



Contra M -Continuous Maps in Neutrosophic Soft Topological Spaces

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Abstract

In this paper, we introduce, study, and explain some of the properties of neutrosophic soft contra M -continuous mappings and irresolute maps in neutrosophic soft topological spaces.

Keywords: N_sSMcs ; N_sSMCs ; N_sSMIrr

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1 Introduction

The fuzzy set was first described by Zadeh,²⁵ and Chang⁶ took on the task of defining its topological structure as fuzzy topological space. In 1983, Atanassov³ initiated intuitionistic fuzzy set and Coker⁸ created intuitionistic fuzzy set in a topology.

Molodstov¹³ initiated the soft set theory in 1999 and applied in different fields. Shabir and Naz¹⁷ presented soft topological spaces. Smarandache¹⁸ introduced the concepts of neutrosophy and neutrosophic set. In 2012, Salama and Alblowi¹⁵ originated neutrosophic topological space. Neutrosophic soft sets were first defined by Maji¹² and modified by Deli and Broumi.⁹ Bera,⁵ presented a neutrosophic soft topological spaces.

δ -open sets defined by Saha¹⁹ in fuzzy topological spaces, Vadivel et al.²⁰⁻²⁴ in N -neutrosophic crisp and neutrosophic topological spaces and Ahu Acikgoz and Ferhat Esenbel¹ in neutrosophic soft topological spaces. The notion of M -open sets in topological spaces were introduced by El-Maghrabi and Al-Juhani¹¹ in 2011.

The basic definitions used in this paper are defined in^{1,5,9,10,12,14}

2 Neutrosophic soft contra M -continuous maps in N_sSts

A set (\tilde{K}, Λ) is said to be a neutrosophic soft

(i) θ interior of (\tilde{K}, Λ) (in-short, $N_sS\theta int(\tilde{K}, \Lambda)$) is defined by

$$N_sS\theta int(\tilde{K}, \Lambda) = \bigcup \{N_sSint(\tilde{N}, \Lambda) : (\tilde{N}, \Lambda) \subseteq (\tilde{K}, \Lambda) \text{ \& } (\tilde{N}, \Lambda) \text{ is a } N_sScs \text{ in } \mathfrak{M}\}.$$

- (ii) θ closure of (\tilde{K}, Λ) (in-short, $N_sS\theta cl(\tilde{K}, \Lambda)$) is defined by $N_sS\theta cl(\tilde{K}, \Lambda) = \bigcap \{N_sScl(\tilde{N}, \Lambda) : (\tilde{K}, \Lambda) \subseteq (\tilde{N}, \Lambda) \text{ \& } (\tilde{N}, \Lambda) \text{ is a } N_sS\theta os \text{ in } \mathfrak{M}\}$.
- (iii) θ -open set (briefly, $N_sS\theta os$) if $(\tilde{K}, \Lambda) = N_sS\theta int(\tilde{K}, \Lambda)$.
- (iv) θ -semi open set (briefly, $N_sS\theta Sos$) if $(\tilde{K}, \Lambda) \subseteq N_sScl(N_sS\theta int(\tilde{K}, \Lambda))$.
- (v) M -open set (briefly, N_sSMos) if $(\tilde{K}, \Lambda) \subseteq N_sScl(N_sS\theta int(\tilde{K}, \Lambda)) \cup N_sSint(N_sS\theta cl(\tilde{K}, \Lambda))$.

The complement of a N_sSMos (resp. $N_sS\theta os$ & $N_sS\theta Sos$) is called a neutrosophic soft M - (resp. θ & θ -semi) closed set (briefly, N_sSMcs (resp. $N_sS\theta cs$ & $N_sS\theta Scs$)) in \mathfrak{M} .

The family of all $N_sS\theta os$ (resp. $N_sS\theta cs$, $N_sS\theta Sos$, $N_sS\theta Scs$, N_sSMos & N_sSMcs) of \mathfrak{M} is denoted by $N_sS\theta OS(\mathfrak{M})$ (resp. $N_sS\theta CS(\mathfrak{M})$, $N_sS\theta SOS(\mathfrak{M})$, $N_sS\theta ScS(\mathfrak{M})$, $N_sSMOS(\mathfrak{M})$ & $N_sSMCS(\mathfrak{M})$).

A set (\tilde{K}, Λ) is said to be a neutrosophic soft

- (i) M interior (resp. θ interior & θ semi interior) of (\tilde{K}, Λ) (briefly, $N_sSMint(\tilde{K}, \Lambda)$ (resp. $N_sS\theta int$ & $N_sS\theta Sint$)) is defined by $N_sSMint(\tilde{K}, \Lambda)$ (resp. $N_sS\theta int$ & $N_sS\theta Sint$) = $\bigcup \{(\tilde{G}, \Lambda) : (\tilde{G}, \Lambda) \subseteq (\tilde{K}, \Lambda) \text{ \& } (\tilde{G}, \Lambda) \text{ is a } N_sSMos \text{ (resp. } N_sS\theta os \text{ \& } N_sS\theta Sos) \text{ in } \mathfrak{M}\}$.
- (ii) M closure (resp. θ closure & θ semi closure) of (\tilde{K}, Λ) (briefly, $N_sSMcl(\tilde{K}, \Lambda)$ (resp. $N_sS\theta cl$ & $N_sS\theta Sccl$)) is defined by $N_sSMcl(\tilde{K}, \Lambda)$ (resp. $N_sS\theta cl$ & $N_sS\theta Sccl$) = $\bigcap \{(\tilde{G}, \Lambda) : (\tilde{K}, \Lambda) \subseteq (\tilde{G}, \Lambda) \text{ \& } (\tilde{K}, \Lambda) \text{ is a } N_sSMcs \text{ (resp. } N_sS\theta cs \text{ \& } N_sS\theta Scs) \text{ in } \mathfrak{M}\}$.

