Kong. Res. J. 2(1) : 40-46, 2015 ISSN 2349-2694
Kongunadu Arts and Science College, Coimbatore.

DOI:10.26524/krj64

INTUITIONISTIC FUZZY ψ-CONTINUOUS MAPPINGS

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ABSTRACT

In this paper we introduce intuitionistic fuzzy ψ-continuous mappings and intuitionistic fuzzy ψ-irresolute mappings. Some of their properties arestudied.

Keywords: Intuitionistic fuzzy topology, intuitionistic fuzzy ψ-closed set, intuitionistic fuzzy ψ-continuous mappings and intuitionistic fuzzy ψ-irresolute mappings.

1. INTRODUCTION

The concept of fuzzy sets was introduced by Zadeh (1965), is a framework to encounter uncertainity, vagueness and parital truth and it represents a degree of membership for each member of the universe of discourse to a subset of it. By adding the degree of non-membership to fuzzy set and later Atanassov (1986) proposed intuitionistic fuzzy set in 1986 which appeals more accurate to uncertainity quantification and provides the opportunity to precisely model the problem, based on the existing knowledge and observations. On the other hand Coker (1997) introduced intuitionistic fuzzy topological spaces using the notation of intuitionistic fuzzy sets. In this paper we introduced intuitionistic fuzzy ψ-continuous mappings and studied some of their basic properties. We provide some characterizations of intuitionistic fuzzy ψ-continuous .

2. PRELIMINARIES

2.1. Definition (Atanassov, 1986)

Let X be a non empty fixed set and I be the closed interval $[0,1]$. In intuitionistic fuzzy set (IFS) A is an object of the following form $A=\{\langle x,\mu_A(x),\nu_A(x)\rangle : x\in X\}$

Where the mapping $\mu_A : X \to I$ *and* $\nu_A : X \to I$ denote the degree of membership (namely $\mu_A(x)$) and the degree of non membership (namely $\nu_A(x)$) for each element $x\in X$ to the set A, respectively and $0\le \mu_A(x)+\nu_A(x)\le 1$ for each $x\in X$.

Obviously, every fuzzy set A on a nonempty set X is an IFS of the following form

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

2.2. Definition (Atanassov, 1986)

Let A and B be IFSs of the form $A=\{\langle x,\mu_A(x), \nu_A(x)\rangle : x\in X\}$ *and* $A=\{\langle x, \mu_B(x), \nu_B(x)\rangle : x\in X\}$ 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* $\nu_A(x)\ge\nu_B(x)$;

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

(iii) $A\cap B=$
$\{\langle x,\mu_A(x)\wedge\mu_B(x),\nu_A(x)\vee\nu_B(x)\rangle : x\in X\}$

(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 = B iff $A\subseteq B$ *and* $B\subseteq A$;

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

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

(viii) $\tilde{1}=\{\langle x, 1, 0\rangle, x\in X\}$ and
$\tilde{0}=\{\langle x, 1, 0\rangle, x\in X\}$

We will use the notation $A=\langle x, \mu_A, \mu_A\rangle$ instead of A= $\{\langle x, \mu_A(x), \nu_A(x)\rangle : x\in X\}$

The intuitionistic fuzzy sets $0_{\sim} = \{ \langle x, 1, 0\rangle, x \in X \}$ and $1_{\sim} = \{ \langle x, 1, 0\rangle, x \in X \}$ are respectively the empty set and the whole set of X.

2.3. Definition (Coker, 1997)

An intuitionistic fuzzy topology (IFT in short) on X is a family τ of IFSs in X satisfying the following axioms.

(i) $0_{\sim}, 1_{\sim} \in \tau$

(ii) $G_1 \cap G_2 \in \tau$ for any $G_1, G_2 \in \tau$

(iii) $\cup G_i \in \tau$ for any family $\{ G_i / i \in J\} \subseteq \tau$.

In this 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 in IFTS (X, τ) is called an intuitionistic fuzzy closed set (IFCS in short) in X.

