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A REAL TIME APPLICATION ON NEUTROSOPHIC NANO SOFT TOPOLOGY

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Abstract. In this paper, we introduce Neutrosophic Nano Topological Space induced by soft set. The "Neutrosophic Nano Soft Topological Space"(NNSTS) is generated by soft lower approximation, soft upper approximation and soft boundary region. The approximations are derived by the soft relation. Also a real life problem is converted to Neutrosophic Nano Soft Topology and solved by calculating score value.

Keywords: Neutrosophic Nano Soft Topological Space, Score value.

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1. Introduction

Nano Topology is a rising division of Topology in the recent years. Many researchers have contributed their work in this area by describing practical applications like medical diagnosis, pattern recognizing, etc., Nano Topology was introduced by Lellis Thivagar [11]. It consists maximum of five elements called the universal set, the empty set, the lower approximation, the upper approximation and the boundary region. He used the concept for criterion reduction in Nano topology [13] for many real life problems. The concept of neutrosophic set in terms of truth membership, indeterminacy and non-membership values, was given by Smarandache [26]. The idea of neutrosophy has been applied where the situation of indeterminacy occurs. The recent researchers Abdel-Basset, et.al., [1, 2, 3, 4, 5] used neutrosophy concept for many practical problems. The generalization of neutrosophic sets, neutrosophic closed sets and neutrosophic crisp sets in neutrosophic topological spaces was introduced by Salama, et.al., [18]. Molodtsov [16] initiated the theory of soft set to deal with uncertainties. The concept of soft set has been applied to many decision making real life situations.

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The Nano soft Topological space was defined by Lellis Thivagar, et.al., [15]. Said Broumi, et.al., [8] presented generalized neutrosophic soft set and worked with neutrosophic soft matrices for multi criterion decision making problems. In this paper we insert the concept of neutrosophy into Nano soft topology and derive a new notion called the Neutrosophic Nano soft topology. The Neutrosophic Nano Soft Topological Space is derived using the soft relation on it. Moreover, some examples are given here and a real life decision making problem is solved.

2. Preliminaries

Definition 2.1. [16] *Let U be the universal set, E be the set of parameters and $P(U)$ be the powerset of U. Let $A \subseteq E$. The soft set denoted by F_A or (F, A) is defined as,*

$$F_A = \{(e, F(e)) : e \in E, F(e) \in P(U)\} \text{ i.e., } F : E \to P(U).$$

Here $F(e) = \emptyset$, if $e \notin A$.

Definition 2.2. [16] *A NULL soft set, denoted by $\widetilde{\emptyset}$, is a soft set (F, A) over U, if $F(e) = \widetilde{\emptyset}$, $\forall e \in A$.*

Definition 2.3. [16] *An absolute soft set, denoted by $\widetilde{U}$, is a soft set (F, A) over U, if $F(e) = U$, $\forall e \in A$.*

Definition 2.4. [16] *Let (F, A) and (G, B) are two soft sets over a common universal set U. The union of these two soft sets F_A and G_B, denoted by (H, C), is defined as*

$$H(e) = \begin{cases} F(e) & \text{if} e \in A - B \\ G(e) & \text{if } e \in B - A \\ F(e) \cup G(e) & \text{if} e \in A \cap B, \forall e \in C, \text{ where } C = A \cup B. \end{cases}$$

In symbol, $(H, C) = (F, A)\widetilde{U}(G, B)$

Definition 2.5. [16] *Let (F, A) and (G, B) are the two soft sets over a common universal set U. The intersection of the two soft sets F_A and G_B, denoted by (H, C) is defined as, $H(e) = F(e) \cap G(e)$, $\forall e \in C$, where $C = A \cap B$.*
In symbol, $(H, C) = (F, A) \widetilde{\cap} (G, B)$

Definition 2.6. [16] *The soft set F_A is a soft subset of G_B, if*

(i) $A \subset B$ and
(ii) $\forall e \in A$, $F(e)$ and $G(e)$ are identical approximation.

In symbol, $F_A \widetilde{\subset} G_B$. Here G_B is said to be the soft superset of F_A.