A map $\gamma : (\mathfrak{M}_1, \tau_1, \Lambda) \rightarrow (\mathfrak{M}_2, \tau_2, \Lambda)$ is said to be neutrosophic soft

- (i) M -continuous (briefly, N_sSMCts) if the inverse image of every $N_sS\theta os$ in $(\mathfrak{M}_2, \tau_2, \Lambda)$ is a N_sSMos in $(\mathfrak{M}_1, \tau_1, \Lambda)$.
- (ii) contra (resp. δ , δS , δP & e) continuous (in short, N_sSCCts (resp. $N_sSC\delta Cts$, $N_sSC\delta ScTs$, $N_sSC\delta PCts$ & $N_sSCeCts$)) if the inverse image of each $N_sS\theta os$ in $(\mathfrak{M}_2, \tau_2, \Lambda)$ is a $N_sS\theta cs$ (resp. $N_sS\delta cs$, $N_sS\delta Scs$, $N_sS\delta Pcs$ & N_sSecs) in $(\mathfrak{M}_1, \tau_1, \Lambda)$.
- (iii) contra θ (resp. θS & M)-continuous (briefly, $N_sSC\theta Cts$ (resp. $N_sSC\theta ScTs$ & $N_sSCMCts$)) if the inverse image of every $N_sS\theta os$ in $(\mathfrak{M}_2, \tau_2, \Lambda)$ is a $N_sS\theta cs$ (resp. $N_sS\theta Scs$ & N_sSMcs) in $(\mathfrak{M}_1, \tau_1, \Lambda)$.

A $N_sSt(\mathfrak{M}, \tau, \Lambda)$ is said to be a neutrosophic soft $MU_{\frac{1}{2}}$ (in short $N_sSMU_{\frac{1}{2}}$)-space, if every N_sSMos in \mathfrak{M} is a $N_sS\theta os$ in \mathfrak{M} .

Let $\mathfrak{M} = \{\zeta_1, \zeta_2, \zeta_3\}$, $\mathfrak{N} = \{v_1, v_2, v_3\}$, $E = \{q_1, q_2\}$ and N_sSs 's (\tilde{K}_1, Λ) , (\tilde{K}_2, Λ) & (\tilde{K}_3, Λ) in \mathfrak{M} and (\tilde{O}_1, Λ) in \mathfrak{N} are defined as

$$\begin{aligned} (\tilde{K}_1, q_1) &= \{\langle \zeta_1, (0.20, 0.5, 0.80) \rangle, \langle \zeta_2, (0.30, 0.5, 0.70) \rangle, \langle \zeta_3, (0.40, 0.5, 0.60) \rangle\} \\ (\tilde{K}_1, q_2) &= \{\langle \zeta_1, (0.21, 0.5, 0.79) \rangle, \langle \zeta_2, (0.31, 0.5, 0.69) \rangle, \langle \zeta_3, (0.41, 0.5, 0.59) \rangle\} \\ (\tilde{K}_2, q_1) &= \{\langle \zeta_1, (0.10, 0.5, 0.90) \rangle, \langle \zeta_2, (0.10, 0.5, 0.90) \rangle, \langle \zeta_3, (0.40, 0.5, 0.60) \rangle\} \\ (\tilde{K}_2, q_2) &= \{\langle \zeta_1, (0.11, 0.5, 0.89) \rangle, \langle \zeta_2, (0.11, 0.5, 0.89) \rangle, \langle \zeta_3, (0.41, 0.5, 0.59) \rangle\} \\ (\tilde{K}_3, q_1) &= \{\langle \zeta_1, (0.20, 0.5, 0.80) \rangle, \langle \zeta_2, (0.20, 0.5, 0.80) \rangle, \langle \zeta_3, (0.30, 0.5, 0.70) \rangle\} \\ (\tilde{K}_3, q_2) &= \{\langle \zeta_1, (0.21, 0.5, 0.79) \rangle, \langle \zeta_2, (0.21, 0.5, 0.79) \rangle, \langle \zeta_3, (0.31, 0.5, 0.69) \rangle\} \\ (\tilde{O}_1, q_1) &= \{\langle v_1, (0.80, 0.5, 0.20) \rangle, \langle v_2, (0.80, 0.5, 0.20) \rangle, \langle v_3, (0.70, 0.5, 0.30) \rangle\} \\ (\tilde{O}_1, q_2) &= \{\langle v_1, (0.79, 0.5, 0.21) \rangle, \langle v_2, (0.79, 0.5, 0.21) \rangle, \langle v_3, (0.69, 0.5, 0.31) \rangle\} \end{aligned}$$

Then we have $\tau_1 = \{0_{(\mathfrak{M}, \Lambda)}, 1_{(\mathfrak{M}, \Lambda)}, (\tilde{K}_1, \Lambda), (\tilde{K}_2, \Lambda)\}$ and $\tau_2 = \{0_{(\mathfrak{N}, \Lambda)}, 1_{(\mathfrak{N}, \Lambda)}, (\tilde{O}_1, \Lambda)\}$.

Let $\gamma : (\mathfrak{M}, \tau_1, \Lambda) \rightarrow (\mathfrak{N}, \tau_2, \Lambda)$ be an Id. map. Then γ is $N_sSCMCts$.

The claims are true, but the converse is false. Every

- (i) $N_sSC\theta Cts$ is a N_sSCCts .
- (ii) $N_sSC\theta Cts$ is a $N_sSC\theta SCts$.
- (iii) $N_sSC\theta SCts$ is a $N_sSCMCts$.
- (iv) N_sSCCts is a $N_sSC\delta SCts$.
- (v) N_sSCCts is a $N_sSC\delta PCts$.
- (vi) $N_sSC\delta SCts$ is a $N_sSCeCts$.
- (vii) $N_sSC\delta PCts$ is a $N_sSCMCts$.
- (viii) $N_sSCMCts$ is a $N_sSCeCts$.

Proof. (i) Let (\tilde{G}, Λ) be a N_sSos in \mathfrak{M}_2 . Since γ is $N_sSC\theta Cts$, $\gamma^{-1}(\tilde{G}, \Lambda)$ is $N_sS\theta cs$ in \mathfrak{M}_1 . Since all $N_sS\theta cs$ are N_sScs , $\gamma^{-1}(\tilde{G}, \Lambda)$ is N_sScs in \mathfrak{M}_1 . Hence γ is a N_sSCCts .

