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Ifgp* Continuous Mapping, Ifgp* Irresolute Mapping, and Ifgp* Connectedness in Intuitionistic Fuzzy Topological Spaces

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ABSTRACT

Intuitionistic fuzzy gp* - continuous mapping, Intuitionistic fuzzy gp* - irresolute mapping and intuitionistic fuzzy gp* - connectedness are introduced in this paper. Here we have also investigated their relations with other intuitionistic fuzzy sets and their properties.

Keywords

Intuitionistic fuzzy gp* - closed sets, intuitionistic fuzzy gp* - open sets, intuitionistic fuzzy gp* - continuous sets and intuitionistic fuzzy gp* - irresolute functions, intuitionistic fuzzy gp* - connectedness.

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1. INTRODUCTION

The concept of Fuzzy was introduced by **Zadeh [27]** and later **Atanassov [3]** generalized this idea to intuitionistic fuzzy sets using notions of fuzzy sets. On the other hand, **Coker [12]** introduced intuitionistic fuzzy topological spaces using the notion of intuitionistic fuzzy sets. **S. S. Thakur** and **Rekha Chaturvedi [26]** initiated Generalized continuity in intuitionistic fuzzy topological spaces. **J. K. Joen, Y. B. Jun** and **J. H. Park [18]** proposed Intuitionistic fuzzy alpha continuous and intuitionistic fuzzy pre continuous. **K. Sakthivel [23]** developed the concept of Intuitionistic fuzzy alpha generalized continuous mapping and intuitionistic alpha generalized irresolute mapping. Generalized alpha continuous mappings in intuitionistic fuzzy topological spaces were proposed by **C. S. Gowri, K. Sakthivel** and **D. Kalamani [15]**. Intuitionistic fuzzy g# closed sets were defined by **R. Dhavaseelan, Abhirami Shanmugasundram [1]**. **Jyothi Pandey Bajpai, S. S. Thakur [19]** found intuitionistic fuzzy g*p closed sets. **P. Rajarajeswari** and **L. Senthil kumar [20]** introduced the concept of Generalized pre closed sets in intuitionistic fuzzy topological spaces. **Gurcay H, Haydar A** and **Coker D [16]** discovered the concept on fuzzy continuity in Intuitionistic fuzzy topological spaces. **Santhi R** and **Sakthivel K [21]** instituted the concept of Intuitionistic fuzzy generalized semicontinuous mapping. **Aman Mahbub Md, Sahadat Hossain Md** and **Altab Hossain M [2]** found connectedness concept in intuitionistic fuzzy topological spaces

In this paper, we have defined the notion of Intuitionistic fuzzy generalized pre star – continuous mapping and intuitionistic fuzzy gp* irresolute mapping and Intuitionistic fuzzy gp* connectedness and study some of the properties regarding it.

2. PRELIMINARIES

2.1 The followings are the intuitionistic fuzzy topological spaces definitions.

Definition 2.1.1[3]: Let X be a non empty fixed set. An intuitionistic fuzzy set (IFS in short) A in X is an object having the form $A = \{< x, \mu_A(x), \nu_A(x) > / x\epsilon X\}$ where the functions $\mu_A(x): X \to [0,1]$ and $\nu_A(x): X \to [0,1]$ denote the degree of membership (namely $\mu_A(x)$) and the degree of non - membership (namely $\nu_A(x)$) of each element $x\epsilon X$ to a set A respectively and $0 \leq \mu_A(x) + \nu_A(x) \leq 1$ for each $x\epsilon X$.

Definition 2.1.2[3]: Let A and B be IFSs of the form $A = \{< x, \mu_A(x), \nu_A(x) > / x\epsilon X\}$ and $B = \{< x, \mu_B(x), \nu_B(x) > / x\epsilon X\}$. Then

a) $A \subset B$ if and only if $\mu_A(x) \leq \mu_B(x)$ and $\nu_A(x) \geq \nu_B(x)$ for all $x\epsilon X$,

b) $A = B$ if and only if $A \subseteq B$ and $B \subseteq A$,

c) $A^C = \{< x, \mu_A(x), \nu_A(x) > / x\epsilon X\}$,

d) $A \cap B = \{< x, \mu_A(x) \cap \mu_B(x), \nu_A(x) \cup \nu_B(x) > / x\epsilon X\}$,

e) $A \cup B = \{< x, \mu_A(x) \cup \mu_B(x), \nu_A(x) \cap \nu_B(x) > / x\epsilon X\}$.

