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On Intuitionistic Fuzzy Multi Weakly Generalized Closed Set

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ABSTRACT
In this paper, the concept of Intuitionistic fuzzy set,Intuitionistic fuzzy multi set in Intuitionistic fuzzy multi topological spaces are recalled. The concept of Intuitionistic fuzzy multi weakly generalized closed set and Intuitionistic fuzzy multi weakly generalized open set in Intuitionistic fuzzy multi topological spaces are introduced.

Keywords
Intuitionistic fuzzy multi topology, Intuitionistic fuzzy multi weakly generalized closed set, Intuitionistic fuzzy multi weakly generalized open set.

1. INTRODUCTION
Fuzzy set(FS),proposed by Lofti A. Zadeh[1] in 1965,as a framework in which membership function assigns for each member of the universe of discourse. In1983,Krassimir T.Atanassov[2] introduced the concept of Intuitionistic fuzzy set(IFS) by introducing a non membership function together with the membership function of the fuzzy set which is a flexible framework to provide vagueness and uncertainity. and also provide opportunity to precisely model the problem. Richard Dedekind[3] is the first person who used the word multi set(MS) in the paper "was sind und was sollen die zahlen" ("The nature and meaning of the numbers") which was published in the year 1888 and Many authors [4],[5],[6],[7] have discussed about multisets and their properties. The multi set(mset in short) is a 'set' where an element can occur more than once. Then R.R.Yager [8]introduced the concept of fuzzy multi set which are useful for handling problems with multi dimensional characterization properties and an element of a fuzzy multi set can occur more than once with possibly the same or different membership value.T.V.Ramakrishnan and S.Sabu[9] proposed fuzzy multi sets in 2010. T.Shinoj and Sunil Jacob John[10] proposed Intuitionistic fuzzy multi sets(IFMS) in 2012 which is the combination of Intuitionistic fuzzy set and fuzzy multiset. P.Rajarajeswari and R.Krishnamoorthy[11] introduced the concept of Intuitionistic fuzzy weakly generalized closed set(IFWGCS).In this paper, Intuitionistic fuzzy multi weakly generalized closed set(IFMWGCS) is introduced which is the combination of Intuitionistic fuzzy weakly generalized closed set and fuzzy multi set and some of the properties of Intuitionistic fuzzy multi weakly generalized closed set are also discussed.

2. PRELIMINARIES
Definition 2.1:[1]Let X be a non empty set.A Fuzzy set(FS in short) A drawn from X is defined as $A =\{ <x, \mu_A(x) > x \epsilon X \}$ where the functions $\mu_A(x) : X \rightarrow [0,1]$ denote the degree of membership function.

Definition 2.2:[2]Let X be a non empty 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 $\mu_A(x) : X \rightarrow [0,1]$ and $\nu_A(x) : X \rightarrow [0,1]$ denote the degree of membership and the degree of non membership of each element $x \epsilon X$ in the set A respectively and $0 \leq \mu_A(x)+\nu_A(x) \leq 1$ for each $x \epsilon X$

Definition 2.3:[9]Let X be a non empty set.A Fuzzy multi set (FMS in short)A drawn from X is characterized by a function 'count membership' of A denoted by $CM_A : X \rightarrow Q$ where Q is the set of all crisp multiples drawn from the unit interval [0,1] For each $x \epsilon X$ the membership sequence is defined as $(\mu_A^1(x), \mu_A^2(x)\ldots\ldots\ldots \mu_A^p(x))$.

Definition 2.4:[10]Let X be a non empty set. An Intuitionistic fuzzy multi set (IFMS in short) A drawn from X is defined by a function 'count membership' of A(CM_A) denoted by $CM_A : X \rightarrow Q$ and 'count non membership' of A denoted by $CA_N : X \rightarrow Q$ where Q is the set of all crisp multiples drawn from the unit interval [0,1]. For each $x \epsilon X$ the membership sequence is defined as (μ_A^1 (x) , μ_A^2 (x)……….. μ_A^p (x)) and non membership sequence by $(\nu_A^1(x) ,\nu_A^2(x)\ldots\ldots\nu_A^p (x))$ such that $0 \leq \mu_A^i (x) + \nu_A^i (x) \leq 1$ for each $x \epsilon X$ and i=1,2...p.