(ii) Let (\tilde{G}, Λ) be a N_sSos in \mathfrak{M}_2 . Since γ is $N_sSC\theta Cts$, $\gamma^{-1}(\tilde{G}, \Lambda)$ is $N_sS\theta cs$ in \mathfrak{M}_1 . Since all $N_sS\theta cs$ are $N_sS\theta Scs$, $\gamma^{-1}(\tilde{G}, \Lambda)$ is $N_sS\theta Scs$ in \mathfrak{M}_1 . Hence γ is a $N_sSC\theta SCts$.

(iii) Let (\tilde{G}, Λ) be a N_sSos in \mathfrak{M}_2 . Since γ is $N_sSC\theta SCts$, $\gamma^{-1}(\tilde{G}, \Lambda)$ is $N_sS\theta Scs$ in \mathfrak{M}_1 . Since all $N_sS\theta Scs$ are N_sSMcs , $\gamma^{-1}(\tilde{G}, \Lambda)$ is N_sSMcs in \mathfrak{M}_1 . Hence γ is a $N_sSCMCts$.

(iv) Let (\tilde{G}, Λ) be a N_sSos in \mathfrak{M}_2 . Since γ is N_sSCCts , $\gamma^{-1}(\tilde{G}, \Lambda)$ is a N_sScs in \mathfrak{M}_1 . Since all N_sScs is a $N_sS\delta Scs$, $\gamma^{-1}(\tilde{G}, \Lambda)$ is a $N_sS\delta Scs$ in \mathfrak{M}_1 . Hence γ is a $N_sSC\delta SCts$.

(v) Let (\tilde{G}, Λ) be a N_sSos in \mathfrak{M}_2 . Since γ is N_sSCCts , $\gamma^{-1}(\tilde{G}, \Lambda)$ is a N_sScs in \mathfrak{M}_1 . Since all N_sScs is a $N_sS\delta PCs$, $\gamma^{-1}(\tilde{G}, \Lambda)$ is a $N_sS\delta PCs$ in \mathfrak{M}_1 . Hence γ is a $N_sSC\delta PCts$.

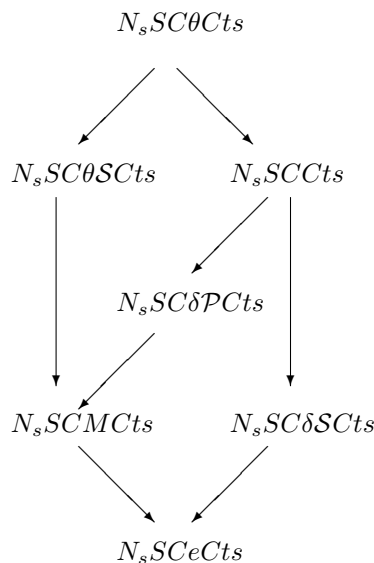
(vi) Let $\tilde{G}, \Lambda)$ be a N_sSos in \mathfrak{M}_2 . Since γ is $N_sSC\delta SCts$, $\gamma^{-1}(\tilde{G}, \Lambda)$ is a $N_sS\delta Scs$ in \mathfrak{M}_1 . Since all $N_sS\delta Scs$ is a N_sSecs , $\gamma^{-1}(\tilde{G}, \Lambda)$ is a N_sSecs in \mathfrak{M}_1 . Hence γ is a $N_sSCeCts$.

(vii) Let $\tilde{G}, \Lambda)$ be a N_sSos in \mathfrak{M}_2 . Since γ is $N_sSC\delta PCts$, $\gamma^{-1}(\tilde{G}, \Lambda)$ is a $N_sS\delta PCs$ in \mathfrak{M}_1 . Since all $N_sS\delta PCs$ is a N_sSMcs , $\gamma^{-1}(\tilde{G}, \Lambda)$ is a N_sSMcs in \mathfrak{M}_1 . Hence γ is a $N_sSCMCts$.

(viii) Let $\tilde{G}, \Lambda)$ be a N_sSos in \mathfrak{M}_2 . Since γ is $N_sSCMCts$, $\gamma^{-1}(\tilde{G}, \Lambda)$ is a N_sSMcs in \mathfrak{M}_1 . Since all N_sSMcs is a N_sSecs , $\gamma^{-1}(\tilde{G}, \Lambda)$ is a N_sSecs in \mathfrak{M}_1 . Hence γ is a $N_sSCeCts$.

□

Using the findings stated above, we derive the diagram shown below.



Note: $\mathfrak{M}_1 \rightarrow \mathfrak{M}_2$ denotes \mathfrak{M}_1 implies \mathfrak{M}_2 , but not conversely.

Let $\mathfrak{M} = \{\zeta_1, \zeta_2, \zeta_3\}$, $\mathfrak{N} = \{v_1, v_2, v_3\}$, $E = \{q_1, q_2\}$ and $N_s S_s$'s (\tilde{K}_1, Λ) & (\tilde{K}_2, Λ) in \mathfrak{M} and (\tilde{O}_1, Λ) in \mathfrak{N} are defined as

$$\begin{aligned} (\tilde{K}_1, q_1) &= \{ \langle \zeta_1, (0.20, 0.5, 0.80) \rangle, \langle \zeta_2, (0.30, 0.5, 0.70) \rangle, \langle \zeta_3, (0.40, 0.5, 0.60) \rangle \} \\ (\tilde{K}_1, q_2) &= \{ \langle \zeta_1, (0.21, 0.5, 0.79) \rangle, \langle \zeta_2, (0.31, 0.5, 0.69) \rangle, \langle \zeta_3, (0.41, 0.5, 0.59) \rangle \} \\ (\tilde{K}_2, q_1) &= \{ \langle \zeta_1, (0.10, 0.5, 0.90) \rangle, \langle \zeta_2, (0.10, 0.5, 0.90) \rangle, \langle \zeta_3, (0.40, 0.5, 0.60) \rangle \} \\ (\tilde{K}_2, q_2) &= \{ \langle \zeta_1, (0.11, 0.5, 0.89) \rangle, \langle \zeta_2, (0.11, 0.5, 0.89) \rangle, \langle \zeta_3, (0.41, 0.5, 0.59) \rangle \} \\ (\tilde{O}_1, q_1) &= \{ \langle v_1, (0.80, 0.5, 0.20) \rangle, \langle v_2, (0.70, 0.5, 0.30) \rangle, \langle v_3, (0.60, 0.5, 0.40) \rangle \} \\ (\tilde{O}_1, q_2) &= \{ \langle v_1, (0.79, 0.5, 0.21) \rangle, \langle v_2, (0.69, 0.5, 0.31) \rangle, \langle v_3, (0.59, 0.5, 0.41) \rangle \} \end{aligned}$$

Then we have $\tau_1 = \{0_{(\mathfrak{M}, \Lambda)}, 1_{(\mathfrak{M}, \Lambda)}, (\tilde{K}_1, \Lambda), (\tilde{K}_2, \Lambda)\}$ and $\tau_2 = \{0_{(\mathfrak{N}, \Lambda)}, 1_{(\mathfrak{N}, \Lambda)}, (\tilde{O}_1, \Lambda)\}$.

