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*- Neutrosophic Crisp Set & *- Neutrosophic Crisp relations

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Abstract. Since the world is full of indeterminacy, the neutrosophics found their place into contemporary research. The purpose of this paper is to introduce a new type of neutrosophic crisp set as the *- neutrosophic crisp sets as a generalization to star intuitionistic set due to Indira et al.[4], and study some of its properties. Finally we introduce and study the notion of *- neutrosophic relation and some of its properties.

Keywords: Neutrosophic Crisp Set; Star Intuitionistic Sets; Neutrosophic Relations; Neutrosophic Data.

1 Introduction

The fundamental concepts of neutrosophic set, introduced by Smarandache in [31, 32, 33], and Salama et al. in [5, 6, 7, 8, 9, 10, 11, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30], provides a natural foundation for treating mathematically the neutrosophic phenomena which exist pervasively in our real world and for building new branches of neutrosophic mathematics. Neutrosophy has laid the foundation for a whole family of new mathematical theories generalizing both their classical and fuzzy counterparts [1, 2, 12, 22, 34] such as a neutrosophic set theory. In this paper we introduce a new type of neutrosophic crisp set as the *- neutrosophic crisp set, and study some of its properties. Finally we introduce and study the notion of *- neutrosophic relation and some of its properties. Possible applications to mathematical computer are touched upon.

2 Terminologies

We recollect some relevant basic preliminaries, and in particular, the work of Smarandache in [31, 32, 33], and Salama et al. in [5, 6, 7, 8, 9, 10, 11, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30]. Smarandache introduced the neutrosophic components T, I, F which represent the membership, indeterminacy, and non-membership values respectively, where $\left]^{-}0, 1^{+}\right[$ is nonstandard unit interval.

3 *- Neutrosophic Crisp Sets

We shall now consider some possible definitions for a new type of neutrosophic crisp set

Definition 3.1

Let X be a non-empty fixed set. A neutrosophic crisp set (NCS for short) A is an object having the form $A=\langle A_1, A_2, A_3\rangle$.

Then we define the *- neutrosophic set A^* as $A^*=\left\langle A_1\cap(A_2\cup A_3)^c, A_2\cap(A_1\cup A_3)^c, A_3\cap(A_1\cup A_2)^c\right\rangle$ where A_1, A_2 and A_3 are subsets of X such that $M=A_1\cap(A_2\cup A_3)^c$, $S=A_2\cap(A_1\cup A_3)^c$ and $R=A_3\cap(A_1\cup A_2)^c$.

A *- neutrosophic crisp set is an object having the form $A^*=\langle M, S, R\rangle$

Lemma 3.1

Let X be a non-empty fixed sample space. A neutrosophic crisp set (NCS for short) A is an object having the form $A=\langle A_1, A_2, A_3\rangle$. Then

$A^*=\left\langle A_1\cap(A_2\cup A_3)^c, A_2\cap(A_1\cup A_3)^c, A_3\cap(A_1\cup A_2)^c\right\rangle$ is also a neutrosophic crisp set.

Proof

It's clear.

Corollary 3.1

Let X be a non-empty fixed set. Then $\phi_N{}^*$ and $X_N{}^*$ are also neutrosophic crisp set.

Theorem 3.1

Let X be a non-empty fixed sample space, two neutrosophic crisp sets A, B are having the form $A=\langle A_1, A_2, A_3\rangle$, $B=\langle B_1, B_2, B_3\rangle$, and two *- neutrosophic sets $A^*=\langle M_1, S_1, R_1\rangle, B^*=\langle M_2, S_2, R_3\rangle$ where

$M_1=A_1\cap(A_2\cup A_3),\quad S_1=A_2\cap(A_1\cup A_3)^c,$

$R_1 = A_3 \cap (A_1 \cup A_2)^c$, $M_2 = B_1 \cap (B_2 \cup B_3)^c$, $S_2 = B_2 \cap (B_1 \cup B_3)^c$, and

$R_2 = B_3 \cap (B_1 \cup B_2)$, Then $A \subseteq B$ implies $A^* \subseteq B^*$.

Proof

Given $A \subseteq B$. Then it is easy to prove that $M_1 \subseteq M_2$, $S_1 \subseteq S_2, R_1 \supseteq R_2$ or $M_1 \subseteq M_2$, $S_1 \subseteq S_2, R_1 \supseteq R_2$ So $A^* \subseteq B^*$.

