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Some New Types of Soft Irresolute Mappings in Soft Generalized Topological Spaces

M. Supriya[1] and Dr. R. Selvi[2]

[1]*Research Scholar (Reg. No: 20211202092007), Department of Mathematics, Sri Parasakthi College for Women, Courtallam - 627802, Tamilnadu, India, Affiliated to Manonmaniam Sundaranar University, Abishekapatti, Tirunelveli - 627012,Tamilnadu, India.*

[2]*Associate Professor and Head, Department of Mathematics, Sri Parasakthi College for Women, Courtallam - 627802, Tamilnadu, India, Affiliated to Manonmaniam Sundaranar University, Abishekapatti, Tirunelveli - 627012, Tamilnadu, India.*

Abstract
In this paper, we introduced the notion of some new types of soft irresolute functions namely soft minimal (μ,η)-irresolute, soft maximal (μ,η)-irresolute, soft para (μ,η)-irresolute, soft (μ,η)-pre-irresolute, soft (μ,η)-semi-irresolute, soft (μ,η)-α-irresolute and soft (μ,η)-β-irresolute mappings in soft generalized topological spaces. Also, we investigate some of the properties of the above irresolute mappings.
Key words: *soft minimal (μ,η)-irresolute, soft maximal (μ,η)-irresolute, soft para (μ,η)-irresolute, soft (μ,η)-pre-irresolute, soft (μ,η)-β-irresolute.*
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I. Introduction

Topology is an important area of mathematics, with many applications in the domain of computer science and physical sciences. In 1999 D. Molodtsov [17] initiated the concept of soft set theory as a mathematical tool for modelling uncertainties. A soft set is a collection of approximate descriptions of an object. Molodtsov [18] applied the soft set theory in several areas of mathematics such as game theory, probability, Perron and Riemann Integration and theory of measurements. He has analysed that the soft set is used to eradicate problems occurring in the field of economics, social science, engineering, medical science, etc. Maji et al. [15] have further improved the theory of soft sets. N. Cagman et al.[1] modified the definition of soft sets which is similar to that of Molodtsov and also Cagman [8] formulated the maximum decision making method by means of soft matrix theory. Many researchers have worked on the topological structure of soft sets. Bashir Ahmad et al. [6] have defined the soft topological structures by using soft points. B.chen [10] was the first one who studied the weak forms of soft open sets and scrutinized soft semiopen sets in soft topological spaces and studied some of its properties. Arockiarani and Arokialancy [3] determined soft β-open sets and prolonged to study weak forms of soft open sets in soft topological space. Gunduz Aras et al. [2] investigated some soft continuous functions for a fixed number of parameters on the initial universe. Mahanta and Das [14] classified many forms of soft mappings such as irresolute, semicontinuous and semiopen soft mappings. Muhammad Shabir et al. [22] introduced soft topological spaces. In 2002 A. Csaszar [11] introduced the concept of generalized topology and also studied some of its properties.

Soft generalized topology is relatively new and promising domain which lead to the development of new mathematical models and innovative approaches that will give solution to complex problems in engineering and environment. Sunil Jacob John et al. [12] introduced the concept of soft generalized topological spaces in 2014. sunil Jacob John [13] also introduced some interesting properties of the soft mapping $\pi : S(U)_E \longrightarrow S(U)_E$ which satisfy the condition $\pi F_B \subset \pi F_D$ whenever $F_B \subset F_D \subset F_{\tilde{E}}$ in soft π-open sets in soft generalized topological spaces in 2015. S. Z. Bai and Y. P. Zuo [5] introduced the concept of g-α-irresolute functions in generalized topological spaces in the year 2011.

These concepts motivate us to enhance our further study in some new types of soft irresolute functions in soft generalized topological spaces.

II. Preliminaries

Definition: 2.1 [13]

A soft set F_A on the universe U is defined by the set of ordered pairs
$F_A = \{(e, f_A(e)) / e \in E, f_A(e) \in \mathcal{P}(U)\}$ where $f_A : E \longrightarrow \mathcal{P}(U)$ such that $f_A(e) = \emptyset$ if $e \notin A$. Here f_A is called an approximate function of the soft set F_A . The value of $f_A(e)$ may be arbitrary. Some of them may be empty, some may have nonempty intersection. The set of all soft sets over U with E as the parameter set will be denoted by $S(U)_E$ or simply $S(U)$.

Definition: 2.2 [13]

Let $F_A \in S(U)$. If $f_A(e) = \emptyset$, for all $e \in E$, then F_A is called an empty soft set, denoted by $F_\emptyset$.
$f_A(e) = \emptyset$ means there is no element in U related to the parameter e in E. Therefore we do not display such elements in the soft sets as it is meaningless to consider such parameters.

Definition: 2.3 [12]

Let $F_A \in S(U)$. If $f_A(e) = U$, for all $e \in A$, then F_A is called an A-universal soft set, denoted by $F_{\tilde{A}}$. If A = E, then the A-universal soft set is called an universal soft set, denoted by $F_{\tilde{E}}$.

Definition: 2.4 [13]

Let $F_A \in S(U)$. Then, the soft complement of F_A, denoted by $(F_A)^c$, is defined by the approximate function, ${f_A}^c(e) = (f_A(e))^c$, where $(f_A(e))^c$ is the complement of the set $f_A(e)$, that is, $(f_A(e))^c = U \setminus f_A(e)$ for all $e \in E$.