2.4. Definition (Coker, 1997)

Let (X, τ) be an IFTS and $A = \langle x, \mu_A, \mu_A \rangle$ be an IFS in X. Then the intuitionistic fuzzy interior and intuitionistic fuzzy closure are defined by

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

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

Note that for any IFS A in (X, τ), we have $cl(A^C) = [\text{int}]^C$ *and* $\text{int}(A^C) = [cl(A)]^C$.

2.5. Definition

An IFS A = $\{\langle x, \mu_A, \mu_A\rangle\}$ in an IFTS (X, τ) is said to be an

(i) Intuitionistic fuzzy semi open set (Joung Kon *et al.,* 2005) (IFSOS in short) if $A \subseteq cl(\text{int}(A))$,

(ii) Intuitionistic fuzzy $\alpha -$ open set (Joung Kon *et al.,* 2005) (IF α OS in short) if $A \subseteq \text{int}(cl(\text{int}(A)))$,

(iii) Intuitionistic fuzzy semi pre open set (Young Bae and Seok-Zun, 2005) (IFSPOS in short) if $A \subseteq cl(\text{int}(cl(A)))$,

(iv) Intuitionistic fuzzy pre open set (Young Bae and Seok-Zun, 2005)(IFPOS in short) if $A \subseteq \text{int}(cl(A))$.

(v) Intuitionistic fuzzy regular open set (Joung Kon *et al.,* 2005) (IFROS in short) if $A = \text{int}(cl(A))$.

The family of all IFOS (respectively IFSOS, IF α OS, IFSPOS, IFPOS, IFROS) of an IFTS (X, τ) is denoted by IFO(X) (respectively IFSO(X), IF αO(X), IFSPO(X), IFPO(X), IFRO(X)).

2.6. Definition

An IFS A = $\{\langle x, \mu_A, \mu_A\rangle\}$ in an IFTS (X, τ) is said to be an

(i) Intuitionistic fuzzy semi closed set (Joung Kon *et al.,* 2005) (IFSCS in short) if $\text{int}(cl(A)) \subseteq A$,

(ii) Intuitionistic fuzzy α -closed set (Joung Kon *et al.,* 2005) (IF α CS in short) if cl($\text{int}(cl(A))) \subseteq A$,

(iii) Intuitionistic fuzzy semi pre closed set (Young Bae and Seok-Zun, 2005) (IFSPCS in short) if int($cl(\text{int}(A))) \subseteq A$,

(iv) Intuitionistic fuzzy pre closed set (Young Bae and Seok-Zun, 2005) (IFPCS in short) if $cl(\text{int}(A)) \subseteq A$.

(v) Intuitionistic fuzzy regular closed set (Joung Kon *et al.,* 2005) (IFRCS in short) if $A = cl(\text{int}(A))$.

The family of all IFCS (respectively IFSCS, IF α CS, IFSPCS, IFPCS, IFRCS) of an IFTS (X, τ) is denoted by IFC(X) (respectively IFSC(X), IF α C(X), IFSPC(X), IFPC(X), IFRC(X)).

2.7. Definition (Young Bae and Seok-Zun, 2005)

Let A be an IFS in an IFTS (X, τ). Then

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

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

Note that for any IFS A in (X, τ), we have $scl(A^C)$ = (sint $(A))^C$ and sint (A^C) = (scl($A))^C$.

2.8. Definition

An IFS A in an IFTS (X, τ) is an

(i) Intuitionistic fuzzy generalised closed set (Thakur and Rekha, 2006) (IFGCS in short) if cl(A) $\subseteq$U whenever A $\subseteq$U and U is an IFOS in X.

(ii) Intuitionistic fuzzy generalised semi closed set (Santhi and Sakthivel, 2009) (IFGSCS in short) if scl(A) $\subseteq$U whenever A

$\subseteq$ U and U is an IFOS in X.