Definition 2.5:[11]An IFS A in an IFTS (X,τ) is said to be an Intuitionistic fuzzy weakly generalized closed set (IFWGCS in short) if $cl(int(A)) \subseteq U$ whenever $A \subseteq U$, U is IFOS in X.

Definition 2.6:[10]Let A and B be two IFMS of the form

$A =\{ < x, (\mu_A^1(x), \mu_A^2(x)\ldots\ldots\ldots \mu_A^p(x)),$

$(\nu_A^1(x) , \nu_A^2(x)\ldots\ldots\ldots\nu_A^p(x)) > / x \epsilon X\}$ and

$B =\{ < x, (\mu_B^1(x), \mu_B^2(x)\ldots\ldots\ldots \mu_B^p(x)),$

$(\nu_B^1(x) , \nu_B^2(x)\ldots\ldots\ldots\nu_B^p (x)) > / x \epsilon X\}$ Then

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

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

c) $A^C =\{ <x, (\nu_A^1(x) , \nu_A^2(x)\ldots\ldots\nu_A^p (x)) ,$
$(\mu_A^1(x), \mu_A^2(x)\ldots\ldots\ldots \mu_A^p(x)) > / x \epsilon X \}$,

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

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

we can use the notation $A = < x, (\mu_A^1, \mu_A^2\ldots\ldots \mu_A^p),$
$(\nu_A^1 , \nu_A^2\ldots\ldots\nu_A^p) >$

instead of $A =\{ <x, (\mu_A^1(x), \mu_A^2(x)\ldots\ldots\ldots \mu_A^p(x)),$
$(\nu_A^1(x) , \nu_A^2(x)\ldots\ldots\nu_A^p (x)) > / x \epsilon X \}$ and

we can use the notation $B = <x, (\mu_B^1, \mu_B^2 \ldots\ldots\ldots \mu_B^p), (\nu_B^1, \nu_B^2 \ldots\ldots \nu_B^p) >$

instead of $B = \{ < x, (\mu_B^1(x), \mu_B^2(x) \ldots\ldots\ldots \mu_B^p(x)), (\nu_B^1(x), \nu_B^2(x) \ldots\ldots \nu_B^p(x)) > / x \in X \}$

The Intuitionistic fuzzy multi sets $0_\sim = \{ <x, 0, 1 > / x \in X\}$ and $1_\sim = \{ <x,1,0 > / x \in X\}$ are respectively the empty set and the whole set

3. INTUITIONISTIC FUZZY MULTI TOPOLOGICAL SPACE AND ITS PROPERTIES

In this section we study Intuitionistic fuzzy multi topological space and its various properties.

Definition 3.1: An Intuitionistic fuzzy multi topology (IFMT in short) on a non empty set X is a Family τ of IFMS 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) $\cup G_i \in \tau$ for any arbitrary family $\{G_i / i \in J\} \subseteq \tau$

In this case the pair (X, τ) is called an Intuitionistic fuzzy multi topological space (IFMTS in short) and any IFMS in τ is known as an Intuitionistic fuzzy multi open set(IFMOS) in X.

The complement A^C of an IFMOS A in an IFMTS (X,τ) is called an Intuitionistic fuzzy multi closed set (IFMCS) in X.

Definition 3.2: $A = < x, (\mu_A^1, \mu_A^2 \ldots \mu_A^p), (\nu_A^1, \nu_A^2 \ldots\ldots \nu_A^p) >$ be an IFMS in X. Then the Intuitionistic fuzzy multi interior and an Intuitionistic fuzzy multi closure are defined by

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

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

Result 3.3: Let A and B be two Intuitionistic fuzzy multi sets of an Intuitionistic fuzzy multi topological space (X, τ).

