X. Then
f^{-1}((f(F))^C⊆F^C and F^C is Intuitionistic fuzzy supra closed set in X. By hypothesis there is an Intuitionistic fuzzy γ supra closed set V of Y such that (f(F))^C ⊆V and f^{-1}(V) ⊆F^C .Therefore F ⊆(f^{-1}(V))^C . Hence V^C⊆f(F)⊆f((f^{-1}(V))^C)⊆V^C which implies f(F)=V^C . SinceV^C is Intuitionistic fuzzy γ supra open set of Y. Hence f (F) is Intuitionistic fuzzy γ supra open in Y and thus f is Intuitionistic fuzzy γ supra open map.

Theorem 3.7

A mapping f : (X, τμ) → (Y, σμ) is Intuitionistic fuzzy γ supra open if and only if f^{-1}(γS-cl(B)⊆S-cl f^{-1}(B) for every Intuitionistic fuzzy set B of Y.

Proof:

Necessity: Suppose that f is an Intuitionistic fuzzy supra γ open map. For any Intuitionistic fuzzy set B of Y f^{-1}(B) ⊆S-cl(A) f^{-1}(B)) Therefore by theorem 6.3 there exists an Intuitionistic fuzzy γ supra closed set F in Y such that B ⊆F and f^{-1}(F) ⊆S-cl(A) f^{-1}(B)). Therefore we obtain that f-^{1}(γS-cl (B)) ⊆f^{-1}(F) ⊆S-cl f^{-1}((B)).

Sufficiency: For the converse suppose that B is an Intuitionistic fuzzy set of Y. and F is an Intuitionistic fuzzy supra closed set of X containing f^{-1}(B). Put V=S-cl(B) , then we have B⊆V and V is Intuitionistic fuzzy γ supra closed and f^{-1}(V) ⊆S-cl(f^{-1}(B))⊆F. Then by theorem 3.6 f is Intuitionistic Intuitionistic fuzzy supra γ open .

Theorem 3.8

If f : (X, τμ) → (Y, σμ) and g : (Y, σμ)→(Z, ρμ) be two Intuitionistic fuzzy map and gof : (X, τμ)→(Z, ρμ) is Intuitionistic fuzzy supra γ open **.** *If g : (Y, σμ)→ (Z, ρμ) is Intuitionistic fuzzy γ supra irresolute then f : (X, τμ) → (Y, σμ) is Intuitionistic fuzzy γ supra open map.*

Proof:

Let H be an Intuitionistic fuzzy supra open set of Intuitionistic fuzzy supra topological space (X, τμ). Then (gof)(H) is Intuitionistic fuzzy γ supra open set of Z because gof is Intuitionistic fuzzy supra γ open map. Now since g:(Y, σμ)→(Z, ρμ) is Intuitionistic fuzzy γ supra irresolute and (gof) (H) is Intuitionistic fuzzy γ supra open set of Z therefore g^{-1}(gof (H)) = f(H) is Intuitionistic fuzzy γ supra open set in Intuitionistic fuzzy supra topological space Y.Hence f is Intuitionistic fuzzy γ supra open map.

4. INTUITIONISTIC FUZZY γ SUPRA CLOSED MAPPINGS

Definition 4.1

A mapping f : (X, τμ) → (Y, σμ) is Intuitionistic fuzzy γ supra closed if image of every Intuitionistic fuzzy supra closed set of X is Intuitionistic fuzzy γ supra closed set in Y.

Remark 4.2

Every Intuitionistic fuzzy supra closed map is Intuitionistic fuzzy γ supra closed but converse may not be true. For,

Example 4.3

Let X = {a, b}, Y = {x, y}Then the mapping f :(X, τμ) → (Y, σμ) defined in Example 3.3 is Intuitionistic fuzzy γ supra closed but it is not Intuitionistic fuzzy supra closed.

Theorem 4.4

A mapping f : (X, τμ) → (Y, σμ) is Intuitionistic fuzzy γ supra closed if and only if for each Intuitionistic fuzzy set S of Y and for each Intuitionistic fuzzy supra open set U of X containing $f^{-1}(S)$ there is a Intuitionistic fuzzy γ supra open set V of Y such that S ⊆V and $f^{-1}(V)$ ⊆U .

Proof:

Necessity: Suppose that f is an Intuitionistic fuzzy γ supra closed map. Let S be the Intuitionistic fuzzy supra closed setof Y and U is an Intuitionistic fuzzy supra open set of X such that $f^{-1}(S) \subseteq U$. Then $V = Y - f^{-1}(U^C)$ is Intuitionistic fuzzy supra γ open set of Y such that $f^{-1}(V) \subseteq U$.

Sufficiency: For the converse suppose that F is an Intuitionistic fuzzy supra closed set of X. Then $(f(F))^C$ is an Intuitionistic fuzzy set of Y and F^C is Intuitionistic fuzzy supra open set in X such that $f^{-1}((f(F))^C) \subseteq F^C$. By hypothesis there is an Intuitionistic fuzzy γ supra open set V of Y such that $(f(F))^C \subseteq V$ and $f^{-1}(V) \subseteq F^C$ .Therefore $F \subseteq (f^{-1}(V))^C$. Hence $V^C \subseteq f(F) \subseteq f((f^{-1}(V))^C) \subseteq V^C$ which implies $f(F) = V^C$. Since V^C is Intuitionistic fuzzy γ supra closed set of Y. Hence f (F) is Intuitionistic fuzzy γ supra closed in Y and thus f is Intuitionistic fuzzy γ supra closed map.

Theorem 4.5

If f : (X, τμ) → (Y, σμ) is Intuitionistic fuzzy supra closed and g:(Y, σμ)→(Z, ρμ) is Intuitionistic fuzzy γ supra closed set. Then gof :(X, τμ)→(Z, ρμ) is Intuitionistic fuzzy γ supra closed set.

Proof:

Let H be an Intuitionistic fuzzy supra closed set of Intuitionistic fuzzy supra topological space (X, τμ). Then f (H) is Intuitionistic fuzzy supra closed set of (Y, σμ)because f is Intuitionistic fuzzy S-closed map. Now(gof) (H) =g(f(H)) is Intuitionistic fuzzy γ supra closed set in Intuitionistic fuzzy supra topological space Z because g is Intuitionistic fuzzy γ supra closed map. Thus gof : (X, τμ) → (Z, ρμ) is Intuitionistic fuzzy γ supra closed set.

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