NSS

Neutrosophic Crisp Set & relations

A. A. Salama[1] and Hewayda ElGhawalby[2]

[1]Department of Mathematics and Computer Science, Faculty of Sciences, Port Said University, Egypt. E-mail:drsalama44@gmail.com
[2]Faculty of Engineering, Port Said University, Egypt. E-mail:hewayda2011@eng.psu.edu.eg

Abstract. In a world full of indeterminacy, traditional crisp set with its boundaries of truth and false has not infused itself with the ability of reflecting the reality. Therefore, neutrosophic found its place into contemporary research as an alternative representation of the real world. In this paper, we aim to develop a new type of neutrosophic crisp sets called the *-Neutrosophic crisp sets as a generalization of the star intuitionistic set introduced by Indira et al.[4] , and hence studying some of its properties . To this end we will investigate the notion of *-Neutrosophic relation and some of its properties.

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

1 Introduction

Established by Florentin Smarandache in 1980, Neutrosophy was presented as the study of the origin, nature, and scope of neutralities, as well as their interactions with different ideational spectra. The main idea was to consider an entity, "A" in relation to its opposite "Non-A", and to that which is neither "A" nor " Non-A ", denoted by "Neut-A". And from then on, Neutrosophy became the basis of neutrosophic logic, neutrosophic probability, neutrosophic set, and neutrosophic statistics.

In [31, 32, 33], Smarandache introduced the fundamental concepts of neutrosophic set, that had led 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], to provide a mathematical treatment for the neutrosophic phenomena which already existed in our real world.
Moreover, the work of Salama et al. formed a starting point to construct new branches of neutrosophic mathematics. Hence, Neutrosophic set theory turned out to be a generalization of both the classical and fuzzy counterparts [1, 2, 12, 22, 34].

This paper is devoted for introducing a new type of neutrosophic crisp set coded the *- neutrosophic crisp set, and studing some of its properties. And hence, we present and study the notion of *- neutrosophic relation and some of its properties.

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

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

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

$S_2=B_2\cap(B_1\cup B_3)^c$, 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: $A^{*c}=\left\langle M^c, S^c, R^c\right\rangle$,

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

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

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

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

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

v) $R^{*} \cap \left(S^{*} \cup Q^{*}\right) = \left(R^{*} \cap S^{*}\right) \cup \left(R^{*} \cap Q^{*}\right)$.

vi) $R^{*} \cup \left(S^{*} \cap Q^{*}\right) = \left(R^{*} \cup S^{*}\right) \cap \left(R^{*} \cup Q^{*}\right)$.

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 $(R^{*} \circ S^{*})^{-1} = S^{*-1} \circ R^{*-1}$.

Conclusion and Future Work

In this paper, a new generalization of the star intuitionistic set called the *-Neutrosophic crisp sets was introduced. The properties and some basic operations relevant to the new type was investigated. Furthermore, the notion of *-Neutrosophic relation and some of its properties were studied. For the future, we intend to introduce the new concepts presented in this paper to some possible applications in computer and mathematics.

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).

Received: October 10, 2014. Accepted: October 29, 2014