(iii) Intuitionistic fuzzy semi generalised closed set (Santhi and Arun Prakash, 2010) (IFSGCS in short) if scl(A) $\subseteq$U whenever

A $\subseteq$U and U is an IFSOS in X.

(iv) Intuitionistic fuzzy α - generalised closed set (Sakthivel, 2010) I (IF α GCS in short) if α cl(A) $\subseteq$U whenever

A $\subseteq$U and U is an IFOS in X.

(v) Intuitionistic fuzzy generalised α - closed set (Gowri *et al.,* 2012) (IFG α CS in short) if α cl(A) $\subseteq$ U whenever A

$\subseteq$U and U is an IF α OS in X.

(vi) Intuitionistic fuzzy generalised semi pre closed set (Young Bae and Seok-Zun, 2005) (IFGSPCS in short) if spcl(A) $\subseteq$U

whenever A $\subseteq$U and U is an IFROS in X.

2.9. Definition

Let f be a mapping from an IFTS (X,τ) into an IFTS (Y,σ). Then f is said to be

(i) Intuitionistic fuzzy semi continuous (Joung Kon *et al.,* 2005) (IFS continuous in short) if $f^{-1}(B) \in IFSO(X)$ for every $B \in \sigma$.

(ii) Intuitionistic fuzzy α continuous (Joung Kon *et al.,* 2005) (IFα continuous in short) if $f^{-1}(B) \in IF\alpha O(X)$ for every $B \in \sigma$.

(iii) Intuitionistic fuzzy pre continuous (Joung Kon *et al.,* 2005) (IFP continuous in short) if $f^{-1}(B) \in IFPO(X)$ for every $B \in \sigma$.

(iv) Intuitionistic fuzzy semi pre continuous (Young Bae and Seok-Zun, 2005) (IFSP continuous in short) if $f^{-1}(B) \in IFSPO(X)$ for every $B \in \sigma$.

2.10. Definition (Thakur and Rekha, 2006)

Let f be a mapping from an IFTS (X,τ) into an IFTS (Y,σ). Then f is said to be

(i) Intuitionistic fuzzy generalised continuous (IFG continuous in short) if $f^{-1}(B) \in IFGCS(X)$ for every IFCS B in Y.

(ii) Intuitionistic fuzzy semi generalised continuous (IFSG continuous in short) if

$f^{-1}(B) \in IFSGCS(X)$ for every IFCS B in Y.

(iii) Intuitionistic fuzzy generalised semi continuous (IFGS continuous in short) if

$f^{-1}(B) \in IFGSCS(X)$ for every IFCS B in Y.

(iv) Intuitionistic fuzzy generalised α - continuous (IFG α continuous in short) if

$f^{-1}(B) \in IFG\alpha CS(X)$ for every IFCS B in Y.

(v) Intuitionistic fuzzy α - generalised continuous (IF α G continuous in short) if

$f^{-1}(B) \in IF\alpha GCS(X)$ for every IFCS B in Y.

(vi) Intuitionistic fuzzy generalised semi pre continuous (IFGSP continuous in short) if

$f^{-1}(B) \in IFGSPCS(X)$ for every IFCS B in Y.

2.11. Theorem (Parimala *et al.,*)

Let (X,τ) be an intuitionistic fuzzy topological space. Then the following are hold

(i) Every IFCS in X is an IF ψ CS in X.

(ii) Every IFRCS in X is an IF ψ CS in X.

(iii) Every IF α CS and hence IFSCS in X is an IF ψ CS in X.

(iv) Every IF ψ CS in X is an IFSPCS in X.

(v) Every IF ψ CS in X is an IFGSPCS in X.

(vi) Every IF ψ CS in X is an IFGSCS and hence IFSGCS in X.

INTUITIONISTIC FUZZY ψ - CONTINUOUS MAPPINGS

In this section we introduce intuitionistic fuzzy ψ-continuous mapping and studied some of its properties.