Let $\gamma : (\mathfrak{M}, \tau_1, \Lambda) \rightarrow (\mathfrak{N}, \tau_2, \Lambda)$ be an Id. map. Then γ is $N_s SCCts$ but not $N_s SC\theta Cts$, because the set $\gamma^{-1}(\tilde{O}_1, \Lambda) = (\tilde{K}_1, \Lambda)$ is a $N_s S_c s$ but not $N_s S\theta c s$.

Let $\mathfrak{M} = \{\zeta_1, \zeta_2, \zeta_3\}$, $\mathfrak{N} = \{v_1, v_2, v_3\}$, $E = \{q_1, q_2\}$ and $N_s S_s$'s (\tilde{K}_1, Λ) , (\tilde{K}_2, Λ) & (\tilde{K}_3, Λ) in \mathfrak{M} and (\tilde{O}_1, Λ) in \mathfrak{N} are defined as

$$\begin{aligned} (\tilde{K}_1, q_1) &= \{ \langle \zeta_1, (0.20, 0.5, 0.80) \rangle, \langle \zeta_2, (0.30, 0.5, 0.70) \rangle, \langle \zeta_3, (0.40, 0.5, 0.60) \rangle \} \\ (\tilde{K}_1, q_2) &= \{ \langle \zeta_1, (0.21, 0.5, 0.79) \rangle, \langle \zeta_2, (0.31, 0.5, 0.69) \rangle, \langle \zeta_3, (0.41, 0.5, 0.59) \rangle \} \\ (\tilde{K}_2, q_1) &= \{ \langle \zeta_1, (0.10, 0.5, 0.90) \rangle, \langle \zeta_2, (0.10, 0.5, 0.90) \rangle, \langle \zeta_3, (0.40, 0.5, 0.60) \rangle \} \\ (\tilde{K}_2, q_2) &= \{ \langle \zeta_1, (0.11, 0.5, 0.89) \rangle, \langle \zeta_2, (0.11, 0.5, 0.89) \rangle, \langle \zeta_3, (0.41, 0.5, 0.59) \rangle \} \\ (\tilde{K}_3, q_1) &= \{ \langle \zeta_1, (0.90, 0.5, 0.10) \rangle, \langle \zeta_2, (0.80, 0.5, 0.20) \rangle, \langle \zeta_3, (0.70, 0.5, 0.30) \rangle \} \\ (\tilde{K}_3, q_2) &= \{ \langle \zeta_1, (0.91, 0.5, 0.09) \rangle, \langle \zeta_2, (0.81, 0.5, 0.19) \rangle, \langle \zeta_3, (0.71, 0.5, 0.29) \rangle \} \\ (\tilde{O}_1, q_1) &= \{ \langle v_1, (0.10, 0.5, 0.90) \rangle, \langle v_2, (0.20, 0.5, 0.80) \rangle, \langle v_3, (0.30, 0.5, 0.70) \rangle \} \\ (\tilde{O}_1, q_2) &= \{ \langle v_1, (0.09, 0.5, 0.91) \rangle, \langle v_2, (0.19, 0.5, 0.81) \rangle, \langle v_3, (0.29, 0.5, 0.71) \rangle \} \end{aligned}$$

Then we have $\tau_1 = \{0_{(\mathfrak{M}, \Lambda)}, 1_{(\mathfrak{M}, \Lambda)}, (\tilde{K}_1, \Lambda), (\tilde{K}_2, \Lambda)\}$ and $\tau_2 = \{0_{(\mathfrak{N}, \Lambda)}, 1_{(\mathfrak{N}, \Lambda)}, (\tilde{O}_1, \Lambda)\}$.

Let $\gamma : (\mathfrak{M}, \tau_1, \Lambda) \rightarrow (\mathfrak{N}, \tau_2, \Lambda)$ be an Id. map. Then γ is $N_s SC\theta S Cts$ but not $N_s SC\theta Cts$, because the set $\gamma^{-1}(\tilde{O}_1, \Lambda) = (\tilde{K}_3, \Lambda)$ is a $N_s S\theta S c s$ but not $N_s S\theta c s$.

Let $\mathfrak{M} = \{\zeta_1, \zeta_2, \zeta_3\}$, $\mathfrak{N} = \{v_1, v_2, v_3\}$, $E = \{q_1, q_2\}$ and $N_s S_s$'s (\tilde{K}_1, Λ) , (\tilde{K}_2, Λ) & (\tilde{K}_3, Λ) in \mathfrak{M} and (\tilde{O}_1, Λ) in \mathfrak{N} are defined as

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Then we have $\tau_1 = \{0_{(\mathfrak{M}, \Lambda)}, 1_{(\mathfrak{M}, \Lambda)}, (\tilde{K}_1, \Lambda), (\tilde{K}_2, \Lambda)\}$ and $\tau_2 = \{0_{(\mathfrak{N}, \Lambda)}, 1_{(\mathfrak{N}, \Lambda)}, (\tilde{O}_1, \Lambda)\}$.

Let $\gamma : (\mathfrak{M}, \tau_1, \Lambda) \rightarrow (\mathfrak{N}, \tau_2, \Lambda)$ be an Id. map. Then γ is $N_s S C M Cts$ but not $N_s SC\theta S Cts$, because the set $\gamma^{-1}(\tilde{O}_1, \Lambda) = (\tilde{K}_3, \Lambda)$ is a $N_s S M c s$ but not $N_s S\theta S c s$.