Remark 3.1

1) All types of $\phi_N{}^*$ and ϕ_N are concedes.
2) All types of $X_N{}^*$ and X_N are concedes.
3) $A^* = B^*$ iff $A^* \subseteq B^*$ and $B^* \subseteq A^*$.

Definition 3.8

Let X be a non-empty set, and $A^* = \langle M, S, R \rangle$ be a *-neutrosophic crisp set on a NCS $A = \langle A_1, A_2, A_3 \rangle$ where $M = A_1 \cap (A_2 \cup A_3)^c$, $S = A_2 \cap (A_1 \cup A_3)^c$, $R = A_3 \cap (A_1 \cup A_2)^c$, Then the complement of the set A^* (A^{*c}, for short) may be defined as three kinds of complements

(C_1) Type1: $A^{*c} = \langle M^c, S^c, R^c \rangle$,

(C_2) Type2: $A^{*c} = \langle R, S, M \rangle$,

(C_3) Type3: $A^{*c} = \langle R, S^c, M \rangle$.

Definition 2.3

Let X be a non-empty fixed set, two neutrosophic crisp sets A, B are having the form $A = \langle A_1, A_2, A_3 \rangle$, $B = \langle B_1, B_2, B_3 \rangle$, and two *- neutrosophic crisp sets $A^* = \langle M_1, S_1, R_1 \rangle, B^* = \langle M_2, S_2, R_2 \rangle$ where

$M_1 = A_1 \cap (A_2 \cup A_3)^c$, $S_1 = A_2 \cap (A_1 \cup A_3)^c$,

$R_1 = A_3 \cap (A_1 \cup A_2)^c$, $M_2 = B_1 \cap (B_2 \cup B_3)^c$,

$S_2 = B_2 \cap (B_1 \cup B_3)^c$, and

$R_2 = B_3 \cap (B_1 \cup B_2)^c$, Then

1) $A^* \cap B^*$ may be defined as two types:
   i) Type1: $A^* \cap B^* = \langle M_1 \cap M_1, S_2 \cap S_2, R_3 \cup R_3 \rangle$ or
   i. Type2: $A^* \cap B^* = \langle M_1 \cap M_1, S_2 \cup S_2, R_3 \cup R_3 \rangle$

4) $A^* \cup B^*$ may be defined as two types:
   i) Type1: $A^* \cup B^* = \langle M_1 \cup M_1, S_2 \cap S_2, R_3 \cap R_3 \rangle$ or
   ii) Type2: $A^* \cup B^* = \langle M_1 \cup M_1, S_2 \cup S_2, R_3 \cap R_3 \rangle$.

Lemma 3.1

Let A^*, B^* are *- neutrosophic crisp sets. Then $A^* - B^* = A^* \cap B^{*C}$

It easy to show that L. H. S is also a *- neutrosophic crisp sets.

Example 3.2

Let $X = \{a,b,c,d,e,f\}$, $A = \langle \{a,b,c,d\},\{e\},\{f\} \rangle$, $B = \langle \{a,b,c\},\{d\},\{e\} \rangle$, $C = \langle \{a,b\},\{c,d\},\{e,f,a\} \rangle$

$D = \langle \{a,b\},\{e,c\},\{f,d\} \rangle$ are NCS. Then

$A^* = \langle \{a,b,c,d\},\{e\},\{f\} \rangle$, $B^* = \langle \{a,b,c\},\{d\},\{e\} \rangle$,

$C^* = \langle \{b\},\{c,d\},\{e,f\} \rangle$,

The complement may be equal as:

1)

$A^{*C} = \langle \{e,f\},\{a,b,c,d,f\},\{a,b,c,d\} \rangle$,

$A^{*C} = \langle \{\{f\},\{e\},\{a,b,c,d\} \rangle$, $A^{*C} = \langle \{\{f\},\{a,b,c,d\},\{a,b,c,d\} \rangle$,

2) $C^{*C} = \langle \{a,c,d,f\},\{a,b,e,f\},\{a,b,c,d\} \rangle$,

$C^{*C} = \langle \{e,f\},\{c,d\},\{b\} \rangle$, $C^{*C} = \langle \{e,f\},\{a,b,e,f\},\{b\} \rangle$.