Definition: 2.5 [12]

Let $F_A \in S(U)$. A Soft Generalized Topology (SGT) on F_A, denoted by μ (or) μ_{F_A} is a collection of soft subsets of F_A having the following properties:

i. $F_\emptyset \in \mu$
ii. $\{F_{A_i} \subseteq F_A$ / i ∈ J ⊆ N$\} \subseteq \mu \implies \cup_{i \in J} F_{A_i} \in \mu$

The pair (F_A, μ) is called a Soft Generalized Topological Space (SGTS).
Observe that $F_A \in \mu$ must not hold.

Definition: 2.6 [12]

Let (F_A, μ) be a SGTS. Then every element of μ is called a soft μ-open set.

Definition 2.7 [19]

Let (X, τ) be a topological space. A nonempty open set U of X is said to be a minimal open set if and only if any open set which is contained in U is $\emptyset$ or U.

Definition 2.8[20]

Let (X, τ) be a topological space. A proper nonempty open subset U of X is said to be a maximal open set if any open set which contains U is X or U.

Definition 2.9[4]

Any open subset U of a topological space X is said to be a paraopen set if it is neither minimal open nor maximal open set.

Definition: 2.10 [12]

A soft generalized topology μ on F_A is said to be strong if $F_A \in \mu$.

Definition: 2.11 [24]

A proper non-empty soft μ-open subset F_K of a soft generalized topological space (F_A, μ) is said to be soft minimal μ-open set if any soft μ-open set which is contained in F_K is $F_\emptyset$ or F_K. The family of all soft minimal μ-open sets in a soft generalized topological space (F_A, μ) is denoted by $\mathcal{SM}_i\mu O\ (F_A)$.

Definition: 2.12 [13]

Let $(F_{\tilde{E}}, \mu)$ be a SGTS. Then a soft set $F_G \subset F_{\tilde{E}}$ is said to be a soft μ-pre-open set iff $F_G \subset i_\mu c_\mu F_G$ (i.e., the case when $\pi = i_\mu c_\mu$). The class of all soft μ-pre-open sets is denoted by $\rho_{(\mu)}$ or ρ_μ.

Definition: 2.13 [13]

Let $(F_{\tilde{E}}, \mu)$ be a SGTS. Then a soft set $F_G \subset F_{\tilde{E}}$ is said to be a soft μ-semi-open set iff $F_G \subset c_\mu i_\mu F_G$ (i.e., the case when $\pi = c_\mu i_\mu$). The class of all soft μ-semi-open sets is denoted by $\delta_{(\mu)}$ or δ_μ.

Definition: 2.14 [13]

Let $(F_{\tilde{E}}, \mu)$ be a SGTS. Then a soft set $F_G \subset F_{\tilde{E}}$ is said to be a soft μ-α-open set iff $F_G \subset i_\mu c_\mu i_\mu F_G$ (i.e., the case when $\pi = i_\mu c_\mu i_\mu$). The class of all soft μ-α-open sets is denoted by $\alpha_{(\mu)}$ or α_μ.

Definition: 2.15 [13]

Let $(F_{\tilde{E}}, \mu)$ be a SGTS. Then a soft set $F_G \subset F_{\tilde{E}}$ is said to be a soft μ-β-open set iff $F_G \subset c_\mu i_\mu c_\mu F_G$ (i.e., the case when $\pi = c_\mu i_\mu c_\mu$). The class of all soft μ-β-open sets is denoted by $\beta_{(\mu)}$ or β_μ.

Definition: 2.16 [16]

A soft mapping $g: A \longrightarrow B$ is called soft pre-continuous (resp., soft semicontinuous) if the inverse image of each soft open set in B is soft pre-open (resp., soft semiopen) set in A.

Definition: 2.17 [16]

A soft mapping $g: A \longrightarrow B$ is called soft α-continuous if the inverse image of each soft open set in B is soft α-open set in A.

Definition: 2.18 [6]

A soft mapping $g: A \longrightarrow B$ is called soft β-continuous (resp., soft α-continuous, soft precontinuous, and soft semicontinuous) if the inverse image of each soft open set in B is soft β-open (resp., soft α-open, soft preopen, and soft semiopen) set in A.

III. Soft $(\boldsymbol{\mu}, \boldsymbol{\eta})$-Irresolute Functions

Definition: 3.1

Let (F_A, μ) and (F_B, η) be two SGTS's. A soft mapping $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ is said to be soft minimal (μ, η)-irresolute (soft min (μ, η)-irresolute) if for each soft minimal η-open set F_L in F_B, its inverse image ${\psi_\chi}^{-1}(F_L)$ is a soft minimal μ-open set in F_A.

Definition: 3.2

Let (F_A, μ) and (F_B, η) be two SGTS's. A soft mapping $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ is said to be soft maximal (μ, η)-irresolute (soft max (μ, η)-irresolute) if for each soft maximal η-open set F_L in F_B, its inverse image ${\psi_\chi}^{-1}(F_L)$ is a soft maximal μ-open set in F_A.

