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(bi)*-Neutrosophic Soft Limit Points in Neutrosophic Soft Bitopological Space

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ABSTRACT

The major goal of the current research is to present the conception of "(bi)*-neutrosophic soft limit points" in "neutrosophic soft Bitopological" spaces. In addition, the research aims to give the essential theorems related to the topic with illustrative examples.

Keywords: Neutrosophic; soft; bitopological; space; interior; closure..

الخلاصة

الهدف الرئيسي من البحث الحالي هو تقديم مفهوم - * (bi)" نقاط الحد اللينة المتعادلة" في فضاءات "نيوتروسوفتيك لينة بيتوبولوجية". بالإضافة إلى ذلك ، يهدف البحث إلى إعطاء النظريات الأساسية المتعلقة بالموضوع بأمثلة توضيحية.

الكلمات المفتاحية: نيوتروسوفيك. لين؛ بيتوبولوجي. الفضاء؛ الداخلية. إنهاء..

INTRODUCTION

In the actual universe, uncertainty manifests itself as ambiguous, which leads to complexity. Scientists in economics, sociology, medicine and many other disciplines struggle with the complexity of analyzing anonymous statistics on a regular [1, 2]. Traditional procedures often do not yield beneficial results since the unknown arising in these sectors could be many types. The probability hypothesis is an old and efficient method for dealing with uncertainty, but it could solely be used on random processes[3-5].

To handle uncertain situations, theories of evidence, intuitionistic fuzzy set (by Atanassov [6]), and fuzzy set (by Zadeh[7]) were introduced. However, as Molodtsov[8] points out, every one of the hypotheses has its number of challenges. The inadequacy of the theories' parametrization toolset is the root of all these complications.

Moludtsov[8] suggested a soft set of hypothesis as a novel mathematical instrument exempts role the parametrization inadequacy syndrome that plagues other hypotheses working with uncertainty. As a result, the hypothesis is highly practical and easy to use in the application. Molodtsov[8] efficiently utilized the soft set hypothesis in numerous domains, including the function's of smoothness, integration of Riemann, gaming evaluation, operations studies, probability, and Perron integration. The Soft set hypothesis and its implementations are already making significant development in a various of

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domains. Shaber et al.[9] established "soft topological spaces" and proposed various soft set notions and separation axioms for these spaces.

Smarandache[10, 11] introduced the "neutrosophic set," a statistical mechanism for handling with imprecise, uncertain, and inconsistent data. Bitopological space is identified on the "neutrosophic soft set structure". Maeji etal.[12] established the conception of the "neutrosophic soft set" by combining conceptions of neutrosophic and soft set. This conception has been modified by[13, 14]. The principle of "neutrosophic soft topological space" was launched by[15, 16]. Al-Nafee et al.[17] projected the presumption of "neutrosophic soft bitopological spaces" and described the basic topological spaces concepts (for example, see, [19], [20-23], and [24-26]).

The current research presents the conception of "(bi)*-neutrosophic soft limit points" in "neutrosophic soft bitopological spaces" and gives the important theorems related to the topic with illustrative examples.

Preliminary

Fundamental theorems and conceptions of "neutrosophic soft set" theory and the conception of "neutrosophic soft bitopological spaces" are presented in this part.

[10, 11]

Assume X be global. A neutrosophic set "θ on M" could be described as:

$\theta = \{<\varepsilon, Ʊ_\theta(\varepsilon), I_\theta(\varepsilon), F_\theta(\varepsilon)> \; : \varepsilon \in X\}$

in which,

$Ʊ_{\theta}, I_\theta, F_\theta : U \to [0,1]$ additionally, $0 \le Ʊ_\theta(\varepsilon) + I_\theta(\varepsilon) + F_{\theta}(\varepsilon) \le 3$

In this equation,

Membership degree $= Ʊ_\theta(\varepsilon)$

indeterminacy degree $= I_\theta(\varepsilon)$

Non-membership degree $= F_\theta(\varepsilon)$

From an intellectual standpoint, the neutrosophic set comprises "real standard" or "non-standard" subsets of "]-0,+1[." However, it is impossible to employ a neutrosophic set with a quantity from a "real standard" or a "non-standard" subset of "]-0,+1[" in real-life implementations, particularly in engineering and scientific concerns. As a result, we take into account the neutrosophicset, that gets its value from the "[0, 1]" subset.[14]

Assume that X represents an "initial universe set", B represents a "set of parameters", and P(X)represent the "set of all X's neutronsohpic". Later, a "neutrosophic soft set βB" covering X is the set described by a "set-valued function β" indicating a mapping between B to P(X), in which β is termed as the "neutrosophic soft set βB's" approximate function. In another aspect, βB is a parameterized relative of certain components of the set P(X), and it may thus be expressed as a "set of ordered pairs".