- **a)** A is an Intuitionistic fuzzy multi closed set in X $\Leftrightarrow$ $cl(A)=A$,
- b) A is an Intuitionistic fuzzy multi open set in X $\Leftrightarrow$ $int(A)=A$,
- c) $cl(A^c) = (int(A))^C$,
- d) 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 3.4: $A = < x, (\mu_A^1, \mu_A^2 \ldots \mu_A^p), (\nu_A^1, \nu_A^2 \ldots\ldots \nu_A^p) >$ be an IFMS in X. Then the Intuitionistic fuzzy multi semi interior and an Intuitionistic fuzzy multi semi closure are defined by

$sint(A) = \cup \{G / G$ is an IFMSOS in X and $G \subseteq A\}$,

$scl(A) = \cap \{K / K$ is an IFMSCS in X and $A \subseteq K\}$.

Result 3.5: Let A be an IFMS in (X,τ), then

$scl(A)=A \cup int(cl(A))$,

$sint(A)= A \cap cl(int(A))$.

Definition 3.6: $A = < x, (\mu_A^1, \mu_A^2 \ldots \mu_A^p), (\nu_A^1, \nu_A^2 \ldots\ldots \nu_A^p) >$ be an IFMS in X. Then alpha multi interior of A and alpha multi closure of A are defined by

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

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

Result 3.7: Let A be an IFMS in (X,τ), then

$\alpha cl(A)=A \cup cl(int(cl(A)))$,

$\alpha int(A)= A \cap int(cl(int(A)))$.

Definition 3.8: Let $A = \{ < x, (\mu_A^1(x), \mu_A^2(x) \ldots\ldots \mu_A^p(x)), (\nu_A^1(x), \nu_A^2(x) \ldots\ldots \nu_A^p(x)) > / x \in X\}$ in IFMTS (X, τ) is called an

- a) Intuitionistic fuzzy multi semi closed set (IFMSCS) if $int(cl(A)) \subseteq A$,
- b) Intuitionistic fuzzy multi α closed set (IFMαCS) if $cl(int(cl(A))) \subseteq A$,
- c) Intuitionistic fuzzy multi pre closed set (IFMPCS) if $cl(int(A)) \subseteq A$,
- d) Intuitionistic fuzzy multi regular closed set (IFMRCS) if $cl(int(A)) = A$,
- e) Intuitionistic fuzzy multi generalized closed set (IFMGCS) if $cl(A) \subseteq U$ whenever $A \subseteq U$ and U is an IFMOS,
- f) Intuitionistic fuzzy multi generalized semi closed set (IFMGSCS) if $scl(A) \subseteq U$ whenever $A \subseteq U$ and U is an IFMOS,
- g) Intuitionistic fuzzy multi α generalized closed set(IFMαCS) if $\alpha cl(A) \subseteq U$ whenever $A \subseteq U$ and U is an IFMOS.

An IFMS A is called Intuitionistic fuzzy multi semi open set, Intuitionistic fuzzy multi α open set, Intuitionistic fuzzy multi pre open set, Intuitionistic fuzzy multi regular open set, Intuitionistic fuzzy multi generalized open set , Intuitionistic fuzzy multi α generalized open set , Intuitionistic fuzzy multi generalized semi open set (IFMSOS, IFMαOS, IFMPOS, IFMROS , IFMGOS, IFMαGOS , IFMGSOS) if A^c is an IFMSCS, IFMαCS, IFMPC S, IFMRC, IFMGCS, IFMαGCS, IFMGSCS and respectively.

4. INTUITIONISTIC FUZZY MULTI WEAKLY GENERALIZED CLOSED SET

In this section we introduce Intuitionistic fuzzy multi weakly generalized closed set and have studied some of its properties.

Definition 4.1: An IFMS A in an IFMTS (X,τ) is said to bean Intuitionistic fuzzy multi weakly generalized closed set (IFMWGCS) if $cl(int(A)) \subseteq U$ whenever $A \subseteq U$ and U is an IFMOS in X.

The family of all IFMWGCSs of an IFMTS (X ,τ) is denoted by IFMGCS(X).