3) $A^* \cup B^*$ may be equals the following forms

$A^* \cup B^* = \langle \{a,b,c,d\},\{e\},\phi \rangle$,

$A^* \cup B^* = \langle \{a,b,c,d\},\phi,\{f\} \rangle$,

4) $A^* \cap B^*$ may be equals the following forms

$A^* \cap B^* = \langle \{a,b,c\},\{e,d\},\{f,e\} \rangle$,

$A^* \cup B^* = \langle \{a,b,c\},\phi,\{f,e\} \rangle$,

Proposition 3.1

Let $\{A_j{}^* : j \in J\}$ be arbitrary family of *- neutrosophic crisp subsets on X, then

1) $\cap A_j{}^*$ may be defined two types as :
   i) Type1: $\cap A^*{}_j = \langle \cap M_j, \cap S_j, \cup R_j \rangle$, or
   ii) Type2: $\cap A^*{}_j = \langle \cap M_j, \cup S_j, \cup R_j \rangle$.
2) $\cup A^*{}_j$ may be defined two types as :
   i) Type1: $\cup A^*{}_j = \langle \cup M_j, \cap S_j, \cap R_j \rangle$ or
   ii) Type2: $\cup A^*{}_j = \langle \cup M_j, \cup S_j, \cap R_j \rangle$.

Corollary 3.2

Let $\{A_i\}$ be a NCSs in X where $i \in J$, where J is an index set and $\{A_i{}^*\}$ are corresponding *- neutrosophic crisp subsets on X then

a) $A_i{}^* \subseteq B^*$ for each $i \in J \Rightarrow \cup A_i{}^* \subseteq B^*$.
b) $B^* \subseteq A_i{}^*$ for each $i \in J \Rightarrow B^* \subseteq \cup A_i{}^*$.
c) $(\cup A_i{}^*)^c = \cap A_i{}^{*c}$; $(\cap A_i{}^*)^c = \cup A_i{}^{*c}$.

d) $A_i^* \subseteq B^* \Leftrightarrow B^{*c} \subseteq A^{*c}$.

e) $A^{*c^c} = A$,

f) $\phi_N^{*c} = X_N ; X_N^{*c} = \phi_N^*$.

Now we shall define the image and preimage of *- neutrosophic crisp set.

Let X, Y be two non-empty fixed sets and $f : X \to Y$, be a function and $A = \langle A_1, A_2, A_3 \rangle$, $B = \langle B_1, B_2, B_3 \rangle$ are neutrosophic crisp sets on X and Y respectively , $A^* = \langle M_1, S_1, R_1 \rangle$, $B^* = \langle M_2, S_2, R_2 \rangle$ be the *- neutrosophic crisp sets on X and Y respectively.

Definition 3.9

(a) If B^* is a *- NCS in Y, then the preimage of B^* under f, denoted by $f^{-1}(B^*)$, is a *- NCS in X defined by $f^{-1}(B^*) = \langle f^{-1}(M_2), f^{-1}(S_2), f^{-1}(R_2) \rangle$

(b) If A^* is a *- NCS in X, then the image of A^* under f, denoted by $f(A^*)$, is the *- NCS in Y defined by $f(A^*) = \langle f(M_1), f(S_1), f(R_1)^c) \rangle$.

Here we introduce the properties of images and preimages some of which we shall frequently use in the following.

Corollary 3.2

Let A^*, $\{A_i^* : i \in J\}$, be a family of *- NCS in X, and B^*, $\{B^*_j : j \in K\}$ *- NCS in Y, and $f : X \to Y$ a function. Then

(a) $A^*_1 \subseteq A^*_2 \Leftrightarrow f(A^*_1) \subseteq f(A^*_2)$,
$B^*_1 \subseteq B^*_2 \Leftrightarrow f^{-1}(B^*_1) \subseteq f^{-1}(B^*_2)$,

(b) $A^* \subseteq f^{-1}(f(A^*))$ and if f is injective, then $A^* = f^{-1}(f(A^*))$,

(c) $f^{-1}(f(B^*)) \subseteq B^*$ and if f is surjective, then $f^{-1}(f(B^*)) = B^*$,

(d) $f^{-1}(\cup B^*_i)) = f^{-1}(B^*_i)$, $f^{-1}(\cap B^*_i)) = \cap f^{-1}(B^*_i)$,

(e) $f(\cup A^*_{ii}) = \cup f(A^*_{ii})$; $f(\cap A^*_{ii}) \subseteq \cap f(A^*_{ii})$; and if f is injective, then $f(\cap A^*_{ii}) = \cap f(A^*_{ii})$;

(f) $f^{-1}(Y^*_N) = X^*_N$, $f^{-1}(\phi^*_N) = \phi^*_N$.