Let $\mathfrak{M} = \{\zeta_1, \zeta_2, \zeta_3\}$, $\mathfrak{N} = \{v_1, v_2, v_3\}$, $E = \{q_1, q_2\}$ and $N_s Ss$'s (\tilde{K}_1, Λ) , (\tilde{K}_2, Λ) & (\tilde{K}_3, Λ) in \mathfrak{M} and (\tilde{O}_1, Λ) in \mathfrak{N} are defined as

$$\begin{aligned} (\tilde{K}_1, q_1) &= \{\langle \zeta_1, (0.20, 0.5, 0.80) \rangle, \langle \zeta_2, (0.30, 0.5, 0.70) \rangle, \langle \zeta_3, (0.40, 0.5, 0.60) \rangle\} \\ (\tilde{K}_1, q_2) &= \{\langle \zeta_1, (0.21, 0.5, 0.79) \rangle, \langle \zeta_2, (0.31, 0.5, 0.69) \rangle, \langle \zeta_3, (0.41, 0.5, 0.59) \rangle\} \\ (\tilde{K}_2, q_1) &= \{\langle \zeta_1, (0.10, 0.5, 0.90) \rangle, \langle \zeta_2, (0.10, 0.5, 0.90) \rangle, \langle \zeta_3, (0.40, 0.5, 0.60) \rangle\} \\ (\tilde{K}_2, q_2) &= \{\langle \zeta_1, (0.11, 0.5, 0.89) \rangle, \langle \zeta_2, (0.11, 0.5, 0.89) \rangle, \langle \zeta_3, (0.41, 0.5, 0.59) \rangle\} \\ (\tilde{K}_3, q_1) &= \{\langle \zeta_1, (0.20, 0.5, 0.80) \rangle, \langle \zeta_2, (0.40, 0.5, 0.60) \rangle, \langle \zeta_3, (0.40, 0.5, 0.60) \rangle\} \\ (\tilde{K}_3, q_2) &= \{\langle \zeta_1, (0.21, 0.5, 0.79) \rangle, \langle \zeta_2, (0.41, 0.5, 0.59) \rangle, \langle \zeta_3, (0.41, 0.5, 0.59) \rangle\} \\ (\tilde{O}_1, q_1) &= \{\langle v_1, (0.80, 0.5, 0.20) \rangle, \langle v_2, (0.60, 0.5, 0.40) \rangle, \langle v_3, (0.60, 0.5, 0.40) \rangle\} \\ (\tilde{O}_1, q_2) &= \{\langle v_1, (0.79, 0.5, 0.21) \rangle, \langle v_2, (0.59, 0.5, 0.41) \rangle, \langle v_3, (0.59, 0.5, 0.41) \rangle\} \end{aligned}$$

Then we have $\tau_1 = \{0_{(\mathfrak{M}, \Lambda)}, 1_{(\mathfrak{M}, \Lambda)}, (\tilde{K}_1, \Lambda), (\tilde{K}_2, \Lambda)\}$ and $\tau_2 = \{0_{(\mathfrak{N}, \Lambda)}, 1_{(\mathfrak{N}, \Lambda)}, (\tilde{O}_1, \Lambda)\}$.

Let $\gamma : (\mathfrak{M}, \tau_1, \Lambda) \rightarrow (\mathfrak{N}, \tau_2, \Lambda)$ be an Id. map. Then γ is $N_s SCeCts$ but not $N_s SCM Cts$, because the set $\gamma^{-1}(\tilde{O}_1, \Lambda) = (\tilde{K}_3, \Lambda)$ is a $N_s Secs$ but not $N_s SMcs$.

Let $\mathfrak{M} = \{\zeta_1, \zeta_2, \zeta_3\}$, $\mathfrak{N} = \{v_1, v_2, v_3\}$, $E = \{q_1, q_2\}$ and $N_s Ss$'s (\tilde{K}_1, Λ) , (\tilde{K}_2, Λ) , (\tilde{K}_3, Λ) , (\tilde{K}_4, Λ) & (\tilde{K}_5, Λ) in \mathfrak{M} and (\tilde{O}_1, Λ) in \mathfrak{N} are defined as

$$\begin{aligned} (\tilde{K}_1, q_1) &= \{\langle \zeta_1, (0.30, 0.5, 0.70) \rangle, \langle \zeta_2, (0.40, 0.5, 0.60) \rangle, \langle \zeta_3, (0.30, 0.5, 0.70) \rangle\} \\ (\tilde{K}_1, q_2) &= \{\langle \zeta_1, (0.31, 0.5, 0.69) \rangle, \langle \zeta_2, (0.41, 0.5, 0.59) \rangle, \langle \zeta_3, (0.31, 0.5, 0.69) \rangle\} \\ (\tilde{K}_2, q_1) &= \{\langle \zeta_1, (0.60, 0.5, 0.40) \rangle, \langle \zeta_2, (0.50, 0.5, 0.50) \rangle, \langle \zeta_3, (0.50, 0.5, 0.50) \rangle\} \\ (\tilde{K}_2, q_2) &= \{\langle \zeta_1, (0.61, 0.5, 0.39) \rangle, \langle \zeta_2, (0.51, 0.5, 0.49) \rangle, \langle \zeta_3, (0.51, 0.5, 0.49) \rangle\} \\ (\tilde{K}_3, q_1) &= \{\langle \zeta_1, (0.60, 0.5, 0.40) \rangle, \langle \zeta_2, (0.50, 0.5, 0.50) \rangle, \langle \zeta_3, (0.40, 0.5, 0.60) \rangle\} \\ (\tilde{K}_3, q_2) &= \{\langle \zeta_1, (0.61, 0.5, 0.39) \rangle, \langle \zeta_2, (0.51, 0.5, 0.49) \rangle, \langle \zeta_3, (0.41, 0.5, 0.59) \rangle\} \\ (\tilde{K}_4, q_1) &= \{\langle \zeta_1, (0.30, 0.5, 0.70) \rangle, \langle \zeta_2, (0.40, 0.5, 0.60) \rangle, \langle \zeta_3, (0.40, 0.5, 0.60) \rangle\} \\ (\tilde{K}_4, q_2) &= \{\langle \zeta_1, (0.31, 0.5, 0.69) \rangle, \langle \zeta_2, (0.41, 0.5, 0.59) \rangle, \langle \zeta_3, (0.41, 0.5, 0.59) \rangle\} \\ (\tilde{K}_5, q_1) &= \{\langle \zeta_1, (0.70, 0.5, 0.30) \rangle, \langle \zeta_2, (0.50, 0.5, 0.50) \rangle, \langle \zeta_3, (0.50, 0.5, 0.50) \rangle\} \\ (\tilde{K}_5, q_2) &= \{\langle \zeta_1, (0.71, 0.5, 0.29) \rangle, \langle \zeta_2, (0.51, 0.5, 0.49) \rangle, \langle \zeta_3, (0.51, 0.5, 0.49) \rangle\} \\ (\tilde{O}_1, q_1) &= \{\langle v_1, (0.30, 0.5, 0.70) \rangle, \langle v_2, (0.50, 0.5, 0.50) \rangle, \langle v_3, (0.50, 0.5, 0.50) \rangle\} \\ (\tilde{O}_1, q_2) &= \{\langle v_1, (0.29, 0.5, 0.71) \rangle, \langle v_2, (0.49, 0.5, 0.51) \rangle, \langle v_3, (0.49, 0.5, 0.51) \rangle\} \end{aligned}$$