For the sake of simplicity, the notation $A = < x, \mu_A, \nu_A >$ shall be used instead of $A = \{< x, \mu_A(x), \nu_A(x) > / x\epsilon X\}$. Also for the sake of simplicity, we use the notation $A = < x, (\mu_A(x)\ \mu_B(x)), (\nu_A(x), \nu_B(x)) >$ instead of $A = < x, (A/\mu_A, B/\mu_B), (A/\nu_A, B/\nu_B) >$. The intuitionistic fuzzy sets $0_\sim = \{< x, 0,1 > / x\epsilon X\}$ and $1_\sim = \{< x, 1,0 > / x\epsilon X\}$ are the empty set and the whole set of X, respectively.

Definition 2.1.3[12]: An intuitionistic fuzzy topology (IFT in short) on a non-empty set X is a family τ of IFSs in X satisfying the following axioms:

a) $0_\sim, 1_\sim \in \tau$,

b) $G_1 \cap G_2 \in \tau$ for any $G_1, G_2 \in \tau$,

c) $UG_i \in \tau$ for any arbitrary family $\{G_i | i \in J\} \subseteq \tau$.

In the case, the pair (X, τ) is called an intuitionistic fuzzy topological space (IFTS in short) and any IFS in τ is known as an intuitionistic fuzzy open set (IFOS in short) in X. The complement A^C of an IFOS A is an IFTS (X, τ) is called an intuitionistic fuzzy closed set (IFCS in short) in X.

Result 2.1.4[12]: Let A and B be any two intuitionistic fuzzy sets of an intuitionistic fuzzy topological space(X, τ). Then

a) A is an intuitionistic fuzzy closed set in $X \Leftrightarrow cl(A) = A$,

b) A is an intuitionistic fuzzy closed set in $X \Leftrightarrow int(A) = A$,

c) $cl(A^C) = (int(A))^C$,

d) $int(A^C) = (cl(A))^C$,

e) $A \subseteq B \Rightarrow int(A) \subseteq int(B)$,

f) $A \subseteq B \Rightarrow cl(A) \subseteq cl(B)$,

g) $cl(A \cup B) = cl(A) \cup cl(B)$,

h) $int(A \cap B) = int(A) \cap int(B)$.

Definition 2.1.5[12]: Let (X, τ) be an IFTS and $A = < x, \mu_A, \nu_A >$ be an IFS in X. Then the intuitionistic fuzzy interior and an intuitionistic fuzzy closure are defined by

a) $int(A) = \cup \{G/G\ is\ an\ IFOS\ in\ X\ and\ G \subseteq A\}$,

b) $cl(A) = \cap \{K/K\ is\ an\ IFCS\ in\ X\ and\ A \subseteq K\}$.

Definition 2.1.6: An IFS $A = \{< x, \mu_A(x), \nu_A(x) > / x\epsilon X\}$ is an IFTS (X, τ) is said to be

a) An **intuitionistic fuzzy pre - open set [16]** if $A \subseteq int\big(cl(A)\big)$ and a **intuitionistic fuzzy pre - closed set** if $cl(int(A) \subseteq A$.

b) An **intuitionistic fuzzy semi - open set [16]** if $A \subseteq cl(int(A))$ and a **intuitionistic fuzzy semi - closed set** if $int\big(cl(A)\big) \subseteq A$.

c) An **intuitionistic fuzzy α- open set [12]** if $A \subseteq int(cl(int(A)))$ and a **intuitionistic fuzzy α- closed set** if $cl(int(cl(A)) \subseteq A$.

d) An **intuitionistic fuzzy generalized closed set [25]** (briefly IFg-closed set) if $cl(A) \subseteq U$ whenever $A \subseteq U$ and U is intuitionistic fuzzy open in X.