Example 4.2: Let X={a,b} and let τ={0~ ,T , 1~} be an IFMT on X.Then T=< x,(0.3,0.4),(0.5,0.6) , (0.2,0.4),(0.5,0.3) > and A = < x,(0.2,0.3),(0.4,0.2) , (0.3,0.5),(0.5,0.4) > where p=2 is an IFMWGCS in X.

Theorem 4.3:Every IFMCS is an IFMWGCS but not conversely.

Proof: Let A be an IFMCS in (X,τ). Let U be an Intuitionistic fuzzy multi open set such that A ⊆ U.Since A is Intuitionistic fuzzy multi closed set, cl(A) = A and hence cl(A) ⊆ U. But cl (int(A) ⊆ cl (A) ⊆ U. Therefore cl (int(A)⊆ U.Hence A is an IFMWGCS in X.

Example 4.4: Let X={a,b} and let τ={0~ ,T , 1~} be an IFMT on X,Then T=< x,(0.2,0.4),(0.6,0.2) , (0.4,0.3),(0.3,0.4) > and A=< x,(0.2,0.1),(0.3,0.2) , (0.4,0.5),(0.6,0.4) > where p=2 is an IFMWGCS but not an IFMCS in X since cl(A)=T^c ≠ A.

Theorem 4.5:Every IFMαCS is an IFMWGCS but not conversely.

Proof:Let A be an IFMαCS in X.Let A ⊆ U and U be an Intuitionistic fuzzy multi open set in (X ,τ). By hypothesis, cl(int(cl(A)) ⊆ A. Hence cl(int(A)) ⊆ cl(int(cl(A)) ⊆ A ⊆ U. Therefore cl(int(A)) ⊆ U.Hence A is an IFMWGCS in X.

Example 4.6: Let X={a,b} and let τ={0~ ,T , 1~ } be an IFMT on X Then T=< X,(0.3,0.4),(0.5,0.6) , (0.7,0.6),(0.5,0.4) > and A= < x,(0.2,0.3),(0.4,0.4) , (0.7,0.6),(0.6,0.6) > where P= 2 is an IFMWGCS in X but not an IFMαCS in X.

Theorem 4.7:Every IFMGCS is an IFMWGCS but not conversely.

Proof: Let A be an IFMGCS in X and let A ⊆ U and U is an IFOS in (X ,τ) .Since cl(A)⊆ U, cl(int(A)) ⊆ cl(A) , That is cl (int(A) ⊆ cl(A) ⊆U.Therefore cl(int(A) ⊆ U. Hence A is an

an IFMWGCS in X.

Example 4.8: Let X={a,b} and let τ={0~ ,T , 1~} be an IFMT on X,Then T=< X,(0.4,0.5),(0.6,0.7) , (0.6,0.5),(0.4,0.3) > and A= < x,(0.2,0.3),(0.4,0.3) , (0.7,0.5),(0.6,0.7) > where p=2 is an IFMWGCS in X but not an IFMGCS in X since A ⊆ T but cl(A) = < x,(0.6,0.5),(0.4,0.3) , (0.4,0.5),(0.6,0.7) > ⊈ T.

Theorem 4.9:Every IFMRCS is an IFMWGCS but not conversely.

Proof: Let A be an IFMRCS in X. Let A ⊆ U and U be an Intuitionistic fuzzy multi open set in (X,τ). Since A is an IFMRCS,cl (int(A)) = A ⊆ U. This implies cl(int(A)) ⊆ U. Hence A is an IFMWGCS in X.

Example 4.10: Let X={a,b} and let τ={0~ ,T , 1~} be an IFMT on X Then T=< x,(0.3,0.5),(0.4,0.6) , (0.2,0.3),(0.4,0.3) > and A = < x,(0.2,0.4),(0.3,0.2) , (0.5,0.3),(0.4,0.6) > where p=2 is an IFMWGCS in X but not an IFMRCS in X since A ⊆ T but

cl(int(A)) = 0 ≠ A.

Theorem 4.11:Every IFMαGCS is an IFMWGCS but not conversely.

