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NEUTROSOPHIC BIMINIMAL SEMI-OPEN SETS

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ABSTRACT. In this article, we introduced the notions of N^{j}_{mX}-semi-open sets, semi-interior and semi-closure operators in neutrosophic biminimal structures. We investigate some basic properties of such notions. Also, we introduced the notion of N^{j}_{mX}-semi-continuous maps and study characterizations of N^{j}_{mX}-semi-continuous maps by using the semi-interior and semi-closure operators in neutrosophic biminimal structures.

1. INTRODUCTION

L.A. Zadeh's [10] Fuzzy set laid the foundation of many theories such as intuitionistic fuzzy set and neutrosophic set, rough sets etc. Later, researchers developed K. T. Atanassov's [1] intuitionistic fuzzy set theory in many fields such as differential equations, topology, computer science and so on. F. Smarandache [8, 9] found that some objects have indeterminacy or neutral other than membership and non-membership. So he coined the notion of neutrosophy. The concept of minimal structure (in short, m-structure) was introduced by V. Popa and T. Noiri [6] in 2000. Also they introduced the notion of $_{mX}$-open set and $_{mX}$-closed set and characterize those sets using $_{mX}$-closure and $_{mX}$-interior operators respectively. Further they introduced $\mathcal{M}$-continuous functions and studied some of its basic properties. M. Karthika et al [5] introduced and studied neutrosophic minimal structure spaces. S. Ganesan [2] introduced the notion of N_{mX}-semi-open neutrosophic minimal structure spaces. S. Ganesan et al [3] introduced the notion of neutrosophic biminimal structure spaces and also applications of neutrosophic biminimal structure spaces. The main objective of this study is to introduce a new hybrid intelligent structure called neutrosophic biminimal semi-open sets. The significance of introducing hybrid structures is that the computational techniques, based on any one of these structures alone, will not always yield the best results but a fusion of two or more of them can often give better results. The rest of this chapter is organized as follows. Some preliminary concepts required in our work are briefly recalled in Section 2. In Section 3, some properties of neutrosophic biminimal semi-open sets are also investigated.

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2. Preliminaries

Definition 2.1. [6] A subfamily m_x of the power set $\wp$(X) of a nonempty set X is called a minimal structure (in short, m-structure) on X if $\emptyset \in m_x$ and X $\in m_x$. By (X, m_x), we denote a nonempty set X with a minimal structure m_x on X and call it an m-space.
Each member of m_x is said to be m_x-open (or in short, m-open) and the complement of an m_x-open set is said to be m_x-closed (or in short, m-closed).

Definition 2.2. [8, 9] A neutrosophic set (in short ns) K on a set X $\neq \emptyset$ is defined by K = $\{\prec$ a, P$_K$(a), Q$_K$(a), R$_K$(a) $\succ\rangle$: a $\in$ X$\}$ where P$_K$: X $\to$ [0,1], Q$_K$: X $\to$ [0,1] and R$_K$: X $\to$ [0,1] denotes the membership of an object, indeterminacy and non-membership of an object, for each a X to K, respectively and 0 $\leq$ P$_K$(a) + Q$_K$(a) + R$_K$(a) $\leq$ 3 for each a $\in$ X.

Definition 2.3. [7] Let K = $\{\prec$ a, P$_K$(a), Q$_K$(a), R$_K$(a) $\succ\rangle$: a $\in$ X$\}$ be a ns.

1. A ns K is an empty set i.e., K = $0_\sim$ if 0 is membership of an object and 0 is an indeterminacy and 1 is a non-membership of an object respectively. i.e., $0_\sim$ = $\{$x, (0, 0, 1) : x $\in$ X$\}$
2. A ns K is a universal set i.e., K = $1_\sim$ if 1 is membership of an object and 1 is an indeterminacy and 0 is a non-membership of an object respectively. $1_\sim$ = $\{$x, (1, 1, 0) : x $\in$ X$\}$
3. K$_1$ $\cup$ K$_2$ = $\{$a, max $\{P_{K_1}$(a), P_{K_2}(a)$\}$, max $\{Q_{K_1}$(a), Q_{K_2}(a)$\}$, min $\{R_{K_1}$(a), R_{K_2}(a)$\}$: a $\in$ X$\}$
4. K$_1$ $\cap$ K$_2$ = $\{$a, min $\{P_{K_1}$(a), P_{K_2}(a)$\}$, min $\{Q_{K_1}$(a), Q_{K_2}(a)$\}$, max $\{R_{K_1}$(a), R_{K_2}(a)$\}$: a $\in$ X$\}$
5. K_1^C = $\{\prec$ a, R$_K$(a), 1 $-$ Q$_K$(a), P$_K$(a) $\succ\rangle$: a $\in$ X$\}$