e) An **intuitionistic fuzzy generalized pre closed set [20]** (briefly IFgp-closed set) if $pcl(A) \subseteq U$ whenever $A \subseteq U$ and U is intuitionistic fuzzy open in X.

f) An **intuitionistic fuzzy generalized # closed set [1]** (briefly IFg#-closed set) if $cl(A) \subseteq U$ whenever $A \subseteq U$ and U is intuitionistic fuzzy generalized α open in X.

g) An **intuitionistic fuzzy generalized α closed set [17]** (briefly IFgα-closed set) if $\alpha cl(A) \subseteq U$ whenever A ⊆ U and U is intuitionistic fuzzy α open in X.

h) An **intuitionistic fuzzy α generalized closed set [22]** (briefly IFαg-closed set) if $\alpha cl(A) \subseteq U$ whenever A ⊆ U and U is intuitionistic fuzzy open in X.

i) An **intuitionistic fuzzy generalized pre closed set [19]** (briefly IFg*p-closed set) if $pcl(A) \subseteq U$ whenever A ⊆ U and U is intuitionistic fuzzy generalized open in X.

j) An **intuitionistic fuzzy pre generalized closed set [9]** (briefly IFpg-closed set) if $pcl(A) \subseteq U$ whenever A ⊆ U and U is intuitionistic fuzzy pre open in X.

Definition 2.1.7[9]: An intuitionistic fuzzy sets A of an intuitionistic fuzzy topological sets (IFTS) (X, τ) is an called **intuitionistic fuzzy generalized pe star closed** (briefly IFgp* - closed) if $cl(A) \subseteq U$ whenever $A \subseteq U$ and U is intuitionistic fuzzy generalized pre - open set in X. The family of all IFgp*cs of ifts (X, τ) is denoted by IFgp*c(X).

Remark 2.1.8[9]: For any IFTS (X, τ), we have the following:

a) Every IF closed sets are IFgp* - closed sets.

b) Every IFg*p - closed sets are IFgp* - closed set.

c) Every IFpg- closed sets are IFgp* - closed sets.

d) Every IFgp*- closed sets are IFg # - closed sets

e) Every IFgp* - closed sets are IFαg - closed sets.

Definition 2.1.9[9]: Suppose a Intuitionistic fuzzy set A is intuitionistic fuzzy generalized pre star closed set in IFTS (X, τ), Then its complement (i,e) 1 - A is called **intuitionistic fuzzy generalized pre star open set** (briefly IFgp* - open) in (X, τ).

Remark 2.1.10[9]: For any IFTS(X, τ), we have the following:

(a) Every IF open sets are IFgp* - open sets.

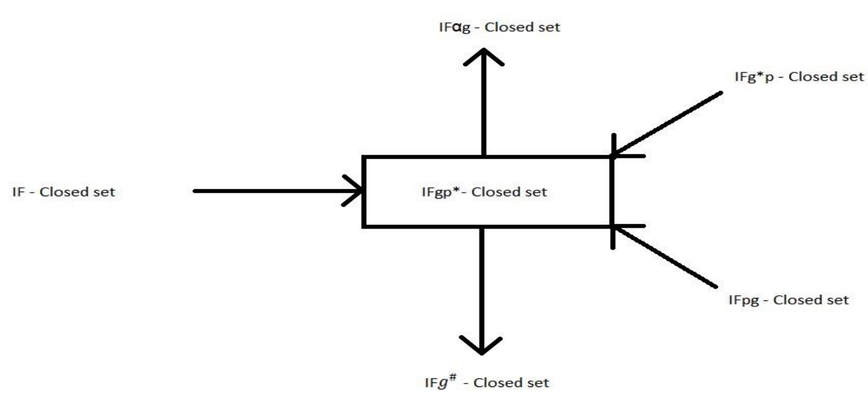
(b) Every IFg*pos is an IFgp*os.

(c) Every IFpgos is an IFgp*os.

(d) Every IFgp*os is an IFg #os.

(e) Every IFgp*os is an IFαgos.

Remark 2.1.11[9]: The following diagram depicts the relation of intuitionistic fuzzy gp*-closed set.