(g) $f(\phi^*_N) = \phi^*_N$, $f(X^*_N) = Y^*_N$, if f is surjective.

(h) If f is surjective, then $(f(A^*))^c \subseteq f(A^*)^c$. if furthermore f is injective, then have $(f(A^*))^c = f(A^*)^c$.

(i) $(f^{-1}(B^*)^c = (f^{-1}(B^*))^c$.

Proof

Clear by definitions.

4 *- Neutrosophic Crisp Set Relations

Here we give the definition relation on *- neutrosophic crisp sets and study of its properties.

Let X, Y and Z be three ordinary nonempty sets

Definition 4.1

Let X be a non-empty fixed set, two neutrosophic crisp sets A , B are having the form $A = \langle A_1, A_2, A_3 \rangle$, $B = \langle B_1, B_2, B_3 \rangle$, and two *- neutrosophic crisp sets $A^* = \langle M_1, S_1, R_1 \rangle$, $B^* = \langle M_2, S_2, R_2 \rangle$ where

$M_1 = A_1 \cap (A_2 \cup A_3)$, $S_1 = A_2 \cap (A_1 \cup A_3)$,

$R_1 = A_3 \cap (A_1 \cup A_2)$,

$M_2 = B_1 \cap (B_2 \cup B_3)$, $S_2 = B_2 \cap (B_1 \cup B_3)$, and

$R_2 = B_3 \cap (B_1 \cup B_2)$, Then

i) The product of two *- neutrosophic crisp sets A^* and B^* is a *- neutrosophic crisp set $A^* \times B^*$ given by

$A^* \times B^* = \langle M_1 \times M_2, S_1 \times S_2, R_1 \times R_2 \rangle$ on $X \times Y$.

ii) We will call a *- neutrosophic crisp relation $R^* \subseteq A^* \times B^*$ on the direct product $X \times Y$.

The collection of all *- neutrosophic crisp relations on $X \times Y$ is denoted as $SNCR(X \times Y)$

Definition 4.2

Let R^* be a *- neutrosophic crisp relation on $X \times Y$, then the inverse of R^* is donated by R^{*-1} where $R^* \subseteq A^* \times B^*$ on $X \times Y$ then $R^{*-1} \subseteq B^* \times A^*$ on $Y \times X$.

Example 4.1

Let $X = \{a, b, c, d, e, f\}$, $A = \langle \{a, b, c, d\}, \{e\}, \{f\} \rangle$, $B = \langle \{a, b, c\}, \{d\}, \{e\} \rangle$, are NCS.

Then $A^* = \langle \{a, b, c, d\}, \{e\}, \{f\} \rangle$, $B^* = \langle \{a, b, c\}, \{d\}, \{e\} \rangle$, then the product of two *- neutrosophic crisp sets given by

$A^* \times B^* = \langle \{(a,a),(a,b),(a,c),(b,a),(b,b),(b,c),(c,a),(c,b),(c,c)\}, \{(e,d)\}, \{(f,e)\} \rangle$

and

$B^* \times A^* = \langle \{(a,a),(a,b),(a,c),(a,d),(b,a),(b,b),(b,c),(b,d),(c,a),(c,b),(c,c),(c,d)\}, \{(d,e)\}, \{(e,f)\} \rangle$

, and $R_1^* = \langle \{(a,a)\}, \{(c,c)\}, \{(d,d)\} \rangle$, $R_1^* \subseteq A^* \times B^*$ on $X \times X$,

$R_2^* = \langle \{(a,b)\}, \{(c,c)\}, \{(d,d),(b,d)\} \rangle$ $R_2^* \subseteq B^* \times A^*$ on $X \times X$, $R_1^{*-1} = \langle \{(a,a)\}, \{(c,c)\}, \{(d,d)\} \rangle \subseteq B^* \times A^*$ and

$R_2^{*-1} = \langle \{(b,a)\}, \{(c,c)\}, \{(d,d),(d,b)\} \rangle \subseteq B^* \times A^*$.