Definition 2.7. [7] *The cartesian product of F_A and G_B is defined as*
$(F, A) \times (G, B) = (H, A \times B)$, where $H : A \times B \to P(U \times U)$ and
$H(a, b) = F(a) \times G(b)$, $\forall (a, b) \in A \times B$
i.e., $H(a, b) = \{(h_i, h_j) : h_i \in F(a)$ and $h_j \in G(b)\}$

Definition 2.8. [7] *The soft binary relation R holds between the soft sets F_A and G_B if $F(a)RF(b)$, $\forall a \in F(a)$ and $b \in G(b)$. i.e., $F(a)XF(b) \in R$*

Definition 2.9. [31] *The binary relation R on F_A is said to be a soft equivalence relation, if it is*

(i) soft reflexive, i.e., $F(a)RF(a)$, $\forall a \in A$
(ii) soft symmetric, i.e., $F(a)RF(b) \Rightarrow F(b)RF(a)$, $\forall a, b \in A$

(iii) soft transitive, i.e., $F(a)RF(b)$*, and* $F(b)RF(c) \Rightarrow F(a)RF(c)$*,* $\forall a, b, c \in A$

Definition 2.10. [7] *The soft equivalence class of* $F(a)$ *on the soft set* F_A *is denoted by* $[F(a)]$ *and defined as* $[F(a)] = \{F(b) : F(a) \times F(b) \in R, \forall a, b \in A\}$.

Definition 2.11. [25] *Let* $\widetilde{\tau}$ *be the collection of soft sets over* U*, then* $\widetilde{\tau}$ *is called a soft topology on* U*, if*

(i) $\widetilde{\emptyset}, \widetilde{U} \in \widetilde{\tau}$

(ii) The union of any soft sets in $\widetilde{\tau}$ *is in* $\widetilde{\tau}$

(iii) The intersection of any two soft sets in $\widetilde{\tau}$ *is in* $\widetilde{\tau}$

The topological space along with the parameter set denoted by $(U, \widetilde{\tau}, E)$ *is called a soft topological space over* U*. The elements belonging to* $\widetilde{\tau}$ *are said to be soft open sets in* U*.*

Definition 2.12. [11] *Let* U *be the universal set , R be an equivalence relation on* U *called the indiscernibility relation. Let* $X \subseteq U$*.*

(i) The lower approximation of X *with respect to R, denoted by* $L_R(X)$ *is the set of all objects, which can be for certain classified as* X*.*

$$\text{i.e., } L_R(X) = \{\textstyle\bigcup_{x \in U} R(x) : R(x) \subseteq X\}$$

(ii) The upper approximation of X *with respect to R, denoted by* $U_R(X)$ *is the set of all obejects which can be possibly classified as* X*.*

$$\text{i.e., } U_R(X) = \{\textstyle\bigcup_{x \in U} R(x) : R(x) \cap X \neq \emptyset\}$$

(iii) The boundary region of X *with respect to R is the set of all objects which can be classified neither as* X *nor as not* X *and is denoted by* $B_R(X)$*.*

$$\text{i.e., } B_R(X) = U_R(X) - L_R(X)$$

Definition 2.13. [11] *Let* U *be the universal set, R be an equivalence relation on* U*. Let* $X \subseteq U$*. Then* $\tau_R(X) = \{U, \emptyset, L_R(X), U_R(X), B_R(X)\}$ *and satisfies,*

(i) U *and* $\emptyset \in \tau_R(X)$

(ii) The union of the elements of any subcollection of $\tau_R(X)$ *is in* $\tau_R(X)$

(iii) The intersection of the elements of finite subcollection of $\tau_R(X)$ *is in* $\tau_R(X)$

is called nano topology on U *with respect to* X*.*

Definition 2.14. [15] *Let* U *be the universal set,* (F, A) *be a soft set over* U *and R is a soft equivqlence relation on* (F, A)*. Elements belonging to the soft equivalence class of* $F(a)$ *denoted by* $[F(a)]$ *are said to be soft indiscernible with one another. Here* (U, F_A) *is said to be soft approximation space. Let* $G_B \subseteq F_A$*.*