2.2 The followings are the intuitionistic fuzzy continuous definitions.

Definition 2.2.1: A **intuitionistic fuzzy pre – continuous [18]** if the pre image of every intuitionistic fuzzy closed set in Y is intuitionistic fuzzy pre closed in X.

Definition 2.2.2: A **intuitionistic fuzzy generalized continuous [26]** if the pre image of every intuitionistic fuzzy closed set in Y is intuitionistic fuzzy generalized closed in X.

Definition 2.2.3: A **intuitionistic fuzzy generalized pre continuous [20]** if the pre image of every intuitionistic fuzzy closed set in Y is intuitionistic fuzzy generalized pre closed in X.

Definition 2.2.4: A **intuitionistic fuzzy generalized star pre continuous [19]** if the pre image of every intuitionistic fuzzy closed set in Y is intuitionistic fuzzy generalized star pre closed in X.

Definition 2.2.5: A **intuitionistic fuzzy α generalized continuous [23]** if the pre image of every intuitionistic fuzzy closed set in Y is intuitionistic fuzzy α generalized closed in X.

Definition 2.2.6: A **intuitionistic fuzzy generalized # continuous [1]** if the pre image of every intuitionistic fuzzy closed set in Y is intuitionistic fuzzy generalized # closed in X.

Definition 2.2.7: A **intuitionistic fuzzy generalized α continuous [15]** if the pre image of every intuitionistic fuzzy closed set in Y is intuitionistic fuzzy generalized α closed in X.

Definition 2.2.8: Let f be a mapping from an IFTS (X, τ) into an IFTS (Y, σ). Then f is said to be **intuitionistic fuzzy continuous [16]** (IF continuous in short) if $f^{-1}(A)$ is intuitionistic fuzzy closed in X for every A of Y.

Definition 2.2.9: A function f from a IFTS (X, τ) into an IFts $(Y,\ \sigma)$. Then f is said to be intuitionistic fuzzy **irresolute [21]** (IF irresolute in short) $f^{-1}(A)$ is intuitionistic fuzzy closed in X for every IFCS B in Y.

Definition 2.2.10: A intuitionistic fuzzy topological space X is said to be **intuitionistic fuzzy - connected [2]** if it has no proper intuitionistic fuzzy clopen set, (A intuitionistic fuzzy set λ in X is proper if λ ≠ 0 and λ ≠ 1, intuitionistic clopen means intuitionistic closed - open).

3. INTUITIONISTIC FUZZY gp* - CONTINUOUS MAPPINGS

Definition 3.1: If X and Y are two intuitionistic fuzzy topological spaces then a mapping $f: X \to Y$ is called **intuitionistic fuzzy gp* - continuous mapping** if $f^{-1}(A)$ is intuitionistic fuzzy gp* - open set in X, for every intuitionistic fuzzy open A of Y.

Definition 3.2: If X and Y are two intuitionistic fuzzy topological spaces then a mapping $f: X \to Y$ is called **intuitionistic fuzzy gp* - irresolute mapping** if $f^{-1}(A)$ is intuitionistic fuzzy gp* - closed set in X, for every intuitionistic fuzzy gp* - closed set A of Y.

Theorem 3.3: A function $f: X \to Y$is intuitionistic fuzzy gp* - continuous if & only if the inverse image of each intuitionistic fuzzy closed set in Y is intuitionistic fuzzy gp* - closed set in X.

Proof: Suppose that X and Y are two intuitionistic fuzzy topological spaces and $f: X \to Y$ be an intuitionistic fuzzy gp* - continuous function. Let A be an intuitionistic fuzzy closed set in Y implies that $1 - A$ is an intuitionistic fuzzy open set in Y. Now as f is an intuitionistic fuzzy gp* - continuous function implies $f^{-1}(1 - A) = 1 - f^{-1}(A)$ is an intuitionistic fuzzy gp* - open set in X, implying $f^{-1}(A)$ is an intuitionistic fuzzy gp* - closed set in X. Conversely let's suppose that A is an intuitionistic fuzzy closed set in Y and $f^{-1}(A)$ is intuitionistic fuzzy gp* - closed in X. Now $1 - A$ is an intuitionistic fuzzy open set in Y and $f^{-1}(1 - A) = 1 - f^{-1}(A)$ is intuitionistic fuzzy gp* - open, which was the required proof.