Then we have $\tau_1 = \{0_{(\mathfrak{M}, \Lambda)}, 1_{(\mathfrak{M}, \Lambda)}, (\tilde{K}_1, \Lambda), (\tilde{K}_2, \Lambda), (\tilde{K}_3, \Lambda), (\tilde{K}_4, \Lambda)\}$ and $\tau_2 = \{0_{(\mathfrak{N}, \Lambda)}, 1_{(\mathfrak{N}, \Lambda)}, (\tilde{O}_1, \Lambda)\}$.

Let $\gamma : (\mathfrak{M}, \tau_1, \Lambda) \rightarrow (\mathfrak{N}, \tau_2, \Lambda)$ be an Id. map. Then γ is $N_s SCM Cts$ but not $N_s SC\delta PCts$, because the set $\gamma^{-1}(\tilde{O}_1, \Lambda) = (\tilde{K}_5, \Lambda)$ is a $N_s SMcs$ but not $N_s S\delta PCs$.

A map $\gamma : (\mathfrak{M}_1, \tau_1, \Lambda) \rightarrow (\mathfrak{M}_2, \tau_2, \Lambda)$ is $N_s SCM Cts$ iff the inverse image of each $N_s Scs$ in \mathfrak{M}_2 is $N_s SMos$ in \mathfrak{M}_1 .

Proof. Let (\tilde{G}, Λ) be a $N_s Scs$ in \mathfrak{M}_2 . This implies $(\tilde{G}, \Lambda)^c$ is $N_s Sos$ in \mathfrak{M}_2 . Since γ is $N_s SCM Cts$, $\gamma^{-1}((\tilde{G}, \Lambda)^c)$ is $N_s SMcs$ in \mathfrak{M}_1 . Since $\gamma^{-1}((\tilde{G}, \Lambda)^c) = (\gamma^{-1}(\tilde{G}, \Lambda))^c$, $\gamma^{-1}(\tilde{G}, \Lambda)$ is a $N_s SMos$ in \mathfrak{M}_1 .

Conversely, let (\tilde{G}, Λ) be a $N_s Scs$ in \mathfrak{M}_2 . Then $(\tilde{G}, \Lambda)^c$ is a $N_s Sos$ in \mathfrak{M}_2 . By hypothesis $\gamma^{-1}((\tilde{G}, \Lambda)^c)$ is $N_s SMcs$ in \mathfrak{M}_1 . Since $\gamma^{-1}((\tilde{G}, \Lambda)^c) = (\gamma^{-1}(\tilde{G}, \Lambda))^c$, $(\gamma^{-1}(\tilde{G}, \Lambda))^c$ is a $N_s SMcs$ in \mathfrak{M}_1 . Therefore $\gamma^{-1}(\tilde{G}, \Lambda)$ is a $N_s SMos$ in \mathfrak{M}_1 . Hence γ is $N_s SCM Cts$. □

Let $\gamma : (\mathfrak{M}_1, \tau_1, \Lambda) \rightarrow (\mathfrak{M}_2, \tau_2, \Lambda)$ be a $N_s SCM Cts$, then γ is a $N_s SC Cts$ if \mathfrak{M}_1 is a $N_s SMU_{\frac{1}{2}}$ -space.

Proof. Let (\tilde{G}, Λ) be a N_sSos in \mathfrak{M}_2 . Then $\gamma^{-1}(\tilde{G}, \Lambda)$ is a N_sSMcs in \mathfrak{M}_1 , by hypothesis. Since \mathfrak{M}_1 is a $N_sSMU_{\frac{1}{2}}$ -space, $\gamma^{-1}(\tilde{G}, \Lambda)$ is a N_sScs in \mathfrak{M}_1 . Hence γ is a $N_sSCMcts$. \square

Let $\gamma : (\mathfrak{M}_1, \tau_1, \Lambda) \rightarrow (\mathfrak{M}_2, \tau_2, \Lambda)$ be a $N_sSCMcts$ map and $g : (\mathfrak{M}_2, \tau_2, \Lambda) \rightarrow (\mathfrak{M}_3, \tau_3, \Lambda)$ be a N_sSCCts , then $g \circ \gamma : (\mathfrak{M}_1, \tau_1, \Lambda) \rightarrow (\mathfrak{M}_3, \tau_3, \Lambda)$ is a $N_sSCMcts$.

Proof. Let (\tilde{K}, Λ) be a N_sSos in \mathfrak{M}_3 . Then $g^{-1}(\tilde{K}, \Lambda)$ is a N_sSos in \mathfrak{M}_2 , by hypothesis. Since γ is a $N_sSCMcts$ map, $\gamma^{-1}(g^{-1}(\tilde{K}, \Lambda))$ is a N_sSMcs in \mathfrak{M}_1 . Hence $g \circ \gamma$ is a $N_sSCMcts$ map. \square

Let $\gamma : (\mathfrak{M}_1, \tau_1, \Lambda) \rightarrow (\mathfrak{M}_2, \tau_2, \Lambda)$ be a $N_sSCMcts$ map. Then the following conditions

- (i) $\gamma(N_sSMcl(\tilde{F}, \Lambda)) \geq N_sSint(\gamma(\tilde{F}, \Lambda))$, for all $N_sScs (\tilde{F}, \Lambda)$ in \mathfrak{M}_1 .
- (ii) $N_sSMcl(\gamma^{-1}(\tilde{G}, \Lambda)) \geq \gamma^{-1}(N_sSint(\tilde{G}, \Lambda))$, for all $N_sScs (\tilde{G}, \Lambda)$ in \mathfrak{M}_2

are hold.