3.1. Definition

A function $f:(X,\tau)\to(Y,\sigma)$ function intuitionistic fuzzy ψ - continuous (IF ψ -continuous in short) if $f^{-1}(B)$ is an IF ψ CS in (X,τ) for every IFCS B of (Y,σ).

3.2. Example

Let $X=\{a,b\},\ Y=\{u,v\}$ and $T_1=\langle\, x,\ (0.5, 0.3), (0.4, 0.3)\,\rangle$, $T_2=\langle\, y,\ (0.5, 0.7), (0.5, 0.3)\,\rangle$. Then $\tau=\{0_\sim, T_1, 1_\sim\}$ and $\sigma=\{0_\sim, T_2, 1_\sim\}$ are IFTs on X and Y respectively. Define a mapping $f:(X,\tau)\to(Y,\sigma)$ by f(a) = u and f(b) = v. Then f is an IF ψ - continuous mapping.

3.3. Theorem

Every IF continuous mapping is an IF ψ -continuous mapping but not conversely.

3.3.1. Proof.

Let $f:(X,\tau)\to(Y,\sigma)$ be an IF continuous mapping. Let A be an IFCS in Y. Since f is an IF continuous mapping, $f^{-1}(A)$ is an IFCS in X. Since every IFCS is an IF ψ CS by Theorem 2.11, $f^{-1}(A)$ is an IF ψ CS in X. Hence f is an IF ψ -continuous mapping.

3.4. Example

Let $X=\{a,b\},\ Y=\{u, v\}$ and $T_1=\langle\, x, (0.5, 0.3), (0.4, 0.3)\,\rangle$, $T_2=\langle\, y,\ (0.5, 0.7), (0.5, 0.3)\,\rangle$. Then $\tau=\{0_\sim, T_1, 1_\sim\}$ and $\sigma=\{0_\sim, T_2, 1_\sim\}$ are IFTs on X and Y respectively. Define a mapping $f:(X,\tau)\to(Y,\sigma)$ by f(a) = u and f(b) = v. The IFS $A=\langle y,\ (0.5, 0.3), (0.5, 0.7)\rangle$ is IFCS in Y.

Then $f^{-1}(A)$ is IF ψ CS in X but not IFCS in X. Therefore f is an IF ψ - continuous mapping but not IF continuous mapping.

3.5. Theorem

Every IF semi continuous mapping is an IF ψ -continuous mapping but not conversely.

3.5.1. Proof.

Let $f:(X,\tau)\to(Y,\sigma)$ be an IFsemi continuous mapping. Let A be an IFCS in Y. Since f is an IF semi-continuous mapping, then $f^{-1}(A)$ is an IFSCS in X by Theorem 2.11. Since every IFSCS is an IF ψ CS in X. Therefore f is an IF ψ - continuous mapping.

3.6. Example

Let $X=\{a,b\},\ Y=\{u, v\}$ and $T_1=\langle\, x,\ (0.2, 0.2), (0.4, 0.5)\,\rangle$, $T_2=\langle\, y,\ (0.5, 0.5),\ (0.1, 0.1)\,\rangle$. Then $\tau=\{0_\sim, T_1, 1_\sim\}$ and $\sigma=\{0_\sim, T_2, 1_\sim\}$ are IFTs on X and Y respectively. Define a mapping $f:(X,\tau)\to(Y,\sigma)$ by f(a) = u and f(b) = v. The IFS $A=\langle\, y, (0.1, 0.1), (0.5, 0.5)\,\rangle$ is IFCS in Y.

Then $f^{-1}(A)$ is IF ψ CS in X but not IFSCS in X. Therefore f is an IF ψ - continuous mapping but not IF semi continuous mapping.

3.7. Theorem

Every IF α -continuous mapping is an IF ψ -continuous mapping but not conversely.

3.7.1. Proof.

Let $f:(X,\tau)\to(Y,\sigma)$ be an IF α -continuous mapping. Let A be an IFCS in Y. Then by hypothesis $f^{-1}(A)$ is an IF α CS in X. Since every IF α CS is an IF ψ CS in X by Theorem 2.11. Therefore f is an IF ψ - continuous mapping.