Theorem 3.4: All intuitionistic fuzzy continuous functions are intuitionistic fuzzy gp* - continuous.

Proof: Suppose that X and Y are two intuitionistic fuzzy topological spaces and $f: X \to Y$ be an intuitionistic fuzzy continuous function. Now, suppose A is a fuzzy open set in Y and as f is intuitionistic fuzzy continuous function implies $f^{-1}(A)$ is intuitionistic fuzzy open set in So by remark 2.1.10 $f^{-1}(A)$ is intuitionistic fuzzy gp* - open set in X, implying that $f: X \to Y$ is an intuitionistic fuzzy gp* - continuous function.

Example 3.5: Let $X = \{a, b\}$ and $Y = \{u, v\}$ and $T_1 = \{X, (0.3,0.5), (0.7,0.5)\}$, $T_2 = \{X, (0.4,0.5), (0.6,0.5)\}$. Then $\tau = \{0, T_1, 1\}$ and $\sigma = \{0, T_2, 1\}$ are IFTS on X and Y respectively. Define a mapping $f: (X, \tau) \to (Y, \sigma)$ by $f(a) = u, f(b) = v$. The IFS $A = \{Y, (0.5,0.3), (0.5,0.7)\}$ is IFCS in Y. Then $f^{-1}(A)$ is IFgp*cs in X but not IFcs in X. Then f is IFgp* continuous mapping but not IF continuous mapping.

Theorem 3.6: All intuitionistic fuzzy g*p - continuous functions are intuitionistic fuzzy gp* - continuous function.

Proof: Let X and Y are two intuitionistic fuzzy topological spaces and $f: X \to Y$ be an intuitionistic fuzzy g*p - continuous function. Now, suppose A is an intuitionistic fuzzy closed set in Y and as f is intuitionistic fuzzy g*p - continuous function implies $f^{-1}(A)$ is intuitionistic fuzzy generalized star pre - closed set in X. Now as by remark 2.1.8 all intuitionistic fuzzy generalized star pre-closed sets are intuitionistic fuzzy gp* closed implying that $f^{-1}(A)$ is also an intuitionistic fuzzy gp* - closed set, means f is intuitionistic fuzzy gp*-continuous.

Example 3.7: Let $X = \{a, b\}$ and $Y = \{u, v\}$ and $T_1 = \{X, (0.3,0.5), (0.7,0.5)\}$, $T_2 = \{X, (0.4,0.5), (0.6,0.5)\}$. Then $\tau = \{0, T_1, 1\}$ and $\sigma = \{0, T_2, 1\}$ are IFTS on X and Y respectively. Define a mapping $f: (X, \tau) \to (Y, \sigma)$ by $f(a) = u, f(b) = v$. The IFS $A = \{Y, (0.5,0.3), (0.5,0.7)\}$ is IFCS in Y. Then $f^{-1}(A)$ is IFgp*cs in X but not IFg*pcs in X. Then f is IFgp* continuous mapping but not IFg*p continuous mapping.

Theorem 3.8: If X, Y and Z are intuitionistic fuzzy topological spaces and $f: X \to Y$ & $g: Y \to Z$ are such that g is an intuitionistic fuzzy gp* - continuous function and f is intuitionistic fuzzy gp* - irresolute, then $g \circ f$ is an intuitionistic fuzzy gp* - continuous function.

Proof: Suppose A is an intuitionistic fuzzy closed set in Z. Also $(g \circ f)^{-1}A = f^{-1}(g^{-1}(A))$. Now as g is intuitionistic fuzzy gp* - continuous, so by its definition $\alpha = (g^{-1}(A))$ is an intuitionistic fuzzy gp* - closed set in Y. Now as f is an intuitionistic fuzzy gp* - irresolute implies $f^{-1}(\alpha) = f^{-1}(g^{-1}(A))$ is also intuitionistic fuzzy gp* - closed set in X, implying that $g \circ f$ is a fuzzy gp* - continuous function.