(i) The soft lower apporximation of F_A *with respect to* G_B *is denoted by* $L_R(G_B)$ *and is defined as*

$$L_R(G_B) = \textstyle\bigcup_{a \in A}\{F(a) : [F(a)] \subseteq G_B\}.$$

(ii) The soft upper approximation of F_A *with respect to* G_B *is denoted by* $U_R(G_B)$ *and defined as*

$$U_R(G_B) = \textstyle\bigcup_{a \in A}\{F(a) : [F(a)] \cap G_B \neq \widetilde{\emptyset}\}$$

(iii) The soft boundary region of F_A *with respect to* G_B *is donted by* $B_R(G_B)$ *and defined as*

$$B_R(G_B) = U_R(G_B) - L_R(G_B)$$

Definition 2.15. [15] *Let* U *be the universal set and* F_A *is a soft set over* U*. Then* (U, F_A) *is a soft approximation space. Let* $G_B \subseteq F_A$*. Then* $\widetilde{\tau}_R(G_B) = \{\widetilde{U}, \widetilde{\emptyset}, L_R(G_B), U_R(G_B), B_R(G_B)\}$ *which satisfies* *(i)* $\widetilde{U}, \widetilde{\emptyset} \in \widetilde{\tau}_R(G_B)$

(ii) The union of the elements of any subcollection of $\widetilde{\tau}_R(G_B)$ *is in* $\widetilde{\tau}_R(G_B)$

(iii) The intersection of the elements of finite subcollection of $\widetilde{\tau}_R(G_B)$ *is in* $\widetilde{\tau}_R(G_B)$

is called a nano soft topological space and is denoted by $(U, \widetilde{\tau}_R, E)$. *The elements of* $\widetilde{\tau}_R$ *are called nono soft open sets in U.*

Definition 2.16. [26] *Let X be an universe of discourse with a general element x, the neutrosophic set is an object having the form*

$$A = \{< x, \mu_A(x), \sigma_A(x), \gamma_A(x) >, x \in X\}$$

where μ, σ *and* γ *each takes the values from* $[0, 1]$ *and called as the degree of membership, degree of indeterminacy and the degree of non-membership of the element* $x \in X$ *to the set A with the condition*

$$0 \leq \mu_A(x) + \sigma_A(x) + \gamma_a(x) \leq 3.$$

Note 1. $L_R(G_B), U_R(G_B)$ *and* $B_R(G_B)$ *are found as in definition 2.14 for the subsequent sections.*

3. Neutrosophic Nano Soft Topological Space

Definition 3.1. *Let U be the universal set, E be the set of parameters and* $D \subseteq E$. *For each element* $x \in U$ *and each* $e \in D$, *there exist a set A, called the neutrosophic set having the form*

$$A = \{< x, \mu_A(x), \sigma_A(x), \gamma_A(x) >, x \in U\}$$

with the condition $0 \leq \mu_A(x) + \sigma_A(x) + \gamma_A(x) \leq 3$, *where* μ, σ *and* γ *[called the degree of membership, degree of indeterminacy and degree of non-membership] each takes the values from* $[0, 1]$.

Define the soft set F_D *over U by*

$$F_D = \{(e, f(e)) : e \in E, F(e) = \bigcup_{x \in U} \{x\text{: } x \text{ satisfies the expectation (preference) of the criterion } e\}\}$$

Then (U, F_D) *is a soft approximation space. Let* $G_B \subseteq F_D$. *Then*
$\widetilde{\tau}(G_B) = \{\widetilde{U}, \widetilde{\phi}, L_R(G_B), U_R(G_B), B_R(G_B)\}$ *forms a topology which satisfies*

(i) $\widetilde{U}, \widetilde{\phi} \in \widetilde{\tau}_R(G_B)$

(ii) The union of the elements of any subcollection of $\widetilde{\tau}_R(G_B)$ *is in* $\widetilde{\tau}_R(G_B)$

(iii) The intersection of the elements of finite subcollection of $\widetilde{\tau}_R(G_B)$ *is in* $\widetilde{\tau}_R(G_B)$

is called a Neutrosophic Nano soft Topology and (U, F_D, E) *is called the Neutrosophic Nano Soft Topological Space.*