Proof. (i) Since $N_sSMcl(\gamma(\tilde{F}, \Lambda))$ is a N_sSMcs in \mathfrak{M}_2 & γ is $N_sSCMcts$, then $\gamma^{-1}(N_sSMcl(\gamma(\tilde{F}, \Lambda)))$ is N_sSMos in \mathfrak{M}_1 .

Now, since $(\tilde{F}, \Lambda) \geq \gamma^{-1}(N_sSint(\gamma(\tilde{F}, \Lambda)))$, $N_sSMcl(\tilde{F}, \Lambda) \geq \gamma^{-1}(N_sSMint(\gamma(\tilde{F}, \Lambda)))$. Therefore, $\gamma(N_sSMcl(\tilde{F}, \Lambda)) \geq N_sSint(\gamma(\tilde{F}, \Lambda))$.

(ii) By replacing (\tilde{F}, Λ) with (\tilde{G}, Λ) in (i), we obtain $\gamma(N_sSMcl(\gamma^{-1}(\tilde{G}, \Lambda))) \geq N_sSint(\gamma(\gamma^{-1}(\tilde{G}, \Lambda))) \geq N_sSint(\tilde{G}, \Lambda)$. Hence, $N_sSMcl(\gamma^{-1}(\tilde{G}, \Lambda)) \geq \gamma^{-1}(N_sSint(\tilde{G}, \Lambda))$. \square

3 Neutrosophic soft contra M-irresolute maps in N_sSts

A map $\gamma : (\mathfrak{M}_1, \tau_1, \Lambda) \rightarrow (\mathfrak{M}_2, \tau_2, \Lambda)$ is called a neutrosophic soft contra M-irresolute (briefly, $N_sSCMIrr$) map if $\gamma^{-1}(\tilde{G}, \Lambda)$ is a N_sSMcs in $(\mathfrak{M}_1, \tau_1, \Lambda) \forall N_sSMos (\tilde{G}, \Lambda)$ of $(\mathfrak{M}_2, \tau_2, \Lambda)$.

Let $\gamma : (\mathfrak{M}_1, \tau_1, \Lambda) \rightarrow (\mathfrak{M}_2, \tau_2, \Lambda)$ be a $N_sSCMIrr$, then γ is a $N_sSCMcts$. But not conversely.

Proof. Let γ be a $N_sSCMIrr$ map. Let (\tilde{G}, Λ) be any N_sSos in \mathfrak{M}_2 . Since every N_sSos is a N_sSMos , (\tilde{G}, Λ) is a N_sSMos in \mathfrak{M}_2 . $\implies \gamma^{-1}(\tilde{G}, \Lambda)$ is a N_sSMcs in \mathfrak{M}_2 . Hence γ is a $N_sSCMcts$. \square

Let $\mathfrak{M} = \{\zeta_1, \zeta_2, \zeta_3\}$, $\mathfrak{N} = \{v_1, v_2, v_3\}$, $E = \{q_1, q_2\}$ & N_sSs 's (\tilde{K}_1, Λ) & (\tilde{K}_2, Λ) in \mathfrak{M} and (\tilde{O}_1, Λ) & (\tilde{O}_2, Λ) in \mathfrak{N} are defined as

$$\begin{aligned} (\tilde{K}_1, q_1) &= \{\langle \zeta_1, (0.20, 0.5, 0.80) \rangle, \langle \zeta_2, (0.30, 0.5, 0.70) \rangle, \langle \zeta_3, (0.40, 0.5, 0.60) \rangle\} \\ (\tilde{K}_1, q_2) &= \{\langle \zeta_1, (0.21, 0.5, 0.79) \rangle, \langle \zeta_2, (0.31, 0.5, 0.69) \rangle, \langle \zeta_3, (0.41, 0.5, 0.59) \rangle\} \\ (\tilde{K}_2, q_1) &= \{\langle \zeta_1, (0.10, 0.5, 0.90) \rangle, \langle \zeta_2, (0.10, 0.5, 0.90) \rangle, \langle \zeta_3, (0.40, 0.5, 0.60) \rangle\} \\ (\tilde{K}_2, q_2) &= \{\langle \zeta_1, (0.11, 0.5, 0.89) \rangle, \langle \zeta_2, (0.11, 0.5, 0.89) \rangle, \langle \zeta_3, (0.41, 0.5, 0.59) \rangle\} \\ (\tilde{O}_1, q_1) &= \{\langle v_1, (0.80, 0.5, 0.20) \rangle, \langle v_2, (0.70, 0.5, 0.30) \rangle, \langle v_3, (0.60, 0.5, 0.40) \rangle\} \\ (\tilde{O}_1, q_2) &= \{\langle v_1, (0.79, 0.5, 0.21) \rangle, \langle v_2, (0.69, 0.5, 0.31) \rangle, \langle v_3, (0.59, 0.5, 0.41) \rangle\} \\ (\tilde{O}_2, q_1) &= \{\langle v_1, (0.80, 0.5, 0.20) \rangle, \langle v_2, (0.60, 0.5, 0.40) \rangle, \langle v_3, (0.60, 0.5, 0.40) \rangle\} \\ (\tilde{O}_2, q_2) &= \{\langle v_1, (0.79, 0.5, 0.21) \rangle, \langle v_2, (0.59, 0.5, 0.41) \rangle, \langle v_3, (0.59, 0.5, 0.41) \rangle\} \end{aligned}$$

Then we have $\tau_1 = \{0_{(\mathfrak{M}, \Lambda)}, 1_{(\mathfrak{M}, \Lambda)}, (\tilde{K}_1, \Lambda), (\tilde{K}_2, \Lambda)\}$ and $\tau_2 = \{0_{(\mathfrak{N}, \Lambda)}, 1_{(\mathfrak{N}, \Lambda)}, (\tilde{O}_1, \Lambda)\}$.