Definition 2.4. [7] A neutrosophic topology (nt) in Salama's sense on a nonempty set X is a family τ of ns in X satisfying three axioms:

1. Empty set ($0_\sim$) and universal set ($1_\sim$) are members of τ.
2. K$_1$ $\cap$ K$_2$ $\in \tau$ where K$_1$, K$_2$ $\in \tau$.
3. $\cup$K$_\delta$ $\in \tau$ for every $\{$K$_\delta$: $\delta \in \Delta\} \leq \tau$.

Each ns in nt are called neutrosophic open sets. Its complements are called neutrosophic closed sets.

Definition 2.5. [5] Let the neutrosophic minimal structure space over a universal set X be denoted by N$_m$. N$_m$ is said to be neutrosophic minimal structure space (in short, nms) over X if it satisfying following the axiom: $0_\sim$, $1_\sim$ $\in$ N$_m$. A family of neutrosophic minimal structure space is denoted by (X, N_{mX}).
Note that the neutrosophic empty set and neutrosophic universal set can form a topology and it is known as neutrosophic minimal structure space.

Definition 2.6. [3] Let X be a nonempty set and N^1_{mX}, N^2_{mX} be nms on X. A triple (X, N^1_{mX}, N^2_{mX}) is called a neutrosophic biminimal structure space (in short, nbims)

Definition 2.7. [3] Let (X, N^1_{mX}, N^2_{mX}) be a nbims and S be any neutrosophic set. Then

1. Every S $\in N^j_{mX}$ is open and its complement is closed, respectively, for j = 1, 2.
2. N$_m cl_j$-closure of S = min $\{$L : L is N^j_{mX}-closed set and L $\geq$ S$\}$, respectively, for j = 1, 2 and it is denoted by N$_m cl_j$(S).
3. N$_m int_j$-interior of S = max $\{$T : T is N^j_{mX}-open set and T $\leq$ S$\}$, respectively, for j = 1, 2 and it is denoted by N$_m int_j$(S).

Proposition 2.1. [3] *Let (X, N^1_{mX}, N^2_{mX}) be a nbims and A $\leq$ X. Then*

(1) $N_m int_j$($0_\sim$) = $0_\sim$
(2) $N_m int_j$($1_\sim$) = $1_\sim$
(3) $N_m int_j$(A) $\leq$ A.
(4) If A $\leq$ B, then $N_m int_j$(A) $\leq$ $N_m int_j$(B).
(5) A is N^j_{mX}-open if and only if $N_m int_j$(A) = A.
(6) $N_m int_j$($N_m int_j$(A)) = $N_m int_j$(A).
(7) $N_m cl_j$(X $-$ A) = X$-$ $N_m int_j$(A) and $N_m int_j$(X$-$ A) = X $-$ $N_m cl_j$(A).
(8) $N_m cl_j$($0_\sim$) = $0_\sim$
(9) $N_m cl_j$($1_\sim$) = $1_\sim$
(10) A $\leq$ $N_m cl_j$(A).
(11) If A $\leq$ B, then $N_m cl_j$(A) $\leq$ $N_m cl_j$(B).
(12) F is N^j_{mX}-closed if and only if $N_m cl_j$(F) = F.
(13) $N_m cl_j$($N_m cl_j$(A)) = $N_m cl_j$(A).

Definition 2.8. [3] Let (X, N^1_{mX}, N^2_{mX}) be a nbims and A be a subset of X. Then A is $N^1_{mX}N^2_{mX}$-closed if and only if N$_m cl_1$(A) = A and N$_m cl_2$(A) = A.

