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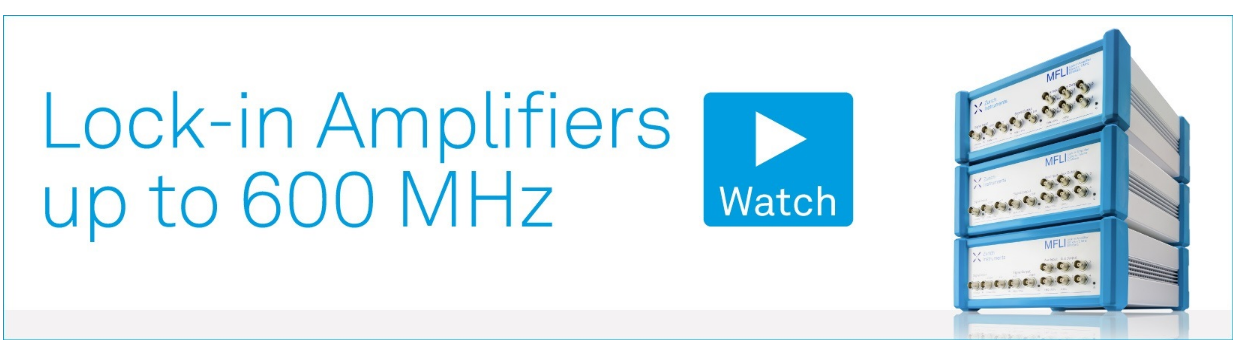

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Neutrosophic Soft Pre-Separation Axioms

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Abstract. In this study, we introduce the concept of neutrosophic soft pre-open (neutrosophic soft pre-closed) sets and pre-separation axioms in neutrosophic soft topological spaces. In particular, the relationship between these separation axioms are investigated. Also, we give a new definition for neutrosophic soft topological subspace and define neutrosophic soft pre irresolute soft and neutrosophic pre irresolute open soft functions.
Keywords: Neutrosophic pre open soft set, neutrosophic soft pre interior point, neutrosophic soft pre cluster point, neutrosophic soft pre-separation axioms, neutrosophic soft subspace
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INTRODUCTION

In 2005, Smarandache introduced the concept of a neutrosophic set [18] as a generalization of classical sets, fuzzy set theory [20], intuitionistic fuzzy set theory [3], etc. By using this theory of neutrosophic set, some scientists made researches in many areas of mathematics [7,16]. Many inherent difficulties exist in classical methods for the inadequacy of the theories of parametrization tools. So, classical methods are insufficient in dealing with several practical problems in some other disciplines such as economics, engineering, environment, social science, medical science, etc. In 1999, Molodtsov [14] pointed out the inherent difficulties of these theories. A different approach was initiated by Molodtsov for modeling uncertainties. This approach was applied in some other directions such as smoothness of functions, game theory, operations research, Riemann integration, Perron integration and so on. The theory of soft topological spaces was introduced by Shabir and Naz [17] for the first time in 2011. Soft topological spaces were defined over an initial universe with a fixed set of parameters and showed that a soft topological space gave a parameterized family of topological spaces. In [1,2,5,6,9,10,12], some scientists made researches and did theoretical studies in soft topological spaces. In 2013, Maji [13] defined the concept of neutrosophic soft sets for the first time. Then, Deli and Broumi [11] modified this concept. In 2017, Bera presented neutrosophic soft topological spaces in [8].

Preliminaries

Definition 1 *[18] A neutrosophic set A on the universe set X is defined as:* $A = \{\langle x, T_A(x), I_A(x), F_A x\rangle : x \in X\}$, *where* $T, I, F : X \to]^{-}0, 1^{+}[$ *and* $^{-}0 \leq T_A(x) + I_A(x) + F_A(x) \leq 3^{+}$.