$\beta_B = \{(\upsilon, \{<\varepsilon, H_{\beta(\upsilon)}(\varepsilon), G_{\beta(\upsilon)}(\varepsilon), J_{\beta(\upsilon)}(\varepsilon)> : \varepsilon \in X\}), \quad \upsilon \in B\}.$

in which, $H_{\beta(\upsilon)}(\varepsilon), G_{\beta(\upsilon)}(\varepsilon), J_{\beta(\upsilon)}(\varepsilon) \in [0,1]$.

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The above functions are illustrated as the "truth-membership", "indeterminacy-membership", and "falsity-membership function of $\beta(\upsilon)$". Because the supremum of each H, G, J is 1, so the inequality is

$0 \leq H_{\beta(\upsilon)}(\varepsilon) + G_{\beta(\upsilon)}(\varepsilon) + J_{\beta(\upsilon)}(\varepsilon) \leq 3$ is apparent.

Since now, the sets of every neutrosohpic sets across X is indicated by N3(X).[17]

Assume (X,B, Ʊ1) and (X,B,Ʊ2) are two "neutrosophic soft topological spaces" (N3-Top spaces, for short) defined on X. So, (X,B, Ʊ1, Ʊ2) is termed a "neutrosophic soft bitopological space" or "N3-Bi-Top for short".

Example2.4

Let $X = \{\varepsilon_1, \varepsilon_2\}$, $B = \{\upsilon\}$ and $\beta_B, \mu_B \in$ N3(X) such that

$\beta_B = \{(\upsilon, \{<\varepsilon1(0.6,0.2,0.5)>, <\varepsilon2(0.5,0.4,0.9)>\})\}$,

$\mu_B = \{(\upsilon, \{<\varepsilon1(0.6,0.2,0.4)>, <\varepsilon2(0.6,0.4,0.7)>\})\}$.

Then, Ʊ1 = $\{\tilde{\emptyset}_B, \tilde{X}_B, \beta_B\}$ is an N3-Top on X and Ʊ2 = $\{\tilde{\emptyset}_B, \tilde{X}_B, \mu_B\}$ is an N3-Top on X.

Therefore, (X, B, Ʊ1, Ʊ2) is an N3-Bi-Top space.[17]

A subset $\beta_B \in$ N3(X) of an N3-Bi-Top space (X,B, Ʊ1, Ʊ2) is called star bineutrosophic soft open (N3-(bi)*-open, for short) in (X,B, Ʊ1, Ʊ2) if and only if $\beta_B \sqsubseteq \left(\overline{(\beta_B)^{o\mho 2}}^{(\mho 1)}\right)^{o\mho 2}$ and their complement is an N3-(bi)*-closed set. The set of all N3-(bi)*-open [N3-(bi)*-closed] sets in (X,B, Ʊ1, Ʊ2) is denoted by $X^{(Bi)^*\text{-}NSO}$ [$X^{(Bi)^*\text{-}NSC}$] respectively.

Example 2.6 [8]

Let $X = \{\varepsilon_1, \varepsilon_2, \varepsilon_3\}$, $B = \{\upsilon\}$ and $\beta_B, \mu_B \in$ N3(X) such that

$\beta_B = \{(\upsilon, \{<\varepsilon1(1,1,0)>, <\varepsilon2(0,0,1)>, <\varepsilon3(0,0,1)>\})\}$,

$\mu_B = \{(\upsilon, \{<\varepsilon1(1,1,0)>, <\varepsilon2(1,1,0)>, <\varepsilon3(0,0,1)>\})\}$.