Definition: 3.3

Let (F_A, μ) and (F_B, η) be two SGTS's. A soft mapping $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ is said to be soft para (μ, η)-irresolute (soft para (μ, η)-irresolute) if for each soft para η-open set F_L in F_B, its inverse image ${\psi_\chi}^{-1}(F_L)$ is a soft para μ-open set in F_A.

Theorem: 3.4

Each soft minimal (μ, η)-irresolute function is soft minimal (μ, η)-continuous but not conversely.

Proof:

Let $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ be a soft minimal (μ, η)-irresolute mapping. Let F_G be any soft minimal η-open set in F_B. Then by definition 3.1, its inverse image ${\psi_\chi}^{-1}(F_G)$ is a soft minimal μ-open set in F_A. Since every soft minimal μ-open set is soft μ-open, ${\psi_\chi}^{-1}(F_G)$ is a soft μ-open set in F_A. Hence $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ is soft minimal (μ, η)-continuous.

Example: 3.5

Let $\mathfrak{S} = \{s_1, s_2, s_3, s_4, s_5, s_6\}$, $I = \{i_1, i_2, i_3\}$, A = $\{i_1, i_2\} \tilde{\subseteq} I$, then $(F_A, \mu) = \{F_\emptyset, F_{A_1}, F_{A_2}, F_{A_3}\}$ is a SGTS where

$F_\emptyset = \{(i_1, \emptyset), (i_2, \emptyset)\}$
$F_A = \{(i_1, \{s_1, s_2, s_3, s_4, s_5\}), (i_2, \{s_1, s_2, s_4, s_5\})\}$
$F_{A_1} = \{(i_1, \{s_1, s_3, s_4, s_5\}), (i_2, \{s_1, s_4, s_5\})\}$
$F_{A_2} = \{(i_1, \{s_1, s_3, s_5\}), (i_2, \{s_1, s_5\})\}$
$F_{A_3} = \{(i_1, \{s_4, s_5\}), (i_2, \{s_1, s_4\})\}$

Let $T = \{t_1, t_2, t_3, t_4, t_5\}$, $J = \{j_1, j_2, j_3\}$, $B = \{j_1, j_2\} \tilde{\subseteq} J$, then $(F_B, \eta) = \{F_\emptyset, F_{B_1}, F_{B_2}, F_{B_3}\}$ is a SGTS where

$F_\emptyset = \{(j_1, \emptyset), (j_2, \emptyset)\}$
$F_B = \{(j_1, \{t_1, t_2, t_3, t_4\}), (j_2, \{t_1, t_2, t_3\})\}$
$F_{B_1} = \{(j_1, \{t_2, t_3, t_4\}), (j_2, \{t_2, t_3\})\}$
$F_{B_2} = \{(j_1, \{t_3, t_4\}), (j_2, \{t_3\})\}$
$F_{B_3} = \{(j_1, \{t_2, t_4\}), (j_2, \{t_2, t_3\})\}$

Define a map $\psi : \mathfrak{S} \longrightarrow T$ by $\psi(s_1) = t_3$, $\psi(s_2) = t_2$, $\psi(s_3) = t_4$, $\psi(s_4) = t_1$, $\psi(s_5) = t_3$, $\psi(s_6) = t_5$ and $\chi : I \longrightarrow J$ by $\chi(i_1) = j_1$, $\psi(i_2) = j_2$, $\psi(i_3) = j_3$. Then $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ is a soft minimal (μ, η)-continuous function but it is not a soft minimal (μ, η)-irresolute function.

Theorem: 3.6

Each soft maximal (μ, η)-irresolute function is soft maximal (μ, η)-continuous but not conversely.

Proof:

Let $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ be a soft maximal (μ, η)-irresolute mapping. Let F_G be any soft maximal

η-open set in F_B. Then by definition 3.2, its inverse image ${\psi_\chi}^{-1}(F_G)$ is a soft maximal μ-open set in F_A. Since every soft maximal μ-open set is a soft μ-open set, ${\psi_\chi}^{-1}(F_G)$ is a soft μ-open set in F_A. Hence $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ is soft maximal (μ, η)-continuous.

Example: 3.7

Let $M = \{m_1, m_2, m_3, m_4, m_5, m_6\}$, $C = \{c_1', c_2', c_3'\}$, A = $\{c_1', c_2'\} \tilde{\subseteq} C$, then
$(F_A, \mu) = \{F_\emptyset, F_{A_1}, F_{A_2}, F_{A_3}, F_{A_4}\}$ is a SGTS where
$F_\emptyset = \{(c_1', \emptyset), (c_2', \emptyset)\}$
$F_{A_1} = \{(c_1', \{m_1, m_2, m_3, m_4, m_5\}), (c_2', \{m_1, m_3, m_4, m_5\})\}$
$F_{A_2} = \{(c_1', \{m_2, m_3, m_4, m_5\}), (c_2', \{m_3, m_4, m_5\})\}$
$F_{A_3} = \{(c_1', \{m_3, m_5\}), (c_2', \{m_4, m_5\})\}$
$F_{A_4} = \{(c_1', \{m_2, m_4, m_5\}), (c_2', \{m_3, m_4\})\}$