Proposition 2.2. [3] *Let N^1_{mX} and N^2_{mX} be nms on X satisfying (Union Property). Then A is a $N^1_{mX}N^2_{mX}$-closed subset of a nbims (X, N^1_{mX}, N^2_{mX}) if and only if A is both N^1_{mX}-closed and N^2_{mX}-closed.*

Proposition 2.3. [3] *Let (X, N^1_{mX}, N^2_{mX}) be a nbims. If A and B are $N^1_{mX}N^2_{mX}$-closed subsets of (X, N^1_{mX}, N^2_{mX}), then A $\wedge$ B is $N^1_{mX}N^2_{mX}$-closed.*

Proposition 2.4. [3] *Let (X, N^1_{mX}, N^2_{mX}) be a nbims. If A and B are $N^1_{mX}N^2_{mX}$-open subsets of (X, N^1_{mX}, N^2_{mX}), then A $\vee$ B is $N^1_{mX}N^2_{mX}$-open.*

Definition 2.9. A map f : (X, N^1_{mX}, N^2_{mX}) $\rightarrow$ (Y, N^1_{mY}, N^2_{mY}) is called N^j_{mX}-continuous map if and only if f^{-1}(V) $\in$ N^j_{mX}-open whenever V $\in$ N^j_{mY}.

Theorem 2.5. *Let f : X $\rightarrow$ Y be a map on two nbims (X, N^1_{mX}, N^2_{mX}) and (Y, N^1_{mY}, N^2_{mY}). Then the following statements are equivalent:*

(1) Identity map from (X, N^1_{mX}, N^2_{mX}) to (Y, N^1_{mY}, N^2_{mY}) is a nbims map.
(2) Any constant map which map from (X, N^1_{mX}, N^2_{mX}) to (Y, N^1_{mY}, N^2_{mY}) is a nbims map.

Proof. The proof is obvious. □

3. $N^1_{mX}N^2_{mX}$-SEMI-OPEN SETS

Definition 3.1. Let (X, N^1_{mX}, N^2_{mX}) be a nbims and A $\leq$ X. A subset A of X is called an $N^1_{mX}N^2_{mX}$-semi-open (in short, N^j_{mX}-semi-open) set if A $\leq$ N$_m cl_j$(N$_m int_j$(A)), respectively, for j = 1, 2.
The complement of an N^j_{mX}-semi-open set is called an N^j_{mX}-semi-closed set.

Remark. *Let (X, N_{mX}) be a nms and A $\leq$ X. A is called an N_m-semi-open set* [2] *if A $\leq$ $N_m$cl($N_m$int(A)). If the nms N_{mX} is a topology, clearly an N^j_{mX}-semi-open set is N_m-semi-open.* From the Definition of 3.1, obviously, the following statement is obtained.

Lemma 3.1. *Let (X, N^1_{mX}, N^2_{mX}) be a nbims. Then*

(1) Every N^j_{mX}-open set is N^j_{mX}-semi-open.
(2) A is an N^j_{mX}-semi-open set if and only if A $\leq$ $N_m cl_j$($N_m int_j$(A)).

(3) *Every N^j_{mX}-closed set is N^j_{mX}-semi-closed.*
(4) *A is an N^j_{mX}-semi-closed set if and only if $N_m int_j(N_m cl_j(A)) \leq A$.*

Theorem 3.2. *Let (X, N^1_{mX}, N^2_{mX}) be a nbims. Any union of N^j_{mX}-semi-open sets is N^j_{mX}-semi-open.*

Proof. Let A_δ be an N^j_{mX}-semi-open set for $\delta \in \Delta$. From Definition 3.1 and Proposition 2.1(4), it follows $A_\delta \leq N_m cl_j(N_m int_j(A_\delta)) \leq N_m cl_j(N_m int_j(\bigcup A_\delta))$. This implies $\bigcup A_\delta \leq N_m cl_j(N_m int_j(\bigcup A_\delta))$. Hence $\bigcup A_\delta$ is an N^j_{mX}-semi-open set. □

Remark. *Let (X, N^1_{mX}, N^2_{mX}) be a nbims. The intersection of any two N^j_{mX}-semi-open sets may not be N^j_{mX}-semi-open set as shown in the next example.*