Example 3.2. *Let* $U = \{x_1(0.6, 0.4, 0.4)$, $x_2(0.7, 0.5, 0.2)$, $x_3(0.4, 0.2, 0.7)$,
$x_4(0.5, 0.3, 0.4)$, $x_5(0.2, 0.6, 0.6)$, $x_6(0.8, 0.2, 0.1)\}$ *be the universal set and*
$E = \{e_1, e_2, e_3, e_4, e_5, e_6\}$ *be the parameter set. Choose* $D = \{e_1, e_2, e_3, e_5\}$ *such that* $D \subseteq E$. *Let the expectation (preference) for the criterions are*
$0.5 \leq \alpha(e_1) \leq 1$, $0.7 \leq \alpha(e_2) \leq 1$, $0.4 \leq \alpha(e_3) \leq 1$, $0.6 \leq \alpha(e_5) \leq 1$.
The criterion is satisfied if the membership value is greater than or equal to the expectation (preference) of the criterion. Hence
$F(e_1) = \{x_1, x_2, x_4, x_6\}$, $F(e_2) = \{x_2, x_6\}$, $F(e_3) = \{x_1, x_2, x_3, x_4, x_6\}$,
$F(e_5) = \{x_1, x_2, x_6\}$,
$F_D = \{(e_1, \{x_1, x_2, x_4, x_6\}), (e_2, \{x_2, x_6\}), (e_3, \{x_1, x_2, x_3, x_4, x_6\}), (e_5, \{x_1, x_2, x_6\})\}$
Let $G_B = \{(e_1, \{x_1, x_4, x_6\}), (e_5, \{x_1, x_2, x_6\})\}$ *such that* $G_B \subseteq F_D$ *and*
$R = \{F(e_1) \times F(e_1), F(e_2) \times F(e_2), F(e_3) \times F(e_3), F(e_5) \times F(e_5), F(e_2) \times F(e_3), F(e_3) \times$

$F(e_2)\}$ *be the soft equivalence relation on U.*
Then $[F(e_1)] = \{F(e_1)\}, [F(e_2)] = \{F(e_2), F(e_3)\}$
$[F(e_3)] = \{F(e_2), F(e_3)\}, [F(e_5)] = \{F(e_5)\}$
The neutrosophic nano soft lower approximation
$L_R(G_B) = \{(e_5, \{x_1, x_2, x_6\})\}$
i.e., $L_R(G_B) = \{(e_5, \{x_1(0.6, 0.4, 0.4), x_2(0.7, 0.5, 0.2), x_6(0.8, 0.2, 0.1)\})\}$
The neutrosophic nano soft upper approximation
$U_R(G_B) = \{(e_1, \{x_1, x_2, x_4, x_6\}), (e_2, \{x_2, x_6\}), (e_3, \{x_1, x_2, x_3, x_4, x_6\}), (e_5, \{x_1, x_2, x_6\})\}$
i.e., $U_R(G_B) = \{(e_1, \{x_1(0.6, 0.4, 0.4), x_2(0.7, 0.5, 0.2), x_4(0.5, 0.3, 0.4), x_6(0.8, 0.2, 0.1)\}),$
$(e_2, \{x_2(0.7, 0.5, 0.2), x_6(0.8, 0.2, 0.1)\}), (e_3, \{x_1(0.6, 0.4, 0.4), x_2(0.7, 0.5, 0.2),$
$x_3(0.4, 0.2, 0.7), x_4(0.5, 0.3, 0.4), x_6(0.8, 0.2, 0.1)\}), (e_5, \{x_1(0.6, 0.4, 0.4), x_2(0.7, 0.5, 0.2),$
$x_6(0.8, 0.2, 0.1)\})\}$
The neutrosophic nano soft boundary region
$B_R(G_B) = \{(e_1, \{x_1, x_2, x_4, x_6\}), (e_2, \{x_2, x_6\}), (e_3, \{x_1, x_2, x_3, x_4, x_6\})\}$
i.e., $B_R(G_B) = \{(e_1, \{x_1(0.6, 0.4, 0.4), x_2(0.7, 0.5, 0.2), x_4(0.5, 0.3, 0.4), x_6(0.8, 0.2, 0.1)\}),$
$(e_2, \{x_2(0.7, 0.5, 0.2), x_6(0.8, 0.2, 0.1)\}), (e_3, \{x_1(0.6, 0.4, 0.4), x_2(0.7, 0.5, 0.2),$
$x_3(0.4, 0.2, 0.7), x_4(0.5, 0.3, 0.4), x_6(0.8, 0.2, 0.1)\})\}$
Then $\tau_R(G_B) = \{U, \emptyset, L_R(G_B), U_R(G_B), B_R(G_B)\}$ *forms a topology called Neutrosophic Nano Soft Topology and* $(U, \tau_R(G_B))$ *is called Neutrosophic Nano Soft Topological space.*