Definition 2 *[11] Let X be an initial universe set and E be a set of parameters. Let* $P(X)$ *denote the set of all neutrosophic sets of X. Then a neutrosophic soft set* $(\widetilde{F}, E)$ *over X is a set defined by a set valued function* $\widetilde{F}$ *representing a mapping* $\widetilde{F} : E \to P(X)$ *where* $\widetilde{F}$ *is called the approximate function of the* neutrosophic soft set $(\widetilde{F}, E)$. *In other words, the neutrosophic soft set is a parametrized family of some elements of the set* $P(X)$ *and therefore it can be written as a set of ordered pairs:*

$$\left(\widetilde{F}, E\right) = \left\{\left(e, \left\langle x, T_{\widetilde{F}(e)}(x), I_{\widetilde{F}(e)}(x), F_{\widetilde{F}(e)}(x)\right\rangle : x \in X\right) : e \in E\right\},$$

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where $T_{\widetilde{F}(e)}(x), I_{\widetilde{F}(e)}(x), F_{\widetilde{F}(e)}(x) \in [0,1]$ *are respectively called the truth-membership, indeterminacy-membership and falsity-membership function of* $\widetilde{F}(e)$. *Since the supremum of each* T, I, F *is* 1, *the inequality*

$$0 \leq T_{\widetilde{F}(e)}(x) + I_{\widetilde{F}(e)}(x) F_{\widetilde{F}(e)}(x) \leq 3$$

is obvious.

Definition 3 *[4] Let* $NSS(X,E)$ *be the family of all neutrosophic soft sets over the universe set* X *and* $\tau \subset NSS(X,E)$. *Then* τ *is said to be a neutrosophic soft topology on* X *if:*

1) $0_{(X,E)}$ *and* $1_{(X,E)}$ *belong to* τ;
2) *the union of any number of neutrosophic soft sets in* τ *belongs to* τ;
3) *the intersection of a finite number of neutrosophic soft sets in* τ *belongs to* τ.

Some properties

Definition 4 *[4] Let* $NSS(X,E)$ *be the family of all neutrosophic soft sets over the universe set* X. *Then neutrosophic soft set* $x^{e}_{(\alpha,\beta,\gamma)}$ *is called* a neutrosophic soft point, *for every* $x \in X$, $0 < \alpha, \beta, \gamma \leq 1$, $e \in E$, *and is defined as follows:*

$$x^{e}_{(\alpha,\beta,\gamma)}(e')(y) = \begin{cases} (\alpha,\beta,\gamma), & \text{if } e' = e \text{ and } y = x \\ (0,0,1), & \text{if } e' \neq e \text{ or } y \neq x \end{cases}$$

Definition 5 *[8] Let* $\left(\widetilde{F},E\right)$ *be a neutrosophic soft set over the universe set* X. *The complement of* $\left(\widetilde{F},E\right)$ *is denoted by* $\left(\widetilde{F},E\right)^{c}$ *and is defined by:*

$$\left(\widetilde{F},E\right)^{c} = \left(e, \left\langle x, F_{\widetilde{F}(e)}(x), 1 - I_{\widetilde{F}(e)}(x), T_{\widetilde{F}(e)}(x)\right\rangle : x \in X\right) : e \in E.$$

Definition 6 *[8] Let* (X,τ,E) *be a neutrosophic soft topological space and* $\left(\widetilde{F},E\right) \in NSS(X,E)$ *be arbitrary. Then the* interior *of* $\left(\widetilde{F},E\right)$ *is denoted by* $\left(\widetilde{F},E\right)^{\circ}$ *and is defined as:*

$$\left(\widetilde{F},E\right)^{\circ} = \bigcup\left\{\left(\widetilde{G},E\right) : \left(\widetilde{G},E\right) \subset \left(\widetilde{F},E\right), \left(\widetilde{G},E\right) \in \tau\right\}$$

i.e., it is the union of all open neutrosophic soft subsets of $\left(\widetilde{F},E\right)$. *Also, the* closure *of* $\left(\widetilde{F},E\right)$ *is denoted by* $\overline{\left(\widetilde{F},E\right)}$ *and is defined as:*

$$\overline{\left(\widetilde{F},E\right)} = \bigcap\left\{\left(\widetilde{G},E\right) : \left(\widetilde{G},E\right) \subset \left(\widetilde{F},E\right), \left(\widetilde{G},E\right)^{c} \in \tau\right\}$$

i.e., it is the intersection of all closed neutrosophic soft super sets of $\left(\widetilde{F},E\right)$.