3.8. Example

Let $X=\{a,b\},\ Y=\{u, v\}$ and $T_1=\langle\, x,\ (0.2, 0.2),\ (0.4, 0.5)\rangle$, $T_2=\langle\, y,\ (0.5, 0.5),\ (0.1, 0.1)\rangle$. Then $\tau=\{0_\sim, T_1, 1_\sim\}$ and $\sigma=\{0_\sim, T_2, 1_\sim\}$ are IFTs on X and Y respectively. Define a mapping $f:(X,\tau)\to(Y,\sigma)$ by f(a) = u and f(b) = v. The IFS $A=\langle\, y,\ (0.1, 0.1), (0.5, 0.5)\,\rangle$ is IFCS in Y. Then $f^{-1}(A)$ is IF ψ CS in X but not IF α CS in X. Then f is an IF ψ - continuous mapping but not IF α - continuous mapping .

3.9. Theorem

Every IF ψ -continuous mapping is an IFSP continuous mapping but not conversely.

3.9.1. Proof.

Let $f:(X,\tau)\to(Y,\sigma)$ be an IF ψ -continuous mapping. Let A be an IFCS in Y. Then by hypothesis $f^{-1}(A)$ is an IF ψ CS in X. Since every IF ψ CS is an IFSPCS by Theorem 2.11, $f^{-1}(A)$ is an IFSPCS in X. Therefore f is an IFSP continuous mapping.

3.9. Example

Let $X=\{a,b\},\ Y=\{u,v\}$ and

$T_1 = \langle\, x,\ (0.5, 0.7), (0.4, 0.3) \,\rangle$,

$T_2 = \langle\, y,\ (0.5, 0.3), (0.5, 0.7) \rangle$. Then $\tau = \{0_\sim, T_1, 1_\sim\}$ and $\sigma = \{0_\sim, T_2, 1_\sim\}$ are IFTs on X and Y respectively. Define a mapping $f : (X, \tau) \to (Y, \sigma)$ by f(a) = u and f(b) = v. The IFS $A = \langle y, (0.5, 0.7), (0.5, 0.3)\rangle$ is IFCS in Y. Then $f^{-1}(A)$ is IFSPCS in X but not IF ψ CS in X.

Then f is an IFSP- continuous mapping but not IF ψ - continuous mapping .

3.10. Theorem

Every IF ψ -continuous mapping is an IFSG continuous mapping but not conversely.

3.10.1. Proof.

Let $f : (X, \tau) \to (Y, \sigma)$ be an IF ψ - continuous mapping. Let A be an IFCS in Y. Then by hypothesis $f^{-1}(A)$ is an IF ψ CS in X. Since every IF ψ CS is an IFSGCS by Theorem 2.11 , $f^{-1}(A)$ is an IFSGCS in X. Therefore f is an IFSG continuous mapping.

3.11. Example

Let $X = \{a,b\},\ Y = \{u, v\}$ and

$T_1 = \langle\, x,\ (0.6, 0.5), (0.3, 0.4) \,\rangle$,

$T_2 = \langle\, y,\ (0.2, 0.2),\ (0.6, 0.6) \,\rangle$. Then $\tau = \{0_\sim, T_1, 1_\sim\}$ and $o = \{0_\sim, T_2, 1_\sim\}$ are IFTs on X and Y respectively. Define a mapping $f : (X, \tau) \to (Y, \sigma)$ by f(a) = u and f(b) = v. The IFS $A = \langle\, y,\ (0.6, 0.6), (0.2, 0.2)\rangle$ is IFCS in Y. Here IFOS $G = \langle\, x, (0.7, 0.6), (0.2, 0.2) \,\rangle$, clearly $A \subseteq G$. Therefore A is an IFSGCS in X. Then $f^{-1}(A)$ is IFSGCS in X but not IF ψ CS in X. Then f is an IFSG continuous mapping but not IF ψ - continuous mapping .