Let $N = \{n_1, n_2, n_3, n_4, n_5\}$, $D = \{\widehat{d_1}, \widehat{d_2}, \widehat{d_3}\}$, $B = \{\widehat{d_1}, \widehat{d_2}\} \tilde{\subseteq} D$, then $(F_B, \eta) = \{F_\emptyset, F_{B_1}, F_{B_2}, F_{B_3}\}$ is a SGTS where
$F_\emptyset = \{(\widehat{d_1}, \emptyset), (\widehat{d_2}, \emptyset)\}$
$F_{B_1} = \{(\widehat{d_1}, \{n_1, n_2, n_4\}), (\widehat{d_2}, \{n_1, n_4\})\}$
$F_{B_2} = \{(\widehat{d_1}, \{n_1, n_2\}), (\widehat{d_2}, \{n_4\})\}$
$F_{B_3} = \{(\widehat{d_1}, \{n_2, n_4\}), (\widehat{d_2}, \{n_1, n_4\})\}$

Define a map $\psi : M \longrightarrow N$ by $\psi(m_1) = n_4$, $\psi(m_2) = n_3$, $\psi(m_3) = n_2$, $\psi(m_4) = n_1$, $\psi(m_5) = n_4$, $\psi(m_6) = n_5$ and $\chi : I \longrightarrow J$ by $\chi(c_1') = \widehat{d_1}, \psi(c_2') = \widehat{d_2}, \psi(c_3') = \widehat{d_3}$. Then $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ is a soft para (μ, η)-continuous function but it is not a soft para (μ, η)-irresolute function.

Theorem: 3.8

Each soft para (μ, η)-irresolute function is soft para (μ, η)-continuous but not conversely

Proof:

Let $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ be a soft para (μ, η)-irresolute mapping. Let F_G be any soft para η-open set in F_B. Then by definition 3.3, its inverse image ${\psi_\chi}^{-1}(F_G)$ is a soft para μ-open set in F_A. Since every soft para μ-open set is a soft μ-open set, ${\psi_\chi}^{-1}(F_G)$ is a soft μ-open set in F_A. Hence $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ is soft para (μ, η)-continuous.

Example: 3.9

Let $M = \{m_1, m_2, m_3, m_4, m_5, m_6\}$, $C = \{c_1', c_2', c_3'\}$, A = $\{c_1', c_2'\} \tilde{\subseteq} C$, then
$(F_A, \mu) = \{F_\emptyset, F_{A_1}, F_{A_2}, F_{A_3}, F_{A_4}\}$ is a SGTS where
$F_\emptyset = \{(c_1', \emptyset), (c_2', \emptyset)\}$
$F_{A_1} = \{(c_1', \{m_1, m_2, m_3, m_4, m_5\}), (c_2', \{m_1, m_3, m_4, m_5\})\}$
$F_{A_2} = \{(c_1', \{m_2, m_3, m_4, m_5\}), (c_2', \{m_3, m_4, m_5\})\}$
$F_{A_3} = \{(c_1', \{m_3, m_5\}), (c_2', \{m_4, m_5\})\}$
$F_{A_4} = \{(c_1', \{m_2, m_4, m_5\}), (c_2', \{m_3, m_4\})\}$
Let $N = \{n_1, n_2, n_3, n_4, n_5\}$, $D = \{\widehat{d_1}, \widehat{d_2}, \widehat{d_3}\}$, $B = \{\widehat{d_1}, \widehat{d_2}\} \tilde{\subseteq} D$, then $(F_B, \eta) = \{F_\emptyset, F_{B_1}, F_{B_2}, F_{B_3}\}$ is a SGTS where

$F_{\emptyset} = \{(\widehat{d_1}, \emptyset), (\widehat{d_2}, \emptyset)\}$
$F_{B_1} = \{(\widehat{d_1}, \{n_1, n_2, n_4\}), (\widehat{d_2}, \{n_1, n_4\})\}$
$F_{B_2} = \{(\widehat{d_1}, \{n_1, n_2\}), (\widehat{d_2}, \{n_4\})\}$
$F_{B_3} = \{(\widehat{d_1}, \{n_2, n_4\}), (\widehat{d_2}, \{n_1, n_4\})\}$

Define a map $\psi : M \longrightarrow N$ by $\psi(m_1) = n_4, \psi(m_2) = n_3, \psi(m_3) = n_2, \psi(m_4) = n_1, \psi(m_5) = n_4, \psi(m_6) = n_5$ and $\chi : I \longrightarrow J$ by $\chi(c_1') = \widehat{d_1}, \psi(c_2') = \widehat{d_2}, \psi(c_3') = \widehat{d_3}$. Then $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ is a soft para (μ, η)-continuous function but it is not a soft para (μ, η)-irresolute function.

Definition: 3.10

The SGTS (F_A, μ) is said to be soft μ-T_{min} space if for each nonempty proper soft μ-open subset of F_A is soft minimal μ-open.

Proposition: 3.11

Let $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ be a soft minimal (μ, η)-irresolute, onto map and F_B be a soft μ-T_{min} space. Then ψ_χ is soft (μ, η)-continuous.