Definition 7 *A subset* $\left(\widetilde{F},E\right)$ *of a neutrosophic soft topological space* (X,τ,E) *is said to be neutrosophic pre open soft, if* $\left(\widetilde{F},E\right) \subset \left[\overline{\left(\widetilde{F},E\right)}\right]^{\circ}$. *The family of all neutrosophic pre open soft sets of* (X,τ,E) *is denoted by* $NSPO(X)$. *A neutrosophic soft point* $x^{e}_{(\alpha,\beta,\gamma)}$ *of a neutrosophic soft topological space* (X,τ,E) *is said to be neutrosophic soft pre interior point of a neutrosophic soft set* $\left(\widetilde{F},E\right)$ *if there exists* $\left(\widetilde{G},E\right) \in NSPO\left(X, x^{e}_{(\alpha,\beta,\gamma)}\right)$ *such that* $x^{e}_{(\alpha,\beta,\gamma)} \not\subseteq \left(\widetilde{G},E\right)^{c}$ *and* $\left(\widetilde{G},E\right) \subset \left(\widetilde{F},E\right)$.

Definition 8 *A neutrosophic soft topological space* (X,τ,E) *is said to be a neutrosophic soft pre* T_0*-space (resp.soft pre* T_1*-space) if for every pair of distinct neutrosophic soft points* $x^{e}_{(\alpha,\beta,\gamma)}$, $y^{e'}_{(\alpha',\beta',\gamma')}$, *there exist neutrosophic pre-open soft sets* $\left(\widetilde{F},E\right)$, $\left(\widetilde{G},E\right)$ *such that* $x^{e}_{(\alpha,\beta,\gamma)} \in \left(\widetilde{F},E\right)$, $y^{e'}_{(\alpha',\beta',\gamma')} \in \left(\widetilde{F},E\right)^{c}$ *or (resp. and* $x^{e}_{(\alpha,\beta,\gamma)} \in \left(\widetilde{G},E\right)^{c}$, $y^{e'}_{(\alpha',\beta',\gamma')} \in \left(\widetilde{G},E\right)$).

Definition 9 *A neutrosophic soft topological space* (X,τ,E) *is said to be a neutrosophic soft pre* T_2*-space if for every pair of distinct neutrosophic soft points* $x^{e}_{(\alpha,\beta,\gamma)}, y^{e'}_{(\alpha',\beta',\gamma')}$ *, there exists neutrosophic pre open soft sets* $\left(\widetilde{F},E\right)$ *and* $\left(\widetilde{G},E\right)$ *such that* $x^{e}_{(\alpha,\beta,\gamma)} \in \left(\widetilde{F},E\right),\ y^{e'}_{(\alpha',\beta',\gamma')} \in \left(\widetilde{F},E\right)^{c},\ y^{e'}_{(\alpha',\beta',\gamma')} \in \left(\widetilde{G},E\right), x^{e}_{(\alpha,\beta,\gamma)} \in \left(\widetilde{G},E\right)^{c}$ *and* $\left(\widetilde{F},E\right) \subset \left(\widetilde{G},E\right)^{c}$.

For a neutrosophic soft topological space (X,τ,E) , we have the following diagram:

$$\begin{array}{c}\text{neutrosophic soft pre } T_2-\text{space}\\ \downarrow \\ \text{neutrosophic soft pre } T_1-\text{space}\\ \downarrow \\ \text{neutrosophic soft pre } T_0-\text{space}\end{array}$$

Conclusion

Therefore, some properties of the notions of neutrosophic pre open soft sets, neutrosophic pre closed soft sets, neutrosophic pre soft interior, neutrosophic pre soft closure, neutrosophic soft pre-interior point, neutrosophic soft pre-cluster point and neutrosophic soft pre separation axioms are introduced. Also, several interesting properties have been established. Additionally, a new approach is made to the concept of neutrosophic soft topological subspace. Since topological structures on neutrosophic soft sets have been introduced by many scientists, we generalize the pre topological properties to the neutrosophic soft sets which may be useful in some other disciplines. For the existence of compact connections between soft sets and information systems [15, 19], the results obtained from the studies on neutrosophic soft topological space can be used to develop these connections.

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