Ʊ1 = $\{\tilde{\emptyset}_B, \tilde{X}_B\}$ is an N3-Top on X and Ʊ2 = $\{\tilde{\emptyset}_B, \tilde{X}_B, \beta_B, \mu_B\}$ is an N3-Top on X. Thus, (X, B, Ʊ1, Ʊ2) is an N3-Bi-Top space.

Hence:

$X^{(Bi)^*\text{-}NSO} = \{\tilde{\emptyset}_B, \tilde{X}_B, \beta_B, \mu_B, \gamma_B\}$.

$X^{(Bi)^*\text{-}NSC} = \{\{(\upsilon, \{<\varepsilon1(0,0,1)>, <\varepsilon2(1,1,0)>, <\varepsilon3(1,1,0)>\})\}, \{(\upsilon, \{<\varepsilon1(0,0,1)>, <\varepsilon2(0,0,1)>, <\varepsilon3(1,1,0)>\})\}, \{(\upsilon, \{<\varepsilon1(0,0,1)>, <\varepsilon2(1,1,0)>, <\varepsilon3(0,0,1)>\})\}, \tilde{\emptyset}_B, \tilde{X}_B\}$.[8]

If (X,B, Ʊ1, Ʊ2) is an N3-(Bi)*-Top space and $\beta_B \in$ N3(X), so, the largest "N3-(bi)*-open set contained" in β_B is described as "(bi)*-neutrosophic soft interior" of β_B, ($(\beta_B)^{0(bi)^*}$ for short). i.e.

$$(\beta_B)^{0(bi)^*} = \sqcup\{(\omega_B): \omega_B \text{ is a N3-(bi)*-open set}, \omega_B \sqsubseteq \beta_B\}.\text{[17]}$$

If (X,B, Ʊ1, Ʊ2) is an N3-(Bi)*-Top space and $\beta_B \in$ N3(X), then the confluence of every "N3-(bi)*-closed sets containing β_B" is indicated as a "(bi)*-neutrosophic soft closure of β_B" $\left(\overline{(\beta_B)}^{(bi)^*}\right.$for short). i.e.

$$\overline{(\beta_B)}^{(bi)^*} = \sqcap\{(\omega_B): \omega_B \text{ is an N3-(bi)*-closed set}, \beta_B \sqsubseteq \omega_B\}. \text{ [17]}$$

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If (X, Ʈ1, Ʈ2) is a N3-(Bi)*-Top space and β_B∈ N3(X). Then the (bi)*-neutrosophic soft exterior of β_B, (bi)*-ext(β_B) for short) is defined as, (bi)*-ext(β_B) = 〖((β_B)^c)〗^(0(bi)*).[17]

If (X,B,Ʈ1, Ʈ2) is a N3-(Bi)*-Top space and β_B∈ N3(X). Then the (bi)*-neutrosophic soft boundary of β_B, ((bi)*-br(β_B) for short) is defined as, (bi)*-br(β_B) = ¯((β_B)^C)^((bi)*)⊓ ¯(β_B)^((bi)*). [18]

Assume "X" is an "initial universe set", and "E" is a "set of parameters". Then the "neutrosophic soft set." 〖〖ε〗^e〗_((α, β, γ)) is described as a "neutrosophic soft point" for all ε∈G ,0<α βγ≤ 1,e∈E, and is described as:

(〖〖ε〗^e〗_((α,β,γ)) (e^')(y)={█((α,β,γ) if e=e^' and ε=y@(0,0,1) if e≠e^' and ε≠y)┤.)

(bi)*-Neutrosophic Soft Limit Point Concepts

Let (X, B, Ʈ1, Ʈ2) be an N3-Bi-Top space and β_B ∈ N3(X). A point 〖ε^e〗_((α,β,γ)) is described as a "(bi)*-neutrosophic soft limit point of β_B" iff all "N3-(bi)*-open set" in (X, B, Ʈ1, Ʈ2) containing 〖ε^e〗_((α,β,γ)) having a minimum of one point of β_B distinct from 〖ε^e〗_((α,β,γ)).

The set of each "(bi)*-neutrosophic soft limit points of β_B" is described as the "(bi)*-neutrosophic soft" derivative set of β_B and is referred as (bi)*-Lim(β_B).