Proof:

Let $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ be a soft minimal (μ, η)-irresolute function. Let F_{B_i} be any non-empty proper soft η-open set in F_B. Since F_B is a soft μ-T_{min} space, F_{B_i} is a soft minimal η-open set in F_B. Since ψ_χ is soft minimal (μ, η)-irresolute, ${\psi_\chi}^{-1}(F_{B_i})$ is a soft minimal μ-open set in F_A. Also, each soft minimal μ-open set is soft μ-open and ψ_χ is an onto map which implies ${\psi_\chi}^{-1}(F_{B_i})$ is a soft μ-open set in F_A. Hence $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ is soft (μ, η)-continuous.

Definition: 3.12

The SGTS (F_A, μ) is said to be soft μ-T_{max} space if for each nonempty proper soft μ-open subset of F_A is soft maximal μ-open.

Proposition: 3.13

Let $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ be a soft maximal (μ, η)-irresolute, onto map and F_B be a soft μ-T_{max} space. Then ψ_χ is soft (μ, η)-continuous.

Proof:

Let $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ be a soft maximal (μ, η)-irresolute function. Let F_{B_i} be any non-empty proper soft η-open set in F_B. Since F_B is a soft μ-T_{max} space, F_{B_i} is a soft maximal η-open set in F_B. Since ψ_χ is soft maximal (μ, η)-irresolute, ${\psi_\chi}^{-1}(F_{B_i})$ is a soft maximal μ-open set in F_A. Also, each soft maximal μ-open set is soft μ-open and ψ_χ is an onto map which implies ${\psi_\chi}^{-1}(F_{B_i})$ is a soft μ-open set in F_A. Hence $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ is soft (μ, η)-continuous.

Definition: 3.14

The SGTS (F_A, μ) is said to be soft μ-T_{para} space if for each nonempty proper soft μ-open subset of F_A is soft para μ-open.

Proposition: 3.15

Let $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ be a soft para (μ, η)-irresolute, onto map and F_B be a soft μ-T_{para} space. Then ψ_χ is soft (μ, η)-continuous.

Proof:

Let $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ be a soft para (μ, η)-irresolute function. Let F_{B_i} be any non-empty proper soft η-open set in F_B. Since F_B is a soft μ-T_{para} space, F_{B_i} is a soft para η-open set in F_B. Since ψ_χ is soft para (μ, η)-irresolute, ${\psi_\chi}^{-1}(F_{B_i})$ is a soft para μ-open set in F_A. Also, each soft para μ-open set is soft μ-open and ψ_χ is an onto map which implies ${\psi_\chi}^{-1}(F_{B_i})$ is a soft μ-open set in F_A. Hence $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ is soft (μ, η)-continuous.

Remark: 3.16

Soft minimal (μ, η)-irresolute and soft (μ, η)-continuous (resp. Soft maximal (μ, η)-continuous, soft para (μ, η)-continuous) maps are independent.

Remark: 3.17

Soft maximal (μ, η)-irresolute and soft (μ, η)-continuous (resp. Soft minimal (μ, η)-continuous, soft para (μ, η)-continuous) maps are independent.

Remark: 3.18

Soft para (μ, η)-irresolute and soft (μ, η)-continuous (resp. Soft minimal (μ, η)-continuous, soft maximal (μ, η)-continuous) maps are independent.

Remark: 3.19

Soft minimal (μ, η)-irresolute and soft maximal (μ, η)-irresolute maps are independent.

Remark: 3.20

Soft minimal (μ, η)-irresolute and soft para (μ, η)-irresolute maps are independent.

Remark: 3.21

Soft maximal (μ, η)-irresolute and soft para (μ, η)-irresolute maps are independent.

Theorem: 3.22

Let (F_A, μ) and (F_B, η) be two SGTS's. A soft mapping $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ is said to be soft minimal (μ, η)-irresolute (soft min (μ, η)-irresolute) if and only if the inverse image of each soft maximal η-closed set in F_B is a soft maximal μ-closed set in F_A.

Proof:

The proof follows from the definition that the complement of soft minimal μ-open set is a soft maximal μ-closed set.

Theorem: 3.23

Let (F_A, μ) and (F_B, η) be two SGTS's. A soft mapping $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ is said to be soft maximal (μ, η)-irresolute (soft max (μ, η)-irresolute) if and only if the inverse image of each soft minimal η-closed set in F_B is a soft minimal μ-closed set in F_A.

Proof:

The proof follows from the definition that the complement of soft maximal μ-open set is a soft minimal μ-closed set.

Theorem: 3.24

Let (F_A, μ) and (F_B, η) be two SGTS's. A soft mapping $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ is said to be soft para (μ, η)-irresolute (soft para (μ, η)-irresolute) if and only if the inverse image of each soft para η-closed set in F_B is a soft para μ-closed set in F_A.

Proof:

The proof follows from the definition that the complement of soft para μ-open set is a soft para μ-closed set.

Theorem: 3.25

Let $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ be a soft minimal (μ, η)-irresolute and $\pi_\phi : (F_B, \eta) \longrightarrow (F_C, \xi)$ be a soft minimal (η, ξ)-irresolute map, then $\pi_\phi \ o \ \psi_\chi : (F_A, \mu) \longrightarrow (F_C, \xi)$ is a soft minimal (μ, ξ)-irresolute map.