We can define the operations of *- neutrosophic crisp relations.

Definition 4.3

Let R^* and S^* be two *- neutrosophic crisp relations between X and Y for every $(x, y) \in X \times Y$ and NCSS A

and B in the form $A = \langle A_1, A_2, A_3 \rangle$, A^* on X, $B = \langle B_1, B_2, B_3 \rangle$, B^* on Y Then we can defined the following operations

i) $R \subseteq S$ may be defined as two types

a) Type1: $R^* \subseteq S^* \Leftrightarrow M_{1_R} \subseteq M_{1_S}$, $S_{1_R} \subseteq S_{1_s}$, $R_{1_R} \supseteq R_{1_s}$

b) Type2: $R^* \subseteq S^* \Leftrightarrow M_{1_R} \subseteq M_{1_S}$, $S_{1_R} \supseteq S_{1_s}$, $R_{1_R} \supseteq R_{1_s}$

ii) $R^* \cup S^*$ may be defined as two types

a) Type1: $R^* \cup S^* = \langle M_{1R} \cup M_{1S}, S_{1R} \cup S_{1S}, R_{1R} \cap R_{1S} \rangle$,

b) Type2: $R^* \cup S^* = \langle M_{1R} \cup M_{1S}, S_{1R} \cap S_{1S}, R_{1R} \cap R_{1S} \rangle$.

iii) $R^* \cap S^*$ may be defined as two types

a) Type1: $R^* \cap S^* = \langle M_{1R} \cap M_{1S}, S_{1R} \cup S_{1S}, R_{1R} \cup R_{1S} \rangle$,

b) Type2: $R^* \cap S^* = \langle M_{1R} \cap M_{1S}, S_{1R} \cap S_{1S}, R_{1R} \cup R_{1S} \rangle$.

Theorem 4.1

Let R^*, S^* and Q^* be three *- neutrosophic crisp relations between X and Y for every $(x, y) \in X \times Y$, then

i) $R^* \subseteq S^* \Rightarrow R^{*-1} \subseteq S^{*-1}$.

ii) $(R^* \cup S^*)^{-1} \Rightarrow R^{*-1} \cup S^{*-1}$.

iii) $(R^* \cap S^*)^{-1} \Rightarrow R^{*-1} \cap S^{*-1}$.

iv) $\left(R^{*-1}\right)^{-1} = R^*$.

v) $R^* \cap (S^* \cup Q^*) = (R^* \cap S^*) \cup (R^* \cap Q^*)$.

vi) $R^* \cup (S^* \cap Q^*) = (R^* \cup S^*) \cap (R^* \cup Q^*)$.

vii) If $S^* \subseteq R^*$, $Q^* \subseteq R^*$, then $S^* \cup Q^* \subseteq R^*$.

Proof

Clear

Definition 5.4

The *- neutrosophic crisp relation $I^* \in SNCR^*(X \times X)$, the *- neutrosophic crisp relation of identity may be defined as two types

i) Type1: $I^* = \{< \{A^* \times A^*\}, \{A^* \times A^*\}, \phi^* >\}$

ii) Type2: $I^* = \{< \{A^* \times A^*\}, \phi^*, \phi^* >\}$

Now we define two composite relations of *- neutrosophic crisp sets.

Definition 5.5

Let R^* be a *- neutrosophic crisp relation in $X \times Y$, and S^* be a neutrosophic crisp relation in $Y \times Z$. Then the composition of R^* and S^*, $R^* \circ S^*$ be a *- neutrosophic crisp relation in $X \times Z$ as a definition may be defined as two types

i) Type1:

$R^* \circ S^* \leftrightarrow (R^* \circ S^*)(x, z)$
$= \cup\{< \{(M_1 \times M_2)_R \cap (M_1 \times M_2)_S\}$,
$\{(S_1 \times S_2)_R \cap (S_1 \times S_2)_S\}$, $\{(R_1 \times R_2)_R \cap (R_1 \times R_2)_S\} >$.

ii) Type2:

$R^* \circ S^* \leftrightarrow (R^* \circ S^*)(x, z)$
$= \cap\{< \{(M_1 \times M_2)_R \cup (M_1 \times M_2)_S\}$,
$\{(S_1 \times S_2)_R \cup (S_1 \times S_2)_S\}$, $\{(R_1 \times R_2)_R \cup (R_1 \times R_2)_S\} >$.