Let $\gamma : (\mathfrak{M}, \tau_1, \Lambda) \rightarrow (\mathfrak{N}, \tau_2, \Lambda)$ be an Id. map. Then γ is $N_sSCMCts$ but not $N_sSCMIrr$, because the set (\tilde{O}_2, Λ) is a N_sSMOs in \mathfrak{N} but $\gamma^{-1}(\tilde{O}_2, \Lambda)$ is not N_sSMcs in \mathfrak{M} .

Let $\gamma : (\mathfrak{M}_1, \tau_1, \Lambda) \rightarrow (\mathfrak{M}_2, \tau_2, \Lambda)$ be a $N_sSCMIrr$, then γ is a N_sSCCts map if \mathfrak{M}_1 is a $N_sSMU_{\frac{1}{2}}$ -space.

Proof. Let (\tilde{G}, Λ) be a N_sSos in \mathfrak{M}_2 . Then (\tilde{G}, Λ) is a N_sSMOs in \mathfrak{M}_2 . Therefore $\gamma^{-1}(\tilde{G}, \Lambda)$ is a N_sSMcs in \mathfrak{M}_1 , by hypothesis. Since \mathfrak{M}_1 is a $N_sSMU_{\frac{1}{2}}$ -space, $\gamma^{-1}(\tilde{G}, \Lambda)$ is a N_sScs in \mathfrak{M}_1 . Hence γ is a N_sSCCts . \square

Let $\gamma : (\mathfrak{M}_1, \tau_1, \Lambda) \rightarrow (\mathfrak{M}_2, \tau_2, \Lambda)$ be $N_sSCMIrr$ map and $g : (\mathfrak{M}_2, \tau_2, \Lambda) \rightarrow (\mathfrak{M}_3, \tau_3, \Lambda)$ be $N_sSCMCts$ map, then $g \circ \gamma : (\mathfrak{M}_1, \tau_1, \Lambda) \rightarrow (\mathfrak{M}_3, \tau_3, \Lambda)$ is a $N_sSCMCts$.

Proof. Let (\tilde{K}, Λ) be a N_sSos in \mathfrak{M}_3 . Then $g^{-1}(\tilde{K}, \Lambda)$ is a N_sSMOs in \mathfrak{M}_2 . Since γ is a $N_sSCMIrr$, $\gamma^{-1}(g^{-1}(\tilde{K}, \Lambda))$ is a N_sSMcs in \mathfrak{M}_1 . Hence $g \circ \gamma$ is a $N_sSCMCts$. \square

Let $\gamma : (\mathfrak{M}_1, \tau_1, \Lambda) \rightarrow (\mathfrak{M}_2, \tau_2, \Lambda)$ and $g : (\mathfrak{M}_2, \tau_2, \Lambda) \rightarrow (\mathfrak{M}_3, \tau_3, \Lambda)$ be mappings. Then $g \circ \gamma : (\mathfrak{M}_1, \tau_1, \Lambda) \rightarrow (\mathfrak{M}_3, \tau_3, \Lambda)$ is:

- (i) $N_sSCMCts$ if γ is N_sSeIrr and g is $N_sSCMCts$.
- (ii) $N_sSCMIrr$ if γ is $N_sSCMIrr$ (resp. N_sSMIrr) and g is N_sSMIrr (resp. $N_sSCMIrr$).

Let $\gamma : (\mathfrak{M}_1, \tau_1, \Lambda) \rightarrow (\mathfrak{M}_2, \tau_2, \Lambda)$ be a mapping.

- (i) If $(\mathfrak{M}_1, \tau_1, \Lambda)$ is $N_sSeU_{\frac{1}{2}}$ -space, then N_sSCCts and $N_sSCMCts$ are equivalent.
- (ii) If $(\mathfrak{M}_2, \tau_2, \Lambda)$ is $N_sSeU_{\frac{1}{2}}$ -space, then $N_sSCMCts$ and $N_sSCMIrr$ are equivalent.
- (iii) If $(\mathfrak{M}_1, \tau_1, \Lambda)$ and $(\mathfrak{M}_2, \tau_2, \Lambda)$ are $N_sSeU_{\frac{1}{2}}$ -spaces, then N_sSCCts , $N_sSCMCts$ and $N_sSCMIrr$ are equivalent.

Let $\gamma : (\mathfrak{M}_1, \tau_1, \Lambda) \rightarrow (\mathfrak{M}_2, \tau_2, \Lambda)$ & $g : (\mathfrak{M}_2, \tau_2, \Lambda) \rightarrow (\mathfrak{M}_3, \tau_3, \Lambda)$ be $N_sSCMCts$ mappings and $(\mathfrak{M}_2, \tau_2, \Lambda)$ be a $N_sSMU_{\frac{1}{2}}$ -space. Then $g \circ \gamma : (\mathfrak{M}_1, \tau_1, \Lambda) \rightarrow (\mathfrak{M}_3, \tau_3, \Lambda)$ is N_sSMCts .

Let $\gamma : (\mathfrak{M}_1, \tau_1, \Lambda) \rightarrow (\mathfrak{M}_2, \tau_2, \Lambda)$ be a map. Then the following conditions are equivalent if \mathfrak{M}_1 & \mathfrak{M}_2 are $N_sSMU_{\frac{1}{2}}$ -spaces.

- (i) γ is a $N_sSCMIrr$.
- (ii) $\gamma^{-1}(\tilde{G}, \Lambda)$ is a N_sSMOs in \mathfrak{M}_1 for each N_sSMcs (\tilde{G}, Λ) in \mathfrak{M}_2 .
- (iii) $N_sScl(\gamma^{-1}(\tilde{G}, \Lambda)) \supseteq \gamma^{-1}(N_sSint(\tilde{G}, \Lambda)) \forall N_sSs$ (\tilde{G}, Λ) of \mathfrak{M}_2 .

4 Conclusions

In this paper, by using N_sSMOs we introduced $N_sSCMCts$ & N_sSCM -irresolute maps are analyzed and studied its properties.

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