Proof:

Let $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ be a soft minimal (μ, η)-irresolute map and $\pi_\phi : (F_B, \eta) \longrightarrow (F_C, \xi)$ be a soft minimal (η, ξ)-irresolute map. Let F_{C_i} be any soft minimal ξ-open set in F_C. Since π_ϕ is a soft minimal (η, ξ)-irresolute function, ${\pi_\phi}^{-1}(F_{C_i})$ is a soft minimal η-open set in F_B. Also, ψ_χ is soft minimal (μ, η)-irresolute, ${\psi_\chi}^{-1}\left({\pi_\phi}^{-1}(F_{C_i})\right) = (\pi_\phi \ o \ \psi_\chi)^{-1}(F_{C_i})$ is a soft minimal μ-open set in F_A. Hence $\pi_\phi \ o \ \psi_\chi : (F_A, \mu) \longrightarrow (F_C, \xi)$ is a soft minimal (μ, ξ)-irresolute map.

Theorem: 3.26

Let $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ be a soft maximal (μ, η)-irresolute and $\pi_\phi : (F_B, \eta) \longrightarrow (F_C, \xi)$ be a soft maximal (η, ξ)-irresolute map, then $\pi_\phi \ o \ \psi_\chi : (F_A, \mu) \longrightarrow (F_C, \xi)$ is a soft maximal (μ, ξ)-irresolute map.

Proof:

Let $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ be a soft maximal (μ, η)-irresolute map and $\pi_\phi : (F_B, \eta) \longrightarrow (F_C, \xi)$ be a soft maximal (η, ξ)-irresolute map. Let F_{C_i} be any soft maximal ξ-open set in F_C. Since π_ϕ is a soft maximal (η, ξ)-irresolute function, ${\pi_\phi}^{-1}(F_{C_i})$ is a soft maximal η-open set in F_B. Also, ψ_χ is soft maximal (μ, η)-irresolute, ${\psi_\chi}^{-1}\left({\pi_\phi}^{-1}(F_{C_i})\right) = (\pi_\phi \ o \ \psi_\chi)^{-1}(F_{C_i})$ is a soft maximal μ-open set in F_A. Hence $\pi_\phi \ o \ \psi_\chi : (F_A, \mu) \longrightarrow (F_C, \xi)$ is a soft maximal (μ, ξ)-irresolute map.

Theorem: 3.27

Let $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ be a soft para (μ, η)-irresolute and $\pi_\phi : (F_B, \eta) \longrightarrow (F_C, \xi)$ be a soft para (η, ξ)-irresolute map, then $\pi_\phi \ o \ \psi_\chi : (F_A, \mu) \longrightarrow (F_C, \xi)$ is a soft para (μ, ξ)-irresolute map.

Proof:

Let $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ be a soft para (μ, η)-irresolute map and $\pi_\phi : (F_B, \eta) \longrightarrow (F_C, \xi)$ be a soft para (η, ξ)-irresolute map. Let F_{C_i} be any soft para ξ-open set in F_C. Since π_ϕ is a soft para (η, ξ)-irresolute function, ${\pi_\phi}^{-1}(F_{C_i})$ is a soft para η-open set in F_B. Also, ψ_χ is soft para (μ, η)-irresolute, ${\psi_\chi}^{-1}\left({\pi_\phi}^{-1}(F_{C_i})\right) = (\pi_\phi \ o \ \psi_\chi)^{-1}(F_{C_i})$ is a soft para μ-open set in F_A. Hence $\pi_\phi \ o \ \psi_\chi : (F_A, \mu) \longrightarrow (F_C, \xi)$ is a soft para (μ, ξ)-irresolute map.

Proposition: 3.28

Let (F_A, μ) and (F_B, η) be two SGTS's. A soft mapping $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ is said to be soft $\rho_{(\mu,\eta)}$-irresolute (soft (μ, η)-pre-irresolute) if for each soft η-pre-open set in F_B, its inverse image $\psi_\chi{}^{-1}(F_L)$ is a soft μ-pre-open set in F_A.

Definition: 3.29

Let (F_A, μ) and (F_B, η) be two SGTS's. A soft mapping $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ is said to be soft $\delta_{(\mu,\eta)}$-irresolute (soft (μ, η)-semi-irresolute) if for each soft η-semi-open set in F_B, its inverse image $\psi_\chi{}^{-1}(F_L)$ is a soft μ-semi-open set in F_A.

Definition: 3.30

Let (F_A, μ) and (F_B, η) be two SGTS's. A soft mapping $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ is said to be soft $\alpha_{(\mu,\eta)}$-irresolute (soft (μ, η)-α-irresolute) if for each soft η-α-open set in F_B, its inverse image $\psi_\chi{}^{-1}(F_L)$ is a soft μ-α-open set in F_A.

Definition: 3.31

Let (F_A, μ) and (F_B, η) be two SGTS's. A soft mapping $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ is said to be soft $\beta_{(\mu,\eta)}$-irresolute (soft (μ, η)-β-irresolute) if for each soft η-β-open set in F_B, its inverse image $\psi_\chi{}^{-1}(F_L)$ is a soft μ-β-open set in F_A.

Theorem: 3.32

Each soft $\rho_{(\mu,\eta)}$-irresolute function is soft $\rho_{(\mu,\eta)}$-continuous but not conversely.