Proof:Let A be an IFMαGCS in X.Let A ⊆ U and U be an Intuitionistic fuzzy multi open set in (X,τ) . By hypothesis,

A ∪ cl (int (cl (A)) ⊆ U.This implies cl (int(cl(A)) ⊆ U. .Therefore cl (int (A)) ⊆ cl(int(cl(A)) ⊆ U. There fore

cl(int(A) ⊆ U .Hence A is an IFMWGCS in X.

Example 4.12: Let X={a,b} and τ={0~ ,T , 1~} be an IFMT

on X,Then T=< x,(0.3,0.4),(0.2,0.3) , (0.4,0.5),(0.7,0.2) > and A=< x,(0.3,0.4), (0.2,0.3) , (0.4,0.6), (0.7,0.2) > where p=2 is an IFMWGCS in X but not an IFMαGCS in X since

αcl(A)=1 ⊈ T.

Remark 4.13:IFMSCS and IFMWGCS are independent to each other which can be seen from the following Example**.**

Example 4.14: Let X={a,b} and τ={0~ ,T , 1~} be an IFMT on X,ThenT=< x,(0.3,0.4),(0.4,0.6) , (0.5,0.3),(0.6,0.4) > and A= < x,(0.2,0.3),(0.4,0.5) , (0.6,0.4),(0.7,0.5) > where p=2 is an IFMWGCS in X but not an IFMSCS in X.

Example 4.15: Let X={a,b} and τ={0~ ,T , 1~} be an IFMT on X,Then T=< x,(0.2,0.2),(0.3,0.4) , (0.6,0.6),(0.5,0.4) > and A=< x,(0.3,0.2),(0.4,0.4) , (0.5,0.6),(0.5,0.4) > where p=2 is an IFMSCS in X but not an IFMWGCS in X.

Remark 4.16: The Union of any two IFMWGCSs need not be an IFMWGCS in general as seen from the following Example.

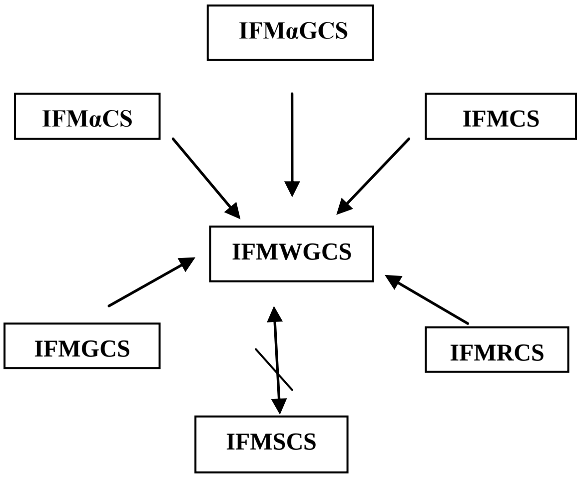
Example 4.17: Let X={a,b} and τ={0~ ,T , 1~} be an IFMT

on X Then T = < x, (0.3,0.4), (0.2,0.3) , (0.4,0.5) , (0.7,0.2) > and A= < x, (0.5,0.4), (0.3,0.2) , (0.6,0.7), (0.8,0.3) > and B=< x,(0.2,0.4),(0.3,0.4) , (0.6,0.6),(0.6,0.5)> are IFMWGCS but A ∪ B is not an IFMWGCS in X.

The following figure represents the relation between Intuitionistic fuzzy multi weakly generalized closed set and other existing Intuitionistic fuzzy multi closed sets.

In this diagram A $\longrightarrow$ B means A implies B and

A $\not\longleftrightarrow$ B means A and B are independent to each other.



5. INTUITIONISTIC FUZZY MULTI WEAKLY GENERALIZED OPEN SET

In this section we introduce Intuitionistic fuzzy multi weakly generalized open set and have studied some of its properties.

Definition 5.1: An IFMS A in an IFMTS (X,τ) is said to be an Intuitionistic fuzzy multi weakly generalized open set (IFMWGOS) in (X,τ) if A^c is an IFMWGCS in X.

The family of all IFMWGOS of an IFMTS (X,τ) is denoted by IFMWGOS(X).