Theorem 4.2

Let R^* be a *- neutrosophic crisp relation in $X \times Y$, and S be a *- neutrosophic crisp relation in $Y \times Z$ then $(R^* \circ S^*)^{-1} = S^{*-1} \circ R^{*-1}$.

Proof

Let $R^* \subseteq A^* \times B^*$ on $X \times Y$ then $R^{*-1} \subseteq B \times A$, $S^* \subseteq B^* \times D^*$ on $Y \times Z$ then $S^{*-1} \subseteq D^* \times B^*$, from Definition 4.3 and similarly we can $I^*_{(R^* \circ S^*)^{-1}}(x, z) = I^*_{S^{*-1}}(x, z)$ and $I^*_{R^{*-1}}(x, z)$ then $(R^* \circ S^*)^{-1} = S^{*-1} \circ R^{*-1}$.

References

[1] K. Atanassov, intuitionistic fuzzy sets, in V.Sgurev, ed., Vii ITKRS Session, Sofia (June 1983 central Sci. and Techn. Library, Bulg. Academy of Sciences (1984).

[2] K. Atanassov, intuitionistic fuzzy sets, Fuzzy Sets and Systems 20, 87-96,(1986).

[3] K. Atanassov, Review and new result on intuitionistic fuzzy sets, preprint IM-MFAIS-1-88, Sofia, (1988).

[4] S. Indira,, R. Raja, Rajeswari, A Study on Star Intuitionistic Sets, International Journal of Mathematics and Statistics Invention, (2)4,pp51-63. ,(2014).

[5] S. A. Alblowi, A.A.Salama and Mohmed Eisa, New Concepts of Neutrosophic Sets, International Journal of Mathematics and Computer Applications Research (IJMCAR),Vol. 4, Issue 1, (2014)pp59-66.

[6] I.M. Hanafy, A.A. Salama and K. Mahfouz, Correlation of Neutrosophic Data, International Refereed Journal of Engineering and Science (IRJES) , Vol.(1), Issue 2 .(2012) PP.39-33

[7] I.M. Hanafy, A.A. Salama and K.M. Mahfouz, Neutrosophic Classical Events and Its Probability, International Journal of Mathematics and Computer Applications Research(IJMCAR) Vol.(3),Issue 1, (2013)pp171-178.

[8] A. A. Salama and S.A. Alblowi, Generalized Neutrosophic Set and Generalized Neutrosophic Topological Spaces, Journal Computer Sci. Engineering, Vol. (2) No. (7), (2012)pp129-132 .

[9] A. A. Salama and S. A. Alblowi, Neutrosophic Set and

Neutrosophic Topological Spaces, ISOR J. Mathematics, Vol.(3), Issue(3), (2012) pp31-35.

[10] A. A. Salama, Neutrosophic Crisp Point & Neutrosophic Crisp Ideals, Neutrosophic Sets and Systems, Vol.1, (2013) pp50-54.

[11] A. A. Salama and F. Smarandache, Filters via Neutrosophic Crisp Sets, Neutrosophic Sets and Systems, Vol.1, (2013) pp34-38.

[12] A.A. Salama and S.A. Alblowi, Intuitionistic Fuzzy Ideals Topological Spaces, Advances in Fuzzy Mathematics , Vol.(7), 1, (2012) pp 51- 60.

[13] A.A. Salama, and H. Elagamy, Neutrosophic Filters, International Journal of Computer Science Engineering and Information Technology Reseearch (IJCSEITR), Vol.3, Issue(1), (2013) pp307-312.

[14] A. A. Salama, F.Smarandache and Valeri Kroumov, Neutrosophic crisp Sets & Neutrosophic crisp Topological Spaces, Neutrosophic Sets and Systems, Vlo.(2),(2014)pp25-30.

[15] A. A. Salama, Florentin Smarandache and Valeri Kroumov, Neutrosophic Closed Set and Neutrosophic Continuous Functions Neutrosophic Sets and Systems, Vol. (4),(2014)pp4-8.