Example 3.3. *Let* $U = \{x_1(0.8, 0.3, 0.2), x_2(0.6, 0.4, 0.5), x_3(0.2, 0.5, 0.5),$
$x_4(0.9, 0.3, 0.2), x_5(0.1, 0.5, 0.7)\}$ *be the universal set and* $E = \{e_1, e_2, e_3, e_4, e_5\}$ *be the set of parameters.*
Let $D = \{e_1, e_3, e_4, e_5\}$ *such that* $D \subseteq E$.
Let the expectation (preference) for the criterions are
$0 \leq \alpha(e_1) \leq 0.5$, $0 \leq \alpha(e_3) \leq 0.7$, $0.7 \leq \alpha(e_4) \leq 1$, $0 \leq \alpha(e_5) \leq 0.3$,
i.e., The criterions e_1, e_3 *and* e_5 *are satisfied, if the membership value is less than or equal to the expectation (preference) of the criterion and* e_4 *is satisfied, if the membership value is greater than or equal to the expectation (preference) of the criterion.*
Now, $F(e_1) = \{x_3, x_5\}$, $F(e_3) = \{x_2, x_3, x_5\}$,$F(e_4) = \{x_1, x_4\}, F(e_5) = \{x_3, x_5\}$,
and $F_D = \{(e_1, \{x_3, x_5\}), (e_3, \{x_2, x_3, x_5\}), (e_4, \{x_1, x_4\}), (e_5, \{x_3, x_5\})\}$
Let $G_B = \{(e_1, \{x_5\}), (e_3, \{x_2, x_3\}), (e_5, \{x_3, x_5\})\}$ *such that* $G_B \subseteq F_D$, *and*
$R = \{F(e_1) \times F_(e_1), F(e_3) \times F(e_3), F(e_4) \times F(e_4), F(e_5) \times F(e_5), F(e_1) \times F(e_3),\ F(e_3) \times F(e_1)\}$ *be the soft equivalence relation on U.*
Then $[F(e_1)] = \{F(e_1), F(e_3)\}$, $[F(e_3)] = \{F(e_1), F(e_3)\}$, $[F(e_4)] = \{F(e_4)\}$,
$[F(e_5)] = \{F(e_5)\}$,
The neutrosophic nano soft lower approximation
$L_R(G_B) = \{(e_5, \{x_3, x_5\})\}$
i.e., $L_R(G_B) = \{(e_5, \{x_3(0.2, 0.5, 0.5), x_5(0.1, 0.5, 0.7)\})\}$
The neutrosophic nano soft upper approximation
$U_R(G_B) = \{(e_1, \{x_3, x_5\}), (e_3, \{x_2, x_3, x_5\}), (e_5, \{x_3, x_5\})\}$
i.e., $U_R(G_B) = \{(e_1, \{x_3(0.2, 0.5, 0.5), x_5(0.1, 0.5, 0.7)\}), (e_3, \{x_2(0.6, 0.4, 0.5),$
$x_3(0.2, 0.5, 0.5), x_5(0.1, 0.5, 0.7)\}), (e_5, \{x_3(0.2, 0.5, 0.5), x_5(0.1, 0.5, 0.7)\})\}$
The neutrosophic nano soft boundary region
$B_R(G_B) = \{(e_1, \{x_3, x_5\}), (e_3, \{x_2, x_3, x_5\})\}$
i.e., $B_R(G_B) = \{(e_1, \{x_3(0.2, 0.5, 0.5), x_5(0.1, 0.5, 0.7)\}),$
$(e_3, \{x_2(0.6, 0.4, 0.5), x_3(0.2, 0.5, 0.5), x_5(0.1, 0.5, 0.7)\})\}$
Then $\tau_R(G_B) = \{U, \emptyset, L_R(G_B), U_R(G_B), B_R(G_B)\}$ *forms a topology called Neutrosophic Nano soft Topology.*