Example 3.2. Let X = $\{a\}$ with $N^1_{mX} = \{0_\sim, A, 1_\sim\}$; $(N^1_{mX})^C = \{1_\sim, B, 0_\sim\}$ and $N^2_{mX} = \{0_\sim, U, 1_\sim\}$; $(N^2_{mX})^C = \{1_\sim, V, 0_\sim\}$ where
A = $\{\prec 0.6, 0.3, 0.8 \succ : x \in X\}$ B = $\{\prec 0.8, 0.7, 0.6) \succ: x \in X\}$
U = $\{\prec 0.4, 0.5, 0.7 \succ : x \in X\}$ V = $\{\prec 0.7, 0.5, 0.4 \succ : x \in X\}$
We know that $0_\sim = \{\prec x, 0, 0, 1 \succ : x \in X\}$, $1_\sim = \{\prec x, 1, 1, 0 \succ : x \in X\}$ and $0^C_\sim = \{\prec x, 1, 1, 0 \succ : x \in X\}$, $1^C_\sim = \{\prec x, 0, 0, 1 \succ : x \in X\}$.
Now we define the two N^j_{mX}-semi-open sets as follows:
$G_1 = \{\prec 0.3, 0.4, 0.5\succ : x \in X\}$ $G_2 = \{\prec 0.5, 0.2, 0.6\succ: x \in X\}$
Here $N_m cl_j(N_m int_j(G_1)) = 1^C_\sim$ and $N_m cl_j(N_m int_j(G_2)) = 1^C_\sim$. But $G_1 \wedge G_2 = \prec (0.3, 0.2, 0.6)\succ$ is not a N^j_{mX}-semi-open set in X.

Definition 3.3. Let (X, N^1_{mX}, N^2_{mX}) be a nbims and S be any neutrosophic set. Then

(1) Every S $\in N^j_{mX}$ is semi-open and its complement is semi-closed, respectively, for j = 1, 2.
(2) $N_m cl_j$-semi-closure of S = min $\{L : L$ is N^j_{mX}-semi-closed set and $L \geq S\}$, respectively, for j = 1, 2 and it is denoted by $N_m scl_j(S)$.
(3) $N_m int_j$-semi-interior of S = max $\{T : T$ is N^j_{mX}-semi-open set and $T \leq S\}$, respectively, for j = 1, 2 and it is denoted by $N_m sint_j(S)$.

Theorem 3.3. *Let (X, N^1_{mX}, N^2_{mX}) be a nbims and $A \leq X$. Then*

(1) $N_m sint_j(0_\sim) = 0_\sim$
(2) $N_m sint_j(1_\sim) = 1_\sim$
(3) $N_m sint_j(A) \leq A$.
(4) *If $A \leq B$, then $N_m sint_j(A) \leq N_m sint_j(B)$.*
(5) *A is N^j_{mX}-semi-open if and only if $N_m sint_j(A) = A$.*
(6) $N_m sint_j(N_m sint_j(A)) = N_m sint_j(A)$.
(7) $N_m scl_j(X - A) = X - N_m sint_j(A)$ *and* $N_m sint_j(X- A) = X - N_m scl_j(A)$.

Proof. (1), (2), (3), (4) Obvious.
(5) It follows from Theorem 3.2.
(6) It follows from (5).
(7) For $A \leq X$, $X - N_m sint_j(A) = X -$ max $\{U : U \leq A$, U is N^j_{mX}-semi-open$\}$ = min $\{ X - U : U \leq A$, U is N^j_{mX}-semi-open = min $\{X\ \ U : X - A \leq X - U$, U is N^j_{mX}-semi-open$\}$ = $N_m scl_j(X - A)$.
Similarly, we have $N_m sint_j(X - A) = X - N_m scl_j(A)$. □

Theorem 3.4. *Let (X, N^1_{mX}, N^2_{mX}) be a nbims and $A \leq X$. Then*

(1) *$N_m scl_j$($0_\sim$) = $0_\sim$*
(2) *$N_m scl_j$($1_\sim$) = $1_\sim$*
(3) *A $\leq N_m scl_j$(A).*
(4) *If A $\leq$ B, then $N_m scl_j$(A) $\leq N_m scl_j$(B).*
(5) *F is N^j_{mX}-semi-closed if and only if $N_m scl_j$(F) = F.*
(6) *$N_m scl_j$($N_m scl_j$(A)) = $N_m scl_j$(A).*

Proof. It is similar to the proof of Theorem 3.3. □

Theorem 3.5. *Let (X, N^1_{mX}, N^2_{mX}) be a nbims and A $\leq$ X. Then*

(1) *x $\in N_m scl_j$(A) if and only if A $\cap$ V $\neq \emptyset$ for every N^j_{mX}-semi-open set V containing x.*
(2) *x $\in N_m sint_j$(A) if and only if there exists an N^j_{mX}-semi-open set U such that U $\leq$ A.*