Theorem 3.9: Suppose $f: X \to Y$ and $g: Y \to Z$ are such that g is an intuitionistic fuzzy continuous function and f is intuitionistic fuzzy gp* - continuous, then $g \circ f$ is an intuitionistic fuzzy gp* continuous function.

Proof: Suppose $A \leq Z$ be any intuitionistic fuzzy closed set in Z. Also $(g \circ f)^{-1}A = f^{-1}(g^{-1}(A))$. Now as g is an intuitionistic fuzzy continuous function, implies $\alpha = (g^{-1}(A))$ is an intuitionistic fuzzy closed set in Y. Now f is an intuitionistic fuzzy gp* - continuous function, implying that $f^{-1}(\alpha) = f^{-1}(g^{-1}(A))$ is an intuitionistic fuzzy gp* - closed set in X. Which shows that $g \circ f$ is an intuitionistic fuzzy gp* - continuous function by theorem 3.3.

Theorem 3.10: Suppose $f: X \to Y$ and $g: Y \to Z$ are intuitionistic fuzzy gp* - irresolute functions, then $g \circ f$ is also intuitionistic fuzzy gp* - irresolute function.

Proof: Let $A \leq Z$ be any intuitionistic fuzzy gp* - closed set in Z. Also $(g \circ f)^{-1}A = f^{-1}(g^{-1}(A))$. Now as g is an intuitionistic fuzzy gp* - irresolute function, implies $\alpha = (g^{-1}(A))$ is an intuitionistic fuzzy gp* - closed set in Y. Now as f is also intuitionistic fuzzy gp* - irresolute, implying that $f^{-1}(\alpha) = f^{-1}(g^{-1}(A))$ is an intuitionistic fuzzy gp* - closed set in X. So, by definition 3.2 $g \circ f$ is also an intuitionistic fuzzy gp* - irresolute function.

THEOREM 3.11: Let X and Y be intuitionistic fuzzy topological spaces and let $f: X \to Y$. Then the following are equivalent.

i. f is IFgp* continuous

ii. for every subset A of X $f(\bar{A}) \subset \overline{f(A)}$

iii. for every intuitionistic fuzzy closed set B of Y the set $f^{-1}(B)$ is IFgp* - closed in X.

iv. for each $x \in X$ and each intuitionistic fuzzy neighborhood V of $f(x)$, there is a IFgp* neighborhood u of x such that $f(U) \subset V$.

NOTE: If the condition (iv) holds for a point x of X we say that f is continuous at a point x. **Proof:**

(i) ⇒ (ii) Assume that f is IFgp* - continuous. Let $A \subseteq X$. If $x \in \bar{A}$, $f(x) \in \overline{f(A)}$. Let V be an intuitionistic fuzzy neighborhood of $f(x)$. Since f f is IFgp* - continuous, $f^{-1}(V)$ is IFgp* open subset of X containing x, it must intersect A in some point y of X. Then V intersects $f(A)$ in the point $f(y)$. So that by theorem

"Let A be a subset of the intuitionistic fuzzy topological space X

i. $x \in \bar{A}$, if and only if every intuitionistic fuzzy open set U containing x insects A.

ii. supposing the intuitionistic fuzzy topology of X is given by a basis, then $x \in \bar{A}$, if and only if every basis B containing x intersects A."

Therefore $f(x) \in \overline{f(A)}$. Hence $f(\bar{A}) \subset \overline{f(A)}$.

(ii) ⇒ (iii) Let B be a intuitionistic fuzzy closed set in Y and let $A = f^{-1}(B)$. We wish to prove that A is IFgp* - closed in X. (ie) First we have to show that $A = \bar{A}$. By elementary set theory we have $f(A) = f\left(f^{-1}(B)\right) \subset B$. Therefore if $x \in \bar{A}, f(x) \in f(\bar{A}) \subset \overline{f(A)} \subset \bar{B} = B$. [By y hypothesis and since B is intuitionistic fuzzy closed $B = \bar{B}$]. So that $f(x) = B$ $\Rightarrow x \in f^{-1}(B) = A$ which implies $x \in A$. Hence $\bar{A} \subset A$. By definition of intuitionistic fuzzy closure $A \subset \bar{A}$. So that $A = \bar{A}$. Therefore A is intuitionistic fuzzy closed and hence A is IFgp* - closed in X.