Example 3.2

Assume X = {ε_1,ε_2,ε_3}, B = {υ} and β_B, μ_B,R_B,S_B∈ N3(X), such that

β_B= {(υ, {< ε1(1,1,0) >, < ε2(0,0,1) > ,< ε3(0,0, 1) >})},

R_B= {(υ, {< ε1(0,0,1) >, < ε2(1,1,0) > ,< ε3(0,0,1) >})},

S_B= {(υ, {< ε1(1,1,0) >, < ε2(1,1,0) > ,< ε3(0,0,1) >})},

μ_B= {(υ, {< ε1(0,0,1) >, < ε2(0,0,1) >, < ε3(1,1,0) >})}.

Ʈ1 = {∅̃_B, X̃_B,μ_B} is an N3-Top on X , and

Ʈ2 = {∅̃_B, X̃_B, β_B, μ_B,S_B} is an N3-Top on X.

Thus, (X, B, Ʈ1, Ʈ2) is an N3-Bi-Top space.

Hence:

X^((Bi)*-NSO)= {∅̃_B, X̃_B, β_B, μ_B,S_B}.

Now:

If we take S_B= {(υ, {< ε1(1,1,0) >, < ε2(1,1 0) > ,< ε3(0,0,1) >})}. Then the neutrosophic soft point 〖〖ε_3〗^e〗_((α,β,γ))={(υ, {< ε1(0,0,1) >, < ε2(0,0,1) >,< ε3(1,1,0) >})} is the only (bi)*-neutrosophic soft limit point of S_B.

Theorem 3.3.

Let (X, B, Ʈ1, Ʈ2) be an N3-Bi-Top space and β_B, μ_B∈ N3(X). Then

β_B⊑μ_B → (bi)*-Lim(β_B) ⊑ (bi)*-Lim(μ_B).

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Proof:

Let ⟦ε^e⟧ _((α,β,γ)) ∈ (bi)*-Lim(β_B). Then, every N3-(bi)*-open set in (X, B, Ʈ1, Ʈ2) containing ⟦ε^e⟧ _((α,β,γ)) having a minimum of one point of β_B differs from ⟦ε^e⟧ _((α,β,γ)).

Since the β_B⊑μ_B, so every N3-(bi)*-open set in (X, B, Ʈ1, Ʈ2) containing ⟦ε^e⟧ _((α,β,γ)) having a minimum of one point of μ_B, different from ⟦ε^e⟧ _((α,β,γ)). This implies that the ⟦ε^e⟧ _((α,β,γ)) pertains to (bi)*-Lim(μ_B). Hence (bi)*-Lim(β_B) ⊑ (bi)*-Lim(μ_B).

Remark 3.4.

In general, the reverse of a theory is not valid; consider the preceding example.

Example 3.5.

Assume X = {ε_1,ε_2,ε_3}, B = {υ} and β_B,R_B,S_B∈ N3(X), such that

β_B= {(υ, {< ε1(1,1,0) >, < ε2(0,0,1) > ,< ε3(0,0,1) >})},

R_B= {(υ, {< ε1(0,0,1) >, < ε2(1,1,0) > ,< ε3(0,0,1) >})},

S_B= {(υ, {< ε1(1, 1, 0) >, < ε2(1, 1, 0) > ,< ε3(0, 0, 1) >})},

Ʈ2 = {∅̃_B, X̃_B,β_B} is an N3-Top on X , and

Ʈ1 = {∅̃_B, X̃_B, R_B, S_B} is an N3-Top on X.

Thus, (X, B, Ʈ1, Ʈ2) is an N3-Bi-Top space.

Hence: X^((Bi)*-NSO)= {∅̃_B, X̃_B, β_B}.

Now:

If we take μ_B= {(υ, {< ε1(1,1,0) >, < ε2(0,0,1) > ,< ε3(0,0,1) >})}, D_B= {(υ, {< ε1(0,0,1) >, < ε2(1,1,0) > ,< ε3(0,0,1) >})}

Then,

(bi)*-Lim(μ_B) = {(υ, {< ε1(0,0,1) >, < ε2(1, 1,0) >,< ε3(1,1,0) >})},

(bi)*-Lim(D_B) = {(υ, {< ε1(0,0,1) >, < ε2(1,1,0) >,< ε3(1,1,0) >})}.