3.12. Theorem

Every IF ψ - continuous mapping is an IFGS continuous mapping but not conversely.

3.12.1. Proof.

Let $f : (X, \tau) \to (Y, \sigma)$ be an IF ψ - continuous mapping. Let A be an IFCS in Y. Then by hypothesis $f^{-1}(A)$ is an IF ψ CS in X. Since every IF ψ CS is an IFGSCS by Theorem 2.11, $f^{-1}(A)$ is an IFGSCS in X. Therefore f is an IFGS continuous mapping.

3.13. Example

Let $X = \{a,b\},\ Y = \{u, v\}$ and

$T_1 = \langle\, x,\ (0.6, 0.5), (0.3, 0.4) \,\rangle$,

$T_2 = \langle\, y,\ (0.2, 0.2),\ (0.6, 0.6) \rangle$. Then $\tau = \{0_\sim, T_1, 1_\sim\}$ and $o = \{0_\sim, T_2, 1_\sim\}$ are IFTs on X and Y respectively. Define a mapping $f : (X, \tau) \to (Y, \sigma)$ by f(a) = u and f(b) = v. The IFS $A = \langle\, y, (0.6, 0.6), (0.2, 0.2)\rangle$ is IFCS in Y. Here IFOS $G = \langle\, x, (0.7, 0.6), (0.2, 0.2) \,\rangle$, clearly $A \subseteq G$. Therefore A is an IFGSCS in X. Then $f^{-1}(A)$ is IFGSCS in X but not IF ψ CS in X. Then f is an IFGS continuous mapping but not IF ψ - continuous mapping .

3.14. Theorem

Every IF ψ -continuous mapping is an IFGSP continuous mapping but not conversely.

3.14.1. Proof.

Let $f : (X, \tau) \to (Y, \sigma)$ be an IF ψ -continuous mapping. Let A be an IFCS in Y. Then by hypothesis $f^{-1}(A)$ is an IF ψ CS in X. Since every IF ψ CS is an IFGSPCS by Theorem 2.11, $f^{-1}(A)$ is an IFGSPCS in X. Therefore f is an IFGSP continuous mapping.

3.15. Example

Let $X = \{a,b\},\ Y = \{u, v\}$ and

$T_1 = \langle x,\ (0.6, 0.5), (0.3, 0.4) \,\rangle$,
$T_2 = \langle y,\ (0.3, 0.4),\ (0.6, 0.5) \,\rangle$. Then

$\tau = \{0_\sim, T_1, 1_\sim\}$ and $o = \{0_\sim, T_2, 1_\sim\}$ are IFTs on X and Y respectively. Define a mapping $f : (X, \tau) \to (Y, \sigma)$ by f(a) = u and f(b) = v. The IFS $A = \langle\, y,\ (0.6, 0.5), (0.3, 0.4)\rangle$ is IFCS in Y. Here IFOS $G = \langle\, x, (0.7, 0.6), (0.3, 0.2)\rangle$, clearly $A \subseteq G$. Therefore A is an IFGSPCS in X. Then $f^{-1}(A)$ is IFGSPCS in X but not IF ψ CS in X. Then f is an IFGSP continuous mapping but not IF ψ - continuous mapping .

3.16. Remark

IF ψ -continuity and IFG-continuity are independent of each other.

3.17. Example

Let $X = \{a,b\}$, $Y = \{u, v\}$ and $T_1 = \langle x, (0.4, 0.5), (0.5, 0.6) \rangle$, $T_2 = \langle y, (0.4, 0.7), (0.2, 0.3) \rangle$. Then $\tau = \{0_\sim, T_1, 1_\sim\}$ and $\sigma = \{0_\sim, T_2, 1_\sim\}$ are IFTs on X and Y respectively. Define a mapping $f : (X, \tau) \to (Y, \sigma)$ by f(a) = u and f(b) = v. Then f is an IFG-continuous but not an IF ψ -continuous mapping since $A = \langle y, (0.2, 0.3), (0.4, 0.7) \rangle$ is an IFCS in Y but $f^{-1}(A) = \langle x, (0.2, 0.3), (0.4, 0.7) \rangle$ is not IF ψ CS in X.