(iii) ⇒ (iv) [(iii) ⇒ (i) and (i) ⇒ (iv)]

(iii) ⇒ (i) Let V be an intuitionistic fuzzy open set of Y. Set $B = Y - V$ is intuitionistic fuzzy closed in Y, then $f^{-1}(B) = f^{-1}(Y) - f^{-1}(V) = X - f^{-1}(V)$. By hypothesis $f^{-1}(B) = X - f^{-1}(V)$ is IFgp*- closed in X. so that $f^{-1}(V)$ is intuitionistic fuzzy open in X. Therefore f is IFgp* continuous.

(i) ⇒ (iv) Let $x \in X$ and let V be an intuitionistic fuzzy neighborhood of $f(x)$. Then the set $U = f^{-1}(V)$ is IFgp* neighborhood of X such that $f(U) \subset V$ [By definition of intuitionistic fuzzy continuous function at a point x].

(iv) ⇒ (i) Let V be an IFgp* open set of Y, we have to show that $f^{-1}(V)$ is an *sg*α open subset of X. For that x be a point of $f^{-1}(V)$. Then $f(x) \in V$, so that by hypothesis there is a IFgp* neighborhood U_X such that $f(U_X) \subset V$ then $U_X \subset f^{-1}(V)$. It follows that $f^{-1}(V)$ can be written as the union of all open sets U_X so that $f^{-1}(V)$ is IFgp* open set in X. Thus $f: X \to Y$ is IFgp* continuous.

4. INTUITIONISTIC FUZZY gp* - CONNECTEDNESS

Definition 4.1: A **intuitionistic fuzzy gp* - connected space** is an intuitionistic fuzzy topological space (X, τ) that cannot be written as the union of two non-empty disjoint intuitionistic fuzzy gp* - open sets in (Y, τ).

Theorem 4.2: If $(X, \tau)$is a IFts, then the following are equivalent;

(a) X is an intuitionistic fuzzy gp* - connected space.

(b) The only subsets in X which are both intuitionistic fuzzy gp* - open and intuitionistic fuzzy gp* - closed are 0_X and 1_X.

Proof: (a) ⇒ (b): Let X is an intuitionistic fuzzy gp* - connected space. Now, suppose $\alpha < Y$ is both intuitionistic fuzzy gp* - open and intuitionistic fuzzy gp* - closed. Then $1 - \alpha$ is also both intuitionistic fuzzy gp* - closed and intuitionistic fuzzy gp* - open. So $X = \alpha \cup (1 - \alpha)$ is the union of two disjoint non empty intuitionistic fuzzy gp* - open sets, which contradicts (a). Implying $\alpha = 0_X$ or $\alpha = 1_X$.

(b) ⇒ (a): Suppose α and β are non-empty disjoint intuitionistic fuzzy gp* - open sets such that $X = \alpha \cup \beta$. Now $\alpha = 1 - \beta$ *and* $\beta = 1 - \alpha$ are intuitionistic fuzzy gp* - open sets, which in turn implies α and β are also intuitionistic fuzzy gp* - closed sets. Now by (b) $\alpha = 0_X$ or $\alpha = 1_X$ implies X is intuitionistic fuzzy gp* - connected.

Theorem 4.3: All intuitionistic fuzzy gp* - connected spaces are intuitionistic fuzzy connected spaces.

Proof: Let X is an intuitionistic fuzzy gp* - connected space and suppose that X is not a connected space. Then by Definition 2.2.10 there exists a non-empty proper intuitionistic fuzzy clopen subset λ in X. Now as every intuitionistic fuzzy closed set is intuitionistic fuzzy gp* - closed implying that λ is also a non-empty proper subset of X, which is both intuitionistic fuzzy gp* - closed and intuitionistic fuzzy gp* - open in X. So, by Theorem 4.2 X is not a intuitionistic fuzzy gp* - connected space, which is a contradiction implying that X is a connected space.