Proof:

Let $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ be a soft $\rho_{(\mu,\eta)}$-irresolute mapping. Let F_G be any soft η-open set in F_B. Since every soft η-open set is soft η-pre-open, F_G is a soft η-pre-open set in F_B. Also ψ_χ is soft $\rho_{(\mu,\eta)}$-irresolute, then by definition 3.28, its inverse image $\psi_\chi{}^{-1}(F_G)$ is a soft μ-pre-open set in F_A. Hence $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ is soft $\rho_{(\mu,\eta)}$-continuous.

Theorem: 3.33

Each soft $\delta_{(\mu,\eta)}$-irresolute function is soft $\delta_{(\mu,\eta)}$-continuous but not conversely.

Proof:

Let $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ be a soft $\delta_{(\mu,\eta)}$-irresolute mapping. Let F_G be any soft η-open set in F_B. Since every soft η-open set is soft η-semi-open, F_G is a soft η-semi-open set in F_B. Also ψ_χ is soft $\delta_{(\mu,\eta)}$-irresolute, then by definition 3.29, its inverse image $\psi_\chi{}^{-1}(F_G)$ is a soft μ-semi-open set in F_A. Hence $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ is soft $\delta_{(\mu,\eta)}$-continuous.

Theorem: 3.34

Each soft $\alpha_{(\mu,\eta)}$-irresolute function is soft $\alpha_{(\mu,\eta)}$-continuous but not conversely.

Proof:

Let $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ be a soft $\alpha_{(\mu,\eta)}$-irresolute mapping. Let F_G be any soft η-open set in F_B. Since every soft η-open set is soft η-α-open, F_G is a soft η-α-open set in F_B. Also ψ_χ is soft $\alpha_{(\mu,\eta)}$-irresolute, then by definition 3.30, its inverse image $\psi_\chi{}^{-1}(F_G)$ is a soft μ-α-open set in F_A. Hence $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ is soft $\alpha_{(\mu,\eta)}$-continuous.

Theorem: 3.35

Each soft $\beta_{(\mu,\eta)}$-irresolute function is soft $\beta_{(\mu,\eta)}$-continuous but not conversely.

Proof:

Let $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ be a soft $\beta_{(\mu,\eta)}$-irresolute mapping. Let F_G be any soft η-open set in F_B. Since every soft η-open set is soft η-β-open, F_G is a soft η-β-open set in F_B. Also ψ_χ is soft $\beta_{(\mu,\eta)}$-irresolute, then by definition 3.31, its inverse image $\psi_\chi{}^{-1}(F_G)$ is a soft μ-β-open set in F_A. Hence $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ is soft $\beta_{(\mu,\eta)}$-continuous.

Theorem: 3.36

Let (F_A, μ) and (F_B, η) be two SGTS's. A soft mapping $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ is said to be soft $\rho_{(\mu,\eta)}$-irresolute (soft (μ, η)-pre-irresolute) if and only if the inverse image of each soft η-pre-closed set in F_B is a soft μ-pre-closed set in F_A.

Proof:

The proof follows from the definition that the complement of soft μ-pre-open set is soft μ-pre-closed set.

Theorem: 3.37

Let (F_A, μ) and (F_B, η) be two SGTS's. A soft mapping $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ is said to be soft $\delta_{(\mu,\eta)}$-irresolute (soft (μ, η)-semi-irresolute) if and only if the inverse image of each soft η-semi-closed set in F_B is a soft μ-semi-closed set in F_A.

Proof:

The proof follows from the definition that the complement of soft μ-semi-open set is soft μ-semi-closed set.

Theorem: 3.38

Let (F_A, μ) and (F_B, η) be two SGTS's. A soft mapping $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ is said to be soft $\alpha_{(\mu,\eta)}$-irresolute (soft (μ, η)-α-irresolute) if and only if the inverse image of each soft η-α-closed set in F_B is a soft μ-α-closed set in F_A.

Proof:

The proof follows from the definition that the complement of soft μ-α-open set is soft μ-α-closed set.

Theorem: 3.39

Let (F_A, μ) and (F_B, η) be two SGTS's. A soft mapping $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ is said to be soft $\beta_{(\mu,\eta)}$-irresolute (soft (μ, η)-β-irresolute) if and only if the inverse image of each soft η-β-closed set in F_B is a soft μ-β-closed set in F_A.

Proof:

The proof follows from the definition that the complement of soft μ-β-open set is soft μ-β-closed set.

Theorem: 3.40

Let $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ be a soft $\rho_{(\mu,\eta)}$-irresolute and $\pi_\phi : (F_B, \eta) \longrightarrow (F_C, \xi)$ be a soft $\rho_{(\eta,\xi)}$-irresolute map, then $\pi_\phi \ o \ \psi_\chi : (F_A, \mu) \longrightarrow (F_C, \xi)$ is a soft $\rho_{(\mu,\xi)}$-irresolute map.