4. Application

In this section, the data were collected from a farmer belonging to a village in Erode District.
Suppose there are eight crops in the universal set as $U = \{C_1, C_2, C_3, C_4, C_5, C_6, C_7, C_8\}$ and the parameter set $E = \{e_1, e_2, e_3, e_4, e_5, e_6, e_7, e_8\}$, where the crop
C_1 stands for crop padi, C_2 stands for sugarcane,
C_3 stands for cotton, C_4 stands for turmeric,
C_5 stands for coconut, C_6 stands for groundnut,
C_7 stands for banana, C_8 stands for maize
and the parameters
e_1 stands for water obsorption, e_2 stands for amount of fertilizer needed,
e_3 stands for amount of pesticides needed, e_4 stands for manpower needed,
e_5 stands for yielding, e_6 stands for investment, e_7 stands for duration and
e_8 stands for area needed.
Suppose a farmer wants to choose particular suitable crop for his land and his wishing parameters are $D = \{e_1, e_4, e_5, e_6, e_8\}$ and $D \subseteq E$.
Let the preference of the farmer's criterions is given by as follows:
$0 \leq \alpha(e_1) \leq 0.4$, $0 \leq \alpha(e_4) \leq 0.5$, $0.8 \leq \alpha(e_5) \leq 1$, $0 \leq \alpha(e_6) \leq 0.4$, $0 \leq \alpha(e_8) \leq 0.7$
The water obsorption of each crop is given by the neutrosophic sets as, $T(e_1) = \{(C_1, 0.9, 0.2, 0.1), (C_2, 0.7, 0.3$
$(C_5, 0.5, 0.5, 0.5), (C_6, 0.3, 0.5, 0.8), (C_7, 0.7, 0.4, 0.5), (C_8, 0.4, 0.6, 0.4)\}$
Similarly all other parameters for each crop is given by the neutrosophic sets as, $T(e_4) = \{(C_1, 0.8, 0.2, 0.3), (C_2, 0.7, 0.3, 0.2), (C_3, 0.7, 0.4, 0.1), (C_4, 0.6, 0.5, 0.2), (C_5, 0.2, 0.5, 0.6), (C_6, 0.4, 0.4, 0.5), (C_7, 0.5, 0.3, 0.5), (C_8, 0.3, 0.6, 0.6)\}$
$T(e_5) = \{(C_1, 0.8, 0.5, 0.3), (C_2, 0.8, 0.5, 0.4), (C_3, 0.7, 0.6, 0.5), (C_4, 0.6, 0.6, 0.4), (C_5, 0.9, 0.6, 0.1), (C_6, 0.8, 0.4, 0.7), (C_7, 0.6, 0.5, 0.6), (C_8, 0.7, 0.4, 0.4)\}$
$T(e_6) = \{(C_1, 0.7, 0.6, 0.2), (C_2, 0.5, 0.5, 0.6), (C_3, 0.4, 0.4, 0.7), (C_4, 0.7, 0.3, 0.3), (C_5, 0.6, 0.5, 0.3), (C_6, 0.5, 0.4, 0.2), (C_7, 0.8, 0.2, 0.1), (C_8, 0.4, 0.5, 0.6)\}$
$T(e_8) = \{(C_1, 0.4, 0.3, 0.5), (C_2, 0.5, 0.4, 0.5), (C_3, 0.5, 0.5, 0.3), (C_4, 0.4, 0.3, 0.2), (C_5, 0.9, 0.4, 0.1), (C_6, 0.6, 0.4, 0.3), (C_7, 0.8, 0.2, 0.2), (C_8, 0.4, 0.4, 0.6)\}$.
We convert this real life situation to mathematical problem as follows:
Here, $U = \{C_1, C_2, C_3, C_4, C_5, C_6, C_7, C_8\}$ and $E = \{e_1, e_2, e_3, e_4, e_5, e_6, e_7, e_8\}$
$D = \{e_1, e_4, e_5, e_6, e_8\}$ and $D \subseteq E$.
$F_D = \{(e_1, \{C_6, C_8\}), (e_4, \{C_5, C_6, C_7, C_8\}), (e_5, \{C_1, C_2, C_5, C_6\}), (e_6, \{C_3, C_8\}), (e_8, \{C_1, C_2, C_3, C_4, C_6, C_8\})\}$
Let $G_B = \{(e_1, \{C_6, C_8\}), (e_4, \{C_5, C_6\}), (e_5, \{C_1, C_2, C_5\}), (e_8, \{C_1, C_2, C_3, C_4, C_6, C_8\})\}$ such that $G_B \subseteq F_D$.
Now, $F(e_1) = \{C_6, C_8\}$, $F(e_4) = \{C_5, C_6, C_7, C_8\}$,
$F(e_5) = \{C_1, C_2, C_5, C_6\}$,$F(e_6) = \{C_3, C_8\}$, $F(e_8) = \{C_1, C_2, C_3, C_4, C_6, C_8\}$
Let the soft equivalence relation on U be
$R = \{F(e_1) \times F(e_1), F(e_4) \times F(e_4), F(e_5) \times F(e_5), F(e_6) \times F(e_6), F(e_8) \times F(e_8), F(e_1) \times F(e_5), F(e_5) \times F(e_1), F(e_6) \times F(e_8), F(e_8) \times F(e_6)\}$
Then $[F(e_1)] = \{F(e_1), F(e_5)\}$, $[F(e_4)] = \{F(e_4)\}$, $[F(e_5)] = \{F(e_1), F(e_5)\}$,
$[F(e_6)] = \{F(e_6), F(e_8)\}$, $[F(e_8)] = \{F(e_6), F(e_8)\}$
The neutrosophic nano soft lower approximation
$L_R(G_B) = \{(e_6, \{C_3, C_8\}), (e_8, \{C_1, C_2, C_3, C_4, C_6, C_8\})\}$
i.e., $L_R(G_B) = \{(e_6, \{C_3, (0.4, 0.4, 0.7), C_8, (0.4, 0.5, 0.6)\}), (e_8, \{C_1, (0.4, 0.3, 0.5), C_2(0.5, 0.4, 0.5), C_3(0.5, 0.5, 0.3), C_4(0.4, 0.3, 0.2), C_6, (0.6, 0.4, 0.3), C_8(0.4, 0.4, 0.6)\})\}$
The neutrosophic nano soft upper approximation