Example 4.4: Let $X = \{a, b\}$. Let $\tau = \{0_{\sim}, G, 1_{\sim}\}$ be an IFT on X, where $G =< (0.2, 0.4), (0.8, 0.6) >$. Then (X, τ) is an IF – Connected space. But (X, τ) is not an IFgp* - connected space since the $A =< (0.9, 0.8), (0.1, 0.2) >$ is both IFgp*cs and IFgp*os in (X, τ).

Theorem 4.5: Suppose $g: G \to H$ is an onto intuitionistic fuzzy gp* - continuous map and G is an intuitionistic fuzzy gp* - connected space then H is also an intuitionistic fuzzy connected space.

Proof: Let's suppose that H is not an intuitionistic fuzzy connected space and suppose that $H = M \cup N$, where M and N are disjoint intuitionistic fuzzy non-empty open sets in H. Since g is intuitionistic fuzzy gp* - continuous implies $g^{-1}(M)$ and $g^{-1}(N)$ are non-empty disjoint intuitionistic fuzzy gp* - open sets in G and as g is onto also implies $G = g^{-1}(M) \cup g^{-1}(N)$, which contradicts intuitionistic fuzzy gp* - connectedness of G. So H is an intuitionistic fuzzy connected space.

Example 4.6: Let $G = \{a, b\}$ and $H = \{u, v\}$ and $T_1 = \{X, (0.3,0.4), (0.7,0.5)\}$, $T_2 = \{X, (0.4,0.5), (0.6,0.5)\}$. Then $\tau = \{0, T_1, 1\}$ and $\sigma = \{0, T_2, 1\}$ are IFTS on G and H respectively. The IFS $A = \{Y, (0.5,0.3), (0.5,0.7)\}$ is IFCS in H. Then H is an IF connected space.

Theorem 4.7: Suppose $g: G \to H$ is an onto intuitionistic fuzzy gp* - irresolute map and G is intuitionistic fuzzy gp* - connected space then H is also an intuitionistic fuzzy gp* - connected space.

Proof: Let's suppose that H is not an intuitionistic fuzzy gp* - connected space and let's suppose that $H = M \cup N$ where M and N are non-empty intuitionistic fuzzy disjoint gp* - open sets in H. Now, as g is intuitionistic fuzzy gp* - irresolute function implies $g^{-1}(M)$ and $g^{-1}(N)$ are non-empty disjoint intuitionistic fuzzy gp* - open sets in G and as g is onto also implies $G = g^{-1}(M) \cup g^{-1}(N)$, which contradicts intuitionistic fuzzy gp* - connectedness of G. Implies H is an intuitionistic fuzzy connected space.

Example 4.8: Let $G = \{a, b\}$ and $H = \{u, v\}$ and $T_1 = \{X, (0.3,0.4), (0.7,0.5)\}$, $T_2 = \{X, (0.4,0.5), (0.6,0.5)\}$. Then $\tau = \{0, T_1, 1\}$ and $\sigma = \{0, T_2, 1\}$ are IFTS on G and H respectively. The IFS $A = \{Y, (0.5,0.3), (0.5,0.7)\}$ is IFCS in H. Then H is an IFgp* connected space.

CONCLUSION

In this paper, we have investigated a new form of intuitionistic fuzzy continuous, intuitionistic fuzzy irresolute and intuitionistic fuzzy connectedness namely intuitionistic fuzzy gp* continuous, intuitionistic fuzzy gp* irresolute and intuitionistic fuzzy gp* connectedness which contain the classes of intuitionistic fuzzy gp*-closed sets, intuitionistic fuzzy gp*-open sets and intuitionistic fuzzy gp* neighborhood. We have also investigated their properties in Intuitionistic Fuzzy Topological Spaces.

The IFgp* - sets can used to derive compact spaces and new separation axioms in our further research. These concepts can be applied in the medical diagnostics support system and we would like to apply our theoretical research of IFgp* in the field of medical diagnosis in next future study.

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