3.18. Example

Let $X = \{a,b\}$, $Y = \{u, v\}$ and $T_1 = \langle x, (0.2, 0.2), (0.4, 0.4) \rangle$, $T_2 = \langle y, (0.5, 0.5), (0.1, 0.1) \rangle$. Then $\tau = \{0_\sim, T_1, 1_\sim\}$ and $\sigma = \{0_\sim, T_2, 1_\sim\}$ are IFTs on X and Y respectively. Define a mapping $f : (X, \tau) \to (Y, \sigma)$ by f(a) = u and f(b) = v. Then f is an IF ψ -continuous but not an IFG-continuous mapping since $A = \langle y, (0.1, 0.1), (0.5, 0.5) \rangle$ is an IFCS in Y but $f^{-1}(A) = \langle x, (0.1, 0.1), (0.5, 0.5) \rangle$ is not IFGCS in X.

3.19. Remark

IF ψ -continuity is independent from IF α G-continuity, IFG α -continuity and pre-continuity.

3.20. Example

Let $X = \{a,b\}$, $Y = \{u,v\}$ and $T_1 = \langle x, (0.4, 0.5), (0.5, 0.6) \rangle$, $T_2 = \langle y, (0.2, 0.3), (0.4, 0.7) \rangle$. Then $\tau = \{0_\sim, T_1, 1_\sim\}$ and $\sigma = \{0_\sim, T_2, 1_\sim\}$ are IFTs on X and Y respectively. Define a mapping $f : (X, \tau) \to (Y, \sigma)$ by f(a) = u and f(b) = v. Then f is an IF α G-continuous but not an IF ψ -continuous mapping since $A = \langle y, (0.4, 0.7), (0.2, 0.3) \rangle$ is an IFCS in Y but $f^{-1}(A) = \langle x, (0.4, 0.7), (0.2, 0.3) \rangle$ is not IF ψ CS in X.

3.21. Example

Let $X = \{a,b\}$, $Y = \{u, v\}$ and $T_1 = \langle x, (0.2, 0.2), (0.3, 0.4) \rangle$, $T_2 = \langle y, (0.5, 0.4), (0.2, 0.2) \rangle$. Then $\tau = \{0_\sim, T_1, 1_\sim\}$ and $\sigma = \{0_\sim, T_2, 1_\sim\}$ are IFTs on X and Y respectively. Define a mapping $f : (X, \tau) \to (Y, \sigma)$ by f(a) = u and f(b) = v. Then f is an IF ψ -continuous but not an IF α G-continuous mapping since $A = \langle y, (0.2, 0.2), (0.5, 0.4) \rangle$ is an IFCS in Y but $f^{-1}(A) = \langle x, (0.2, 0.2), (0.5, 0.4) \rangle$ is not IF α GCS in X.

3.22. Example

Let $X = \{a,b\}$, $Y = \{u, v\}$ and $T_1 = \langle x, (0.6, 0.5), (0.3, 0.4) \rangle$, $T_2 = \langle y, (0.2, 0.2), (0.6, 0.6) \rangle$. Then $\tau = \{0_\sim, T_1, 1_\sim\}$ and $\sigma = \{0_\sim, T_2, 1_\sim\}$ are IFTs on X and Y respectively. Define a mapping $f : (X, \tau) \to (Y, \sigma)$ by f(a) = u and f(b) = v. Let $A = \langle y, (0.6, 0.6), (0.2, 0.2) \rangle$ is an IFCS in Y. Here IFOS $G = \langle x, (0.9, 0.9), (0.1, 0.1) \rangle$, clearly $A \subseteq G$. Therefore A is an IFG α CS in X. Then f is an IFG α -continuous but not an IF ψ -continuous mapping since but $f^{-1}(A) = \langle x, (0.6, 0.6), (0.2, 0.2) \rangle$ is not IF ψ CS in X.