$U_R(G_B) = \{(e_1, \{C_6, C_8\}), (e_4, \{C_5, C_6\}), (e_5, \{C_1, C_2, C_5\}), (e_6, \{C_3, C_8\}),$
$(e_8, \{C_1, C_2, C_3, C_4, C_6, C_8\})\}$
i.e., $U_R(G_B) = \{(e_1, \{C_6(0.3, 0.5, 0.8), C_8(0.4, 0.6, 0.4)\}), (e_4, \{C_5(0.2, 0.5, 0.6),$
$C_6(0.4, 0.4, 0.5)\}), (e_5, \{C_1(0.8, 0.5, 0.3), C_2(0.8, 0.5, 0.4), C_5(0.9, 0.6, 0.1)\}),$
$(e_6, \{C_3(0.4, 0.4, 0.7), C_8(0.4, 0.5, 0.6)\}), (e_8, \{C_1(0.4, 0.3, 0.5), C_2(0.5, 0.4, 0.5),$
$C_3(0.5, 0.5, 0.3), C_4(0.4, 0.3, 0.2), C_6(0.6, 0.4, 0.3), C_8(0.4, 0.4, 0.6)\})\}$
The neutrosophic nano soft boundary region
$B_R(G_B) = \{\{(e_1, \{C_6, C_8\}), (e_4, \{C_5, C_6\}), (e_5, \{C_1, C_2, C_5\})\}$
$B_R(G_B) = \{(e_1, \{C_6(0.3, 0.5, 0.8), C_8(0.4, 0.6, 0.4)\}), (e_4, \{C_5(0.2, 0.5, 0.6),$
$C_6(0.4, 0.4, 0.5)\}), (e_5, \{C_1(0.8, 0.5, 0.3), C_2(0.8, 0.5, 0.4), C_5(0.9, 0.6, 0.1)\})\}$
Then $\tau_R(X) = \{U, \emptyset, L_R(G_B), U_R(G_B), B_R(G_B)\}$ forms a topology calledneutrosophic nano soft topology.
The score values are found using this concept as follows.The neutrosophic values for the above problem are given in Table 1.