Proof. (1) Suppose there is an N^j_{mX}-semi-open set V containing x such that A $\cap$ V = $\emptyset$. Then X $-$ V is an N^j_{mX}-semi-closed set such that A $\leq$ X $-$ V, x $\notin$ X $-$ V. This implies x $\notin$ N$_m scl_j$(A).
The reverse relation is obvious.
(2) Obvious. □

Lemma 3.6. *Let (X, N^1_{mX}, N^2_{mX}) be a nbims and A $\leq$ X. Then*

(1) *$N_m int_j$($N_m cl_j$(A)) $\leq N_m int_j$($N_m cl_j$($N_m scl_j$(A))) $\leq N_m scl_j$(A).*
(2) *$N_m sint_j$(A) $\leq N_m cl_j$($N_m int_j$($N_m sint_j$(A))) $\leq N_m cl_j$($N_m int_j$(A)).*

Proof. (1) For A $\leq$ X, by Theorem 3.4, N$_m scl_j$(A) is an N^j_{mX}-semi-closed set. Hence from Lemma 3.1, we have N$_m int_j$(N$_m cl_j$(A)) $\leq$ N$_m int_j$(N$_m cl_j$(N$_m scl_j$(A))) $\leq$ N$_m scl_j$(A).
(2) It is similar to the proof of (1). □

Definition 3.4. A map f : (X, N^1_{mX}, N^2_{mX}) $\to$ (Y, N^1_{mY}, N^2_{mY}) is called N^j_{mX}-semi-continuous map if and only if f^{-1}(V) $\in N^j_{mX}$-semi-open whenever V $\in N^j_{mY}$.

Theorem 3.7. *Every N^j_{mX}-continuous is N^j_{mX}-semi-continuous but the conversely.*

Proof. The proof follows from Lemma 3.1 (1). □

Theorem 3.8. *Let f : X $\to$ Y be a map on two nbims (X, N^1_{mX}, N^2_{mX}) and (Y, N^1_{mY}, N^2_{mY}). Then the following statements are equivalent:*

(1) *f is N^j_{mX}-semi-continuous.*
(2) *f^{-1}(V) is an N^j_{mX}-semi-open set for each N^j_{mX}-open set V in Y.*
(3) *f^{-1}(B) is an N^j_{mX}-semi-closed set for each N^j_{mX}-closed set B in Y.*
(4) *f($N_m scl_j$(A)) $\leq N_m cl_j$(f(A)) for A $\leq$ X.*
(5) *$N_m scl_j$(f^{-1}(B)) $\leq$ f^{-1}($N_m cl_j$(B)) for B $\leq$ Y.*
(6) *f^{-1}($N_m int_j$(B)) $\leq N_m sint_j$(f^{-1}(B)) for B $\leq$ Y.*

Proof. (1) $\Rightarrow$ (2) Let V be an N^j_{mX}-open set in Y and x $\in$ f^{-1}(V). By hypothesis, there exists an N^j_{mX}-semi-open set U$_x$ containing x such that f(U) $\leq$ V. This implies x $\in$ U$_x$ $\leq$ f^{-1}(V) for all x $\in$ f^{-1}(V). Hence by Theorem 3.2, f^{-1}(V) is N^j_{mX}-semi-open.
(2) $\Rightarrow$ (3) Obvious.
(3) $\Rightarrow$ (4) For A $\leq$ X, f^{-1}(N$_m cl_j$(f(A))) = f^{-1}(min {F $\leq$ Y : f(A) $\leq$ F and F is N^j_{mX}-closed}) = min {f^{-1}(F) $\leq$ X : A $\leq$ f^{-1}(F) and F is N^j_{mX}-semi-closed} $\geq$ min {K $\leq$ X : A