3.23. Example

Let $X = \{a,b\}$, $Y = \{u, v\}$ and $T_1 = \langle x, (0.8, 0.8), (0.2, 0.1) \rangle$, $T_2 = \langle y, (0.1, 0.3), (0.9, 0.7) \rangle$. Then $\tau = \{0_\sim, T_1, 1_\sim\}$ and $\sigma = \{0_\sim, T_2, 1_\sim\}$ are IFTs on X and Y respectively. Define a mapping $f : (X, \tau) \to (Y, \sigma)$ by f(a) = u and f(b) = v. Then f is an IF ψ -continuous but not an IFG α -continuous mapping since $A = \langle y, (0.9, 0.7), (0.1, 0.3) \rangle$ is an IFCS in Y but $f^{-1}(A) = \langle x, (0.9, 0.7), (0.1, 0.3) \rangle$ is not IFG α CS in X.

3.24. Example

Let $X = \{a,b\}$, $Y = \{u, v\}$ and $T_1 = \langle x, (0.4, 0.5), (0.5, 0.6) \rangle$,

$T_2 = \langle\, y,\ (0.4, 0.7), (0.2, 0.3) \rangle$. Then $\tau = \{0_\sim, T_1, 1_\sim\}$ and $\sigma = \{0_\sim, T_2, 1_\sim\}$ are IFTs on X and Y respectively. Define a mapping $f : (X, \tau) \to (Y, \sigma)$ by f(a) = u and f(b) = v. Then f is an IFP-continuous but not an IF ψ -continuous mapping since $A = \langle\, y, (0.2,\ 0.3), (0.4,\ 0.7) \rangle$ is an IFCS in Y but $f^{-1}(A)$ $= \langle\, x, (0.2, 0.3), (0.4, 0.7) \rangle$ is not IFPCS in X.

3.25. Example

Let $X = \{a, b\}$, $Y = \{u, v\}$ and $T_1 = \langle\, x, (0.3, 0.4), (0.7, 0.6) \rangle$, $T_2 = \langle\, y, (0.4, 0.5), (0.6, 0.5) \rangle$. Then

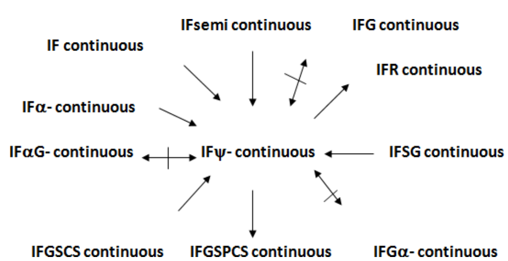
$\tau = \{0_\sim, T_1, 1_\sim\}$ and $\sigma = \{0_\sim, T_2, 1_\sim\}$ are IFTs on X and Y respectively. Define a mapping $f : (X, \tau) \to (Y, \sigma)$ by f(a) = u and f(b) = V. Then f is an IF ψ -continuous but not an IFP-continuous mapping since $A = \langle\, y, (0.6, 0.5), (0.4, 0.5) \rangle$ is an IFCS in Y but $f^{-1}(A)$ $= \langle\, x, (0.6, 0.5), (0.4, 0.5) \rangle$ is not IFPCS in X.

3.26. Theorem

A mapping $f : X \to Y$ is an IF ψ -continuous if and only if the inverse image of each IFOS in Y is an IF ψ OS in X.

3.26.1. Proof.

Let A be an IFOS in Y. This implies A^C is an IFCS in Y. Since f is an IF ψ -continuous, $f^{-1}(A^C)$ is IF ψ CS in X. Since $f^{-1}(A^C) = (f^{-1}(A))^C$, $f^{-1}(A)$ is an IF ψ OS in X.



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