Example 5.2: Let X={a,b} and let $\tau=\{0_\sim ,T , 1_\sim\}$ be an IFMT on X. Then T=< x,(0.3,0.4),(0.3,0.5) , (0.4,0.5),(0.4,0.5) > and A = < x,(0.6,0.5),(0.4,0.5) , (0.3,0.2),(0.3,0.2) > where p=2 is an IFMWGOS in X.

Theorem 5.3: For any IFMTS (X,τ), We have the following

i)Every IFMOS is an IFMWGOS

ii)Every IFMSOS is an IFMWGOS

iii)Every IFMαOS is an IFMWGOS

iv)Every IFMROS is an IFMWGOS

Proof: Straight forward.

The Converse of the above statement need not be true in general which can be seen from the following Examples.

Example 5.4: Let X={a,b} and let $\tau=\{0_\sim ,T , 1_\sim\}$ be an IFMT on X Then T= < x,(0.3,0.4),(0.5,0.6) , (0.4,0.1),(0.2,0.3) > and A = < x,(0.5,0.2),(0.3,0.4) , (0.2,0.3),(0.4,0.5) > where p=2 is an IFMWGOS in (X,τ) but not an IFMOS in X.

Example 5.5: Let X={a,b} and let $\tau=\{0_\sim ,T , 1_\sim\}$ be an IFMT on X Then T=< x,(0.3,0.6),(0.6,0.5) , (0.2,0.1),(0.4,0.3) > and A=< x,(0.2,0.3), (0.5,0.6) , (0.3,0.5),(0.5,0.4) > where p=2 is an IFMWGOS in $(X.\tau)$ but not an IFMSOS in X.

Example 5.6: Let X={a,b} and let $\tau=\{0_\sim ,T , 1_\sim\}$ be an IFMT on X,Then T=< x,(0.5,0.6),(0.4,0.3) , (0.2,0.3),(0.2,0.4) > and A=< x,(0.3,0.4), (0.3,0.5) , (0.4,0.6),(0.3,0.2) > where p=2 is an IFMWGOS in $(X.\tau)$ but not an IFMαOS in X.

Example 5.7: Let X={a,b} and let $\tau=\{0_\sim ,T , 1_\sim\}$ be an IFMT on X Then T = < x, (0.3,0.4),(0.5,0.6) , (0.3,0.4), (0.3,0.2) > and A=< x,(0.6,0.5),(0.4,0.5) , (0.2,0.3),(0.2,0.4) > where p=2 is an IFMWGOS in $(X.\tau)$ but not an IFMROS in X.

Theorem 5.8: An IFMS A of an IFMTS (X,τ) is an IFMWGOS if and only if $F \subseteq int(cl(A))$ whenever F is an IFMCS and $F \subseteq A$.

Proof:**Necessary:** Suppose A is an IFWGOS in X.Let F be an IFMCS and $F \subseteq A$ and F^c is an IFOS in X such that $A^c \subseteq F^c$ A^c is an IFMWGCS,$cl(int(A^c)) \subseteq F^c$.Hence $(int(cl(A)))^c \subseteq F^c$. This implies $F \subseteq int(cl(A))$.

Sufficient: Let A be an IFMS and $F \subseteq (int(cl(A))$ whenever F is an IFMCS and $F \subseteq A$.Then $A^c \subseteq F^c$ and F^c is an IFMOS By hypothesis,$(int(cl(A)))^c \subseteq F^c$.Hence $cl(int(A^c)) \subseteq F^c$.Hence A is an IFMWGOS of X.

6. CONCLUSION

In this paper ,The hybroid intelligent concept of Intuitionistic fuzzy multi weakly generalized closed set is introduced which is a class of Intuitionistic fuzzy multi closed set and the relationship between Intuitionistic fuzzy multi weakly generalized closed set and other existing Intuitionistic fuzzy multi closed sets are also discussed and some of the properties of Intuitionistic fuzzy multi weakly generalized closed set are investigated.The concept of multi intuitionism can be applied in information retrivel and flexible querying and there is a scope for detailed analysis about this topic.

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