crop(→) criterion(↓)	**C$_1$**	**C$_2$**	**C$_3$**	**C$_4$**	**C$_5$**	**C$_6$**	**C$_7$**	**C$_8$**
e$_1$(0.4)	0.9,0.2, 0.1	0.7,0.3, 0.2	0.6,0.4, 0.4	0.7,0.3, 0.3	0.5,0.5, 0.5	0.3,0.5, 0.8	0.7,0.4, 0.5	0.4,0.6, 0.4
e$_4$(0.5)	0.8,0.2, 0.3	0.7,0.3, 0.2	0.7,0.4, 0.1	0.6,0.5, 0.2	0.2,0.5, 0.6	0.4,0.4, 0.5	0.5,0.3, 0.5	0.3.0.6, 0.6
e$_5$(0.8)	0.8,0.5, 0.3	0.8,0.5, 0.4	0.7,0.6, 0.5	0.6,0.6, 0.4	0.9,0.6, 0.1	0.8,0.4 0.7	0.6,0.5, 0.6	0.7,0.4, 0.4
e$_6$(0.4)	0.7,0.6, 0.2	0.5,0.5, 0.6	0.4,0.4, 0.7	0.7,0.3, 0.3	0.6,0.5, 0.3	0.5,0.4, 0.2	0.8,0.2, 0.1	0.4,0.5, 0.6
e$_8$(0.7)	0.4,0.3, 0.5	0.5,0.4, 0.5	0.5,0.5, 0.3	0.4,0.3, 0.2	0.9,0.4, 0.1	0.6,0.4, 0.3	0.8,0.2, 0.2	0.4,0.4, 0.6

Table 1

Consider the boundary region in the Neutrosophic Nano Soft Topology of the given problem to find the score values.
The cell values in Table 2 are found as follows:
$C_{ij} = [\alpha(e_i) - \mu_j(Te_i)] + [\alpha(e_i) - \sigma_j(Te_i)] - [\alpha(e_i) - \gamma_j(Te_i)]$, for each $i = 1, 4, 6, 8$
For e_5 (yielding),
$C_{ij} = [\mu_j(Te_5) - \alpha(e_5)] + [\sigma_j(Te_5) - \alpha(e_5)] - [\gamma_j(Te_5) - \alpha(e_5)]$

According to the farmer's criterion and wish, he should select C_5 (coconut) for his land.

Comparison with Neutrosophic Soft Set Concept

Score value by Neutrosophic Soft Set

The result obtained here is the farmer should select C_8 (maize). The second chance of selecting the crop is C_5 (coconut).
The result obtained by Neutrosophic Nano Soft Topology is more appropriate, since the particular farmer (from whom the data were collected) is cultivating C_5 (coconut) in his land which gives convenient to his criterions.

criterion (↓), crop (→)	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
$e_1(\mathbf{0.4})$						0.4		-0.2
$e_4(\mathbf{0.5})$					0.4	0.2		
$e_5(\mathbf{0.8})$	0.2	0.1			0.6			
$e_6(\mathbf{0.4})$								
$e_8(\mathbf{0.7})$								
score	**0.2**	**0.1**	**-**	**-**	**1.0**	**0.6**	**-**	**-0.2**

Table 2

criterion (↓), crop (→)	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
$e_1(\mathbf{0.4})$	0	3	4	4	5	9	5	2
$e_4(\mathbf{0.5})$	3	2	-1	-1	8	6	7	5
$e_5(\mathbf{0.8})$	9	6	5	4	14	0	-1	0
$e_6(\mathbf{0.4})$	-4	6	12	4	2	4	0	9
$e_8(\mathbf{0.7})$	11	6	0	7	-3	2	2	11
score	**19**	**23**	**20**	**18**	**26**	**21**	**13**	**27**

Table 3

Conclusion

In this paper, a new combination of neutrosophy and nano soft topology was found and called as neutrosophic nano soft topology. Also a real life decision making problem is solved using this new concept. The work may be extended for other decision making problems.

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