$\leq$ K and K is N^j_{mX}-semi-closed} = N$_m scl_j$(A). Hence f(N$_m scl_j$(A)) $\leq$ N$_m cl_j$(f(A)).
(4) $\Rightarrow$ (5) For A $\leq$ X, from (4), it follows f(N$_m scl_j$(f^{-1}(A))) $\leq$ N$_m cl_j$(f(f^{-1}(A))) $\leq$ N$_m cl_j$(A). Hence we get (5).
(5) $\Rightarrow$ (6) For B $\leq$ Y, from N$_m int_j$(B) = Y $-$ N$_m cl_j$(Y $-$ B) and (5), it follows: f^{-1}(N$_m int_j$(B)) = f^{-1}(Y $-$ N$_m cl_j$(Y $-$ B)) = X $-$f^{-1}(N$_m cl_j$(Y $-$ B)) $\leq$ X $-$ N$_m scl_j$(f^{-1}(Y $-$ B)) = N$_m sint_j$(f^{-1}(B)). Hence (6) is obtained.
(6) $\Rightarrow$ (1) Let x $\in$ X and V an N^j_{mX}-open set containing f(x). Then from (6) and Proposition 2.1, it follows x $\in$ f^{-1}(V) = f^{-1}(N$_m int_j$(V)) $\leq$ N$_m sint_j$(f^{-1}(V)). So from Theorem 3.5, we can say that there exists an N^j_{mX}-semi-open set U containing x such that x $\in$ U $\leq$ f^{-1}(V). Hence f is N^j_{mX}-semi-continuous. □

Theorem 3.9. *Let f : X $\rightarrow$ Y be a map on two nbims (X, N^1_{mX}, N^2_{mX}) and (Y, N^1_{mY}, N^2_{mY}). Then the following statements are equivalent:*

(1) f is N^j_{mX}-semi-continuous.
(2) $f^{-1}(V) \leq N_m cl_j(N_m int_j(f^{-1}(V)))$ for each N^j_{mX}-open set V in Y.
(3) $N_m int_j(N_m cl_j(f^{-1}(F))) \leq f^{-1}(F)$ for each N^j_{mX}-closed set F in Y.
(4) $f(N_m int_j(N_m cl_j(A))) \leq N_m cl_j(f(A))$ for $A \leq X$.
(5) $N_m int_j(N_m cl_j(f^{-1}(B))) \leq f^{-1}(N_m cl_j(B))$ for $B \leq Y$.
(6) $f^{-1}(N_m int_j(B)) \leq N_m cl_j(N_m int_j(f^{-1}(B)))$ for $B \leq Y$.

Proof. (1) $\Leftrightarrow$ (2) It follows from Theorem 3.8 and Definition of N^j_{mX}-semi-open sets.
(1) $\Leftrightarrow$ (3) It follows from Theorem 3.8 and Lemma 3.1.
(3) $\Rightarrow$ (4) Let A $\leq$ X. Then from Theorem 3.8(4) and Lemma 3.6, it follows N$_m int_j$(N$_m cl_j$(A)) $\leq$ N$_m scl_j$(A)) $\leq$ f^{-1}(N$_m cl_j$(f(A))). Hence f(N$_m int_j$(N$_m cl_j$(A))) $\leq$ N$_m cl_j$(f(A)).
(4) $\Rightarrow$ (5) Obvious.
(5) $\Rightarrow$ (6) From (5) and Proposition 2.1, it follows: f^{-1}(N$_m int_j$(B)) = f^{-1}(Y $-$ N$_m cl_j$(Y $-$ B)) = X $-$f^{-1}(N$_m cl_j$(Y $-$ B)) $\leq$ X $-$ N$_m int_j$(N$_m cl_j$(f^{-1}(Y $-$ B)))
= N$_m cl_j$(N$_m int_j$(f^{-1}(B))). Hence, (6) is obtained.
(6) $\Rightarrow$ (1) Let V be an N^j_{mX}-open set in Y. Then by (6) and Proposition 2.1, we have f^{-1}(V) = f^{-1}(N$_m int_j$(V)) $\leq$ N$_m cl_j$(N$_m int_j$(f^{-1}(V))). This implies f^{-1}(V) is an N^j_{mX}-semi-open set. Hence by (2), f is N^j_{mX}-semi-continuous. □

4. CONCLUSIONS

The neutrosophic set is a general formal framework, which generalizes the concept of the classic set, fuzzy set, interval-valued fuzzy set, intuitionistic fuzzy set, and interval intuitionistic fuzzy set. Since the world is full of indeterminacy, the neutrosophic biminimal spaces found their place in the contemporary research world. This chapter can be further developed into several possible such as Geographical Information Systems (GIS) field including remote sensing, object reconstruction from the airborne laser scanners, real-time tracking, routing applications and modeling cognitive agents. In GIS there is a need to model spatial regions with indeterminate boundaries and under indeterminacy. Hence this neutrosophic biminimal spaces can also be extended to a neutrosophic spatial region. In future, we will research neutrosophic soft set biminimal structure spaces.. The results of this study may be helpful in many researches.

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