Proof:

Let $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ be a soft $\rho_{(\mu,\eta)}$-irresolute map and $\pi_\phi : (F_B, \eta) \longrightarrow (F_C, \xi)$ be a soft $\rho_{(\eta,\xi)}$-irresolute map. Let F_{C_i} be any soft ξ-pre-open set in F_C. Since π_ϕ is a soft $\rho_{(\eta,\xi)}$-irresolute function, ${\pi_\phi}^{-1}(F_{C_i})$ is a soft η-pre-open set in F_B. Also, ψ_χ is soft $\rho_{(\mu,\eta)}$-irresolute, ${\psi_\chi}^{-1}\left({\pi_\phi}^{-1}\left(F_{C_i}\right)\right) = (\pi_\phi \ o \ \psi_\chi)^{-1}\left(F_{C_i}\right)$ is a soft μ-pre-open set in F_A. Hence $\pi_\phi \ o \ \psi_\chi : (F_A, \mu) \longrightarrow (F_C, \xi)$ is a soft $\rho_{(\mu,\xi)}$-irresolute map.

Theorem: 3.41

Let $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ be a soft $\delta_{(\mu,\eta)}$-irresolute and $\pi_\phi : (F_B, \eta) \longrightarrow (F_C, \xi)$ be a soft $\delta_{(\eta,\xi)}$-irresolute map, then $\pi_\phi \ o \ \psi_\chi : (F_A, \mu) \longrightarrow (F_C, \xi)$ is a soft $\delta_{(\mu,\xi)}$-irresolute map.

Proof:

Let $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ be a soft $\delta_{(\mu,\eta)}$-irresolute map and $\pi_\phi : (F_B, \eta) \longrightarrow (F_C, \xi)$ be a soft $\delta_{(\eta,\xi)}$-irresolute map. Let F_{C_i} be any soft ξ-semi-open set in F_C. Since π_ϕ is a soft $\delta_{(\eta,\xi)}$-irresolute, ${\pi_\phi}^{-1}(F_{C_i})$ is a soft η-semi-open set in F_B. Also, ψ_χ is a soft $\delta_{(\mu,\eta)}$-irresolute, ${\psi_\chi}^{-1}\left({\pi_\phi}^{-1}\left(F_{C_i}\right)\right) = \pi_\phi \ o \ {\psi_\chi}^{-1}\left(F_{C_i}\right)$ is a soft μ-semi-open set in F_A. Hence $\pi_\phi \ o \ \psi_\chi : (F_A, \mu) \longrightarrow (F_C, \xi)$ is a soft $\delta_{(\mu,\xi)}$-irresolute map.

Theorem: 3.42

Let $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ be a soft $\alpha_{(\mu,\eta)}$-irresolute and $\pi_\phi : (F_B, \eta) \longrightarrow (F_C, \xi)$ be a soft $\alpha_{(\eta,\xi)}$-irresolute map, then $\pi_\phi \ o \ \psi_\chi : (F_A, \mu) \longrightarrow (F_C, \xi)$ is a soft $\alpha_{(\mu,\xi)}$-irresolute map.

Proof:

Let $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ be a soft $\alpha_{(\mu,\eta)}$-irresolute map and $\pi_\phi : (F_B, \eta) \longrightarrow (F_C, \xi)$ be a soft $\alpha_{(\eta,\xi)}$-irresolute map. Let F_{C_i} be any soft ξ-α-open set in F_C. Since π_ϕ is a soft $\alpha_{(\eta,\xi)}$-irresolute function, ${\pi_\phi}^{-1}(F_{C_i})$ is a soft η-α-open set in F_B. Also, ψ_χ is soft $\alpha_{(\mu,\eta)}$-irresolute, ${\psi_\chi}^{-1}\left({\pi_\phi}^{-1}\left(F_{C_i}\right)\right) = (\pi_\phi \ o \ \psi_\chi)^{-1}\left(F_{C_i}\right)$ is a soft μ-α-open set in F_A. Hence $\pi_\phi \ o \ \psi_\chi : (F_A, \mu) \longrightarrow (F_C, \xi)$ is a soft $\alpha_{(\mu,\xi)}$-irresolute map.

Theorem: 3.43

Let $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ be a soft $\beta_{(\mu,\eta)}$-irresolute and $\pi_\phi : (F_B, \eta) \longrightarrow (F_C, \xi)$ be a soft $\beta_{(\eta,\xi)}$-irresolute map, then $\pi_\phi \ o \ \psi_\chi : (F_A, \mu) \longrightarrow (F_C, \xi)$ is a soft $\beta_{(\mu,\xi)}$-irresolute map.

Proof:

Let $\psi_\chi : (F_A, \mu) \longrightarrow (F_B, \eta)$ be a soft $\beta_{(\mu,\eta)}$-irresolute map and $\pi_\phi : (F_B, \eta) \longrightarrow (F_C, \xi)$ be a soft $\beta_{(\eta,\xi)}$-irresolute map. Let F_{C_i} be any soft ξ-β-open set in F_C. Since π_ϕ is a soft $\beta_{(\eta,\xi)}$-irresolute function, ${\pi_\phi}^{-1}(F_{C_i})$ is a soft η-β-open set in F_B. Also, ψ_χ is soft $\beta_{(\mu,\eta)}$-irresolute, ${\psi_\chi}^{-1}\left({\pi_\phi}^{-1}\left(F_{C_i}\right)\right) = (\pi_\phi \ o \ \psi_\chi)^{-1}\left(F_{C_i}\right)$ is a soft μ-β-open set in F_A. Hence $\pi_\phi \ o \ \psi_\chi : (F_A, \mu) \longrightarrow (F_C, \xi)$ is a soft $\beta_{(\mu,\xi)}$-irresolute map.

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