Hence:

(bi)*-Lim(β_B) ⊑ (bi)*-Lim(μ_B), but β_B⋢μ_B.

Theorem 3.6.

Let (X, B, Ʈ1, Ʈ2) be an N3-Bi-Top space and β_B, μ_B∈ N3(X). Then ((bi)*-Lim(β_B) ⊔ (bi)*-Lim(μ_B)) ⊑ (bi)*-Lim ⟦(β⟧ _B⊔μ_B).

Proof:

β_B⊑ ⟦(β⟧ _B⊔μ_B)→ (bi)*-Lim(β_B) ⊑ (bi)*-Lim ⟦(β⟧ _B⊔μ_B) …..(1

μ_B⊑ ⟦(β⟧ _B⊔μ_B)→ (bi)*-Lim(μ_B) ⊑ (bi)*-Lim ⟦(β⟧ _B⊔μ_B) …..(2

From (1), (2), we get

((bi)*-Lim(β_B) ⊔ (bi)*-Lim(μ_B)) ⊑ (bi)*-Lim ⟦(β⟧ _B⊔μ_B).

Theorem 3.7.

Let (X, B, Ʈ1, Ʈ2) be an N3-Bi-Top space and β_B, μ_B∈ N3(X). Then (bi)*-Lim ⟦(β⟧ _B⊓μ_B) ⊑((bi)*-Lim(β_B) ⊓ (bi)*-Lim(μ_B)).

Proof:

Let $\varepsilon^e_{(\alpha,\beta,\gamma)}$ belong to (bi)*-Lim $(\beta_B \sqcap \mu_B)$. Then, every N3-(bi)*-open set in (X, B, Ʈ1, Ʈ2) containing $\varepsilon^e_{(\alpha,\beta,\gamma)}$ has a minimum of one point of $\beta_B \sqcap \mu_B$ differs from $\varepsilon^e_{(\alpha,\beta,\gamma)}$. And from the distributive property of intersection (⊓), we get that every N3-(bi)*-open set in (X, B, Ʈ1, Ʈ2) has $\varepsilon^e_{(\alpha,\beta,\gamma)}$ has at least one point of $\beta_B$different from $\varepsilon^e_{(\alpha,\beta,\gamma)}$ and every N3-(bi)*-open set in (X, B, Ʈ1, Ʈ2) containing $\varepsilon^e_{(\alpha,\beta,\gamma)}$ has a minimum of one point of μ_B different from $\varepsilon^e_{(\alpha,\beta,\gamma)}$. This implies that, the $\varepsilon^e_{(\alpha,\beta,\gamma)}$ contains to (bi)*-Lim(β_B) and $\varepsilon^e_{(\alpha,\beta,\gamma)}$ contains to (bi)*-Lim(μ_B). Hence $\varepsilon^e_{(\alpha,\beta,\gamma)}$ belongs to ((bi)*-Lim(β_B) ⊓ (bi)*-Lim(μ_B)).

Remark 3.8.

The equality of the previous theory is not valid in all cases, as illustrated in the below example.

Example 3.9.

Take the previous Example 3.5 and note that:

(bi)*-Lim(β_B) ⊓ (bi)*-Lim(μ_B) = {(υ, {< ε1(0,0,1) >, < ε2(1,1,0) >,< ε3(1,1,0) >})}, but (bi)*-Lim $(\beta_B \sqcap \mu_B) = \tilde{\emptyset}_B$. i.e. (bi)*-Lim($\beta_B$) ⊓ (bi)*-Lim($\mu_B$) ⋢ (bi)*-Lim $(\beta_B \sqcap \mu_B)$.

Conclusions

The topological organization on "neutrosophic soft set" has been presented in this analysis. "Neutosophic soft interior" and "neutrosophic soft closure" features are proposed. We've also described the foundation for "neutrosophic soft topological space", subspace on "neutrosophic soft set", and "separation axioms" with appropriate instances. In each example, numerous associated physical and structural aspects were studied. This concept will open up new possibilities for the "neutrosophic soft set" hypothesis and advancement.

Conflict of interests.

There are non-conflicts of interest.

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