[16] A. A. Salama, Mohamed Eisa and M. M. Abdelmoghny, Neutrosophic Relations Database, International Journal of Information Science and Intelligent System, 3(1) (2014)pp33-46 .

[17] A. A. Salama , Florentin Smarandache and S. A. Alblowi, New Neutrosophic Crisp Topological Concepts, Neutrosophic Sets and Systems, Vol(4), (2014)pp50-54.

[18] A. A. Salama, Said Broumi and Florentin Smarandache, Neutrosophic Crisp Open Set and Neutrosophic Crisp Continuity via Neutrosophic Crisp Ideals, I.J. Information Engineering and Electronic Business, Vol.3, (2014)pp1-8

[19] A.A. Salama, Florentin Smarandache and S.A. Alblowi. The Characteristic Function of a Neutrosophic Set, Neutrosophic Sets and Systems, 2014, Vol. (3), pp14-18.

[20] A. A. Salama, Neutrosophic Crisp Points & Neutrosophic Crisp Ideals, Neutrosophic Sets and Systems, 2013,Vol.(1) pp50-53

[21] A. A. Salama, Mohamed Abdelfattah and S. A. Alblowi, Some Intuitionistic Topological Notions of Intuitionistic Region, Possible Application to GIS Topological Rules, International Journal of Enhanced Research in Management&ComputerApplications, (2014),Vol.(3), no. (6)pp1-13.

[22] A. A. Salama, Mohamed Abdelfattah and Mohamed Eisa, A Novel Model for Implementing Security over Mobile Ad-hoc Networks using Intuitionistic Fuzzy Function, International Journal of Emerging Technologies in Computational and Applied Sciences (IJETCAS), 2014,Vol.(6)pp1-7.

[23] A. A. Salama and Said Broumi, Roughness of Neutrosophic Sets, Elixir Appl. Math. 74 (2014)pp26833-26837.

[24] A. A. Salama, Mohamed Abdelfattah and Mohamed Eisa, Distances, Hesitancy Degree and Flexible Querying via Neutrosophic Sets, International Journal of Computer Applications, Volume 101– No.10, (2014)pp0975 – 8887

[25] A.A. Salama, Haithem A. El-Ghareeb, Ayman. M. Maine and Florentin Smarandache. Introduction to Develop Some Software Programs for dealing with Neutrosophic Sets, Neutrosophic Sets and Systems, Vol(4), (2014)pp51-52.

[26] A. A. Salama, F. Smarandache, and M. Eisa. Introduction to Image Processing via Neutrosophic Technique, Neutrosophic Sets and Systems, Vol. (5) (2014) pp59-63.

[27] A. A. Salama, Haitham A. El-Ghareeb, Ayman M. Manie and M. M. Lotfy, Utilizing Neutrosophic Set in Social Network Analysis e-Learning Systems, International Journal of Information Science and Intelligent System, 3(2), (2014)pp61-72.

[28] A. A. Salama, O. M. Khaled, and K. M. Mahfouz. Neutrosophic Correlation and Simple Linear Regression, Neutrosophic Sets and Systems, 2014, Vol. (5) pp3-8.

[29] A. A. Salama, and F. Smarandache. Neutrosophic Crisp Set Theory, Neutrosophic Sets and Systems, 2014, Vol. (5) pp27-35.

[30] A. A. Salama , Florentin Smarandache and S. A. ALblowi, New Neutrosophic Crisp Topological Concepts, Neutrosophic Sets and Systems, 2014, Vol(4)pp50-54.

[31] Florentin Smarandache, Neutrosophy and Neutrosophic Logic, First International Conference on Neutrosophy , Neutrosophic Logic, Set, Probability, and Statistics University of New Mexico, Gallup, NM 87301, USA(2002).

[32] Florentin Smarandache, A Unifying Field in Logics: Neutrosophic Logic. Neutrosophy, Neutrosophic Set, Neutrosophic Probability. American Research Press, Rehoboth, NM, (1999).

[33] Florentin Smarandache, Neutrosophic set, a generialization of the intuituionistics fuzzy sets, Inter. J. Pure Appl. Math., 24 (2005), 287 – 297.

[34] L.A. Zadeh, Fuzzy Sets, Inform and Control 8, 338-353.(1965).

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